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Spatial Agglomeration and Regional Disparities: A Comparative Analysis Based on the Interregional Input-Output Model

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ABSTRACT

Interregional disparities remain a significant challenge to achieving inclusive economic development in Indonesia. This study compares two investment strategies aimed at reducing inequality in Quadrant IV provinces: (1) the Agricultural Development-Led Industrialization (ADLI) strategy, which prioritizes strengthening the agricultural sector, and (2) a sector-based investment strategy aligned with each province's comparative advantage. The analysis employed a simulation using the national Interregional Input-Output (IRIO) model, covering 34 provinces and 21 economic sectors, with an equal investment stimulus applied to all Quadrant IV provinces. The impacts were evaluated in terms of output, GDP, employment absorption, and income generation. Meanwhile, interprovincial disparities were measured using the Williamson Coefficient of Variation. The results indicate that the sector-based strategy generates higher national output and GDP. However, the ADLI strategy is more effective in promoting employment, enhancing income distribution, and reducing interprovincial inequality. ADLI reduces income disparities by 6.25%, compared to a 4.13% reduction under the sector-based strategy. Moreover, ADLI stimulates sectoral agglomeration in underdeveloped regions, thereby strengthening economic linkages across provinces. The policy implications suggest a hybrid approach: implementing ADLI in underdeveloped agrarian provinces to foster economic inclusion, while applying the sector-based strategy in industrialized and service-oriented regions. This spatial-sectoral integration is projected to accelerate economic growth while simultaneously reducing regional disparities.

1. INTRODUCTION

Indonesia is the world's largest archipelago, comprising 17,508 islands. It is also the fourth most populous nation globally, with an estimated population of 281.6 million in 2024 [1]. There are at least seven major islands in Indonesia: Java, Sumatra, Kalimantan, Sulawesi, Bali and Nusa Tenggara, Maluku, and Papua. In terms of spatial economic structure in 2024, Java Island contributed the largest share to the national economy, at 57.02%, followed by Sumatra (22.12%), Kalimantan (8.24%), Sulawesi (7.12%), Bali and Nusa Tenggara at (2.81%), and Maluku and Papua (2.69%) [2]. These figures highlight the persistent regional income disparities across Indonesia's vast archipelago. Similar to poverty, inequality can manifest across multiple dimensions—such as income, life expectancy, mortality, and education—which are key issues in the pursuit of the Sustainable Development Goals (SDGs). Although conceptually, reducing income inequality can often lead to a decline in absolute poverty, the relationship is not always guaranteed. Literature [3] argues that reducing inequality, specifically through a "pro-poor shift in income distribution," often contributes significantly to poverty reduction.

Interregional economic disparity remains a critical issue and poses a significant challenge for Indonesia's future economic development. Imbalanced regional growth can give rise to a range of social, economic, and political problems, including the potential for disintegrative political instability. Economic inequality occurs not only between islands but also among provinces and between rural and urban areas. Variations in regional growth rates further exacerbate disparities in Gross Regional Domestic Product (GRDP) values across regions. Between 1998 and 2007, interprovincial economic disparity measured by the Williamson Coefficient of Variation tended to increase, rising from 0.605 in 1998 to 0.855 in 2007, indicating a widening gap. However, in the subsequent period (2014-2024), the disparity tended to be lower, with the coefficient recorded at 0.708 in 2014 and 0.712 in 2024, suggesting a slight moderation in regional inequality.

Disparities in regional development remain a central concern in Indonesia's development strategy. Despite the implementation of fiscal decentralization policies and regional development programs since the onset of regional

autonomy, spatial disparities among provinces, particularly between the western and eastern regions of Indonesia persist [4, 5]. These disparities are reflected not only in differences in GRDP per capita but also in economic structures, fiscal capacity, and interregional linkage. In this context, adopting a spatially integrated sectoral development approach has become increasingly essential to fostering inclusive and equitable growth.

One relevant strategic framework is the concept of Agricultural Development-Led Industrialization (ADLI), developed by Adelman [6] and Adelman et al. [7]. ADLI posits that the agricultural sector when managed efficiently and synergistically integrated with agro-processing industries and supporting services can serve as a key driver of economic transformation and early-stage industrialization, particularly in developing countries. This strategy is grounded in the assumption that agriculture exhibits strong forward linkages (providing inputs for industry) and backward linkages (through the absorption of production inputs), along with a significant multiplier effect on domestic consumption and demand [7]. Within the Indonesian context, ADLI is particularly pertinent, considering that most provinces outside Java Island possess substantial agriculture and plantation sector potential but remain insufficiently integrated into the broader national industrial ecosystem [8].

On the other hand, an alternative yet widely adopted development approach is the leading sector-based strategy. This approach is rooted in the fundamental principle of regional economics that regional economic development should be anchored in base sectors, those possessing comparative and competitive advantages in each specific region [9]. Leading sectors are expected to generate local multiplier effects by increasing demand for production inputs, labor, and supporting services, thereby strengthening regional production networks. Empirical studies in the Indonesian context have demonstrated that leading sector-based strategies can enhance spatial efficiency and reinforce intersectoral linkages, particularly when supported by industrial agglomeration [10, 11].

Nevertheless, there has been limited research that systematically compares the effectiveness of the ADLI strategy and the leading sector-based strategy in the context of reducing regional disparities and promoting economic agglomeration. This is notable given the distinct conceptual frameworks and structural assumptions of the two frameworks. The ADLI strategy employs a sectoral approach, emphasizing the strengthening of vertical linkages between agriculture and industry. In contrast, the leading sector-based strategy places greater emphasis on sectoral structural differences across regions as the foundation for investment planning. A comparative empirical analysis of these strategies is therefore essential for identifying the most effective sectoral and spatial investment strategies to promote interregional connectivity and reduce development gaps.

Several previous studies have partially addressed sectoral linkages, agglomeration, and regional disparities in Indonesia. For instance, Amalina and Asmara [8] examined the interconnections between agriculture and manufacturing industries using an interprovincial input-output matrix. Other researchers have highlighted the importance of selective spatial approaches in regional planning through leading sector-based agglomeration [12-15] provided empirical evidence that agglomeration in the agricultural sector can contribute to poverty reduction in rural areas. Despite these contributions, no existing study has directly compared the ADLI and leading sector-based approaches within a spatial framework, particularly by utilizing the Interregional Input-Output (IRIO) model.

At the international level, Ding [16] found that agricultural industrial agglomeration in China had a positive impact on farmers' incomes and the development of surrounding regions. However, this finding has yet to be explored in the context of a comparative simulation of different sectoral investment strategies. Addressing this gap, the present study compares the effectiveness of two sectoral development strategies within a spatial framework, employing the Interregional Input-Output (IRIO) model as an analytical tool to assess their simultaneous impacts on agglomeration and interregional disparities.

This study aims to analyze and compare the impacts of two sectoral development investment strategies on agglomeration and interprovincial disparities in Indonesia, namely: (1) the Agricultural Development-Led Industrialization (ADLI) strategy, as formulated by Adelman [6] and Adelman et al. [7], focusing on strengthening linkages in the agricultural sector as a foundation for industrialization; and (2) the province-specific leading sector strategy, which prioritizes investment in base sectors identified as having competitive advantages within each region's economic structure. By comparing the simulation results of both strategies within a consistent interregional framework, this study aimed to contribute both theoretically and practically to the formulation of regional development policies that are more efficient, inclusive, and grounded in interregional economic linkages in Indonesia.

2. RESEARCH METHODS

2.1 Analysis method

The Interregional Input-Output (IRIO) model is an extension of the conventional Input-Output (IO) model applied within a specific regional economic system. The primary focus of the IRIO model is to measure and model the economic linkages among various sectors within a region and across different regions. Like most Interregional Input-Output Tables, the IRIO table consists of a final demand matrix for each province and a primary input matrix for each region. Final demand includes household and government consumption, private and public investment, and exports of goods and services. Changes in inventory are included only to balance input and output values within individual sectors, while primary inputs consist of foreign imports, wages and salaries, depreciation, net indirect taxes, and operating surplus.

In simple terms, to illustrate the flow of transactions between sectors and across regions, the structure of a two-sector, two-region Interregional Input-Output model can be represented in the form of a matrix as follows:

$$X = \begin{bmatrix} x^{nn} & x^{nm} \\ x^{mn} & x^{mm} \end{bmatrix} \quad (1)$$

The matrices x^{nm} and x^{mn} represent interregional trade (interregional linkage), while matrices x^{nn} and x^{mm} illustrate intra-regional trade (within the same region). In the

analytical framework of the IRIO model, and when read by rows, this study is formulated across 21 sectors and 34 provincial regions. A fundamental condition of the IRIO model is the balance between input and output. Given the values of x_{ij}^R and X_j^R, the technical coefficient, a_{ij}^R, can be calculated as follows:

$$a_{ij}^{nn} = \frac{z_{ij}^{nn}}{X_j^R} \text{ and } a_{ij}^{mm} = \frac{z_{ij}^{mm}}{X_j^R} \quad (2)$$

This equation is commonly referred to as the *technical coefficient*, also known as the *input-output coefficient* or *direct input coefficient* [17]. The coefficient a_{ij} represents the amount of input from sector *i* required to produce one unit of output in sector *j*. In the IRIO framework, the coefficients a_{ij}^{nn} and a_{ij}^{mm} are referred to as *intra-regional input coefficients*. The model also incorporates *inter-regional input coefficients*, which are defined as follows:

$$a_{ij}^{nm} = \frac{x_{ij}^{nm}}{X_j^1} \text{ and } a_{ij}^{mn} = \frac{x_{ij}^{mn}}{X_j^2} \quad (3)$$

In general, the technical coefficients in both the IO and IRIO models can be written as follows:

$$a_{ij} = \frac{x_{ij}}{X_j} \quad (4)$$

By performing a simplification process, we can derive the output multiplier formula, also known as the *Leontief* inverse matrix, as follows:

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

where,

$(I - A)^{-1}$ = *Leontief* inverse matrix (output multiplier)

F = Final demand, considered exogenous

X = output, determined by incorporating various values of final demand (F)

The Indonesian Interregional Input-Output (IRIO) Table represents a composite of the individual IO Tables from all provinces across the country. As of 2023, Indonesia has expanded to 38 provinces; however, the most recent available IRIO data is based on the 2016 table, which includes 34 provinces and 52 sectors. This study utilized the 2016 Interregional Input-Output Table, updated in 2022, with a reclassified structure of 21 sectors. In the process of updating the IRIO table, imbalances frequently occur between rows and columns, that is, between expenditures and receipts of certain transactions, thus violating the condition required in the IRIO framework. Lemelin et al. [18] proposed that such imbalances can be resolved using the RAS method or the Cross-Entropy (CE) method [19, 20]. Cross Entropy, a generalization of the RAS technique, offers greater flexibility and improved estimation efficiency. Two primary approaches are commonly used in CE applications: deterministic and stochastic [21, 22]. This study employed the deterministic Cross-Entropy method for the IRIO estimation.

The concept of cross-entropy was first introduced by El-Said and Robinson [22] as a means to estimate the loss function. It was later extended by Kullback and Leibler [23] to measure the cross-entropy distance between two probability distributions, particularly in the estimation of IRIO tables. This method was utilized to derive an updated set of technical coefficient matrices (A_{ij}) by minimizing the cross-entropy distance between the updated coefficient matrix and the prior matrix ($\bar{A}$). Mathematically, this can be expressed as follows:

$$\begin{aligned} \underset{\{A\}}{\text{Min}}\, I &= \left[\sum_i \sum_j A_{ij} Ln \frac{A_{ij}}{\bar{A}_{ij}}\right] \\ &= \left[\sum_i \sum_j A_{ij}\, ln\, A_{ij} - \sum_i \sum_j A_{ij}\, ln \bar{A}\right] \end{aligned} \quad (6)$$

Subject to the following constraints: $\sum_j A_{ij}\, y_j^* = y_i^*$; $\sum_j A_{ji} = 1$ and $0 \leq A_{ji} \leq 1$. Further elaboration on this formulation can be found in references [23, 24]. In this study, the GAMS software was employed as a computational tool to solve the cross-entropy equilibrium model. To measure regional disparities, this study applied the *Williamson Coefficient of Variation*, whose detailed derivation and applications are discussed in references [25, 26]. The weighted coefficient of variation (CV_w) is formulated as follows:

$$CV_w = \frac{\sqrt{\sum_{i=1}^n w_i (y_i - \bar{y}_w)^2}}{\bar{y}_w} \quad (7)$$

where,

CV_w = weighted coefficient of variation

y_i = per capita income (GRDP per capita) of region i

w_i = population share of region i, such that $\sum_{i=1}^n w_i = 1$

$\bar{y}_w = \sum_{i=1}^n w_i y_i$ = population-weighted national average per capita income

This measure captures regional inequality while accounting for population distribution. Unlike the unweighted coefficient of variation, which assigns equal importance to each region regardless of its population size, the weighted version reflects individual-based welfare inequality rather than administrative regional disparity. By incorporating population weights (w_i), the CV_w adjusts both the mean and the variance of regional income, providing a more accurate representation of inequality from a welfare-theoretic perspective. Consequently, regions with larger populations exert greater influence on the overall inequality measure, aligning the indicator with the concept of aggregate social welfare, as emphasized by Williamson [25] and Gluschenko [26].

2.2 Simulation basis

Figure 1 shows the mapping results using the Klassen typology diagram. Quadrant I represents rapidly growing and advanced regions, marked by provinces with relatively higher economic growth rates and income levels compared to the national average. The provinces classified in Quadrant 1 include DKI Jakarta, North Kalimantan, Central Sulawesi, and West Papua. Quadrant II represents developing regions, characterized by high economic growth rates but relatively lower per capita income compared to the national average. The provinces include Central Kalimantan, North Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, West Sulawesi, Maluku, and North Maluku. Quadrant III

represents advanced yet pressured regions, which are areas with higher per capita income but lower economic growth rates compared to the provincial average. These include Riau, Riau Islands, East Kalimantan, and Papua. Quadrant IV, on the other hand, includes relatively underdeveloped regions, characterized by both lower economic growth and lower per capita income compared to the provincial average. These regions include Aceh, North Sumatra, West Sumatra, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, West Java, Central Java, Yogyakarta Special Region, East Java, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, and South Kalimantan.

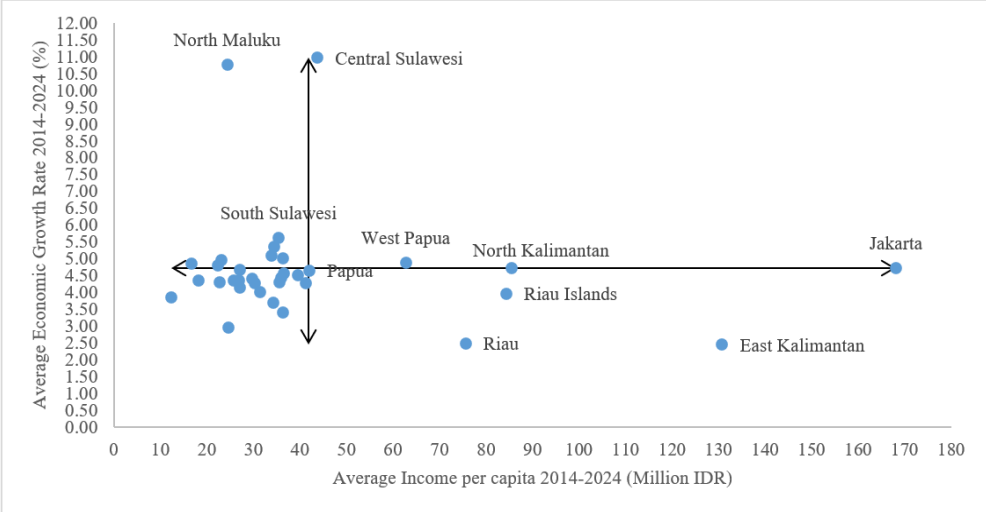

Figure 1. Provincial mapping by quadrants

Table 1. Realization of domestic investment (PMDN) and foreign investment (PMA) in 2024

No.	Province	PMDN	PMA		Total
		(IDR Billion)	(Billion US$)	(IDR Billion)*	(IDR Billion)
1	Aceh	8,317	76.70	1,112	9,429
2	North Sumatra	22,446	1,721.70	24,965	47,410
3	West Sumatra	7,956	115.90	1,681	9,637
4	Riau	61,098	1,813.30	26,293	87,390
5	Jambi	9,986	105.60	1,531	11,517
6	South Sumatra	36,671	2,283.30	33,108	69,779
7	Bengkulu	7,983	86.70	1,257	9,240
8	Lampung	7,218	162.90	2,362	9,580
9	Bangka Belitung Islands	15,725	102.30	1,483	17,208
10	Riau Islands	10,017	2,483.00	36,004	46,021
11	DKI Jakarta	128,402	7,563.40	109,669	238,071
12	West Java	101,552	9,972.30	144,598	246,150
13	Central Java	33,299	2,358.00	34,191	67,490
14	DI Yogyakarta	3,630	35.40	513	4,144
15	East Java	92,410	3,661.10	53,086	145,496
16	Banten	47,606	3,868.20	56,089	103,695
17	Bali	12,312	1,613.70	23,399	35,711
18	Nusa Tenggara Barat	43,385	651.00	9,440	52,825
19	Nusa Tenggara Timur	2,626	106.20	1,540	4,165
20	West Kalimantan	15,416	616.00	8,932	24,348
21	Central Kalimantan	15,229	419.10	6,077	21,306
22	South Kalimantan	16,579	551.40	7,995	24,575
23	East Kalimantan	55,079	1,417.10	20,548	75,627
24	North Kalimantan	11,925	1,347.70	19,542	31,466
25	North Sulawesi	5,784	112.40	1,630	7,414
26	Central Sulawesi	4,593	9,019.30	130,780	135,373
27	South Sulawesi	8,412	374.90	5,436	13,848
28	Southeast Sulawesi	5,517	369.10	5,352	10,869
29	Gorontalo	4,004	34.90	506	4,510
30	West Sulawesi	2,893	2.20	32	2,925
31	Maluku	1,570	120.70	1,750	3,320
32	North Maluku	9,135	4,392.40	63,690	72,825
33	West Papua	1,378	777.30	11,271	12,649
34	Papua	975	8.70	126	1,101
	Indonesia	811,127	58,344	845,987	1,657,114

Note * = Exchange Rate of Rupiah Against the US Dollar IDR 14,500
Source: BPS, 2025 (processed)

The investment stimulus was allocated to provinces categorized under Quadrant IV, representing relatively underdeveloped regions identified through the Klassen typology. Two simulation strategies were designed to capture alternative policy orientations. The first, the ADLI strategy, reallocates investment toward the agricultural sector as a driver of industrialization and rural transformation. The second, the Key Sector Strategy, concentrates investment in the key or leading sectors specific to each province, reflecting their comparative advantages and structural potential.

The magnitude of the investment shocks applied to each Quadrant IV province is presented in Table 1. The effects of these investment scenarios were then evaluated through changes in output, Gross Regional Domestic Product (GRDP), total income, and sectoral income. Furthermore, the simulation assessed the extent to which these interventions influence interregional inequality across Indonesia's provincial economies.

3. RESULTS AND DISCUSSION

3.1 Intersectoral linkages and leading sectors

Backward and forward linkages represent conceptual measures of the interconnection between a given sector and its upstream and downstream sectors. Backward linkages refer to the sector's dependence on input materials (input provision), calculated by rows; whereas forward linkages reflect the sector's role in supplying finished goods, calculated by columns in the Leontief inverse matrix (output multiplier). In addition to capturing interdependencies across sectors and regions, the IRIO model also enables the identification of leading sectors in each province. The Leontief inverse matrix, also known as the output multiplier, is presented in Table 2. Due to space limitations, the table displays only the leading sectors in each province, including the Backward Linkage Index (BLI), Forward Linkage Index (FLI), and total output multipliers for each sector and province.

The Backward Linkages column illustrates that if the final demand for the manufacturing sector in Aceh Province increases by IDR 1 million, the output in Aceh Province will increase by IDR 1.66 million, while the output in other regions collectively will increase by IDR 0.34 million, resulting in a total output increase of IDR 2 million. A similar interpretation applies to other provinces. For instance, if the final demand for the manufacturing sector in North Sumatra Province increases by IDR 1 million, the output in North Sumatra will increase by IDR 2.55 million, while the output in other provinces will collectively increase by IDR 1.06 million, leading to a total output increase of IDR 3.61 million.

In essence, backward and forward linkages in the IRIO (Interregional Input-Output) model are calculated in the same manner as in the standard IO model; however, the key distinction lies in the inclusion of provincial-level elements. Similar to the IO model, a sector is considered a leading or key sector in a given region if both its direct BLI and FLI exceed a value of 1. The results of the BLI and FLI analyses are presented in Table 2.

Table 2. Linkage indices and leading sectors of each province in Indonesia

Province	Leading Sector	Forward Linkages			Backward Linkages			FLI	BLI
		Total	Intra	Inter	Total	Intra	Inter		
Aceh	Manufacturing Industry	2.07	1.97	0.10	2.00	1.66	0.34	1.27	1.22
	Electricity and Gas Supply	2.98	2.91	0.07	3.61	2.55	1.06	1.82	2.20
	Transportation and Warehousing	1.68	1.60	0.08	1.98	1.39	0.58	1.03	1.21
North Sumatra	Manufacturing Industry	6.04	3.18	2.86	2.10	1.80	0.30	3.69	1.28
	Electricity and Gas Supply	2.01	1.88	0.12	3.13	1.67	1.46	1.23	1.91
	Transportation and Warehousing	2.48	1.90	0.58	1.89	1.51	0.38	1.52	1.15
West Sumatra	Manufacturing Industry	1.92	1.44	0.48	1.91	1.55	0.36	1.17	1.16
	Information and Communication Services	1.99	1.84	0.15	1.71	1.45	0.27	1.22	1.05
	Electricity and Gas Supply	1.80	1.67	0.13	3.11	1.68	1.44	1.10	1.90
	Transportation and Warehousing	2.82	2.37	0.45	1.79	1.38	0.41	1.72	1.09
Riau	Manufacturing Industry	8.80	3.06	5.75	1.87	1.69	0.17	5.38	1.14
	Electricity and Gas Supply	2.13	2.03	0.10	3.19	2.04	1.15	1.30	1.95
Jambi	Manufacturing Industry	3.03	2.14	0.89	1.93	1.53	0.40	1.85	1.18
	Electricity and Gas Supply	2.56	2.29	0.28	3.16	2.25	0.91	1.56	1.93
	Mining and Quarrying	2.29	1.56	0.73	1.72	1.32	0.40	1.40	1.05
	Transportation and Warehousing	1.75	1.57	0.18	1.98	1.53	0.44	1.07	1.21
South Sumatra	Manufacturing Industry	6.96	4.17	2.78	1.98	1.70	0.29	4.25	1.21
	Information and Communication Services	1.67	1.54	0.13	1.64	1.41	0.23	1.02	1.00
	Construction	1.98	1.62	0.36	2.10	1.65	0.45	1.21	1.28
Bengkulu	Electricity and Gas Supply	3.22	2.22	1.00	3.15	2.94	0.21	1.97	1.93
	Manufacturing Industry	2.20	2.14	0.06	1.97	1.56	0.41	1.35	1.20
	Transportation and Warehousing	1.71	1.61	0.10	2.01	1.32	0.70	1.05	1.23
Lampung	Manufacturing Industry	3.07	2.51	0.56	1.89	1.66	0.24	1.88	1.16
	Electricity and Gas Supply	2.23	2.16	0.07	2.92	2.08	0.84	1.36	1.78
Bangka Belitung Islands	Manufacturing Industry	1.87	1.78	0.09	1.80	1.60	0.20	1.14	1.10
	Electricity and Gas Supply	2.36	2.35	0.00	3.11	1.97	1.14	1.44	1.90
Riau Islands	Transportation and Warehousing	1.79	1.76	0.03	1.95	1.46	0.48	1.09	1.19
	Electricity and Gas Supply	2.02	1.47	0.55	2.38	1.57	0.81	1.24	1.46
DKI Jakarta	P. Administration, Defense, and Social Security	1.67	1.12	0.54	1.66	1.49	0.17	1.02	1.02
	Construction	2.22	1.34	0.88	1.65	1.45	0.20	1.36	1.01
West Java	Electricity and Gas Supply	3.25	2.30	0.95	3.16	2.34	0.82	1.98	1.93
	Manufacturing Industry	11.74	4.05	7.69	1.90	1.69	0.21	7.18	1.16
	Jasa Perusahaan	1.96	1.54	0.42	1.65	1.52	0.14	1.20	1.01

Central Java	Electricity and Gas Supply	3.62	2.42	1.19	2.96	2.52	0.43	2.21	1.81
	Transportation and Warehousing	2.36	1.58	0.78	1.82	1.65	0.17	1.44	1.11
	Manufacturing Industry	12.10	4.31	7.80	1.78	1.55	0.24	7.40	1.09
	Information and Communication Services	1.87	1.65	0.23	1.65	1.42	0.24	1.14	1.01
DI Yogyakarta	Electricity and Gas Supply	4.43	1.93	2.50	2.88	1.89	0.99	2.70	1.76
	Transportation and Warehousing	2.20	1.50	0.70	1.89	1.60	0.29	1.34	1.16
	Manufacturing Industry	2.30	1.91	0.39	1.97	1.51	0.46	1.41	1.20
	Information and Communication Services	1.78	1.60	0.19	1.65	1.35	0.30	1.09	1.01
East Java	Electricity and Gas Supply	1.68	1.64	0.05	4.03	1.52	2.50	1.03	2.46
	Accommodation and Food Service Activities	1.66	1.36	0.30	1.81	1.45	0.35	1.02	1.10
	Transportation and Warehousing	2.23	1.87	0.36	1.94	1.38	0.56	1.36	1.18
	Manufacturing Industry	12.02	3.12	8.89	1.79	1.53	0.27	7.34	1.09
	Information and Communication Services	2.77	1.60	1.16	1.71	1.53	0.18	1.69	1.04
	Corporate Service	2.58	1.50	1.08	1.75	1.56	0.19	1.57	1.07
	Electricity and Gas Supply	3.35	2.30	1.05	2.85	2.00	0.85	2.05	1.74
	Accommodation and Food Service Activities	1.81	1.21	0.60	1.72	1.49	0.24	1.11	1.05
	Transportation and Warehousing	2.72	1.57	1.15	1.79	1.45	0.35	1.66	1.10
Banten	Electricity and Gas Supply	6.58	2.08	4.50	2.80	1.78	1.03	4.02	1.71
	Transportation and Warehousing	4.37	1.91	2.46	1.71	1.43	0.28	2.67	1.04
	Information and Communication Services	1.78	1.73	0.06	1.67	1.48	0.19	1.09	1.02
Bali	Electricity and Gas Supply	2.91	2.87	0.04	4.19	2.61	1.58	1.78	2.56
	Accommodation and Food Service Activities	2.20	1.65	0.55	1.72	1.33	0.39	1.35	1.05
	Transportation and Warehousing	2.09	1.68	0.41	1.96	1.42	0.54	1.27	1.20
	Manufacturing Industry	1.70	1.64	0.06	2.01	1.70	0.31	1.04	1.23
Nusa Tenggara Barat	Electricity and Gas Supply	2.52	2.49	0.03	3.26	2.18	1.09	1.54	1.99
	Transportation and Warehousing	2.01	1.87	0.14	1.94	1.38	0.55	1.23	1.18
Nusa Tenggara Timur	Electricity and Gas Supply	2.43	2.41	0.02	3.29	2.13	1.16	1.49	2.01
	Transportation and Warehousing	1.78	1.71	0.08	1.91	1.31	0.60	1.09	1.17
	Manufacturing Industry	2.42	2.27	0.14	1.88	1.65	0.23	1.48	1.15
West Kalimantan	Information and Communication Services	1.81	1.74	0.06	1.66	1.41	0.25	1.10	1.02
	Electricity and Gas Supply	2.46	2.24	0.21	3.15	2.20	0.95	1.50	1.93
	Transportation and Warehousing	1.93	1.69	0.24	1.99	1.44	0.55	1.18	1.22
	Manufacturing Industry	3.11	2.75	0.37	2.06	1.69	0.38	1.90	1.26
Central Kalimantan	Electricity and Gas Supply	2.20	2.19	0.01	3.40	2.04	1.36	1.34	2.08
	Transportation and Warehousing	2.26	2.04	0.21	2.03	1.39	0.64	1.38	1.24
	Manufacturing Industry	2.63	2.47	0.16	1.93	1.62	0.31	1.60	1.18
South Kalimantan	Electricity and Gas Supply	2.13	2.09	0.04	2.88	2.46	0.43	1.30	1.76
	Transportation and Warehousing	1.67	1.50	0.17	1.68	1.38	0.30	1.02	1.03
	Manufacturing Industry	11.26	4.50	6.76	1.77	1.61	0.15	6.88	1.08
	Information and Communication Services	1.64	1.44	0.20	1.65	1.46	0.19	1.00	1.01
East Kalimantan	Construction	1.74	1.46	0.27	1.85	1.52	0.34	1.06	1.13
	Electricity and Gas Supply	2.45	2.31	0.14	3.16	2.97	0.20	1.49	1.93
	Wholesale and Retail Trade	1.98	1.53	0.46	1.68	1.50	0.18	1.21	1.03
	Transportation and Warehousing	2.37	1.63	0.74	1.91	1.78	0.13	1.45	1.17
	Manufacturing Industry	1.90	1.67	0.23	1.67	1.38	0.29	1.16	1.02
North Kalimantan	Electricity and Gas Supply	2.34	2.32	0.02	3.30	2.61	0.69	1.43	2.02
	Transportation and Warehousing	1.86	1.73	0.13	1.96	1.35	0.62	1.14	1.20
	Manufacturing Industry	1.71	1.58	0.13	1.96	1.64	0.32	1.05	1.20
North Sulawesi	Information and Communication Services	1.89	1.84	0.04	1.70	1.49	0.22	1.15	1.04
	Electricity and Gas Supply	2.38	2.34	0.04	3.00	2.23	0.77	1.45	1.83
	Transportation and Warehousing	2.63	2.44	0.19	1.89	1.46	0.42	1.61	1.15
	Manufacturing Industry	2.11	1.55	0.56	1.85	1.48	0.37	1.29	1.13
Central Sulawesi	Information and Communication Services	1.64	1.57	0.07	1.75	1.41	0.34	1.00	1.07
	Electricity and Gas Supply	2.36	2.32	0.04	2.92	2.18	0.73	1.44	1.78
	Manufacturing Industry	4.94	2.51	2.44	1.85	1.56	0.29	3.02	1.13
South Sulawesi	Electricity and Gas Supply	2.03	1.97	0.06	2.88	2.36	0.53	1.24	1.76
	Transportation and Warehousing	2.38	1.79	0.59	1.81	1.32	0.48	1.46	1.10
Southeast Sulawesi	Manufacturing Industry	1.75	1.56	0.19	1.73	1.42	0.32	1.07	1.06
	Electricity and Gas Supply	2.27	2.19	0.08	2.82	1.93	0.88	1.39	1.72
Gorontalo	Electricity and Gas Supply	2.91	2.89	0.02	3.56	2.53	1.04	1.78	2.18
	Transportation and Warehousing	1.92	1.91	0.01	1.88	1.38	0.50	1.18	1.15
West Sulawesi	Manufacturing Industry	1.87	1.76	0.11	2.19	1.76	0.43	1.14	1.34
	Electricity and Gas Supply	1.91	1.91	0.00	3.57	1.97	1.60	1.17	2.18
Maluku	Electricity and Gas Supply	2.27	2.20	0.07	2.66	1.78	0.88	1.39	1.63
North Maluku	Electricity and Gas Supply	3.18	3.18	0.00	4.12	3.24	0.88	1.95	2.52
	Transportation and Warehousing	1.85	1.80	0.04	1.90	1.36	0.54	1.13	1.16
West Papua	Manufacturing Industry	2.45	1.98	0.47	1.87	1.68	0.19	1.50	1.14
	Electricity and Gas Supply	2.57	2.56	0.01	3.23	2.80	0.43	1.57	1.97
Papua	Electricity and Gas Supply	2.01	1.93	0.07	3.04	2.28	0.77	1.23	1.86
	Transportation and Warehousing	2.42	2.25	0.17	1.74	1.29	0.45	1.48	1.07

3.2 Intersectoral and interregional dependencies

Table 2 presents the leading sectors for each province; however, not all of these sectors exhibit self-sufficiency. Many remain highly dependent on other provinces. Regional production activities may source inputs either internally or externally, highlighting the degree of interdependence across provinces. The interpretation of Table 2 reveals that Aceh Province demonstrates a relatively high dependency on other provinces, as indicated by an interregional backward linkage coefficient greater than one, specifically, 1.06 in the Electricity and Gas Supply sector. A similar pattern is observed in North Sumatra Province, where the corresponding coefficient reaches 1.46. These values suggest that both Aceh and North Sumatra rely substantially on input provisions from other provinces to generate output in the Electricity and Gas Supply sector. Similar interpretation applies to other provinces as well.

In North Sumatra Province, the Manufacturing Industry sector exhibits a total output multiplier value of 6.04 and an interregional forward linkage coefficient of 2.86. These values suggest that the sector is highly dependent on other provinces, particularly in terms of demand for its output distribution. In other words, the Manufacturing Industry in North Sumatra serves as a key supplier to other provinces, especially the output of the same sector.

Overall, the analysis reveals that each province has at least one leading sector. The Electricity and Gas Supply emerges as a leading sector in nearly all provinces, with the exception of Bengkulu Province. Similarly, the Manufacturing Industry sector holds a relatively prominent position across most provinces, except in the provinces of Riau Islands, DKI Jakarta, Banten, Bali, East Nusa Tenggara, Gorontalo, Maluku, North Maluku, and Papua.

3.3 Provinces with the highest agricultural linkage

The results of the interregional input-output analysis indicate that several key provinces exhibit exceptionally strong linkages in the agricultural sector. Amalina and Asmara [8] classified Indonesian provinces based on the interconnections between the agricultural sector and the manufacturing industry. Their study identified Lampung, South Sulawesi, South Kalimantan, and North Sumatra as the provinces with the highest total backward and forward linkage indices in agriculture. This implies that in these provinces, the agricultural sector is highly integrated with other sectors: agricultural outputs are extensively utilized as inputs for industrial activities, which indicates strong forward linkages, while the local agricultural sector also depends significantly on inputs from other sectors, which indicates strong backwards linkages.

For example, Lampung Province is well known for its strong agricultural and plantation base (such as cassava, sugarcane, and coffee), alongside its agro-processing industries, including sugar, food products, and animal feed. Recent data from Statistics Indonesia (BPS) indicate that Lampung has two primary key sectors: manufacturing and electricity and gas supply. However, the agriculture, forestry, and fisheries sector also contributes the highest gross value-added multiplier to both Lampung and national economies [27]. This high contribution highlights the significant potential of Lampung's agricultural sector, particularly if it is effectively integrated with other sectors. From a spatial perspective, Lampung's economic linkages are predominantly interregional: its input-output relationships are more extensively connected with Java Island than with other regions in Sumatra. In particular, Lampung demonstrates the strongest forward and backwards linkages with South Sumatra and provinces in Java. This pattern suggests the formation of a regional economic cluster, in which Lampung serves as a hub for agricultural raw materials linked to industrial processing centers in Java. These strong interprovincial interactions align with the concept of agglomeration, which does not necessarily concentrate within a single administrative area but may manifest as an interregional, agglomerated economic network.

North Sumatra Province also demonstrates strong intersectoral linkages, primarily driven by its large-scale plantation subsector, particularly palm oil, rubber, and cocoa, which supplies agro-processing industries both within the province and beyond. Medan and its surrounding areas have long functioned as a central hub, absorbing agricultural outputs from North Sumatra and neighbouring provinces. Due to high forward linkages, North Sumatra's agricultural products serve as critical inputs for the manufacturing sector, especially the food and chemical industries. The sector's backward linkages to the agricultural sector are also relatively strong, as plantation activities require inputs from other sectors, such as fertilizers and logistics services. In Eastern Indonesia, South Sulawesi Province stands out for its strong agricultural linkages. It functions as a regional granary for rice and maize, as well as a major trading center for agricultural commodities in the eastern region. Food processing industries (such as rice milling, animal feed production, and oleochemical manufacturing from coconuts) are concentrated in Makassar and Maros, supporting high forward linkages. The province also demonstrates strong backward linkages, as its agricultural sector relies on inputs, such as seeds, fertilizers, and transportation services provided by other sectors. Amalina and Asmara [8] classified South Sulawesi among the provinces with the highest levels of agriculture–industry linkages, indicating its role as an agglomeration hub for agriculture-based economic activity in Eastern Indonesia.

South Kalimantan Province provides another illustrative example. Although the regional economy is primarily driven by the mining sector, the province also possesses extensive plantation areas, particularly rubber and oil palm, as well as food crop agriculture. The manufacturing sector, including rubber processing and crude palm oil (CPO) refining, is less developed than in North Sumatra or Lampung. Nonetheless, it plays an essential role in absorbing local agricultural output. The study [28] shows that South Kalimantan's agricultural sector plays a significant role and is intricately connected to the regional economy through complex input–output linkages. South Kalimantan ranks among the provinces with a high agricultural linkage index, comparable to Lampung, South Sulawesi, and North Sumatra. This aligns with the province's characteristics, which include plantation clusters and related processing industries (such as palm oil and rubber industries in the Banua Enam area) that contribute to the local economy.

In contrast, Amalina and Asmara [8] identified several provinces with low agricultural-industrial linkages, including North Maluku, East Nusa Tenggara, West Kalimantan, West Java, East Java, and Banten. Some of the more economically developed provinces in Java, namely West Java, East Java,

and Banten, exhibit relatively low agricultural linkage indices. This finding suggests that the agricultural sector in these provinces is less integrated with other sectors. This phenomenon is likely due to the economic structure of Java, which has increasingly shifted toward manufacturing and service industries. As a result, the role of local agricultural outputs in regional industrial supply chains has diminished. For instance, the manufacturing industries in West Java and Banten are dominated by non-agricultural sectors, such as textiles, electronics, and automotive manufacturing, whose raw materials are primarily sourced from imports or other provinces rather than from local agricultural production. Similarly, agricultural inputs (e.g., fertilisers and agricultural machinery) in these regions are often supplied by producers from outside the province. Consequently, both the forward and backwards linkages of agriculture in these provinces are below the national average. This condition indicates a missed potential opportunity for agriculturally advanced regions in the absence of local downstream processing. Without local processing, agricultural products may be exported outside the region without contributing to local value-added activities, thereby minimizing their economic multiplier effect.

3.4 Agglomeration as a spatial and agricultural sector reinforcement

The high degree of agricultural sector linkages observed in provinces of Lampung, North Sumatra, South Sulawesi, and South Kalimantan can be effectively explained through the concept of agglomeration economies. Economic agglomeration occurs when related sectors are geographically concentrated, forming interconnected industrial clusters. In the agriculture context, this agglomeration is exemplified by the formation of agro-clusters zones where agricultural production is closely integrated with processing industries, distribution networks, and supporting services. The benefits of agglomeration for the agricultural sector have been widely discussed in the literature, which emphasizes that spatially oriented development approaches through agglomeration are key drivers of regional economic growth. The concentration of economic activities produces a variety of positive externalities, including enhanced efficiency, greater employment absorption, and accelerated economic development. Specifically, agglomeration fosters higher productivity and income for agricultural actors, as geographic proximity facilitates access to markets and inputs, encourages knowledge sharing, and enables economies of scale. Moreover, industrial clusters have the potential to attract new investments to the region, stimulate technology transfer, and enhance workforce quality as production networks evolve.

In this way, agglomeration not only strengthens intersectoral linkages but also reinforces the structural transformation of the regional economy.

Empirical studies in Indonesia and other countries support the benefits of agglomeration in strengthening the agricultural sector. Wardhana et al. [15] analyzed agro-clusters across 545 subdistricts in West Java and found that a high concentration of agricultural labor (agro-cluster) is associated with a significant reduction in poverty rates, both in the cluster core and in neighboring subdistricts. This finding indicates the presence of spatial spillovers: agricultural agglomeration not only improves welfare in core areas (through increased income and employment opportunities in agriculture and related industries) but also generates positive effects in surrounding regions. The localization of agricultural activities creates critical localization externalities that underpin the success of the sector, for example, farmers gain easier access to processing facilities or markets, while industries benefit from stable raw material supplies and a skilled local workforce.

From an international perspective, studies [6, 29] identified similar patterns in China, where agro-industrial agglomeration significantly increases farmers' income within cluster regions while generating positive spillover effects on farmers' income in neighboring areas. Notably, the primary driver of this impact is not merely increased agricultural production, but rather the emergence of robust agribusiness organizations and institutions, such as cooperatives and local agribusiness firms that thrive in agglomerated environments. In other words, agricultural agglomeration fosters more structured supply chains and improved market access, ultimately leading to higher household incomes for farmers. These studies also confirm the presence of spatial spillovers, economic advancement in one area due to agglomeration can contribute to the upliftment of surrounding regions. These international findings align with the evidence from Indonesia, suggesting that agglomeration can serve as an effective strategy for rural poverty reduction and welfare improvement through the integrated agricultural sector development.

Returning to the cases of Lampung, North Sumatra, South Sulawesi, and South Kalimantan, the strong intersectoral linkages of agriculture in these provinces reflect the early emergence of agribusiness agglomeration. In Lampung, for instance, the concentration of sugarcane plantations and sugar/ethanol factories in Central and East Lampung marks a sugarcane sugar cluster; similarly, the cassava–starch cluster is evident in the integration between cassava production centers (such as North Lampung and Tulang Bawang) and nearby tapioca processing plants. In North Sumatra, the eastern coastal region (e.g., Deli Serdang, Langkat) shows palm oil agglomeration, with CPO refining industries concentrated in Belawan. South Sulawesi features a rice cluster in Sidrap Pinrang and food processing industries in Makassar. South Kalimantan has rubber and palm oil plantation clusters in Hulu Sungai and Barito Kuala, which supply crumb rubber and palm oil processing plants. These clusters contribute to the high forward and backwards linkages of the agricultural sector, as they reflect strong vertical integration between agricultural production and downstream or upstream industries. In other words, local agriculture functions as a base sector that drives both upstream and downstream economic activities within the region.

Conversely, provinces such as West Java or East Java, despite having significant agricultural potential, tend to exhibit weaker intersectoral linkages, suggesting that agribusiness agglomeration has not developed as extensively as in some provinces outside Java. For example, East Java, while being a national food barn (notably for rice, maize, and sugarcane) and home to major manufacturing industries, often processes its agricultural products (such as unhusked rice or sugarcane) outside their production centers or mixes them with supplies from other regions. In West Sumatra indicates that many agricultural subsectors (e.g., rice, maize, oil palm, coffee) could become leading sectors with linkage

indices greater than one, if they were processed locally. The implication is clear: without downstream processing and supporting clusters, agricultural regions risk losing potential value added from their production activities.

An analysis of intersectoral and interprovincial linkages reveals that several provinces in Indonesia, particularly Lampung, North Sumatra, South Sulawesi, and South Kalimantan exhibit the highest linkage indices in the agricultural sector, indicating the sector's essential role as an economic driver through strong upstream–downstream connections. These high levels of linkage are aligned with the emergence of agriculture-based economic agglomerations in these regions. Within the agglomeration framework, the spatial concentration of agricultural activities and related industries yields benefits such as greater efficiency, increased productivity, enhanced employment absorption, and higher regional income. Empirical evidence suggests that agricultural agglomeration can strengthen the sector both spatially and sectorally, spatially, by fostering economic linkage between regions, leading to the emergence of agricultural growth poles that stimulate surrounding areas; and sectorally, by deepening supply chain integration, thereby enhancing the value added of local agriculture and reinforcing its linkages to the industrial sector.

The findings in Table 2 are supported by a range of relevant studies. Provinces with strong agricultural linkages generally experience better agricultural economic performance and benefit from agglomeration effects, such as reduced rural poverty (as seen in the case of agro-clusters in West Java). In contrast, provinces with weak linkages tend to be those where agriculture is separated from the industrial sector, thereby leaving the full potential of the agricultural sector untapped. This pattern does not imply that more developed provinces (such as those in Java) are incapable of benefiting from agricultural agglomeration. Rather, it highlights the necessity of targeted strategies to strengthen agricultural clusters in such areas. For instance, the strategies may include the promotion of downstream processing programs, the establishment of processing centers near production hubs, and improvements in logistics infrastructure to ensure that local agricultural output is absorbed by the industrial sector.

From a policy perspective, the agglomeration approach has proven effective in strengthening the agricultural sector, both in terms of spatial development and sectoral integration. The government can implement regional development policies that focus on agricultural cluster development tailored to the specific characteristics of each region (spatially selective development). Such policies should prioritize high-potential areas through measures such as generating local employment in agribusiness, increasing investment in local processing industries, and improving the quality of agricultural production. These targeted actions are expected to stimulate local economic growth while promoting the sustainability of agricultural clusters in the respective regions.

In conclusion, robust integration between the agricultural sector and other sectors at the provincial level represents a positive indicator of inclusive economic development. Agricultural agglomeration provides a framework for both spatial collaboration across regions (e.g., the Lampung, South Sumatra, and Java corridor) and sectoral collaboration between agriculture, processing industries, and related service sectors. By strategically applying the principles of agglomeration, agricultural provinces can enhance their sectoral competitiveness, improve farmers' welfare, and catalyze more equitable and sustainable regional economic growth. The empirical findings and literature discussed in this study support the notion that developing integrated agricultural clusters with fully optimized intersectoral input-output linkages constitutes a strategic pathway for maximizing the potential of Indonesia's agricultural sector in the era of modern economic development.

3.5 Comparison between the ADLI strategy and leading sector strategy in quadrant IV provinces

Quadrant IV provinces namely Aceh, North Sumatra, West Sumatra, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, West Java, Central Java, Yogyakarta Special Region, East Java, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, and South Kalimantan are characterized by relatively underdeveloped economic performance, with both economic growth rates and per capita income levels below the national average. The government faces strategic investment choices to promote development in these provinces. Two approaches are compared: the Agricultural Development Led Industrialization (ADLI) strategy which involves channeling greater investment into the agricultural and agro-industrial sectors to stimulate industrialization from an agrarian base (Simulation 1) versus the Leading Sector Strategy, which focuses investment on key or leading sectors specific to each province (Simulation 2), such as mining in resource-rich regions, manufacturing in industrial areas, tourism in tourist destinations, and so forth. The simulation results are presented in Table 3.

The ADLI strategy emphasizes investment in the agricultural (primary) sector and small-to-medium-scale agro-industrial activities in underdeveloped regions, based on the assumption that increased productivity and income in this sector will stimulate domestic demand and inter-sectoral linkages that drive inclusive industrialization. The core of the ADLI approach lies in reallocating a greater share of investment toward small-to-medium-scale food agriculture, as this sector is more labor-intensive and possesses stronger domestic linkages compared to large-scale agriculture or capital-intensive sectors. Given that the majority of the population in Quadrant IV provinces depends on agribusiness, ADLI investments are expected to increase agricultural output, diversify local agro-industries, and raise farmers' incomes, thereby creating a market for domestic industrial products (demand-side multiplier effect) [30].

The study [30] advocates for concentrating investment in sectors with the strongest economic linkages to maximize growth. In the context of Quadrant IV provinces, this strategy involves directing investment toward the most productive or highest-contributing sectors in each province's economy—for example, mining in South Sumatra, manufacturing in Banten and West Java, and tourism in Bali. Identified that the implementation of the ADLI strategy in developing countries can accelerate industrialization at a rate comparable to that of export-oriented manufacturing strategies. ADLI offers additional advantages, such as higher employment absorption, more equitable income distribution, and more significant poverty reduction. This is because traditional agricultural sectors tend to absorb more local labor compared to manufacturing industries, even those that are labor-

intensive. On the other hand, the Leading Sector Strategy is derived from the theory of unbalanced growth as proposed by Shannon [31], which advocates focusing investment on sectors with the strongest linkages in order to stimulate maximum growth. In the context of Quadrant IV provinces, this strategy implies that each province receives investment in the economic sector deemed most productive or most significantly contributing to growth, for example, mining in South Sumatra, manufacturing in Banten/West Java, tourism in Bali, and so forth.

Table 3. Comparison between the ADLI strategy and the leading sector strategy in quadrant IV provinces

Code	Province	Output		NTB		Labor		Income	
		SIM 1	SIM 2	SIM 1	SIM 2	SIM 1	SIM 2	SIM 1	SIM 2
11	Aceh	5.54	9.07	7.15	5.74	10.21	5.32	7.28	4.66
12	North Sumatra	5.30	8.14	7.87	6.23	20.04	4.99	7.63	5.38
13	West Sumatra	3.85	6.71	5.21	5.46	8.42	3.96	4.59	4.65
14	Riau	0.34	18.92	0.34	12.40	0.32	10.53	0.33	11.19
15	Jambi	5.78	15.52	7.91	12.77	18.53	7.22	8.77	9.02
16	South Sumatra	12.34	32.85	17.02	30.07	50.94	12.40	19.95	22.19
17	Bengkulu	12.10	16.70	15.14	13.91	27.81	10.72	13.31	11.28
18	Lampung	3.04	6.53	4.35	5.30	6.69	3.67	4.30	4.27
19	Bangka Belitung Islands	18.25	27.96	24.95	17.30	63.82	13.14	25.17	15.19
21	Riau Islands	0.10	20.45	0.10	13.04	0.12	7.09	0.09	8.47
31	DKI Jakarta	0.49	13.44	0.49	8.82	0.48	6.05	0.47	8.59
32	West Java	8.51	14.13	12.52	11.83	23.82	9.80	14.28	11.86
33	Central Java	4.33	9.78	6.18	7.99	12.88	5.94	5.82	6.75
34	DI Yogyakarta	2.37	4.71	3.51	4.08	4.30	3.34	2.70	3.81
35	East Java	7.72	9.06	9.92	8.02	33.58	6.21	10.49	7.96
36	Banten	5.24	19.03	8.40	12.15	26.08	7.32	12.26	11.35
51	Bali	11.79	18.34	16.57	13.06	30.70	7.29	13.40	11.36
52	Nusa Tenggara Barat	28.72	45.18	39.55	26.33	72.12	31.50	40.05	23.95
53	Nusa Tenggara Timur	3.51	5.86	4.44	3.18	9.34	2.50	4.54	2.59
61	West Kalimantan	12.29	18.44	16.35	13.82	53.52	8.49	23.56	8.82
62	Central Kalimantan	0.80	18.99	0.93	13.37	0.96	11.32	0.90	11.38
63	South Kalimantan	9.85	16.60	13.87	11.60	36.71	10.97	30.15	11.46
64	East Kalimantan	0.72	26.76	0.67	24.59	0.47	21.14	0.57	22.97
65	North Kalimantan	0.31	59.07	0.31	38.75	0.23	29.46	0.31	34.50
71	North Sulawesi	0.18	8.75	0.19	7.10	0.22	5.36	0.20	6.69
72	Central Sulawesi	0.40	118.37	0.49	76.59	0.62	45.62	0.57	62.76
73	South Sulawesi	0.18	5.43	0.21	4.45	0.25	4.23	0.19	3.60
74	Southeast Sulawesi	0.23	16.34	0.25	9.50	0.51	9.25	0.27	7.88
75	Gorontalo	0.23	18.60	0.30	8.62	0.31	7.54	0.22	6.75
76	West Sulawesi	0.05	11.75	0.06	6.54	0.05	9.11	0.05	6.25
81	Maluku	0.26	10.43	0.27	3.53	0.38	2.47	0.25	3.18
82	North Maluku	0.28	305.61	0.34	117.11	0.40	99.51	0.35	117.42
91	West Papua	0.13	35.07	0.15	26.48	0.12	11.69	0.14	22.69
94	Papua	0.20	2.16	0.23	1.62	0.06	0.61	0.15	1.24
	Total	4.94	15.83	6.85	11.75	20.44	8.57	7.54	10.39

From a theoretical standpoint, these leading sectors function as driving forces that stimulate other sectors through backward and forward linkages. This approach is expected to produce a substantial increase in output and value-added in the short term within the respective provinces, although it tends to be more capital-intensive and less equitable. Shannon [31] argued that in traditional agrarian economies, the agricultural sector has few industrial linkages since most of its output is either self-consumed or exported in raw form and thus has limited capacity to initiate structural transformation. Therefore, concentrating limited resources in more modern leading sectors is considered more effective in generating higher Gross Regional Domestic Product (GRDP) growth, compared to distributing those resources across traditional sectors like agriculture in a fragmented manner. The leading sector strategy aligns with the view that manufacturing industries have historically served as the primary engine of economic growth in developing countries. Thus, accelerating industrialisation in a few strategic hubs is expected to increase aggregate growth [32-34]. These two strategies reflect a fundamental trade-off between maximising output growth and promoting equity and employment generation.

3.6 Impact on regional economic performance

Simulation data reveal that the leading sector strategy produces significantly higher output growth than the ADLI strategy across nearly all provinces in Quadrant IV. For instance, Aceh experienced a 9.07% increase in output under the leading sector strategy, compared to only 5.54% under ADLI. Similar patterns are observed in North Sumatra (8.14% vs 5.30%), West Sumatra (6.71% vs 3.85%), and Central Java (9.78% vs 4.33%). The gap widens further in provinces whose leading sectors are dominated by mining or manufacturing, such as South Sumatra (32.85% vs 12.34%), Banten (19.03% vs 5.24%), and Bangka Belitung (27.96% vs 18.25%). On average, output in Quadrant IV increases by 15.8% under the leading sector strategy, nearly double the 8.9% achieved through the ADLI approach. This finding aligns with classical development theories that emphasize the pivotal role of investments in modern, high-productivity sectors in accelerating GDP growth [31, 35]. Empirical studies [6, 30] further supports this view, stating that

medium-to-large-scale manufacturing sectors generally have higher output multipliers than agriculture. However, these advantages warrant critical examination. The quality and sustainability of output, particularly in extractive sectors are often enclave in nature and lack inclusivity. Extreme output surges, such as those observed in North Maluku and Central Sulawesi (up to 305%), do not necessarily reflect sustainable improvements in local welfare. Prior studies have shown that commodity-based growth, especially in the mining sector, is prone to volatility and tends to generate limited distributive effects. Nevertheless, from an aggregate perspective, the leading sector strategy demonstrates clear superiority in accelerating output growth in Quadrant IV. Its contribution to national output is also more substantial, generating an increase of 15.83%, compared to only 4.94% under the ADLI scenario, which fails to fully capitalize on the growth potential of more advanced provinces such as Riau and East Kalimantan.

Gross Value Added (GVA) refers to the portion of output that becomes factor income (wages, business surplus) after deducting intermediate inputs, and is thus equivalent to the region's contribution to GRDP. Interestingly, despite lower output under the ADLI strategy, simulation results indicate that it generates comparable or even higher GVA in many Quadrant IV provinces. The average GVA increase under ADLI reaches 12.3%, slightly higher than 11.6% under the leading sector strategy. This finding suggests that ADLI investment, largely targeting agriculture, local processing, and MSMEs, generates greater domestic value added due to lower import dependency and reduced leakage outside the region. In contrast, leading sectors such as mining or energy are typically capital-intensive and outward-oriented, resulting in lower local GVA. For instance, in Aceh and West Nusa Tenggara, ADLI outperforms in GVA despite lagging in output [36] found that an investment of IDR 12.39 trillion in the national food industry generated an additional GVA of IDR 4.22 trillion and created 49,000 jobs, reflecting the high local content of agro-industrial sectors. This aligns with findings that ADLI strengthens the local economic base and surplus distribution [7, 36]. Although exceptions exist, such as South Sumatra (GVA: 30.07% under the leading sector vs. 17.02% under ADLI) and Jambi, where leading sectors yield higher GVA due to high output prices or profit margins overall, ADLI continues to offer competitive GVA outcomes. Supporting evidence from reference [37] also confirms that the development of primary agriculture and small-scale agro-industries contributes significantly to output and GDP. Thus, while not always superior in the output, the ADLI strategy proves more effective in generating equitable and sustainable GVA, serving as a valid alternative for enhancing the quality of growth in underdeveloped regions.

The most striking difference between the ADLI and the leading sector strategies is observed in employment absorption. The ADLI strategy consistently results in significantly higher employment gains across Quadrant IV provinces. On average, employment under the ADLI strategy increases by 28.3%, compared to only 8.6% under the leading sector strategy. This trend is observed in nearly all provinces within the quadrant, reflecting ADLI's inherent reliance on labor-intensive sectors, such as smallholder agriculture and MSMEs, as opposed to the capital-intensive nature of leading sectors, which tend to generate limited employment despite their high output. Adelman [6] emphasized that agriculture is far more labor-intensive than even the most labor-intensive industries. This finding is supported by Susilowati [38], whose analysis of Indonesia's Social Accounting Matrix revealed that the ADLI strategy not only drives labor absorption but also strengthens broader inter-sectoral linkages. International evidence further reinforces this view. Byerlee et al. [39] found that agriculture-based growth is twice as effective in reducing poverty compared to growth in other sectors. Similarly, Christiaensen et al. [40] demonstrated that in low-income countries, agricultural growth has a significant impact on employment absorption and poverty reduction. Conversely, the leading sector strategy presents the risk of jobless growth, as the additional output often fails to absorb the local labor force. Some mining regions experience high GRDP growth without reducing poverty due to the limited involvement of local workers, an outcome commonly referred to as the resource curse phenomenon. To mitigate this risk, the leading sector strategy must be complemented by enabling supporting policies, including workforce training development programs and the strengthening of local SMEs, to enhance inclusivity and ensure that economic benefits are more broadly shared.

The income indicator in this analysis refers to household income or total income derived from economic activities. Simulation results reveal that the ADLI strategy fosters higher and more widespread income growth in Quadrant IV provinces compared to the leading sector strategy, with an average increase of 13.8% and 9.8%, respectively. This outcome reflects a stronger and more evenly distributed income multiplier effect through the strengthening of agriculture and community-based enterprises, particularly benefiting farmers, labourers, and MSME actors. Furthermore, the ADLI strategy tends to narrow the rural–urban income gap. While the leading sector strategy occasionally generates higher income, as observed in provinces such as Jambi and South Sumatra, its benefits are often elitist and less equitably distributed among the local population. Although national output under ADLI is lower, its contribution to national income remains relatively substantial: 7.54% (ADLI) vs 10.39% (leading sector), reflecting a smaller gap compared to output disparities. These findings support existing evidence suggesting that ADLI is more effective in promoting inclusive welfare distribution and achieving long-term poverty reduction [31, 37, 40].

Table 4. Comparison between the ADLI strategy and the leading sector strategy

Region	Output (%Δ)		NTB (%Δ)		Labor (%Δ)		Income (%Δ)	
	SIM 1	SIM 2	SIM 1	SIM 2	SIM 1	SIM 2	SIM 1	SIM 2
Aceh	5.54	9.07	7.15	5.74	10.21	5.32	7.28	4.66
South Sumatra	12.34	32.85	17.02	30.07	50.94	12.4	19.95	22.19
West Java	8.51	14.13	12.52	11.83	23.82	9.8	14.28	11.86
Nusa Tenggara Barat	28.72	45.18	39.55	26.33	72.12	31.5	40.05	23.95
Quadrant IV Average	8.90	15.80	12.30	11.60	28.30	8.60	13.80	9.80
National (Aggregate)	4.94	15.83	6.85	11.75	20.44	8.57	7.54	10.39

Table 4 presents a comparative summary of the two development strategies, reinforcing the key points of the preceding analysis. The leading sector strategy excels in boosting output, as evidenced by the higher figures in the output column for the leading sector across all examples. However, the ADLI strategy provides a much greater boost to employment and income, with the employment and income indicators under ADLI exceeding those of the leading sector in nearly all cases. Meanwhile, the Net Trade Balance (NTB) is relatively balanced or slightly higher under ADLI in many provinces, although there are exceptions, such as in South Sumatra. At the national level, investment in the leading sectors increases output and GDP more significantly. However, the ADLI scenario proves more effective in employment generation, creating more than twice the number of jobs compared to the leading sector scenario (20.44% vs 8.57% employment).

The differing impacts across Quadrant IV provinces carry significant macroeconomic implications, particularly in highlighting the trade-off between GDP growth and equitable development. The leading sector strategy generates higher national output (15.83% compared to 4.94% under ADLI) and often aligns with central government policies that prioritize the development of growth centers. However, its limited impact on employment absorption is limited raises concerns about the risk of jobless growth and the exacerbation of regional disparities. In contrast, the ADLI strategy, while associated with lower aggregate GDP growth, proves highly effective in reducing unemployment and poverty. It increases national employment by more than 20%, expanding the production base and enhancing purchasing power. Agricultural growth in the agricultural sector is two to three times more effective in reducing poverty than in other sectors. Moreover, rising incomes among farmers and agricultural laborers stimulate domestic demand across the industrial and service sectors, generating a broader industrialization multiplier effect [36].

The ADLI strategy also promotes a more balanced structural transformation by absorbing surplus labor from the agricultural sector, increasing productivity, and strengthening networks in the manufacturing and agro-industry. Meanwhile, a leading sector strategy that neglects traditional sectors risks widening economic dualism, in which urban areas grow rapidly while rural areas are increasingly left behind. From an economic resilience standpoint, the ADLI strategy enhances the current account balance by increasing food production, reducing dependency on imports, and stimulating growth in agro-exports. In contrast, development strategies heavily reliant on mining may increase dependence on global commodities and imported capital goods. Consequently, a hybrid policy approach is necessary. As reference [41] suggested, investment in leading sectors remains essential for accelerating growth; however, it must be complemented by sustained investment in agriculture and education in underdeveloped regions to ensure more inclusive and sustainable outcomes [42, 43]. Leading sectors, such as manufacturing and tourism, can be developed in Quadrant IV hubs (e.g., Bali and NTB), provided they are integrated with local economies through active participation of MSMEs and local labor. With this approach, rapid economic growth and equitable development can progress simultaneously.

3.7 Analysis of the impact on interprovincial disparities

Interprovincial development inequality remains one of the key structural challenges of development in Indonesia. Disparity indicators, such as the Williamson index and the interprovincial variation index, demonstrate that national economic growth is frequently not accompanied by an equitable distribution of development benefits. Within this context, the choice of investment strategy plays a crucial role in addressing spatial disparities. The simulation results are presented in Table 5.

Table 5. Comparison between ADLI and leading sector strategies on disparities

	Base	SIM 1	Δ%	SIM 2	Δ%
Output	0.762	0.731	-4.099	0.743	-2.478
GDP	0.728	0.685	-5.893	0.698	-4.097
Income	0.787	0.738	-6.246	0.754	-4.131

Among the three main indicators (output, GDP, and income), the ADLI strategy shows a more substantial reduction in interprovincial disparities compared to the leading sector strategy. Specifically, output disparity decreased by 4.10% under ADLI, compared to 2.48% under the leading sector strategy; GDP disparity declined by 5.89% versus 4.10%; and income disparity fell by 6.25% versus 4.13%. These findings affirm that although the leading sector strategy generates higher aggregate growth, its benefits are more spatially concentrated.

In contrast, the ADLI strategy, with its emphasis on agriculture and local agro-industrial development, promotes more equitable growth, especially in structurally underdeveloped provinces in Quadrant IV. The effectiveness of the ADLI strategy in reducing inequality aligns with the theory of inclusive agglomeration [6, 7], which emphasizes the importance of locally based investment in generating spillover effects to rural areas. ADLI also promotes broader participation by absorbing more local labor, smallholder farmers, and micro, small, and medium enterprises (MSMEs), thereby facilitating a more equitable distribution of development benefits. On the other hand, the leading sector strategy tends to reinforce core regions, as investment primarily flows into capital-intensive sectors that are geographically concentrated [35, 44]. The greater reduction in income disparity compared to output disparity indicates that ADLI not only supports balanced production but also distributes the outcomes of development more equitably.

The ADLI strategy has proven to be the most effective in reducing disparities in Quadrant IV provinces, as it aligns with the sectoral and socio-economic characteristics of these regions. Most of these provinces, such as West Sumatra, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), and Bengkulu, are dominated by smallholder agriculture and plantations, exhibit unemployment and poverty rates above the national average, and suffer from low economic connectivity. These structural conditions make them particularly responsive to labour-intensive development approaches such as ADLI. ADLI investments strengthen local and interregional linkages by increasing demand for local goods and services, fostering the growth of rural agro-industries, and raising the incomes of farmers and informal workers factors that directly contribute to inequality reduction [45-48]. In contrast, the leading sector strategy dominated by extractive and manufacturing industries, as seen in South Sumatra and Banten tends to exacerbate disparities by reinforcing structural divergence between more developed and underdeveloped provinces. This outcome aligns with the theory of cumulative causation [49,

50], in which growth in core regions absorbs resources from peripheral areas without generating balanced returns.

At the national level, the ADLI strategy reduces income disparity by 6.2% and GDP disparity by 5.9%, outperforming the leading sector strategy, which achieves only a 4.1% reduction in both indicators. This finding supports the assertion in reference [39] that agriculture-based growth is more effective in reducing poverty and inequality, as it has a greater capacity to absorb labor and increase household income in peripheral regions. The resulting reduction in disparity also strengthens both social and fiscal stability, as more equitable income distribution lowers the burden of subsidies and transforms underdeveloped regions into emerging engines of growth. Therefore, the ADLI strategy demonstrates greater effectiveness in distributing added value, increasing local income, and reducing spatial inequality compared to the leading sector approach. These findings are consistent with the literature on inclusive development [6, 30, 39], and provide a critical foundation for designing policies that balance economic growth with equity.

In the Interregional Input-Output (IRIO) model, labor measurement is conducted mechanically through technical coefficients, which link the amount of labor to the total sectoral output. This approach is aggregative in nature, as the primary objective of the IRIO framework is to trace intersectoral and interregional linkages in the flow of goods, services, and income. Consequently, the model is not designed to capture labor market heterogeneity, such as distinctions between formal and informal employment or skill levels [51, 52]. Attempts to disaggregate these categories would require integrating micro-level labor or industrial survey data, which are often dynamic and not consistently available across regions [53]. Although this simplification limits the IRIO model's capacity to assess the inclusiveness dimension of employment, it remains relevant for macroeconomic estimation and sectoral linkage analysis. The IRIO's main objective is to measure how final demand or investment shocks affect total employment at the aggregate level rather than the distribution across worker groups. Therefore, this study acknowledges such limitations as a methodological compromise aimed at maintaining systemic consistency and interregional balance within the model structure. For a more detailed analysis of employment distribution, the Computable General Equilibrium (CGE) or Social Accounting Matrix (SAM) approaches are recommended, as they are capable of capturing behavioral responses and factor substitution effects endogenously [54, 55].

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Leading sector strategies are generally more effective in boosting aggregate output and gross domestic product (GDP). In contrast, the ADLI (Agriculture, Domestic demand, Labour-Intensive industries) strategy has proven more effective in increasing employment absorption and household income, particularly in agriculturally based and underdeveloped provinces classified in Quadrant IV. In terms of interprovincial disparities, the ADLI strategy is demonstrably more effective in reducing spatial inequality. These findings indicate that investments in agriculture and local labour-intensive sectors are more capable of fostering equitable development than leading sector strategies, which are typically concentrated in capital-intensive and industrialized regions.

The impact of investment Quadrant IV provinces varies significantly between the ADLI strategy and the leading sector strategy. The leading sector strategy tends to be effective in boosting output and gross regional domestic product (GRDP) in the short term by targeting on high-productivity sectors. However, it generates limited employment opportunities and may exacerbate inequality due to its emphasis on capital-intensive sectors. In contrast, the ADLI strategy produces more inclusive development outcomes: it substantially increases employment absorption, promotes more equitable income growth, particularly among lower-income groups, and enhances regional gross value added through strong domestic linkages. While the ADLI approach may result in slower national output growth, it contributes to long-term stability mitigating unemployment and poverty.

4.2 Recommendations

Based on the above analysis, the following policy recommendations are proposed to effectively and sustainably address interprovincial disparities. First, the ADLI (Agriculture, Domestic demand, Labour-Intensive industries) strategy should be prioritized for provinces in Quadrant IV. Second, the ADLI strategy should be implemented selectively in Quadrant IV provinces, particularly those with strong potential in agriculture, smallholder plantations, fisheries, and local agro-industries. Third, investment should be directed towards improving agricultural productivity (e.g., irrigation infrastructure, high-quality seeds, agricultural machinery), supporting small- and medium-scale agricultural processing, and strengthening local market development. While strategies focusing on leading sectors remain essential for provinces with established industrial or tourism infrastructure, these efforts should be integrated with the ADLI strategy to ensure that growth is inclusive and benefits extend to local sectors and economic actors. Thus, implementing this hybrid policy model can foster sustainable economic growth while simultaneously reducing sectoral and spatial disparities.

Reducing disparities requires the integration of markets and logistics distribution across regions. Investments in transportation, energy, and digital infrastructure in underdeveloped areas will strengthen the spillover effects from more advanced provinces. Local institutions such as farmers' cooperatives, village-owned enterprises (BUMDes), and small business groups must be empowered to facilitate participatory investment management and to promote a more equitable distribution of economic benefits. Sectoral development approaches should be complemented by spatial strategies in development planning. National fiscal and spatial planning instruments such as the National Medium-Term Development Plan (RPJMN) and intergovernmental fiscal transfers must explicitly incorporate sectoral-spatial linkage scenarios.

ADLI strategy has demonstrated effectiveness in enhancing economic performance and equity in developing countries. Nevertheless, targeted investments in sectors with strong intersectoral linkages are equally important to prevent economic stagnation. Therefore, policy measures should integrate a dual approach: advancing leading sectors to accelerate economic growth, while simultaneously reinforcing traditional sectors through the ADLI framework. In this

context, investment in underdeveloped provinces should not focus solely on output expansion, but must also consider its impact on employment creation and income distribution. ADLI-oriented programs, such as agricultural infrastructure, extension services, and rural agro-industries, can be implemented in parallel with the development of high-potential sectors, including mineral downstream processing and special industrial zones. This hybrid approach fosters sustainable, inclusive, and equitable growth. Ultimately, the success of development efforts in Quadrant IV should be measured not merely by increases in GRDP but by its capacity to establish a more balanced and just national economic structure.

The Interregional Input-Output (IRIO) model operates under a fixed-price framework, ignoring price, exchange-rate, and market-adjustment mechanisms. This assumption makes the model linear and may lead to overestimation of growth effects when simulating investment or policy shocks, as feedbacks from prices and competitiveness are excluded. In an open economy such as Indonesia, this limitation can bias output and income estimates. Therefore, Computable General Equilibrium (CGE) or Interregional CGE (ICGE) models are often preferred, as they capture intersectoral, factor-market, and price interactions endogenously, providing a more realistic assessment of economic policy impacts.

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