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# The Identification of Key Sector for Sustainable Development in Indonesia: An Extended Input-output Analysis

Muhammad Handry Imansyah[1*], Titi Putranti[2], and Muzdalifah[1]

[1]SDGs Center and Faculty of Economics and Business, Lambung Mangkurat University
[2]Faculty of Administration, University of Indonesia
[*]Corresponding author

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**Abstract**

This paper investigates key sectors that can drive sustainable development. Generally, obtaining sustainable development in identifying key sectors for development based on their output multiplier and $CO_2$ emission elasticity. However, one aspect that forgotten is social inclusivity.

The present paper has identified seven key sectors with high output multipliers, low $CO_2$ emissions, and try to simulate the potential impact on income distribution. By simulating investment shocks in these sectors, the present authors try to assess their impact on inclusivity, emphasizing the importance of balancing economic growth, environmental protection, and income distribution that meaning social justice within the sustainable development framework. While prioritizing green economy sectors as key drivers can be beneficial, however, there is potential negative impacts on income distribution. Hence, it is recommended that the policy drives green economy sectors by promoting sustainable growth, resource use efficiency, and social inclusivity. This aligns with the core principles of a green economy, ensuring a future that is prosperous, equitable, and environmentally sound.

**Keywords** – $CO_2$ emissions, sustainable development, income distribution, input-output analysis.

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## Introduction

This paper aims to obtain sustainable development that most methods have often focused on sectors selected primarily for their economic output and carbon footprint. However, this paper tries to examine the intersection of economic growth, environmental protection, and social equity, proposing a new framework for identifying pivotal sectors that can drive sustainable development trajectory.

The application of extended input-output analysis, seven sectors has been identified that stand out for their robust output multipliers and minimal CO2 emissions—sectors that not only drive economic growth but also align with the principles of a low-carbon economy. More importantly, these sectors hold the promise of improving equitable income distribution, a critical component of social inclusivity.

To measure the potential impact of income distribution, it is simulated that investment shocks to gauge the ripple effects across the economy. The findings underscore the significance of a balanced approach—one that does not sacrifice environmental integrity or social equity in the pursuit of economic expansion. This paper illuminates the path forward, advocating for a sustainable development framework that harmonizes economic growth with the imperatives of environmental protection and social justice.

Generally, aligning economic growth with low-carbon emissions is a key challenge in sustainable development. Identifying sectors that support both goals simultaneously requires careful planning and innovative solutions to minimize conflicts and maximize synergistic effect. Balancing economic growth, environmental sustainability, and social inclusiveness is at the core of sustainable development. Therefore, obtaining sustainable development is quite challenging.

Indonesia has pledged adherence to the United Nations Framework Convention on Climate Change (UNFCCC) since 1994, as well as to subsequent international agreements like the Kyoto Protocol and the Paris Agreement, affirming its support for climate change mitigation through ratification. This pledge is articulated in Indonesia's Nationally Determined Contribution (NDC), which initially aimed for a 29% reduction but has since been revised to a 31% reduction by 2030 relative to the Business-as-usual (BAU) scenario, using domestic means. With international assistance, the target has been elevated from 41% to 43%.

Indonesia ranks as the eighth-largest carbon emitter globally, with total emissions amounting to 692.24 million tons of $CO_2$ as of 2022[1]. This highlights the importance of Indonesia's efforts to reduce emissions and transition towards a green economy.

Furthermore, the World Bank Group has published the Indonesia Country Climate and Development Report, which discusses Indonesia's commitments and challenges in climate change adaptation and mitigation, as well as the balance between reducing greenhouse gas emissions and economic growth (World Bank Group, 2023). This report can be a valuable resource for understanding the context and strategies of Indonesia in addressing climate change.

Sustainable development is often depicted as a tripartite model encompassing the economic, environmental, and social pillars. These three facets are inseparable in the developmental journey (Gidding et al., 2002). The green economy emerges as a novel approach to realize sustainable development, encapsulating the crucial triad of economy, environment, and society. In essence, the green economy represents the necessary measures for attaining sustainability. Broadly, it accentuates the entirety of the sustainable development paradigm (Ocampo, 2013). The United Nations Environment Program characterizes the green economy as an economic model that enhances well-being, social fairness, and mitigates environmental degradation (UNEP, 2011). This concept is underpinned by three critical elements: low carbon emissions, resource efficiency, and social inclusivity. A closer examination reveals that the

[1] https://ycharts.com/indicators/indonesia_carbon_dioxide_emissions

“green economy” is essentially a rebranding of “sustainable development,” sharing the same core and objectives.  Globally, nations are pivoting towards sustainable economic practices. The economic development focus is transitioning from the traditional brown economy, which prioritizes economic growth, to a green economy that also considers environmental preservation. The Paris Agreement stands as a testament to international commitment against environmental harm, outlining emission reduction pledges since its inception at the 2015 United Nations Climate Change Conference. In Indonesia, the 2020-2024 National Medium-Term Development Plan (RPJMN) features a green economy policy with ambitious emission reduction goals, aligning with the nation’s 2045 vision and the Paris Agreement. Indonesia can emulate developed nations in providing green economic incentives and should pinpoint low-emission economic sectors to boost production of goods and services.

According to UNEP (2011), government policies should predominantly target green sectors. This research seeks to identify sectors meeting green economy standards. In harmony with Indonesia’s green economy strategy for its 2045 vision, this study will supplement the government’s efforts in formulating robust sectoral policies. The targeted sector should yield a significant economic multiplier effect, maintain low emissions, and improve income distribution. Mohan et al. (2021) advocate for the Leontief Input-Output (IO) model as a robust structural analysis tool, extensively utilized in academia. This paper advances the standard IO model to the Miyazawa IO, incorporating a detailed energy balance to pinpoint sectors that bolster the green economy and, by extension, sustainable development. The paper aims to inform academics and policymakers about key sectors for sustainable development. Our research try to fill the gap by spotlighting priority sectors within the Indonesian green economy, a topic scarcely explored in developing countries. Employing a macroeconomic lens and three indicators, this paper identifies priority sectors for sustainable development. Additionally, it examines the impact of these sectors on Indonesia’s sustainable development using an expanded Miyazawa IO framework, detailing household groups and integrating energy considerations.

The main sectors contributed to $CO_2$ emissions in Malaysia, which include mining, petroleum refining, transportation, electricity and gas supply, production of basic chemicals, fertilizers, tires, plastics, other chemical products, various manufacturing activities, metal product manufacturing, and the combined sectors of wholesale, retail trade, hotels, and restaurants (Othman & Jafari, 2016). Conversly, the predominant emission sectors in China for 2017 were metal smelting, pressing, and nonmetal mineral products, responsible for 35.6% and 13.9% of the total forward and backward emissions, respectively , marking them as significant in terms of carbon emissions (Yuan et al., 2020).

Indeed, achieving the Sustainable Development Goals (SDGs) requires a delicate balance between social and environmental objectives (Scherer et al., 2018). They emphasized that addressing social issues like poverty and inequality (SDGs 1 & 10) must be pursued alongside efforts to reduce environmental impact, as outlined by other SDGs, to ensure that advancements in one area do not undermine progress in others. Similarly, Huq & Ichihashi (2023) observed that a narrow focus on economic measure such as employment and growth may fall short of achieving sustainable development if it overlooks environmental factors.

Hubacek et al. (2021) discovered that 32 mainly developed nations have managed to absolutely decouple their GDP growth from production-based emissions (PBE), according to recent data (2015-2018). However, while these countries saw a reduction in PBE, there is a concern that this may be due to the transfer of emissions elsewhere, as only 23 countries achieved absolute decoupling when considering consumption-based emissions (CBE).

Jiang et al. (2021) argued that industries involved in deep-processing typically exhibit high carbon emission inflows, making this insight crucial for developing targeted carbon reduction strategies within production chains. Identifying these key high-emission sectors is essential for policymakers to devise effective policies. Choi et al. (2016) demonstrated that the environmentally extended input-output framework is adept at clarifying the relationship between environmental indicators and the intricate economic structures at the sectoral level, proving beneficial for energy policy analysis. However, focusing on a single energy indicator might require sacrificing economic growth, presenting a dilemma. Furthermore, expanding the criteria to three dimensions could greatly increase the complexity of the analysis.

This paper be divided into several parts, including Section 2 method and data description. Section 3 presents the results and empirical discussion, while the conclusions and policy implications are presented in Section 4.

## Methods and Data Description

Input-output analysis is a method for examining how different economic sectors interact. It helps identify sectors crucial for economic growth (key sectors) and those influencing other sectors (forward and backward linkages).

The core of input-output analysis is a mathematical model represented by the equation (Miller & Blair, 2009):

$AX + Y = X$ *(1)*

Where:

- A is a matrix showing how much output from one sector is used as input in another.
- X is the total output of each sector.
- Y is the final demand for each sector's output.

This model calculates multipliers to assess how changes in final demand affect overall production.

**Technology coefficient matrix (a)**

The technology coefficient matrix, denoted by A, is a square matrix where each element $a_{ij}$ represents the amount of output from sector *i* required as input to produce one unit of output in sector *j*. Mathematically,

$a_{ij} = x_{ij} / X_j$ (2)

where:

- $a_{ij}$ is the technology coefficient for sectors *i* and *j*
- $x_{ij}$ is the value of output from sector *i* used as input in sector *j*
- $X_j$ is the total output of sector *j*

Each column of matrix A essentially outlines the input structure of a particular sector, reflecting the technological dependencies within the production process. Importantly, input-output analysis typically assumes a constant returns to scale production function.

**Leontief inverse matrix (b)**

The Leontief inverse matrix, denoted by B, is calculated as the inverse of the matrix (I - A), where I is the identity matrix. Mathematically,

$B = (I - A)^{-1}$ (3)

This matrix is crucial for determining the overall impact of changes in final demand on the entire economy.

**Multiplier analysis**

The Leontief inverse matrix, often referred to as the multiplier matrix, is instrumental in understanding how changes in final demand for one sector ripple through the economy and affect the output of all sectors. By multiplying the Leontief inverse matrix by a vector of changes in final demand, we can calculate the corresponding changes in total output for each sector.

**Elasticity analysis**

Alcántara & Padilla (2003) introduced the concept of emission elasticity to quantify the relationship between changes in a sector's value added and its corresponding emissions. Specifically, emission elasticity measures the percentage change in emissions of sector *i* relative to total emissions for a 1% increase in value added produced by sector *j*. The mathematical representation of this concept is as follows:

$$E^{v} = \hat{g}(I - A')^{-1}\hat{s} \quad (4)$$

where:

- $E_{ij}$ is the emission elasticity of sector *i* with respect to value added in sector *j*
- $E_i$ is the total emissions of sector *i*
- $V_j$ is the value added of sector *j*

The components of the equation are defined as:

- *x*: an n x 1 vector representing total production for each sector
- *v*: an n x 1 vector representing value added for each sector
- *A*: an n x n technical coefficient matrix indicating input-output relationships
- *s*: an n x 1 value added coefficient matrix showing the relationship between value added and production for each sector
- *u*: an n x 1 unitary vector
- *c*: an n x 1 vector of sectoral direct emissions
- *C*: a scalar representing total CO2 emissions
- *g*: a CO2 coefficient
- *: diagonal vector, with non-diagonal elements equal to zero
- ′: transpose of a matrix or vector

By summing the emission elasticities across all sectors for a specific sector *j*, we can determine the total percentage change in $CO_2$ emissions resulting from a 1% increase in value added in sector *j*. This analysis provides insights into the sectoral distribution of emissions and the potential impact of economic growth on overall emissions.

**Miyazawa input-output model**

In this study, the team will divide income groups in the value-added row or primary inputs that are originally 1 household group into 10 groups using SAKERNAS and SUSENAS data, namely the wage and salary rows will be divided into 10 income groups and household consumption columns divided into 10 columns of household consumption. The detailed method to calculate income distribution impact can bee seen in Miyazawa (1976). Thus, there will be an analysis of the impact of the *shock* on potential income inequality, especially the selected key sector of the economy. From the impact analysis, it will be known which income groups benefit the most as a result of the development of key sectors of the selected key economy.

Data used in this study is based on Input-output Table including energy row, employment row and as well as wages/and salary and household consumtion divided into decile for rural and urban area in 2016 for 73 sectors. This Table is processed by BPS. Carbon ($CO_2$) emission calculation is based on the consumption of energy of respective sector and then it is converted to $CO_2$ emission depending on the type of energy used.

## Results and Discussion

### The output multiplier

Figure 1 displays the output multipliers for various sectors in the Indonesian economy, emphasizing the importance of sectors like food manufacturing in driving economic growth. Notably, the highest output multipliers are found within the food manufacturing sector. This trend is significant as output multipliers indicate the broader economic impact of a change in final demand on the overall output of an economy. Sectors such as Dairy products, Meat and meat products, Animal feeds, and Tea and coffee rank among the top contributors. Final demand encompasses household consumption, government expenditure, investments, and exports. The large output multiplier observed in these sectors reflects their potential to catalyze economic growth by influencing production across the value chain. This analysis aligns with the strategies of many developing economies, where agriculture and food manufacturing remain critical to not only fostering economic growth but also ensuring food security.

**The role of output multipliers in economic growth**

High output multipliers, particularly in food manufacturing, signal that an increase in demand for these products would significantly boost production throughout the economy. Indonesia's focus on sectors like Dairy products, Meat, Tea, and Animal feeds exemplifies the potential for such industries to stimulate economic growth by strengthening linkages within the supply chain. Similar strategies have been observed in other developing nations. For instance, the development of food processing industries in India has played a critical role in strengthening domestic supply chains and generating alternative employment opportunities (Dixit & Ravichandran, 2022). This trend suggests that the transformation of agricultural raw materials into processed goods enhances the value added to the economy while also reducing wastage and creating jobs in rural areas.

Similarly, Ireland's agri-food sector, which accounted for 7.1% of employment in 2019, has demonstrated a multiplier effect that amplifies economic activity beyond the primary sector. In Ireland, the output multipliers for beef and dairy processing range between 2.0 and 2.5, far higher than the average for other sectors (1.4) (Declan & Keane, 2015). This demonstrates how the prioritization of food manufacturing industries, such as in Indonesia, can catalyze broader economic benefits by generating increased output and employment across sectors.

The food manufacturing sector's high multipliers also have direct implications for rural development. Given that a significant proportion of Indonesia's population resides in rural areas, the expansion of food manufacturing industries has the potential to uplift rural communities by creating jobs and fostering regional development. As discussed by Mandiriza et al. (2016), agro-processing has been a key instrument in facilitating rural economic diversification and stimulating local employment in South Africa. In Indonesia, by focusing on food manufacturing industries such as dairy, meat, and animal feeds, rural economies can experience similar transformations, where job creation in processing plants supports the livelihoods of rural populations. This strategy also reduces the rural-urban divide by promoting industrialization in less developed areas.

Moreover, the literature on agricultural value chains underscores the importance of integrating smallholder farmers into processing sectors to enhance rural income and productivity.  Wilkinson & Rocha (2015) highlight that developing countries that strengthen their food processing industries benefit from an increase in agricultural productivity and rural incomes due to the growing demand for raw materials. By prioritizing food processing, Indonesia can leverage its vast agricultural base to generate inclusive growth across both urban and rural regions, much like other agriculture-dependent economies such as Benin.

Agriculture and food manufacturing are deeply intertwined with food security, an issue of growing importance as supply chains. According to Pereira et al. (2020) agricultural development is not only essential for ensuring food security but also for promoting rural development and economic growth. By bolstering its food processing industries, Indonesia can mitigate the risks associated with fluctuating global food markets, reduce import dependency, and secure a stable domestic food supply.

Moreover, research by Kinkpe et al. (2023) demonstrates that in agriculture-based economies like Benin, the development of the food processing sector enhances agricultural productivity by increasing the demand for raw materials, raising farm-gate prices, and improving rural incomes. This economic model can be applied to Indonesia, where the expansion of food manufacturing has the potential to integrate smallholder farmers into the broader economic structure, increasing their resilience to price shocks and improving food security.

By focusing on industries such as Dairy products, Meat and meat products, and Animal feeds, Indonesia can leverage these sectors to not only spur economic growth but also enhance its food security. Indonesia's prioritization of food manufacturing as a growth driver is consistent with the strategies of other developing economies. According to the Food and Agriculture Organization (Winger & Wall, 2018) food product innovation and agro-processing are essential in creating more value from agricultural commodities, reducing post-harvest losses, and reducing waste.

Looking beyond Indonesia, other developing countries offer valuable lessons on the integration of food manufacturing with broader economic goals. For example, Ghana's agricultural sector, despite its declining share in the country's GDP, remains a vital part of its economy, particularly for rural employment and food security. In Ghana, agricultural output multipliers have been used to identify sectors with the greatest potential for economic development, much like in Indonesia (World Bank Group, 2018). The development of sectors such as maize, cocoa, and processed foods has contributed significantly into higher-value goods, Indonesia can replicate the successes seen in countries like Benin, India, and Ghana. The development of food processing not only benefits rural producers by providing stable demand for agricultural products but also creates jobs in urban areas where processing plants are often located. This dual impact ensures a more balanced and inclusive economic growth that spans both urban and rural populations.

While the focus on food manufacturing is critical for Indonesia's short-term economic growth and food security, long-term sustainable development requires diversification beyond the agricultural and food sectors. Wilkinson & Rocha (2015) have argued that while agri-processing is essential for developing economies, over-reliance on a single sector can expose economies to risks related to global commodity price fluctuations. Hence, as Indonesia continues to develop its food manufacturing industries, it must also explore opportunities for diversifying its industrial base.

Diversification can also help Indonesia transition from an economy heavily dependent on raw material exports to one that exports higher-value manufactured goods. This shift can be supported by policies that foster innovation in food and beverage manufacturing. Research shows that food industry innovation contributes significantly to enhancing both the quality and quantity of exports, which can further strengthen economic growth. For instance, in the United States, the food and beverage sector is a major contributor to exports, and its multiplier effects have been seen to generate additional economic activity across the supply chain (Ghosh & Holland, 2004). Indonesia could emulate this model by enhancing its capacity to produce processed goods for both domestic and international markets.

As food demand becomes more sophisticated globally, innovation and technology are essential for maintaining competitiveness in the food processing sector. The FAO highlights the growing role of food product innovation in meeting consumer demand while reducing waste and increasing efficiency across the supply chain. Innovations in food technology, such as improved processing methods and better storage solutions, allow countries like Indonesia to improve their production capabilities, reduce losses, and offer higher-quality products to both domestic and international consumers.

The development of innovative food processing industries is particularly relevant for Indonesia as it seeks to enhance the efficiency of its supply chains and meet growing consumer demand. This focus on innovation not only enhances competitiveness but also supports the broader goals of sustainable development. As outlined in the Agricultural and Food Engineering Working Document, technological advancements in agri-processing can contribute to economic growth by enabling the production of higher-value goods and reducing reliance on low-cost raw materials.

To maximize the benefits of food manufacturing and agricultural development, Indonesian policymakers must implement strategies that prioritize investment in infrastructure, technology, and research. Building efficient transportation networks and enhancing access to modern farming and processing technologies will enable farmers and processors to participate more fully in the value chain. For example, in India, government policies aimed at strengthening rural infrastructure and promoting food processing clusters have resulted in more integrated and competitive agri-food sectors.

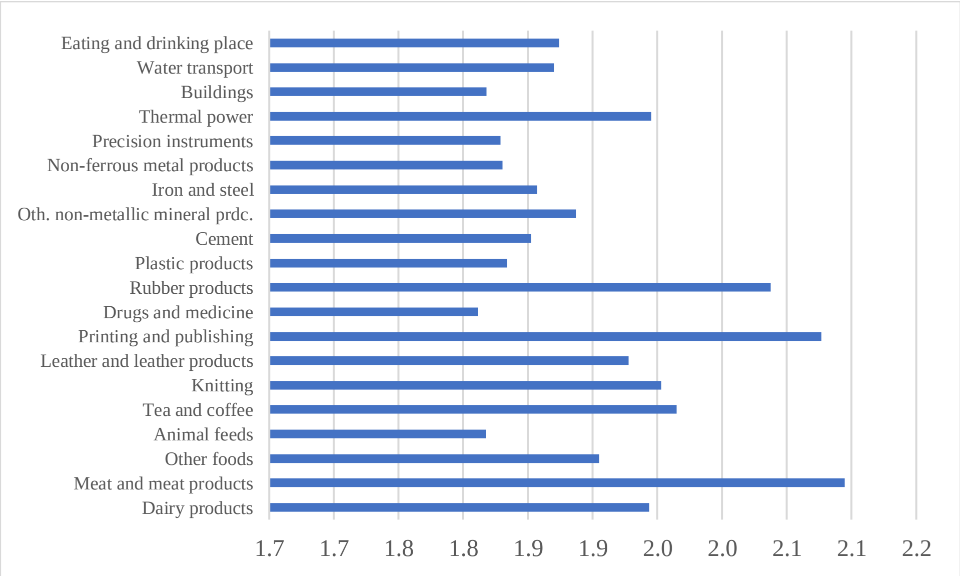
In addition to infrastructure, policies that support small and medium-sized enterprises (SMEs) in the food processing industry are essential for ensuring inclusive growth. Studies have shown that SMEs play a critical role in expanding access to markets for rural farmers, providing employment opportunities, and promoting innovation. By fostering a business environment that supports SME growth, Indonesia can ensure that the benefits of food processing are widely distributed across the economy.

Finally, promoting public-private partnerships and foreign direct investment (FDI) in food processing can help Indonesia access the capital and expertise needed to modernize its agricultural sector. In Benin, for example, public and private investments in the food processing industry have contributed to significant increases in agricultural productivity and rural incomes. Similarly, Indonesia can benefit from increased collaboration between government agencies, local businesses, and international investors to drive the development of a robust and competitive food manufacturing sector.

In summary, food manufacturing plays a vital role in Indonesia's economic growth, particularly due to the high output multipliers seen in sectors like Dairy products, Meat and meat products, and Animal feeds. The development of these industries has the potential to stimulate rural development, improve food security, and contribute to the overall industrialization of the country. Drawing on the experiences of other developing countries like India, Ghana, Benin, and South Africa, Indonesia can build a food processing sector that not only adds value to its agricultural products but also drives inclusive economic growth.

However, to ensure long-term sustainability, Indonesia must also focus on diversifying its economy, investing in innovation, and fostering competitive and modern agri-processing industries. By prioritizing these strategies, Indonesia can achieve balanced, inclusive, and resilient economic growth that benefits both rural and urban populations, while securing its position as a key player in the global food manufacturing industry.

**Figure 1. Type 1 Output Multiplier (The highest 20)**




## Analysis of low $CO_2$ emission sectors and sustainable development

Figure 2 illustrates the twenty sectors with the lowest $CO_2$ emissions within the Indonesian economy. The ten sectors with the lowest $CO_2$ emission elasticity include Other transport equipment, Shipbuilding and repair, Dairy products, Tea and coffee, Drugs and medicines, Non-ferrous metal products, Beverages, Fruits, Meat and meat products, and Wooden furniture. These sectors show a lower sensitivity to increases in $CO_2$ emissions relative to their economic output (value added). In other words, as these sectors grow in economic value, their $CO_2$ emissions rise at a slower rate. This pattern of low elasticity is crucial for identifying industries that can lead sustainable development while minimizing their environmental impact. Notably, many of these low-emission elasticity sectors are in food manufacturing and resource-based manufacturing, such as wooden furniture and non-ferrous metal products. Consequently, these sectors can be prioritized as part of a low-carbon development strategy.

The concept of $CO_2$ emission elasticity reflects the responsiveness of $CO_2$ emissions to changes in a sector's output. A low elasticity value means that even as a sector's output increases, its emissions grow at a slower pace. Sectors with low emission elasticity are thus vital for sustainable development because they can contribute to economic growth without proportionally increasing environmental degradation.

Avenyo & Tregenna (2022) argued that technological intensity in manufacturing plays a significant role in reducing $CO_2$ emissions. They note that sectors with medium- and high-technology intensity tend to emit less $CO_2$ compared to low-technology industries. This supports the findings of low elasticity in sectors like Dairy products and Non-ferrous metal products in Indonesia, where advancements in technology have allowed for production expansion without a corresponding rise in emissions.

Furthermore, Shabir et al. (2023) emphasize the importance of optimizing food processing systems to reduce the carbon footprint across the supply chain. Their review highlights that food processing industries can achieve lower emissions through energy-efficient practices and the use of renewable energy. This is particularly relevant for sectors like Dairy products, Tea and coffee, and Meat and meat products, which are central to Indonesia's agricultural economy. By adopting sustainable practices in these sectors, Indonesia can maintain its competitive edge in food production while aligning with global emission reduction goals.

The identification of key sectors based on both high output multipliers and low elasticity of $CO_2$ emissions is an effective strategy for promoting sustainable growth. The selection of the top 20 sectors with the highest output multipliers and the 20 sectors with the lowest $CO_2$ elasticity resulted in a subset of seven sectors: Dairy products, Tea and coffee, Drugs and medicines, Non-ferrous metal products, Meat and meat products, Animal feeds, and Precision instruments. These seven sectors are critical for sustainable development because they offer a balance between high economic output and low environmental impact.

For example, the Dairy products sector, which has one of the lowest emission elasticities, is a major contributor to Indonesia's agricultural economy. Research shows that Dairy products have substantial economic multipliers, meaning that growth in this sector drives economic activity in related industries. Moreover, the $CO_2$ emissions associated with dairy production in Indonesia are relatively low compared to other manufacturing sectors, thanks to improved production methods and better management of energy and resources. This is consistent with global trends, where sustainable dairy practices have been adopted to reduce the carbon footprint of dairy production systems.

The Tea and coffee sector also demonstrates low $CO_2$ elasticity, making it another key player in Indonesia's sustainability strategy. Prastiyo et al. (2020) point out that agriculture, particularly in developing countries like Indonesia, is responsible for a significant share of greenhouse gas (GHG) emissions, but improvements in agricultural practices and processing can help mitigate these emissions. By focusing on sectors like Tea and coffee, Indonesia can ensure that its agricultural sector remains competitive while reducing its environmental footprint. Additionally, the export potential of these sectors provides further motivation to invest in low-carbon technologies and practices.

The food manufacturing sector, particularly industries like Meat and meat products and Animal feeds, plays a crucial role in Indonesia's economy. These sectors not only contribute to food security but also offer opportunities for sustainable development due to their low $CO_2$ emission elasticity. Mrówczyńska-Kamińska et al. (2021) found that food production systems account for roughly 10–12% of global anthropogenic GHG emissions, with significant variation between animal-based and plant-based food production. Meat production, in particular, is often associated with high GHG emissions, but recent advances in feed efficiency, energy use, and waste management have helped reduce emissions per unit of output.

In Indonesia, the Meat and meat products sector has embraced more sustainable practices, resulting in lower emission elasticity. This aligns with Balogh (2019), who argues that countries can achieve environmental sustainability in agriculture by adopting low-carbon farming practices and optimizing resource use. By prioritizing sectors like Meat and meat products and Animal feeds, Indonesia can promote sustainable agricultural practices that meet both economic and environmental goals.

Similarly, resource-based industries like Non-ferrous metal products and Wooden furniture are important for Indonesia's sustainable development strategy. These sectors, while traditionally associated with high environmental impact, have increasingly adopted cleaner technologies and more efficient production methods. Avenyo & Tregenna (2022) note that medium- and high-technology industries are associated with lower emissions compared to traditional manufacturing sectors. The adoption of such technologies in the Non-ferrous metal products and Wooden furniture sectors has contributed to their low emission elasticity, making them vital components of Indonesia's green industrialization efforts.

The carbon footprint of the key sectors identified in Figure 2 is relatively low, accounting for only 0.2296% of total emissions in the Indonesian economy. This is a significant finding because it demonstrates that these sectors can contribute to economic growth without exacerbating Indonesia's overall carbon emissions. Bajan & Mrówczyńska-Kamińska (2020) suggest that better environmental performance in agribusiness can be achieved through technological innovations that improve efficiency while reducing emissions. This is particularly relevant for the food manufacturing sectors in Indonesia, where sustainable practices have already begun to take root.

In the context of agribusiness, Shabir et al. (2023) highlight the importance of life cycle assessments (LCAs) for understanding the full environmental impact of food production, from raw material extraction to end-of-life disposal. By adopting LCA methodologies, Indonesia's food manufacturing sectors can further reduce their carbon footprint and improve their environmental performance. This approach will be critical for sectors like Dairy products, Tea and coffee, and Meat and meat products, which have the potential to become global leaders in sustainable food production.

To further reduce $CO_2$ emissions and enhance sustainable development, Indonesia must focus on fostering the adoption of cleaner technologies across its key sectors, especially in food manufacturing and resource-based industries. The use of advanced technologies in production processes can significantly lower carbon emissions, as seen in the case of Non-ferrous metal products and Precision instruments. By shifting to more energy-efficient practices, these sectors can reduce their environmental footprint while maintaining high levels of economic output.

Green industrialization refers to the process of industrial growth that minimizes environmental degradation by incorporating sustainable practices and clean technologies. Avenyo & Tregenna (2022) emphasize that green industrialization is crucial for developing countries that seek to balance industrial growth with environmental preservation. For Indonesia, this means promoting sectors like Non-ferrous metal products and Wooden furniture, which have demonstrated low $CO_2$ emission elasticity due to the integration of cleaner technologies and more sustainable practices.

Moreover, green industrialization in Indonesia's manufacturing sector can contribute to long-term economic resilience by reducing dependence on carbon-intensive industries. As Balogh (2019) suggests, sectors that exhibit both high economic output and low carbon footprints are better positioned to withstand the pressures of global climate policies and shifting market demands. This is particularly important as international trade increasingly emphasizes sustainability, with consumers and governments alike favoring products that have a minimal environmental impact.

Agriculture and food manufacturing sectors are not only vital for economic growth but also for mitigating climate change. The agriculture sector alone contributes a significant portion of global GHG emissions, with Indonesia being no exception. Prastiyo et al. (2020) point out that the agricultural and manufacturing sectors in Indonesia are major drivers of economic growth but also significant contributors to carbon emissions. The challenge, therefore, is to reduce emissions from these sectors without compromising their economic contribution.

This can be achieved through the adoption of sustainable farming practices, such as water-efficient rice cultivation and the use of renewable energy sources, which have been recommended as key strategies for reducing agricultural emissions in Indonesia. Similarly, the food manufacturing sector can adopt more sustainable energy sources and improve waste management practices to further reduce its carbon footprint. Shabir et al. (2023) underscore the importance of optimizing the food supply chain, from production to packaging, to minimize emissions across the entire lifecycle of food products.

The Environmental Kuznets Curve (EKC) hypothesis, which suggests that environmental degradation initially worsens with economic growth but improves as economies reach higher levels of income, is relevant to the discussion of sustainable development in Indonesia. Prastiyo et al. (2020) found that Indonesia's manufacturing and agricultural sectors have contributed to rising GHG emissions, but there is potential for these emissions to decline as the country industrializes and adopts cleaner technologies.

This transition is already visible in sectors like Non-ferrous metal products and Wooden furniture, where technological advancements have helped reduce emissions without hindering economic growth. The EKC hypothesis suggests that as Indonesia continues to grow economically, particularly in sectors with low $CO_2$ elasticity, the country can achieve a turning point where economic growth no longer comes at the expense of environmental quality.

Looking beyond Indonesia, the experience of other countries provides valuable insights into the relationship between economic growth and carbon emissions. Bajan & Mrówczyńska-Kamińska (2020) stated that countries like China and Brazil have successfully increased food production while reducing the carbon intensity of their agribusiness sectors. This was achieved through the adoption of low-carbon technologies, improved agricultural practices, and policy incentives that encouraged sustainable development.

Indonesia can follow a similar path by continuing to invest in sustainable agricultural practices and promoting sectors with low $CO_2$ emission elasticity. By focusing on sectors like Dairy products and Tea and coffee, which have demonstrated low emission growth relative to their economic output, Indonesia can ensure that its agricultural sector remains competitive while minimizing its environmental impact.

To fully capitalize on the potential of low $CO_2$ elasticity sectors, Indonesia's policymakers must implement targeted strategies that encourage sustainable growth. This includes providing financial incentives for industries that adopt cleaner technologies and energy-efficient practices. Avenyo & Tregenna (2022) argue that policy interventions such as subsidies for green technologies and stricter environmental regulations can help accelerate the transition to sustainable industrialization.

Additionally, policymakers must focus on fostering innovation in its manufacturing and food production sectors, particularly in industries with low $CO_2$ emission elasticity, such as Dairy products, Tea and coffee, and Non-ferrous metal products. The adoption of energy-efficient technologies, renewable energy sources, and improved waste management systems will be essential in reducing the environmental impact of these industries while maintaining economic growth.

The implementation of green industrial policies is also critical for Indonesia's long-term sustainability goals. Prastiyo et al. (2020) found that Indonesia faces significant challenges in reducing greenhouse gas emissions from its industrial and agricultural sectors, which are the backbone of its economy. To mitigate the environmental impact of these sectors, Indonesia must adopt policies that incentivize the use of renewable energy, promote resource efficiency, and encourage the development of low-carbon technologies.

One policy approach that has proven successful in other countries is the use of carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems. By putting a price on carbon emissions, Indonesia can create financial incentives for businesses to reduce their carbon footprint and invest in cleaner technologies. Additionally, government support for research and development in green technologies will be crucial in driving innovation and ensuring that Indonesia's key industries remain competitive in a low-carbon global economy.

Indonesia's focus on reducing $CO_2$ emissions while promoting economic growth is part of a broader trend seen in many developing countries. For instance, Bajan & Mrówczyńska-Kamińska (2020) demonstrate how agribusiness sectors in countries like Brazil and China have achieved significant reductions in carbon emissions per unit of output through the adoption of sustainable practices and technological innovations. Similarly, Balogh (2019) highlights the role of low-carbon agriculture in reducing the environmental impact of food production while maintaining high levels of productivity. These examples provide valuable lessons for Indonesia as it seeks to balance economic development with environmental sustainability.

In the case of Brazil, improvements in livestock management, feed efficiency, and land use practices have led to substantial reductions in methane emissions from the meat and dairy industries. These practices could be adapted for use in Indonesia's Meat and meat products and Animal feeds sectors, further reducing their environmental impact while enhancing productivity. Moreover, Brazil's experience with bioenergy production from agricultural residues offers a model for Indonesia to develop its own bioenergy sector, reducing reliance on fossil fuels and lowering $CO_2$ emissions across multiple industries.

China, another major developing economy, has also made significant strides in reducing the carbon intensity of its industrial and agricultural sectors. According to Bajan & Mrówczyńska-Kamińska (2020) China's agribusiness sector has successfully increased output while reducing emissions per unit of GDP through the use of precision farming techniques, advanced irrigation systems, and energy-efficient processing technologies. These innovations have not only improved China's environmental performance but have also enhanced the competitiveness of its food manufacturing sector in global markets.

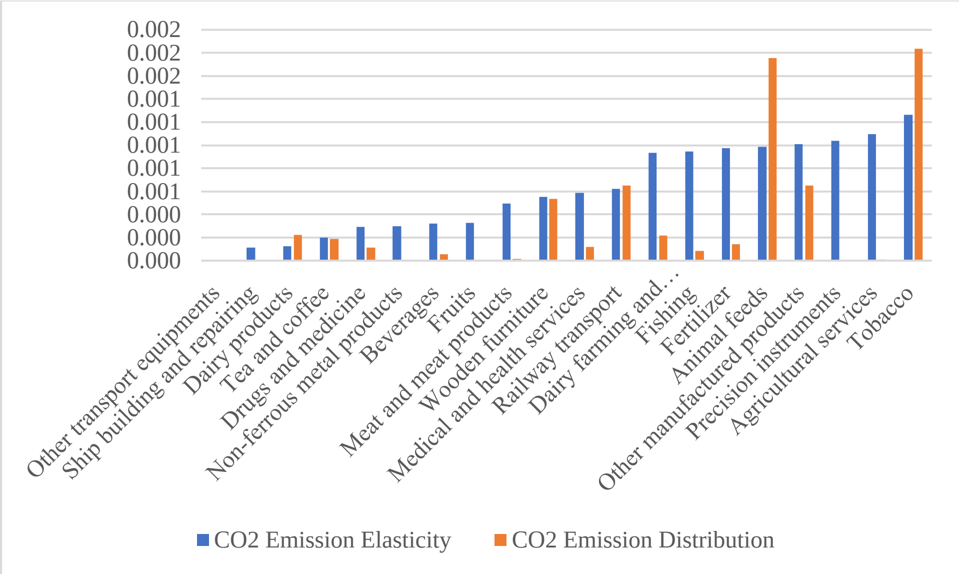
By studying the experiences of Brazil, China, and other developing countries, Indonesia can identify best practices and policy approaches that can be tailored to its own unique economic and environmental challenges. For example, investments in precision agriculture and resource-efficient manufacturing technologies could help Indonesia's key sectors reduce their carbon footprint while maintaining high levels of productivity.

In conclusion, the identification of key sectors with both high output multipliers and low elasticity of $CO_2$ emissions is essential for achieving sustainable development in Indonesia. Sectors such as Dairy products, Tea and coffee, Drugs and medicines, and Non-ferrous metal products are well-positioned to drive economic growth while minimizing their contribution to carbon emissions. These sectors, which together account for only 0.2296% of total $CO_2$ emissions in the economy, represent the cornerstone of a low-carbon development strategy.

To fully realize the potential of these sectors, Indonesia must continue to invest in green technologies, promote resource efficiency, and implement policies that encourage the reduction of $CO_2$ emissions. This includes supporting research and development in low-carbon manufacturing processes, adopting renewable energy sources, and promoting sustainable agricultural practices. Moreover, the adoption of carbon pricing mechanisms, such as carbon taxes or cap-and-trade systems, could provide financial incentives for businesses to reduce their emissions and invest in cleaner technologies.

Learning from the experiences of other developing countries, such as Brazil and China, can provide valuable insights into how Indonesia can achieve sustainable growth while reducing its environmental impact. By focusing on sectors with low $CO_2$ emission elasticity and high economic potential, Indonesia can position itself as a leader in green industrialization, contributing to global efforts to combat climate change while securing long-term economic prosperity.

**Figure 2 Distribution and Elasticity of $CO_2$ Emission (20 sectors of the lowest elasticity)**




## Extended analysis on social inclusiveness and income distribution

Social inclusiveness is a critical pillar of sustainable development, ensuring that economic growth benefits all segments of society, particularly marginalized and low-income groups. In the context of Indonesia, measuring social inclusiveness involves assessing how income distribution would be affected if the seven key sectors identified for sustainable development — those with high output multipliers and low carbon emissions — were prioritized for investment and development.

The simulation conducted by the authors involved a hypothetical Rp 1 million investment in each of these sectors, analyzing the impact on household income across various income deciles. Figure 3 illustrates that investment in these sectors has a more pronounced positive effect on the incomes of the wealthiest households, particularly those in urban areas. This observation aligns with findings from studies such as Zou et al. (2023), which emphasize that economic growth often benefits wealthier households disproportionately. As such, despite the sustainability benefits of these sectors, their development may exacerbate existing income inequalities unless counterbalanced by targeted policies.

### Income disparities between urban and rural areas

The simulation reveals a stark difference in how urban and rural households benefit from investments in these key sectors. The top 10% of the urban population enjoys 38.71% of the total income increase, compared to 26.23% for the top 10% of rural households. Moreover, the bottom 10% of both urban and rural populations receive less than 3% of the total income gains, further highlighting the unequal distribution of benefits.

These results are consistent with the findings of Chen & Zhang (2023), who argue that environmental and economic policies, even those designed to promote sustainability, can inadvertently widen the income gap between urban and rural populations. In particular, policies that focus on green economic growth tend to favor wealthier, urban households that are better positioned to capitalize on new economic opportunities, while rural households, which often rely on traditional industries, lag behind.

Further compounding this issue is the fact that urban populations generally have better access to infrastructure, education, and financial services, all of which are crucial for leveraging new economic opportunities. Mondlane & van Seventer (2019) demonstrate that in developing countries like Mozambique, rural households, particularly those in agriculture, tend to benefit less from economic growth than their urban counterparts due to these structural disadvantages. Similarly, in Indonesia, the rural population may find it more challenging to transition to the new jobs and industries created by investment in high-output, low-carbon sectors, leading to a widening urban-rural income gap.

### Sectoral impact on income distribution

Figures 4 and 5 further highlight the disparities in how different sectors impact income distribution. In the top income decile, sectors such as Precision instruments and Tea and coffee provide the most significant income gains for urban and rural households, respectively. However, even within these sectors, the benefits are skewed towards wealthier households.

This is a common trend in many developing economies, where high-tech and export-oriented sectors tend to favor wealthier, more urbanized populations.

In Indonesia, sectors like Precision instruments, which require advanced technology and skills, are likely to generate more jobs and income in urban areas, where such infrastructure and expertise are concentrated.

Conversely, rural areas, which are more reliant on traditional sectors like agriculture, may benefit less from these investments. Even in sectors such as Tea and coffee, which are more closely tied to rural economies, the benefits are unevenly distributed, with wealthier farmers and landowners capturing a larger share of the income gains.

**Implications for sustainable development**

The findings from this simulation raise important questions about the inclusivity of Indonesia's sustainable development strategy. While the seven key sectors identified for investment have the potential to drive economic growth and reduce carbon emissions, their development may exacerbate income inequality, particularly between urban and rural areas. This presents a challenge for policymakers, who must balance the need for economic growth with the imperative to ensure that the benefits of this growth are equitably distributed.

One potential solution, as highlighted by Bhattacharya et al. (2022), is to implement policies that specifically target low-income and rural households. This could include measures such as improving access to education and training in rural areas, investing in rural infrastructure, and providing financial support to help rural households transition to new industries. By ensuring that rural populations have the skills and resources needed to participate in the new green economy, policymakers can help mitigate the widening income gap.

Another important consideration is the need for social protection policies that shield the most vulnerable households from the negative impacts of economic transitions. Mondlane & van Seventer (2019) argue that in economies like Mozambique, social protection programs, such as cash transfers and subsidies, can play a crucial role in ensuring that low-income households benefit from economic growth. In Indonesia, similar programs could help ensure that the poorest households are not left behind as the economy transitions towards more sustainable industries.

**Addressing inequality in a sustainable development strategy**

In conclusion, while the seven key sectors identified for sustainable development in Indonesia offer significant potential for economic growth and environmental sustainability, their development may have unintended consequences for income distribution. As the simulation shows, investment in these sectors disproportionately benefits wealthier, urban households, while low-income and rural populations see relatively little improvement in their incomes. This could lead to a worsening of income inequality, particularly between urban and rural areas.

To address this issue, policymakers must adopt a more holistic approach to sustainable development, one that not only promotes economic growth and environmental sustainability but also prioritizes social inclusiveness. This could involve targeted investments in rural infrastructure and education, as well as social protection programs to support low-income households. By taking these steps, Indonesia can ensure that its transition to a green economy benefits all segments of society, not just the wealthiest.

**Figure 3 Income Distribution of Key Sector- High Output Multiplier with Low Elasticity $CO_2$ Emission**

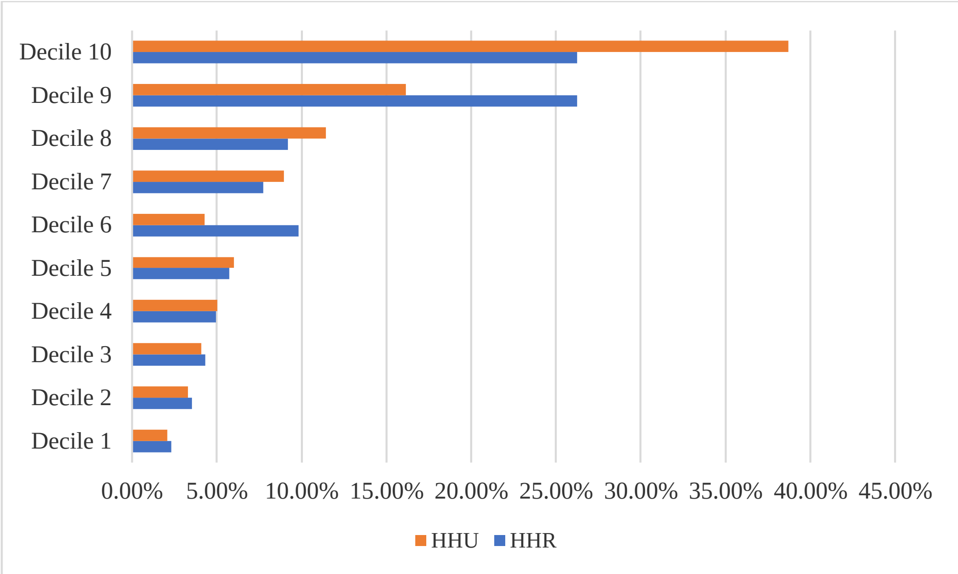



**Figure 4. The Impact of Investment on 7 Key Sector to their Respective Sectors on the Highest Decile**

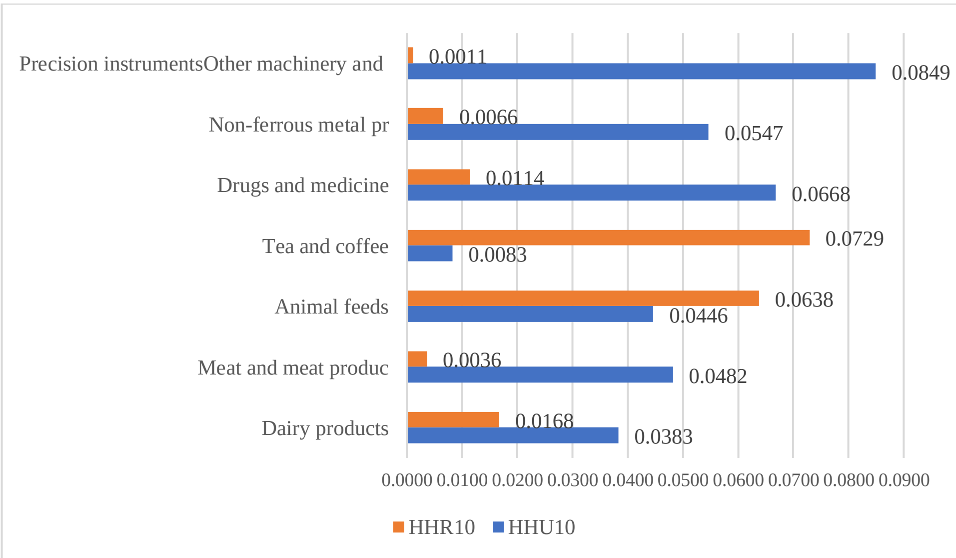
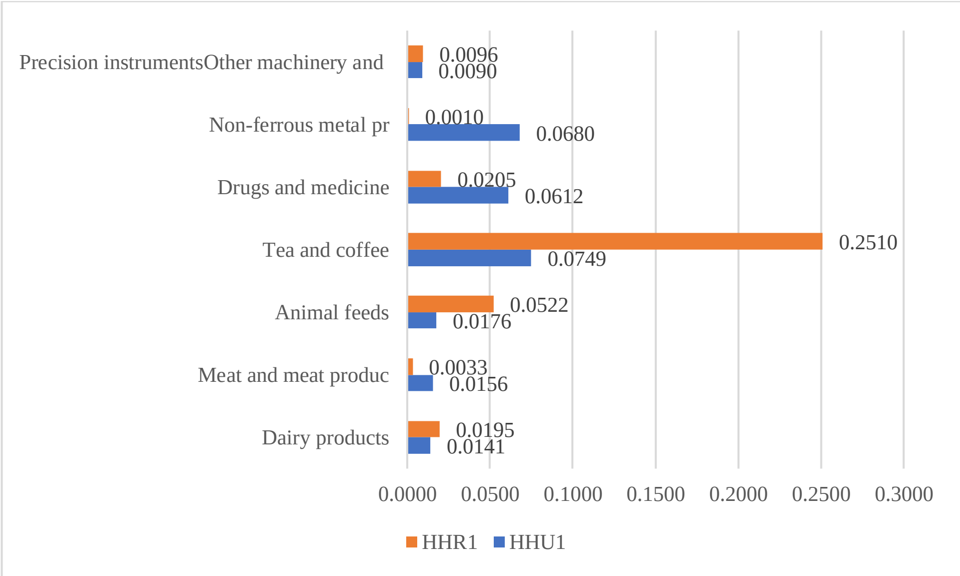


**Figure 5 The Impact of Investment on 7 Key Sector to their Respective Sectors on the Lowest Decile**




## Conclusions and Policy Implications

The identification of seven key sectors with high economic growth low carbon emission to achieve green economy are Dairy products, Meat and meat product, Animal feeds,Tea and coffee, Drugs and medicine, Non-ferrous metal product, Precision instruments, Other machinery and other manufacturing product. However, if investment in sectors with high output multipliers and low carbon emissions can promote economic growth, the benefits are unevenly distributed, favoring wealthier urban households. This disparity exacerbates income inequality between urban and rural populations, as rural households, particularly those in the lowest income deciles, benefit the least from such investments. The sectors identified—such as Dairy products, Tea and coffee, and Precision instruments—are vital for both economic growth and environmental sustainability, yet they contribute to worsening income distribution without targeted interventions.

To address these challenges, several policy recommendations are proposed:

1. **Targeted Investment in Rural Infrastructure**: Investments in transportation, education, and healthcare in rural areas are critical to ensuring that rural populations can participate in the economic opportunities created by these key sectors. Improving access to markets and services will allow rural households to benefit from the growth in sectors like food manufacturing and precision instruments.
2. **Education and Training Programs**: Enhancing access to education and vocational training in rural areas can equip low-income households with the skills needed to transition into high-output, low-carbon sectors. This will help reduce the urban-rural income gap by enabling rural populations to participate more fully in the green economy.
3. **Social Protection Programs**: Implementing social protection measures, such as cash transfers and subsidies for low-income households, can help mitigate the negative impacts of economic transitions. These programs should be designed to support households that are unable to immediately benefit from investments in high-output sectors.
4. **Promotion of Inclusive Industrial Policies**: Policymakers should encourage the development of inclusive industrial policies that integrate smallholder farmers and rural enterprises into the broader value chain. Strengthening the linkages between agriculture and food processing industries can help improve rural incomes and promote more equitable growth.
5. **Adoption of Green Technologies**: To ensure long-term sustainability, Indonesia must invest in green technologies across key sectors, particularly in food manufacturing and resource-based industries. These technologies can help reduce the environmental impact of economic growth while maintaining high levels of productivity.

By addressing the inequalities in income distribution and promoting sustainable industrialization, Indonesia can achieve balanced, inclusive, and resilient economic growth that benefits all segments of society while minimizing environmental degradation.

**Acknowledgement**

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## Appendix tables

### Appendix Table 1. Output Multiplier

| No Sector | Sector | Type I | Type II |
|---|---|---|---|
| 1 | Paddy | 1.3298 | 1.2606 |
| 2 | Fruits | 1.2160 | 1.2017 |
| 3 | Dairy farming and Livestock raising | 1.5319 | 1.5351 |
| 4 | Other edible crops | 1.2388 | 1.2071 |
| 5 | Non-edible crops | 1.3424 | 1.3361 |
| 6 | Agricultural services | 1.3199 | 1.3235 |
| 7 | Forestry (Inc. Hunting) | 1.1833 | 1.1864 |
| 8 | Fishing | 1.2169 | 1.2180 |
| 9 | Coal | 1.5859 | 1.5926 |
| 10 | Crude oil and Natural gas | 1.3425 | 1.3452 |
| 11 | Metal ores mining | 1.3675 | 1.3730 |
| 12 | Non-metallic ores mining | 1.4199 | 1.4276 |
| 13 | Dairy products | 1.9437 | 1.9457 |
| 14 | Meat and meat products | 2.0946 | 2.0993 |
| 15 | Other foods | 1.9052 | 1.8991 |
| 16 | Animal feeds | 1.8174 | 1.8127 |
| 17 | Tea and coffee | 1.9647 | 1.9566 |
| 18 | Beverages | 1.7354 | 1.7476 |
| 19 | Tobacco | 1.5483 | 1.6152 |
| 20 | Spinning and weaving | 1.7514 | 1.7910 |
| 21 | Knitting | 1.9531 | 1.9770 |
| 22 | Wearing apprl. and oth. fabrct. txt. prdc. | 1.7009 | 1.7205 |
| 23 | Leather and leather products | 1.9278 | 1.9931 |
| 24 | Timber and wooden products | 1.7744 | 1.7919 |
| 25 | Wooden furniture | 1.7180 | 1.7684 |
| 26 | Pulp, paper and paper products | 1.8054 | 1.8428 |
| 27 | Printing and publishing | 2.0768 | 2.1037 |
| 28 | Fertilizer | 1.7700 | 1.7764 |
| 29 | Drugs and medicine | 1.8113 | 1.8772 |
| 30 | Soap, detergent and toiletries | 1.7494 | 1.7570 |
| 31 | Other chemical products | 1.6953 | 1.7050 |
| 32 | Petroleum refinery products | 1.4828 | 1.4855 |
| 33 | Rubber products | 2.0375 | 2.0388 |
| 34 | Plastic products | 1.8338 | 1.8449 |
| 35 | Cement | 1.8522 | 1.8628 |
| 36 | Glass and glass products | 1.7307 | 1.7413 |
| 37 | Oth. non-metallic mineral prdc. | 1.8869 | 1.9011 |
| 38 | Iron and steel | 1.8571 | 1.8712 |
| 39 | Iron and steel products | 1.7300 | 1.7493 |
| 40 | Non-ferrous metal products | 1.8305 | 1.8390 |
| 41 | Metallic furniture and accessories | 1.7445 | 1.7571 |
| 42 | Other fabricated metal products | 1.8012 | 1.8737 |
| 43 | Household electrical appliances | 1.5609 | 1.5770 |
| 44 | Oth. elect. machn. and apprts | 1.7134 | 1.8125 |
| 45 | Motor vehicle | 1.6087 | 1.6411 |

| No Sector | Sector | Type I | Type II |
|---|---|---|---|
| 46 | Ship building and repairing | 1.6102 | 1.6337 |
| 47 | Other transport equipments | 1.6707 | 1.6888 |
| 48 | Precision instruments | 1.8288 | 1.8495 |
| 49 | Other machinery and equipments | 1.5524 | 1.6327 |
| 50 | Other manufactured products | 1.6293 | 1.6462 |
| 51 | Thermal power | 1.9452 | 1.9525 |
| 52 | Gas supply | 1.4784 | 1.4799 |
| 53 | Water supply (Inc. sewage, etc.) | 1.4048 | 1.4148 |
| 54 | Buildings | 1.8181 | 1.8381 |
| 55 | Civil engineering | 1.8076 | 1.8225 |
| 56 | Commerce | 1.4166 | 1.4211 |
| 57 | Railway transport | 1.7829 | 1.7917 |
| 58 | Road transport | 1.6625 | 1.6729 |
| 59 | Water transport | 1.8700 | 1.8829 |
| 60 | Air transport | 1.7852 | 1.7975 |
| 61 | Oth. transp. and transp. relt. serv. | 1.5960 | 1.6232 |
| 62 | Eating and drinking place | 1.8739 | 1.8760 |
| 63 | Hotels & other lodging place | 1.5536 | 1.5604 |
| 64 | Postal and telecomnc. serv. | 1.4781 | 1.4819 |
| 65 | Financial and insurance services | 1.3823 | 1.3856 |
| 66 | Real estate services | 1.3535 | 1.3572 |
| 67 | Business services | 1.6118 | 1.6199 |
| 68 | Public administration | 1.6955 | 1.7026 |
| 69 | Education | 1.5117 | 1.5322 |
| 70 | Medical and health services | 1.7177 | 1.7278 |
| 71 | Repair of motor vehicles | 1.3915 | 1.3981 |
| 72 | Other repairs, n.e.c | 1.5490 | 1.5587 |
| 73 | Other services | 1.6105 | 1.6159 |

Source: BPS, IO Energy Miyazawa Table, 2021, calculated by Authors

## Appendix Table 2. Carbon Emission Elasticity

| No. Sector | Sector | Carbon Emission Elasticity |
|---|---|---|
| 1 | Paddy | 0.001709 |
| 2 | Fruits | 0.000325 |
| 3 | Dairy farming and Livestock raising | 0.000933 |
| 4 | Other edible crops | 0.002609 |
| 5 | Non-edible crops | 0.024158 |
| 6 | Agricultural services | 0.001094 |
| 7 | Forestry (Inc. Hunting) | 0.002693 |
| 8 | Fishing | 0.000943 |
| 9 | Coal | 0.020166 |
| 10 | Crude oil and Natural gas | 0.033066 |
| 11 | Metal ores mining | 0.011395 |
| 12 | Non-metallic ores mining | 0.017978 |
| 13 | Dairy products | 0.000123 |
| 14 | Meat and meat products | 0.000493 |
| 15 | Other foods | 0.005551 |
| 16 | Animal feeds | 0.000983 |

| No. Sector | Sector | Carbon Emission Elasticity |
|---|---|---|
| 17 | Tea and coffee | 0.000198 |
| 18 | Beverages | 0.000319 |
| 19 | Tobacco | 0.001265 |
| 20 | Spinning and weaving | 0.006443 |
| 21 | Knitting | 0.001922 |
| 22 | Wearing apprl. and oth. fabrct. txt. prdc. | 0.005584 |
| 23 | Leather and leather products | 0.002669 |
| 24 | Timber and wooden products | 0.002124 |
| 25 | Wooden furniture | 0.000554 |
| 26 | Pulp, paper and paper products | 0.008415 |
| 27 | Printing and publishing | 0.001757 |
| 28 | Fertilizer | 0.000974 |
| 29 | Drugs and medicine | 0.000291 |
| 30 | Soap, detergent and toiletries | 0.001541 |
| 31 | Other chemical products | 0.022868 |
| 32 | Petroleum refinery products | 0.015378 |
| 33 | Rubber products | 0.003556 |
| 34 | Plastic products | 0.073863 |
| 35 | Cement | 0.033568 |
| 36 | Glass and glass products | 0.002430 |
| 37 | Oth. non-metallic mineral prdc. | 0.002238 |
| 38 | Iron and steel | 0.024960 |
| 39 | Iron and steel products | 0.079182 |
| 40 | Non-ferrous metal products | 0.000299 |
| 41 | Metallic furniture and accessories | 0.013443 |
| 42 | Other fabricated metal products | 0.240827 |
| 43 | Household electrical appliances | 0.027525 |
| 44 | Oth. elect. machn. and apprts | 0.006180 |
| 45 | Motor vehicle | 0.009678 |
| 46 | Ship building and repairing | 0.000111 |
| 47 | Other transport equipments | 0.000003 |
| 48 | Precision instruments | 0.001039 |
| 49 | Other machinery and equipments | 0.003138 |
| 50 | Other manufactured products | 0.001010 |
| 51 | Thermal power | 0.016021 |
| 52 | Gas supply | 0.017234 |
| 53 | Water supply (Inc. sewage, etc.) | 0.002905 |
| 54 | Buildings | 0.003191 |
| 55 | Civil engineering | 0.001612 |
| 56 | Commerce | 0.087929 |
| 57 | Railway transport | 0.000619 |
| 58 | Road transport | 0.013039 |
| 59 | Water transport | 0.003688 |
| 60 | Air transport | 0.004728 |
| 61 | Oth. transp. and transp. relt. serv. | 0.008878 |
| 62 | Eating and drinking place | 0.001696 |

| No. Sector | Sector | Carbon Emission Elasticity |
|---|---|---|
| 63 | Hotels & other lodging place | 0.001443 |
| 64 | Postal and telecomnc. serv. | 0.014758 |
| 65 | Financial and insurance services | 0.032179 |
| 66 | Real estate services | 0.008479 |
| 67 | Business services | 0.032211 |
| 68 | Public administration | 0.006919 |
| 69 | Education | 0.006377 |
| 70 | Medical and health services | 0.000586 |
| 71 | Repair of motor vehicles | 0.011077 |
| 72 | Other repairs, n.e.c | 0.001781 |
| 73 | Other services | 0.003075 |

Source: BPS, IO Energy Miyazawa Table, 2021, calculated by Authors