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Economic Simulation of Central Java: Indonesia's Province-Based IRIO Analysis

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Abstract

This study simulates increased sectoral investment in the economy of Central Java Province, Indonesia. Using output and household income indicators, several policy scenarios are applied to Indonesia's interregional input-output (IRIO) tables, including green economic scenarios. The aim of this research is to identify the most impactful policy on the economy of Central Java based on the results of investment policy simulations. Investment injections are conducted in production sectors within Central Java and in sectors outside the province. By assessing the direct, indirect and induced effects on economic sectors and households, cross-sectoral insights for regional development policies, the simulation results show that the Central Java economy experiences the best impact in terms of sectoral household output and income levels. In IRIO analysis, this impact is seen as a multiplier effect from sectors within and beyond Central Java. The findings imply that policies focused on local sector development will generate the highest income levels and largest output multiplier for Central Java given the existing economic conditions, while green economic policies do not have insignificant economic impacts compared to non-green policies. It is crucial to develop additional policy scenarios targeting both local and non-local industries to obtain more sensitive simulation results.

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INTRODUCTION

Central Java Province is one of the main provinces in Indonesia in terms of economies of scale. Situated strategically in the middle of Java Island, this province had a population of 37 million in 2022, which accounted for approximately 13% of Indonesia's population. Additionally, its real Gross Domestic Product (GDP) capacity constitutes 8.97% of Indonesia's GDP, positioning it as the fourth largest province in the country. The growth of Central Java's Gross Regional Domestic Product (GRDP) follows a similar pattern to that of Indonesia's overall GDP (Figure 1).

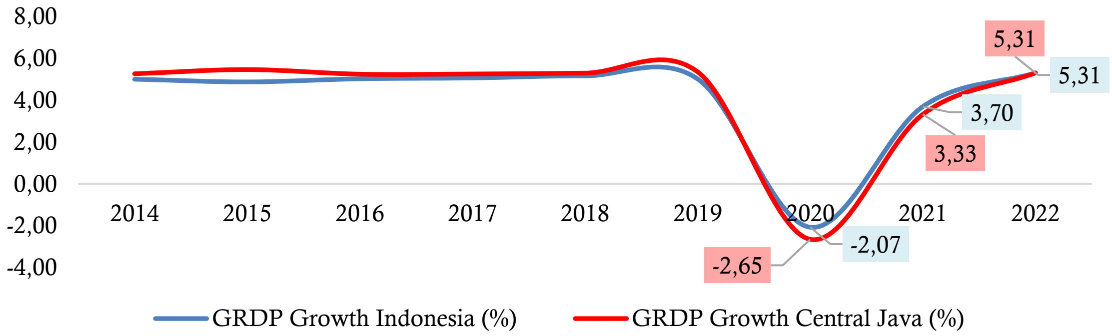

Figure 1. Annual Development of Central Java Province's Real GRDP and Indonesia's GDP (%)
Sources: Statistics Indonesia, 2023 (Processed)

From Figure 2, it is evident that the Manufacturing sector makes the largest contribution to the economy of Central Java Province, followed by the Wholesale and Retail Trade sector, and Repair of Motor Vehicles and Motorcycles sector.

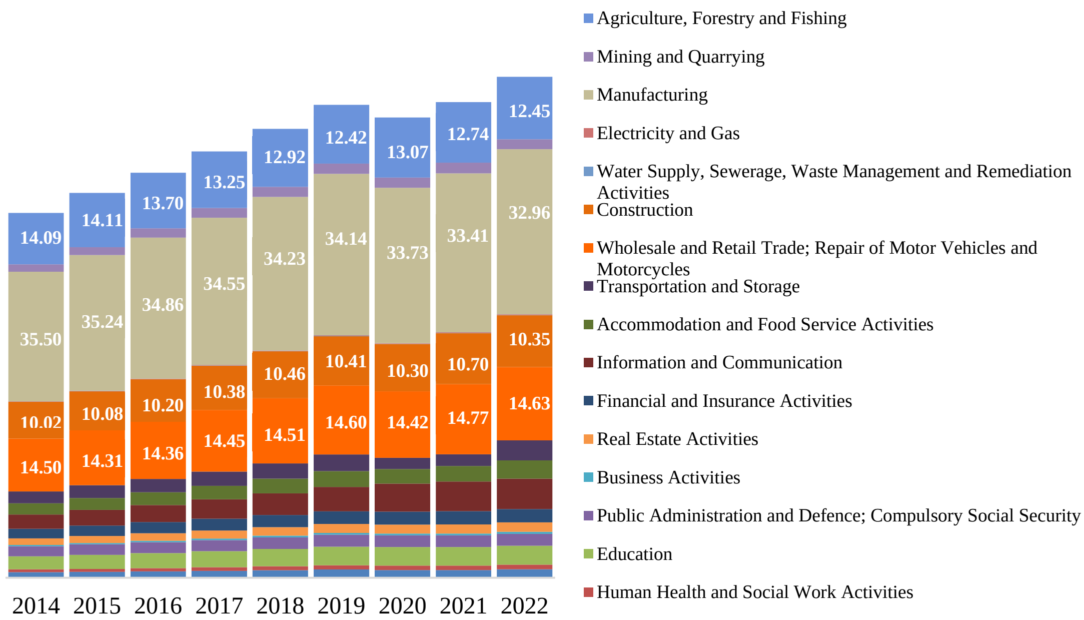

Figure 2. Annual Development of Sectoral Real GRDP in Central Java Province
Source: Statistics Indonesia, 2023 (Processed)

The economy of a province, such as Central Java, has strong linkages with other provinces in Indonesia. Unlike relationships between countries, economic relations between provinces in Indonesia are highly open, with a system that allows for the free movement of goods and people, sharing the same political system and jurisdiction from one province to another. As a result, the economy of a province is greatly influenced by the economies of other provinces. Several pertinent studies emphasizing the interconnectedness between regions or provinces in economic development include (Cong, 2021; Tang et al., 2021; Vo et al., 2020; Wang & Ge, 2023).

Vo et al. (2020) explored the economic ties and spillover effects among Vietnamese provinces using spatial regression. Their findings revealed significant inter-provincial correlations in GDP, capital investment, and labor, emphasizing that capital and labor not only affect a province's GDP but also neighboring ones. This highlights the broader impact of inter-provincial interactions on economic dynamics, suggesting that provinces' economies are influenced by both internal factors and external relations with each other.

Through econometric analysis using instrumental variables for panel data, Cong (2021) demonstrated the significant role metropolises play in the economic structure transformation of Vietnamese provinces. These roles include being migration destinations, remittance sources, markets for goods and services, and centers of information and knowledge. The study highlights the substantial impact of external factors like metropolis characteristics on provincial economic restructuring, emphasizing the importance of inter-regional linkages and influences in economic development studies, especially in developing countries like Vietnam. This approach sheds light on how urban dynamics can significantly influence provincial economic development.

Tang et al. (2021) employed the Theil index and kernel density estimation to analyze regional disparities in digital economy development across Chinese provinces. They further utilized network methods to examine correlations in digital economic development levels province-wide. Their study revealed significant polarized and uncoordinated development, with the southern region showing higher digital economy advancement than the north. The network analysis indicated beneficial and spillover effects across provinces. This research offers new insights into how digital economy impacts broader economic development in China, highlighting the importance of spatial and regional factors in understanding complex, interlinked economic dynamics.

Wang & Ge (2023) assessed the economic resilience of 31 provinces in China from 2012 to 2020, emphasizing the importance of spatial correlation patterns for sustainable economic development. Utilizing entropy-TOPSIS methods and Social Network Analysis, their research identified Jiangsu, Shandong, Guangdong, Hubei, and Shaanxi as key nodes in the spatial correlation of economic resilience. The findings suggest that geographical proximity and human capital variations influence the formation of spatial association networks, while differences in external openness and physical capital pose challenges, offering valuable insights for economic development policy.

As an example of the interconnectedness between provinces in Indonesia, Central Java is a major producer of various products and resources that are crucial for other provinces, including products from the Manufacture of Tobacco Products Sector, alongside East Java. Fluctuations in the supply of these products from Central Java, as well as changes in demand from other regions, can have an impact on the economy of Central Java itself and the economies of other provinces.

Positively, the movement of goods and people between provinces is increasingly influenced by enhanced investments and infrastructure development. Investments in sectors like transportation, energy, or industry can enhance inter-provincial connectivity, facilitate the flow of goods and services, and foster economic growth in Central Java and other provinces. As a result, the success of a sector or region often relies on strong linkages with other sectors or regions, necessitating collaborative efforts to leverage synergies and promote comprehensive economic growth.

The concept of regional economic linkages, within the context of regional economic theory, explains the significance of relationships and interactions among different economic sectors within a specific area or region. It highlights how the development in one sector or region can have an impact and create linkages with other sectors or regions. Several concepts associated with economic linkages include the theory of spillover effects, industrial clusters, value chains, and multiplier effects.

The spillover effect occurs when economic activity or development in one sector or area has a positive or negative impact on other sectors or areas (Mrkaic et al., 2021). For instance, the growth of the manufacturing industry in a particular area can generate a positive spillover effect on supporting service sectors such as transportation, trade, or financial services. Industrial clusters, on the other hand, emphasize the presence of groups of companies within the same or related sectors, geographically concentrated in a specific area (Breschi and Malerba, 2020). Industrial clusters facilitate extensive interaction among companies in the supply chain, enhance access to skilled resources and workforce, promote knowledge exchange and innovation, and foster mutual competitiveness.

The value chain encompasses multiple stages of product or service production and distribution, spanning from raw material suppliers to final consumers (World Bank, 2008). It involves numerous interconnected economic actors, including producers, suppliers, distributors, and retailers, which collectively influence the growth and efficiency of the economic sector while also impacting related sectors. On the other hand, the multiplier effect transpires when changes in spending or investment within an area yield broader economic changes (Edwards, 2017). For instance, heightened government investment in infrastructure can trigger a multiplier effect by stimulating increased labour demand, spurring growth in related sectors, and boosting consumer spending.

Research on economic inter-provincial linkages, trade patterns, multiplier effects, supply chain relationships, and economic interactions within countries has been conducted in various locations. These studies aim to support regional development policies, enhance economic synergies between provinces, and promote sustainable growth across countries. For example, one study measured the economic benefits and environmental costs driven by inter-provincial linkages in the electricity sector in China using China's inter-provincial input-output model (Chen et al., 2023). Another research evaluated the spatial interrelationships of Thailand's regional economy at the provincial level, employing an interregional input-output model to identify spatial interdependence between industries, regional multipliers, spillover effects, and feedback effects (Shibusawa et al., 2018).

Using the input-output (I-O) model involves examining a matrix-style table containing data on exchanges of goods and services, as well as the connections between different sectors within a defined region for a given time frame. This table is commonly referred to as the I-O table. The production process in input-output analysis follows either the Leontief production function or the fixed proportion production function. The fixed proportion production function is characterized by a substitution elasticity of zero (σ=0) and takes the isoquant form L' (Nicholson and Snyder, 2017). In this case, substitutions between inputs are not possible. Every level of production necessitates a distinct blend of labor and capital, and achieving higher production levels is only feasible by introducing additional labor and capital in specific proportions (Pindyck and Rubinfeld, 2018). A firm will always operate at an isoquant angle as it represents the most efficient combination. The mathematical expression for the fixed proportion production function is $\boldsymbol{q} = \mathbf{min}(\boldsymbol{\alpha k}.\boldsymbol{\beta l})$, $\boldsymbol{\alpha}, \boldsymbol{\beta} > \mathbf{0}$, where 'min' indicates that q is determined by the smaller value between the two in parentheses [10]. Furthermore, this production function exhibits the property of constant returns to scale, meaning that the proportional increase in output is equal to the proportional increase in input. This condition applies to all sectors within the economy.

Based on the assumption of σ=0 in the production process, it implies that each output consistently requires input in the same ratio. In the sectoral approach of Input-Output analysis, this input ratio is referred to as the input coefficient or technology coefficient, represented by Leontief's inverse matrix. The input coefficient is calculated using the formula $\boldsymbol{A_{ij}} = \frac{x_{ij}}{X_j}$, where X_{ij} is the input value of sector j originating from sector i, and X_j is the total input of sector j (Firmansyah *et al.*, 2019). The consistent use of intermediate inputs leads to the formation of a convergent geometric series, which is expressed in the inverse Leontief matrix equation $(I-A)^{-1}$ and can be represented as $(I-A)^{-1}F_k$, describing all the intermediaries involved in the production of the final demand (Dine and Chalil, 2021). Based on region, Input-Output models are divided into two, namely Single-region Models and Many-region Models (Miller and Blair, 2009). The single region model contains linkages between sectors within a region. This model can be used to see the economic structure of a region (Reis and Rua, 2009; Marconi et al., 2016; Firmansyah et al., 2023; Hurwicz, 2024), changes in the economic structure of a region (Guo and Planting, 2000; Hayashi, 2005; Munjal, 2007; Li et al., 2017; Norbu et al., 2021; Firmansyah et al., 2023) and can be used to simulate the economic impact of a region due to changes in final demand or a shock to the economy (Ivanova and Rolfe , 2011; Kim and Kim, 2015; Ding et al., 2017; Firmansyah et al., 2023).

Based on region, Input-Output models are divided into two categories: Single-region Models and Many-region Models (Miller and Blair, 2009). The single-region model contains linkages between sectors within a region. This model can be used to analyze the economic structure of a region (Reis and Rua, 2009; Marconi et al., 2016; Firmansyah et al., 2023; Hurwicz, 2024), track changes in the economic structure of a region (Guo and Planting, 2000; Hayashi, 2005; Munjal, 2007; Li et al., 2017; Norbu et al., 2021; Firmansyah et al., 2023) and simulate the economic impact of changes in final demand or shocks to the economy (Ivanova and Rolfe, 2011; Kim and Kim, 2015; Ding et al., 2017; Firmansyah et al., 2023).

Nevertheless, Single-region models inherently lack the capacity to account for external impacts beyond the region (known as spillovers) in regional or sectoral intricacy. Various economic inquiries entail ramifications that extend beyond a single region and have significant implications on a national scale (Miller and Blair, 2009). Addressing this issue, the many-regions model, employing an interregional approach, emerges as a solution capable of addressing such complexities.

Freeman and Sultan (1997) employed a multi-regional input-output (MRIO) model to assess the comprehensive impact of tourism on the Israeli economy and its spatial distribution. Akita and Kataoka (2002) utilized an interregional input-output system encompassing Kyushu, Kanto, and other regions of Japan to analyze the effects of evolving economic conditions and governmental policies on the output growth of the Kyushu region from 1965 to 1990. Martínez et al. (2013) also employed an interregional input-output model to investigate the socio-economic effects, including added value, imports, and employment, stemming from bioethanol production derived from sugar cane in Northeastern Brazil, particularly on the economy of the Northeastern region and other Brazilian regions. Nakano et al. (2018) emphasized the importance of inter-regional and inter-sectoral linkages in optimizing renewable energy utilization, leading to the development of IONGES (Input-Output Table for a Next Generation Energy System). Haddad et al. (2023) utilized an interregional input-output model to assess the economic and environmental repercussions following the disruption of the sole refinery operation in Morocco. Furthermore, numerous studies in China have leveraged interregional input-output models to delineate economic connections and carbon emissions among different regions (Li et al., 2018; Pan et al., 2018; Ning et al., 2019; Wang et al., 2021), as well as to monitor energy and water flows between regions while measuring their mutual interdependence (Wang et al., 2018).

This study analyses the development potential of Central Java's economy within the context of sectoral economic relations with other provinces. The analysis involved simulating various scenarios of sectoral investment policies, including injections into the intra-Central Java sectoral economy, sectoral investment policies in other provinces, and a combination of internal and external investment policies in Central Java Province. The objective was to determine the policy scenario that had the most positive impact on the economy of Central Java.

The results of these simulations will be compared to identify the most suitable policies and yield the best outcomes for the economy of Central Java. The simulation scenarios developed in this study are currently limited but can be further expanded and refined to enhance the specificity and sensitivity of the results.

This study is vital for determining the most effective sectoral investment policies to enhance Central Java's economic development, an essential aspect of Indonesia's overall economic growth. The main challenge is to identify the optimal investment strategy for Central Java's economy, analyzing the impact of various internal and external sectoral investments. The study aims to overcome the limitations of current simulations to provide a more comprehensive understanding of the most beneficial economic policies for the province.

RESEARCH METHODS

This study employs Interregional Input-Output (IRIO) analysis to examine the interdependencies among sectors within Central Java Province and their connections with sectors in other Indonesian provinces. The analysis reveals the extent of support Central Java receives from various provinces and identifies the sectors contributing significantly to this support. Beyond provincial distinctions, the research identifies the specific sectors in various provinces that contribute most significantly to supporting Central Java. The utilized IRIO table corresponds to the 2016 edition of the Indonesian Interregional Input-Output Table.

The 2016 Indonesia Interregional Input-Output (IRIO) table is a domestic transaction table that captures producer prices. This table illustrates the flow of goods and services produced by industries within a region, which are then utilized by that region as well as other regions within the country. Inputs sourced from outside the region (other provinces and abroad) are categorized as imports. The fundamental data utilized in the Indonesia IRIO Table is based on the 2016 dataset provided by Statistics Indonesia. The structure of the IRIO table is presented in Table 1, encompassing 52 sectors across 34 provinces (resulting in a 52x34 basic matrix). The classification of the 52 sectors for each province is outlined in Table 2, while Table 3 provides the classification of the provinces.

Table 1. Indonesian IRIO Table Structure 52 Sectors and 34 Provinces

Description			Intermediate Demand			Final Demand			Export	Output Total
			1. Prov. Aceh	…	34. Prov. Papua	1. Prov. Aceh	..	34. Prov. Papua		
			Industry		Industry	Component		Component		
			1 … 52		1 … 52	1 … 52		1 … 52		
Intermediate Input	1. Industry Prov. Aceh	1 : 52	X_{ii}^{AA}	…	X_{ij}^{AB}	F_{ii}^{AA}	…	F_{ij}^{AB}	E_i^A	X_j^A
	: :	: :	:	:	:	:	:	:	:	:
	34. Industry Prov. Papua	1 : 52	X_{ij}^{BA}	…	X_{jj}^{BB}	F_{ij}^{BA}	…	F_{jj}^{BB}	E_i^B	X_j^B
Imports			X_j^{MA}	…	X_j^{MB}	F_j^{MA}	..	F_j^{MB}		
Value Added			V_j^A	…	V_j^B					
Input Total			X_j^A	…	X_j^B					

Source: Statistics Indonesia, 2021 (Processed)

As an illustration of the transactions in Appendix 1, let's consider the transaction X_{ij}^{BA}. When read in-line, it represents the output value (in rupiah) of Sector i in Province B, which is distributed to Sector j in Province A. When read by column, the transaction value (in rupiah) signifies the input value of Sector j in Province A, originating from Sector i in Province B. For final demand and primary inputs, such as those in Appendix 2, the data is adjusted based on the province.

To see the impact of changes in final demand in a sector in Central Java on the Central Java economy or the impact of changes in a sector in another province on the Central Java economy, we need to know how many times economic output will increase if there is a change in final demand in a sector. Therefore, we need to calculate how big the output multiplier is for these sectors.

The matrix relationship in Table I-O can be expressed as follows (Firmansyah, 2006):

$$(I - A) X = Y \quad \text{..(1)}$$

Where, I is a square identity matrix with dimensions n x n, and A, X, and Y are matrices representing technology coefficients, output column vectors, and final demand column vectors, all with dimensions of n x n and n x 1, respectively.

If there's a shift in the overall demand in the economy, it will lead to a corresponding adjustment in the national production, which can be expressed as follows:

$$X = (I - A)^{-1}Y \quad \text{... (2)}$$

The Leontief inverse matrix is denoted as $(I-A)^{-1}$. This matrix highlights that the production level is directly affected by the final demand's magnitude. The subsequent section will cover the computation and explanation of individual elements in this matrix. As a result of the equation's linearity, equation (2) can alternatively be expressed as follows:

$$\Delta X = (I-A)^{-1}\Delta Y \quad \text{.. (3)}$$

Where, ΔY represents the change vector in final demand, and ΔX represents the change vector in output.

The sector-specific output multiplier for sector j signifies the overall economic output generated when the final demand for that sector changes by one unit. This output multiplier is numerically equivalent to the count of columns in Leontief's inverse matrix components. In mathematical notation, it can be expressed as follows:

$$O_j = \sum_{i=1}^{n} \alpha_{ij} \quad \text{...(4)}$$

Where, O_j denotes the output multiplier for sector j, i = 1,2, …, n, and αij represents an element of Leontief's inverse matrix, $(I-A)^{-1}$.

The household income multiplier in a specific sector indicates how an increase of one unit of money in the final demand for that sector results in a corresponding change in household income. The input-output matrix's (n+1) row, denoted as the salary and wage coefficient, reveals the connection between the total output of each sector and labor compensation. This coefficient essentially demonstrates the relationship between the total input value (HR) and the value of salaries and wages. Therefore, you can assess the impact of final demand on household income by utilizing the output multiplier and the household income coefficient, which is commonly referred to as the household income multiplier (H_j). Household income multiplier matrix:

H_j = HR. O_j ....(5)

Where, HR is the n+1 row vector, as it assumes that the transaction matrix and input coefficient matrix have an order of n x n.

$$\text{HR} = \begin{bmatrix} a_{n+1,1} & a_{n+1,2} & \cdots & a_{n+1,n} \end{bmatrix}$$

$$a_{n+1,j} = \frac{x_{n+1,j}}{X_j} \text{, j = 1, 2,3, …n .... (6)}$$

In the formula $x_{n+1,j}$ corresponds to the same value as the row v (primary input)..
For each sector, the household income multiplier is calculated as follows:

$$H_j = \sum_{i=1}^{n} a_{n+1},_j \ \alpha_{ij} \quad \text{................................ (7)}$$

In Table 2, we can observe the general table structure of IRIO, which not only reveals the relationships among sectors but also the connections between sectors and regions. Table 2 presents a scenario involving two distinct regions referred to as Region-r and Region-s. Each of these regions comprises three economic sectors. This arrangement is established through the exchange of goods and services among different sectors and industries. These two regions exhibit economic interdependence, where shifts in final demand within Region-r lead to increased output within Region-r itself. Consequently, this output change influences the output level in Region-s, leading to subsequent impacts on Region-r once again.

Table 2. General Structure of IRIO Table

Seller Sector		**Buyer Sector**					
		r Region			**s Region**		
		1	**2**	**3**	**1**	**2**	**3**
r Region	1	z_{11}^{rr}	z_{12}^{rr}	z_{13}^{rr}	z_{11}^{rs}	z_{12}^{rs}	z_{13}^{rs}
	2	z_{21}^{rr}	z_{22}^{rr}	z_{23}^{rr}	z_{21}^{rs}	z_{22}^{rs}	z_{23}^{rs}
	3	z_{31}^{rr}	z_{32}^{rr}	z_{33}^{rr}	z_{31}^{rs}	z_{32}^{rs}	z_{33}^{rs}
s Region	1	z_{11}^{rr}	z_{11}^{rr}	z_{11}^{rr}	z_{11}^{ss}	z_{12}^{ss}	z_{13}^{ss}
	2	z_{11}^{sr}	z_{12}^{sr}	z_{13}^{sr}	z_{21}^{ss}	z_{22}^{ss}	z_{23}^{ss}
	3	z_{21}^{sr}	z_{22}^{sr}	z_{23}^{sr}	z_{31}^{ss}	z_{32}^{ss}	z_{33}^{ss}

Source: Miller and Blair (2009)

Matrix Z in Equation 9 can be derived from Table 4 (Miller and Blair, 2009).

$$Z = \begin{bmatrix} Z^{rr} & Z^{rs} \\ Z^{sr} & Z^{ss} \end{bmatrix} \quad \text{... (8)}$$

The regional input coefficients, which are the technical coefficients for Region-r and Region-s, are expressed in Equations 10 and 11.

$$a_{ij}^{rr} = \frac{z_{ij}^{rr}}{x_j^r} \quad \text{.. (9)}$$

$$a_{ij}^{ss} = \frac{z_{ij}^{ss}}{x_j^s} \quad \text{..(10)}$$

The following are the coefficients for inter-regional trade:

$$a_{ij}^{rs} = \frac{z_{ij}^{rs}}{x_j^s} \quad \text{...(11)}$$

$$a_{ij}^{sr} = \frac{z_{ij}^{sr}}{x_j^r} \quad \text{...(12)}$$

The multiplier effect calculation in the IRIO table is the same as the single region I-O table.

We have constructed three simulation scenarios to assess increased investment in this research. This scenario grouping is based on a specific policy rationale:

Scenario 1: Central Java's local sectoral empowerment to drive its own economy by injecting investment into the local sector or implementing internal policies within Central Java. Scenario 1 consists of three sub-scenarios: 1A, 1B and 1C. In Scenario 1A, a 10 trillion-rupiah investment is injected and divided among the 10 sectors with highest multiplier output in Central Java based on the proportion of their final demand.

The 10 sectors that have the highest output multiplier in Central Java are (sector codes can be seen in Appendix 1): Electricity (C-28); Manufacturing of Food Products and Beverages (C-13); Manufacturing of Rubber, Rubber Products and Plastics Products (C-20); Food and Beverage Service Activities (C41); Manufacture of Paper and Paper Products, Printing and Reproduction of Record Media (C-18); Manufacturing of Basic Metal (C-22); Manufacturing of Chemicals and Pharmaceuticals and Botanical Products (C-19); Manufacturing of Furniture (C-26); Manufacturing of Leather and Related Products and Footwear (C-16); and Manufacture of Wood and of Products of Wood and Cork, and Articles of Straw and Plaiting Materials (C-17).

In Scenario 1B, a 10 trillion-rupiah investment is evenly distributed across all production sectors in Central Java (all sectors in this scenario are all sectors in the IRIO Table, sector names and sector codes can be seen in Appendix 1). In Scenario 1C, a 10 trillion-rupiah investment is injected and divided among 5 sectors with the lowest input ratio to the Coal Industry and Oil and Gas Refining sector, namely C-1, C-2, C-4, C-43, C-45. The 1C scenario is a green economic policy scenario.

Scenario 2: External forces from outside Central Java that act as the major economic drivers of Central Java's economy by injecting investment in selected production sectors located outside Central Java. These sectors are chosen based on their high output multiplier for Central Java. Scenario 2 consists of three sub-scenarios: 2A, 2B and 2C. In Scenario 2A, a 10 trillion-rupiah investment is injected into 2 sectors selected from the 5 provinces with the highest output multiplier for Central Java, resulting in a total of 10 sectors.

The 5 provinces are DI Yogyakarta (injected sectors are C-28 and C-11), East Nusa Tenggara (C-16 and C-28), West Nusa Tenggara (C-35 and C-36), Bali (C- 28 and C-15), and Gorontalo (C-28 and C-35). Each sector receives an investment injection of 1 trillion-rupiah. Scenario 2B involves a 10 trillion-rupiah investment that is divided equally among the 10 sectors with the highest output multiplier, regardless of their provincial ranking: C-16 in Papua, C-16 in East Nusa Tenggara, C-28 in DI Yogyakarta, C-15 in South Sulawesi, C-14 in South Sumatra, C-28 in North Maluku, C-28 in Gorontalo, C-36 in East Nusa Tenggara, C-35 in West Nusa Tenggara.

In Scenario 2C, a 10 trillion-rupiah investment is injected into 2 selected sectors (sectors with the lowest input usage from the Coal and Oil and Gas Industry sector) from the 5 provinces with the highest output multiplier for Central Java, resulting in a total of 10 sectors (C-1 and C-46 in DI Yogyakarta, C-1 and C-46 in East Nusa Tenggara, C-1 and C-46 in West Nusa Tenggara, C-1 and C-46 in Bali, C -1 and C-46 in Gorontalo. Scenario 2C is a green economic policy scenario.

Scenario 3: A mix of Scenario 1 and Scenario 2. Scenario 3 consists of five sub-scenarios: 3A (Scenario 1A and Scenario 2A), 3B

(Scenario 1A and Scenario 2B), 3C (Scenario 1B and Scenario 2A), and 3D (Scenario 1B and Scenario 2B). The 5th sub-scenario is Scenario 3E, which is a combination of scenarios 1C and 2C.

Each scenario is simulated by injecting an equal increase in investment of 10 trillion-rupiah, which is divided into selected sectors. The investment amount is kept the same across scenarios to allow for testing and comparison of the resulting changes in the economy under different policy scenarios.

RESULTS AND DISCUSSION

Figure 3 displays the simulation results regarding the total output impact of different injection scenarios. Upon examining the simulation results of Scenario 1 (specifically Scenario 1A and Scenario 1B) and Scenario 2 (Scenario 2A and Scenario 2B), it becomes apparent that increasing local sectoral investment in Central Java province, on average, yields a larger total output impact compared to the average results of Scenario 2 simulations. This suggests that an increase in local sectoral investment in Central Java can have a greater impact on Central Java's economic output compared to the sectoral investment outside Central Java policy. This finding aligns with the conclusions of Marconi *et al.* (2016) regarding the Brazilian economy. They argue that expanding the production of agricultural commodities and minerals does not significantly improve the economy due to the lowest linkage index, whereas sectors related to manufacturing can stimulate other sectors, such as advanced services, because of the high impact of their linkage on other sectors.

The average outcome of Scenario 3 is still smaller than the average outcome of Scenario 1, while the combined scenario yields a larger positive impact on economic output compared to Scenario 2. This implies that the combined strategy of increasing sectoral investment inside and outside Central Java does not produce a favourable result in doubling Central Java's economic output compared to solely increasing local sectoral investment Central Java. However, it does yield better results than the average impact resulting from increasing sectoral investment in outside Central Java.

When examining each scenario individually, the order of highest output impact with the same amount of funds is as follows: Scenarios 1A, 1B, 1C, 3B, 3A, 3D, 3C, 3E, 2B, 2A and 2C. The best simulation results, particularly in Scenario 1A, demonstrate that if all investments are directed towards local sectors in Central Java with the highest output multiplier, it will have the most significant output impact on Central Java.

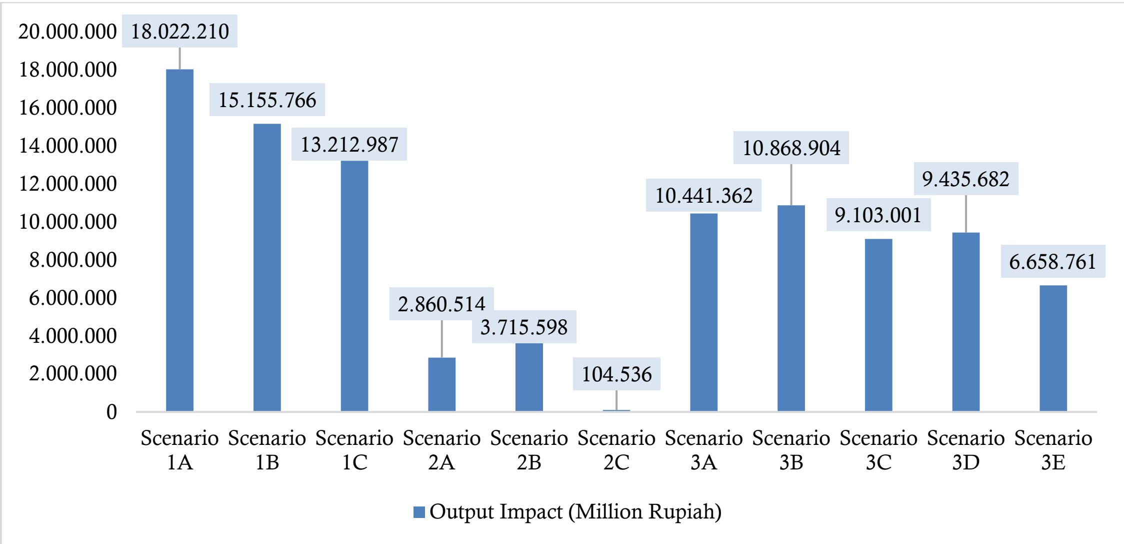

Figure 3. Simulation Results of Output Impact for Various Scenarios
Source: Central Bureau Indonesia, 2021 (Processed)

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Although the simulation results of Scenario 3, which combines internal and external investment policies, indeed yield output impacts smaller than those of Scenario 1 and greater than those of Scenario 2, there is a notable transformation of impacts originating from outside the region. This transformation is accompanied by the construction of transportation routes, which has notably improved in recent years, thereby enhancing provincial linkages within and from Central Java, as well as nationally in general. This observation aligns with findings from research conducted by Akita and Kataoka (2002) in Japan.

Tabel 3. Sector with Largest Output Impact in Each Scenario

Description	Sector Code*
Scenario 1A	C-13
	C-41
	C-1
Scenario 1B	C-13
	C-31
	C-32
Scenario 1C	C-1
	C-24
	C-14
Scenario 2A	C-12
	C-28
	C-16
Scenario 2B	C-12
	C-16
	C-28
Scenario 2C	C-12
	C-5
	C-33
Scenario 3A	C-13
	C-41
	C-28
Scenario 3B	C-13
	C-41
	C-28
Scenario 3C	C-12
	C-13
	C-32
Scenario 3D	C-12
	C-13
	C-33
Scenario 3E	C-1
	C-43
	C-45

Note: *Look at Appendix 1 for the sector's names
Source: Statistics Indonesia, 2021 (Processed)

The findings from this study provide a critical perspective on regional economic policy formulation. The superior performance of Scenario 1, particularly 1A, underscores the significant role of targeted local investments in sectors with high output multipliers within Central Java. This suggests that precision in identifying and investing in high-impact local sectors can lead to maximized economic benefits. However, the relatively lesser impact of combined internal-external investment strategies (Scenario 3) indicates a need for careful consideration of external investments and their alignment with local economic priorities. These insights are crucial for policymakers in optimizing resource allocation to stimulate economic growth effectively within the province.

The greater impact generated by the investment injection in Scenario 1 can be attributed to the direct investment in economic sectors within Central Java, which yields a higher multiplier effect on the local economy owing to the lower "leakage" or "spillover" factor in fund circulation. This indicates that local investments result in a greater circulation of funds within the economy of Central Java, thereby bolstering businesses and employment opportunities in the region through efficient distribution linkages between sectors. Conversely, investments made in sectors outside Central Java, while still influencing the region through economic interconnections, tend to divert some economic benefits primarily to the area of investment origin, thus diminishing the direct multiplier effect on Central Java.

To delve deeper, particularly into Scenario 1, which exhibits the most substantial output impact in Central Java, it can be elucidated that larger investments directed towards the Electricity Sector and Manufacturing Sector tend to yield greater output compared to investments in the green sector. This is because the Electricity and Manufacturing Sectors possess broader economic significance and exert a higher multiplier effect on the economy. These sectors often serve as the industrial and economic backbone of a region, bolstering various other sectors by providing energy and raw materials. In contrast, while the Green Sector holds importance for environmental sustainability, it may exhibit fewer direct and indirect economic linkages with other sectors in the economy and lacks a robust market presence to stimulate economic growth as rapidly as the Electricity and Manufacturing Sectors do.

The sectors most impacted by the investment injection in all scenarios are outlined in Table 3. If the policy aligns with Scenario 1A, the greatest impact on economic output is expected, particularly affecting the third-largest sectors: C-13 (Manufacturing of Food Products and Beverages), C-41 (Food and Beverage Service Activities), and C-1 (Food Crops). Sectors primarily affected in terms of output in Scenario 1A are those associated with agriculture and food. This phenomenon arises due to the fact that the ten sectors with the largest output multipliers are related to the food industry.

In comparison, Scenario 1C, which received investment injection in 5 sectors with the smallest input usage in the coal, oil, and gas sectors, mainly impacting the agricultural and financial sectors, demonstrated the largest output impact on Food Crops (C-1). However, the two sectors with the largest output impact are the manufacturing sectors (C-14 and C-24), primarily influenced by investment in the financial sector.

For the simulation results of Scenario 1B, the most significant output impact is observed in sector C-13, consistent with the impact observed in Scenario 1A. This is unsurprising given the significant role of the agricultural manufacturing sector in Central Java province. It's worth noting that these sectors also happen to be large consumers of fossil energy in their operations.

Figure 4 presents the income impact of various scenarios. The simulation results indicate that, on average, the income impact of Scenario 1 is greater than the average income impact of Scenario 2 and Scenario 3. These findings align with the output impact as well. This suggests that investment policies targeted towards the local sector in Central Java can lead to a more substantial increase in sectoral household income within the province compared to sectoral investment policies implemented by other regional governments or the central government in sectors outside of Central Java Province. This is a realistic outcome as the development of the local sector in Central Java is likely to employ more local workers than foreign workers. When investments are made within Central Java, the local workforce will experience a higher increase in income levels overall

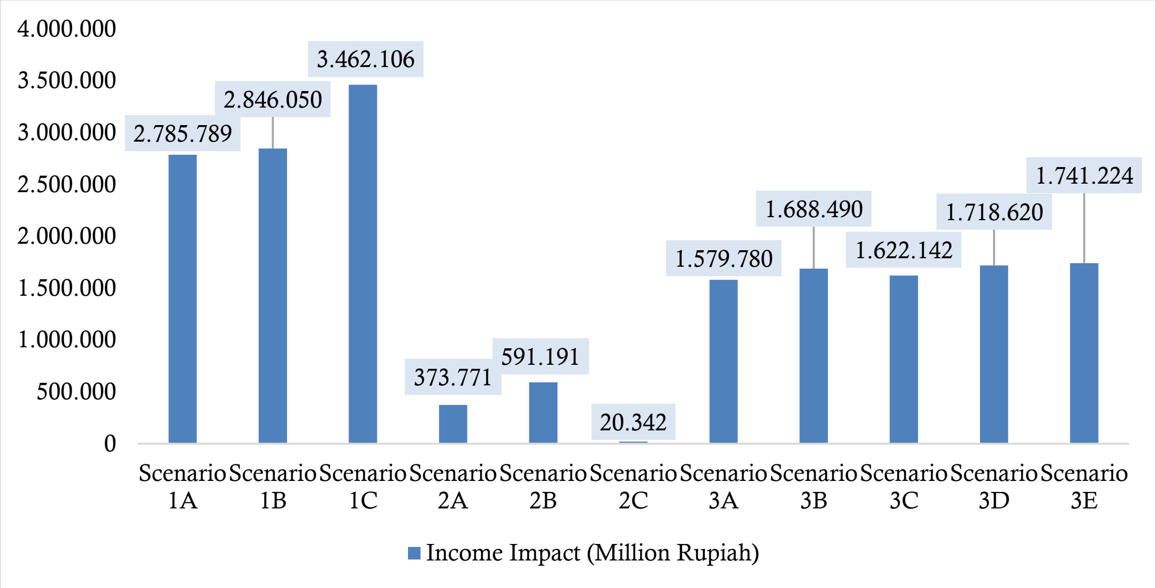

Figure 3. Simulation Results of Income Impact for Various Scenarios
Source: Statistics Indonesia, 2023 (Processed)

Based on the simulation results, Scenario 2 yields the smallest total income impact, while the impact of the Scenario 3 simulation results in a higher level of total income compared to Scenario 2 on average. Mathematically, this can be attributed to the influence of Scenario 1, which is a component of the combined policies in Scenario 3, thus contributing to the improved income outcomes.

The income impact in the simulation results for Scenarios 1A, 1B, and 1C exhibits a different magnitude compared to the output impact. If the output impact of Scenario 1A is the most significant, relative to 1B and 1C, then in the income impact simulation results, Simulation 1C demonstrates the highest impact compared to 1B and 1A. These findings suggest that focusing on the green sector can further enhance sectoral welfare, as these sectors employ more workers than manufacturing sectors. This notion finds support in the research of Martinez et al. (2013), indicating that positive socio-economic impacts can be attained through the development and expansion of the green sector.

Table 4 illustrates three sectors in Central Java that have the most significant income impact.

Tabel 4. Sector with Largest Income Impact in Each Scenario

Description	Sector Code*
Scenario 1A	C-13
	C-41
	C-1
Scenario 1B	C-33
	C-31
	C-50
Scenario 1C	C-43
	C-4
	C-45
Scenario 2A	C-16
	C-12
	C-11
Scenario 2B	C-16
	C-12
	C-14
Scenario 2C	C-5
	C-33
	C-12
Scenario 3A	C-13
	C-41
	C-1
Scenario 3B	C-13
	C-41
	C-16
Scenario 3C	C-33
	C-31

Description	Sector Code*
	C-50
Scenario 3D	C-33
	C-16
	C-31
Scenario 3E	C-43
	C-4
	C-45

Note: *Look at Appendix 1 for the sector's names
Source: Statistics Indonesia, 2021 (Processed)

Based on the simulation results of the 8 scenarios, it is evident that the strategy to increase investment in the local Central Java sector will have a greater impact on increasing output and improving the welfare of local communities in Central Java Province.

The simulation results reveal that local sector investment in Central Java has a more significant impact on increasing household incomes within the province compared to investments directed at sectors outside Central Java. This greater impact is likely due to the local employment opportunities created by such investments. Investments within Central Java not only boost the local economy but also improve the welfare of the community, underscoring the importance of focusing on local sector development for economic resilience and community welfare in the province.

CONCLUSION

Based on the results of various impact simulations using different injection scenarios to increase investment, policies oriented towards local sectoral development in Central Java have a greater impact on income and output compared to external policies and combined policies. Therefore, the government of Central Java needs to formulate policies that can attract investors to the region, particularly in sectors with high output multipliers. However, investment geared towards the green sector would likely have a more favorable impact on enhancing welfare, especially if these sectors are more labor-intensive.

Moreover, a combined policy may be necessary if the central government aims to develop the economy in Central Java while considering the impact on the Indonesian economy as a whole. To support the central government, the Central Java provincial government can implement policy innovations that are internally oriented by considering the value chain of external sectors entering Central Java. These policies can foster the development of external sectors that have significant impacts, aligning them with policies focused on sectors with internal impact pathways within Central Java.

The limitations of the investment injection scenario results in this study lie in the selection of injected sectors and the distribution amounts within those sectors. These factors can influence the magnitude of the impact simulation results. Therefore, expanding the assumptions of scenarios, including the method of fund distribution to sectors and sectoral investment priorities, is crucial in determining the size of the impact. Hence, the selection and distribution of funds to sectors as part of development policies should be rational and provide a wide range of choices to ensure sensitivity and enable meaningful comparisons.

REFERENCES

Akita, T. and Kataoka, M. (2002) 'Interregional interdependence and regional economic growth: An interregional input-output analysis of the Kyushu region', *Review of Urban and Regional Development Studies*, 14(1), pp. 18–40. Available at: https://doi.org/10.1111/1467-940X.00046.

Breschi, S. and Malerba, F. (2020) 'Cluster, Networks, and Innovation: Research Result and New Direction', in *Clusters, Networks, and Innovation*. New York, pp. 1–25. Available at: Oxford University Press.

Chen, W., Zhang, Z. and Chen, K. (2023) 'Inter-regional economic-environmental correlation effects of power sector in China', *Energy*, 278, p. 127764. Available at: https://doi.org/10.1016/j.energy.2023.127764.

Dine, M.N. and Chalil, T.M. (2021) 'Impact of backward linkages and domestic contents of exports on labor productivity and employment: Evidence from japanese industrial data', *Journal of Economic Integration*, 36(4), pp. 607–625. Available at: https://doi.org/10.11130/j ei.2021.36.4.607.

Ding, Q., Cai, W., Wang, C. and Sanwal, M. (2017) 'The relationships between household consumption activities and energy consumption in china— An input-output analysis from the lifestyle perspective', *Applied Energy*, 207, pp. 520–532. Available at: https://doi.org/10.1016/j.apenergy.2017.06.003.

Edwards, M.E. (2017) *Regional and Urban Economics and Economic Development*. New York: Routledge. Available at: https://doi.org/10.4324/9781315088969.

Firmansyah (2006) *Operasi Matrix dan Analisis Input-Output [I-O] untuk Ekonomi : Aplikasi Praktis dengan Microsoft Excel dan Matlab*. Semarang: Badan Penerbit Universitas Diponegoro.

Firmansyah, F., Kurnia, A.S., Oktavilia, S. and Prayogi, R. (2019) 'Forestry Sector Impact on the Economy of Central Java, Indonesia', *Jejak*, 12(1), pp. 168–189. Available at: https://doi.org/10.15294/jejak.v12i1.18575.

Firmansyah, Oktavilia, S. and Handayani, S. (2023) 'Industries Development with the Input-Output Analysis: Investment Simulation on Two Regencies in Indonesia', *Economy of Regions*, 19(1 SE-Sectoral Economics), pp. 220–229. Available at: https://doi.org/10.17059/ekon.reg.2023-1-17.

Firmansyah, Oktavilia, S., Sugiyanto, F.X. and Hudaya, A. (2023) 'Structural Changes and Growth of the Indonesian Fishery, 1975-2010: an Input-Output Perspective', *International Journal of Professional Business Review*, 8(3 SE-Articles), p. e01147. Available at: https://doi.org/10.26668/businessreview/2023.v8i3.1147.

Firmansyah, Prasetyo, A.B., Oktavilia, S., Azyzia, S.H., Puspita, D.W., Boykhair, A. and Nugraha, F. (2023) 'Economic Recovery Strategy of Sectoral Industries Post-COVID-19: Input–Output Model Simulations', *Economies*. Available at: https://doi.org/10.3390/economies11050151.

Freeman, D. and Sultan, E. (1997) 'The economic impact of tourism in Israel: a multi-regional input—output analysis', *Tourism Economics*, 3(4), pp. 341–359.

Guo, J. and Planting, M.A. (2000) *Using input-output analysis to measure US economic structural change over a 24 year period*. United States of America: Bureau of Economic Analysis.

Haddad, E.A., Araújo, I.F., Chawki, C., El-Mansoum, R. and Masnaoui, M. (2023) 'Analysis of economic and environmental impacts of shutting down the Moroccan Refinery Samir: An interregional input-output approach', *Scientific African*, 20. Available at: https://doi.org/10.1016/j.sciaf.2023.e01690.

Hayashi, M. (2005) 'Structural changes in indonesian industry and trade: an input-output analysis', *The developing economies*, 43(1), pp. 39–71.

Hurwicz, L. (2024) 'Input-Output Analysis and Economic Structure', *The American Economic Review*. Edited by W. Leontief, 45(4), pp. 626–636. Available at: http://www.jstor.org/stable/1811637.

Ivanova, G. and Rolfe, J. (2011) 'Using input-output analysis to estimate the impact of a coal industry expansion on regional and local economies', *Impact Assessment and Project Appraisal*, 29(4), pp. 277–288.

Kim, H. and Kim, B.-G. (2015) 'Economic impacts of the hotel industry: An input-output analysis', *Tourism Review*, 70(2), pp. 132–149.

Li, Y., Luo, E., Zhang, H., Tian, X. and Liu, T. (2018) 'Measuring interregional spillover and feedback effects of economy and CO2 emissions: A case study of the capital city agglomeration in China', *Resources, Conservation and Recycling*, 139(January), pp. 104–113. Available at: https://doi.org/10.1016/j.resconrec.2018.07.02

Li, Z., Sun, L., Geng, Y., Dong, H., Ren, J., Liu, Z., Tian, X., Yabar, H. and Higano, Y. (2017) 'Examining industrial structure changes and corresponding carbon emission reduction effect by combining input-output analysis and social network analysis: A comparison study of China and Japan', *Journal of Cleaner Production*, 162, pp. 61–70. Available at: https://doi.org/10.1016/j.jclepro.2017.05.200.

Marconi, N., Rocha, I.L. and Magacho, G.R. (2016) 'Sectoral capabilities and productive structure: An input-output analysis of the key sectors of the Brazilian economy', *Brazilian Journal of Political Economy*, 36, pp. 470–492.

Martínez, S.H., Van Eijck, J., Pereira Da Cunha, M., Guilhoto, J.J.M., Walter, A. and Faaij, A. (2013) 'Analysis of socio-economic impacts of sustainable sugarcane-ethanol production by means of inter-regional Input-Output analysis: Demonstrated for Northeast Brazil', *Renewable and Sustainable Energy Reviews*, 28, pp. 290–316. Available at: https://doi.org/10.1016/j.rser.2013.07.050.

Miller, R.E. and Blair, P.D. (2009) *Input–Output Analysis: Fundations and Extensions*. England: Cambridge University Press.

Mrkaic, M., Mircheva, B., Barkema, J. and Yang, Y. (2021) 'How Do We Discuss Spillovers in Article IV Staff Reports', *IMF Working Papers*, 2021(134), p. 1. Available at: https://doi.org/10.5089/9781513573670.001.

Munjal, P. (2007) 'Structural Changes in Indian Economy: An Input-Output Analysis', *Indian Economic Review*, 42(1), pp. 77–95. Available at: http://www.jstor.org/stable/29793876.

Nakano, S., Arai, S. and Washizu, A. (2018) 'Development and application of an inter-regional input-output table for analysis of a next generation energy system', *Renewable and Sustainable Energy Reviews*, 82, pp. 2834–2842. Available at: https://doi.org/https://doi.org/10.1016/j.rser.2017.10.011.

Nicholson, W. and Snyder, C. (2017) *Microeconomic Theory: Basic Principles and Extensions*. 12th edn. Boston: Cengage Learning.

Ning, Y., Miao, L., Ding, T. and Zhang, B. (2019) 'Carbon emission spillover and feedback effects in China based on a multiregional input-output model', *Resources, Conservation and Recycling*, 141(March 2018), pp. 211–218. Available at: https://doi.org/10.1016/j.resconrec.2018.10.022.

Norbu, N.P., Tateno, Y. and Bolesta, A. (2021) 'Structural transformation and production linkages in Asia-Pacific least developed countries: An input-output analysis', *Structural Change and Economic Dynamics*, 59, pp. 510–524.

Pan, Wei, Pan, Wulin, Shi, Y., Liu, S., He, B., Hu, C., Tu, H., Xiong, J. and Yu, D. (2018) 'China's inter-regional carbon emissions: An input-output analysis under considering national economic strategy', *Journal of Cleaner Production*, 197, pp. 794–803. Available at: https://doi.org/10.1016/j.jclepro.2018.06.207.

Pindyck, R.S. and Rubinfeld, D.L. (2018) *Microeconomics*. 9th edn. Edinburgh: Pearson Education Limited.

Reis, H. and Rua, A. (2009) 'An input–output analysis: Linkages versus leakages', *International Economic Journal*, 23(4), pp. 527–544.

Shibusawa, H., Anantsuksomsri, S., Tontisirin, N. and Puttanapong, N. (2018) 'Evaluating the Spatial Linkages of Thailand's Inter-Provincial Economies and Industries: An Input-Output Approach', in *The Future of Southeast Asian Countries – Population Change, Climate Change, Management of Japanese Companies and Competitiveness*. Yachiyo Shuppan Co., Ltd., pp. 16–34.

Statistics Indonesia (2021) [*Tabel Interregional Input-Output Indonesia Tahun 2016 Tahun Anggaran 2021]*. Jakarta.

Statistics Indonesia (2023a) *[Seri 2010 PDB Seri 2010 Berdasarkan Lapangan Usaha\ (Milyar Rupiah) 2010-2022*, *Statistics Indonesia]*. Available at: bps.go.id (Accessed: 30 May 2023).

Statistics Indonesia (2023b) *GRDP of Jawa Tengah at 2010 Constant Market Price by Industry (Million Rupiahs), 2010 - 2022*, *Statistics Indonesia*. Available at: jateng.bps.go.id (Accessed: 30 May 2023).

Wang, P.P., Li, Y.P., Huang, G.H., Wang, S.G., Suo, C. and Ma, Y. (2021) 'A multi-scenario factorial analysis and multi-regional input-output model for analyzing CO2 emission reduction path in Jing-Jin-Ji region', *Journal of Cleaner Production*, 300. Available at: https://doi.org/10.1016/j.jclepro.2021.126782.

Wang, S., Liu, Y. and Chen, B. (2018) 'Multiregional input–output and ecological network analyses for regional energy–water nexus within China', *Applied Energy*, 227(19), pp. 353–364. Available at: https://doi.org/10.1016/j.apenergy.2017.11.093.

World Bank (2008) *Growing Industrial Clusters in Asia*, *Growing Industrial Clusters in Asia*. Edited by S. Yusuf, K. Nabeshima, and S. Yamashita. Washington, DC: The World Bank. Available at: https://doi.org/10.1596/978-0-8213-7213-5.