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THE POTENTIAL IMPACT OF CARBON TAX IMPLEMENTATION ON INDONESIA'S OUTPUT AND EMPLOYMENT LEVELS

SYAHRITUAH SIREGAR *
Student, Doctorate Program, Agriculture Science Study Program, Lambung Mangkurat University, Indonesia. * Corresponding Author Email: syahrituahsiregar.iesp@ulm.ac.id; syahrisiregar@gmail.com

LUTHFI FATAH
Professor, Doctorate Program, Agriculture Science Study Program, Lambung Mangkurat University, Indonesia.

M. HANDRY IMANSYAH
Professor, Doctorate Program, Agriculture Science Study Program, Lambung Mangkurat University, Indonesia.

SUNARDI
Professor, Doctorate Program, Agriculture Science Study Program, Lambung Mangkurat University, Indonesia.

Abstract

At present, climate change presents a substantial obstacle to our existence, resulting in extensive effects on ecosystems, businesses, and society globally. Indonesia, a significant contributor to worldwide greenhouse gas emissions through deforestation, agriculture, and fossil fuel consumption, demonstrates its dedication by officially supporting the Paris Agreement. Indonesia is obligated to comply with the targets outlined in the Nationally Determined Contribution (NDC) in order to reduce carbon emissions. Indonesia has made a resolute pledge to implement a carbon tax by 2025. It becomes a main instrument in the scenario of combatting global warming. Industries may have concerns about implementing carbon pricing due to the potential for higher production costs. In the absence of adequate measures to tackle these problems, there are possibilities of opposing it. The study aims to analyze the potential effects of implementing a carbon tax on the production levels and employment rates in Indonesia. This study utilizes input-output analysis as the primary instrument. The result shows that the implementation of carbon tax has the potential to reduce total output by 0.126% and total employment by 0.045%, with the highest intensity observed in the manufacturing sector with a decrease of 0.388% and 0.074% consecutively. The decrease in output and employment per sector is highly influenced by the interrelationship of input-output, not directly on the carbon tax value incurred or the scale of production. The top six sectors experiencing the highest impact intensity consistently also rank within the top 10 in terms of contribution to the total economic output decline. The impact on employment shows that the service sector and agricultural sector are the most affected, with a 42.74% and 33.28% decrease respectively in job opportunities to the total decrease, while the intensity in decline discovers manufacturing sector experiences the highest reduction (0.074%), followed closely by the mining sector (0.0609%). The top four sectors in terms of job opportunity decline intensity are also among the top ranks in terms of the share of carbon tax they bear. The top three sectors in terms of contribution to job loss are the Non-edible Crops sector, the Paddy sector in the Agricultural sector, and the Commerce sector in the Service sector. The Commerce sector has the highest contribution to job loss at 20.26%, followed by the Non-edible Crops sector at 10.53% and the Paddy sector at 9.19%. Policymakers need to consider the potential economic contraction and inflationary effects when designing carbon tax policies and account for broader aspects to mitigate adverse impacts. The transition to a low-carbon economy for long-term ultimate goal involves macroeconomic costs and requires careful policy planning to balance environmental goals with economic stability and growth.

Keywords: Industries, Carbon Tax, Output, Employment, Intensity, Share.

INTRODUCTION

At present, climate change presents a substantial obstacle to our existence, resulting in extensive effects on ecosystems, businesses, and society globally. The main factor behind this occurrence is the gradual buildup of greenhouse gases in the atmosphere, predominantly carbon dioxide released from the burning of fossil fuels, deforestation, and other industrial operations.

The significance of mitigating climate change resides in its capacity to induce irreparable harm to the environment and human civilizations (Wu, 2020). Climate change can result in the occurrence of severe weather phenomena, such as extreme weather events, as well as the increase in sea levels, changes in food production, and the loss of biodiversity, among various other impacts. These alterations not only provide hazards to the environment but also jeopardize economic stability and human well-being.

Carbon taxes, which are categorized as a type of carbon pricing mechanisms, are essential instruments in the battle against climate change. They operate by utilizing a carbon pricing mechanism, which effectively raises the financial costs associated with carbon emissions, hence increasing the financial burden of environmental harm. This economic strategy provides incentives for both enterprises and individuals to decrease their carbon emissions, allocate resources to improve energy efficiency, and shift towards renewable energy sources. Carbon taxes facilitate the transition of economies towards a sustainable and low-carbon future, aligning with international endeavours to address climate change, as exemplified by the Paris Agreement.

Efficiently addressing climate change is crucial for the conservation of our world and the welfare of future generations. Carbon pricing systems are a potent and influential tool for reducing emissions and promoting sustainable development. Indonesia, a significant contributor to worldwide greenhouse gas emissions through deforestation, agriculture, and fossil fuel consumption, demonstrates its dedication by officially supporting the Paris Agreement. Indonesia is obligated to comply with the targets outlined in the Nationally Determined Contribution (NDC) in order to reduce carbon emissions and address the issue of global warming.

Currently, the implementation of carbon price is still inadequate. The absence can be attributed to several issues, including the intricate nature of the implementation and worries of competitiveness. Implementing a carbon price mechanism necessitates a substantial degree of administrative capability and technological proficiency. Creating a successful system in Indonesia is difficult because of the country's heterogeneous economy and diversified physical landscape, necessitating careful consideration of different industries and regions. Industries may have concerns about implementing carbon pricing due to the potential for higher production costs and reduced competitiveness, especially for sectors heavily reliant on energy. In the absence of adequate measures to tackle these problems, there is a possibility of encountering opposition when it comes to implementing carbon pricing. Another key factor to consider is the dependence on fossil fuels. The Indonesian economy mostly depends on fossil fuels, particularly coal and oil. Implementing carbon pricing may lead to significant disruptions in industries and communities that rely on these resources, requiring meticulous preparation and transition solutions.

Despite these challenges, Indonesia has made a resolute pledge to implement a carbon tax by 2025. The carbon price will be integrated into the wider emissions reduction framework. It has been stated and published that the Indonesia's tax rate for carbon dioxide equivalent is IDR 30 per kilogram. Indonesia's Nationally Determined Contribution (NDC) plan has a carbon price mechanism that specifically addresses emissions stemming from energy consumption, a significant driver of the nation's greenhouse gas emissions (Allen & Overy & Ginting & Reksodiputro, 2021; Gugler et al., 2020; Pandey et al., 2022).

To successfully accomplish the objectives, the execution should proceed smoothly, devoid of any significant hindrances. It is important to thoroughly assess the possible negative economic consequences that may follow. Acquiring a thorough comprehension of the distinct circumstances and preferences of a country is crucial for developing strong policy structures and engaging stakeholders efficiently. The study aims to analyze the potential effects of implementing a carbon tax on the production levels and employment rates in Indonesia.

LITERATURE REVIEW

The measurement and analysis of carbon emissions and the evaluation of measures to mitigate them are crucial and have led to a wide range of research endeavors. The Dynamic Integrated model of Climate and the Economy (DICE) model, developed by Nordhaus in 2016, is a tool used to quantify the Social Cost of Carbon (SCC)(Nordhaus, 2017). The SCC is considered the most significant economic term in the field of climate change economics. Ohlendorf has also focused on the influence on income distribution (Ohlendorf et al., 2021). The impact of carbon taxes on output and employment levels is derived from the principles of environmental economics and macroeconomic theory, and it manifests more promptly compared to the previously described effects.

The implementation of a carbon price regime often affects both output and employment in the short run. An academic article examining the effects of carbon price legislation on industrial output and employment reveals that in the short-run, there is a decrease in both employment and output. Certain industries will completely compensate for the losses over extended periods of time. Simultaneously, there is a significant outflow of goods or services to foreign markets in certain industries, especially when taking into account the decrease in exports (Ho et al., 2011). This study examines the effects of carbon control legislation using an Input Output (IO) paradigm, focusing on four different time periods.

A study conducted by Arlinghaus thoroughly examines the effects of carbon prices on several variables, such as employment and output (Arlinghaus, 2015). This paper examines the existing literature on the actual effects of competitiveness indicators at various levels of analysis. Most publications assess systems that include exclusions and

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the allocation of emissions permits without charge. Very few studies have examined the post-facto evidence of the effects of carbon taxes on competitiveness. These studies have shown large reductions in energy intensity, but have observed very minor impacts on competitiveness. The analysis concludes that energy and carbon taxes have no discernible effect on the competitive position, such as output and employment, of the enterprises under scrutiny. However, these taxes do yield positive environmental consequences. Technological advancements that enable the replacement of carbon-based technologies could assist in avoiding this path.

Diverse impacts of carbon pricing are evident at both the macro and micro scales among European nations. According to the study, carbon pricing shocks generally result in a decrease in economic activity, increased inflation, and stricter financial conditions across countries. The average reactions mentioned in the statement hide the fact that there is a significant amount of variation: the impacts are more pronounced in nations that generate higher levels of carbon (Berthold et al., 2023). In certain instances, there is a correlation between actual price hikes and the establishment of carbon tax rates in the United States. Industries characterized by high carbon emissions, such as agriculture, extraction, transportation, utilities, and chemicals, may witness a rise in product prices ranging from 10 to 30 percent, assuming a tax rate of $200 per ton of CO2e (Kay & Jolley, 2023).

The effect of carbon pricing on US industry across different time periods underscores the significance of providing corporations with adequate timeframes to adapt their pricing strategies. If companies are unable to transfer increased expenses to customers, the decline in earnings in some energy-intensive trade-exposed (EITE) sectors will be significant. According to a research, when output prices are able to increase in response to increasing energy costs, the decrease in profits is significantly reduced (Adkins et al., 2012). In fact, policies aimed at mitigating the decline in output and profit can be much more successful. However, throughout the medium- and long-terms, the impact on output becomes more diverse as more adjustments take place, primarily due to the influence of general equilibrium effects.

A recent study examines the fluctuating effects of production volatility (VOL) on CO2 emissions in Turkey between 1980 and 2015. The analysis identifies a pattern known as the Environmental Kuznets Curve (EKC). According to the Environmental Kuznets Curve (EKC), environmental deterioration tends to increase in the early stages of economic development but eventually improves if a certain level of affluence is reached (Genç et al., 2022). The results suggest that attaining macro-stability through a "just transition" is essential for obtaining both economic and environmental advantages. This is consistent with global accords such as the Paris Agreement and the European Union Green Deal.

A study conducted in China utilized a multi-regional computable general equilibrium (CGE) model to demonstrate the significance of employing a suitable combination of policies in order to effectively manage the economic consequences (Wu, 2020). The analysis concludes that implementing a renewable energy policy would result in higher economic costs for decreasing greenhouse gas emissions. Additionally, it would cause a decrease in the level of carbon pricing if a carbon pricing mechanism, including subsidies,

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were already in effect. Simultaneously, implementing a renewable energy policy has the potential to generate significant financial influx to central and western regions. An suitably crafted policy combination would be prudent to enhance low-carbon investment in less developed regions. It has the potential to generate employment opportunities and contribute to economic progress.

A carbon tax is a levy placed on the amount of carbon present in fuels(Metcalf & Stock, 2020; Parry, 2019). Carbon pricing is a method used to decrease carbon dioxide and other greenhouse gas emissions. A carbon tax is imposed on the carbon content of fossil fuels, which effectively increases the cost of these fuels and enhances the competitiveness of renewable energy sources. Implementing a carbon tax raises the production expenses for industries that heavily depend on energy sources with high carbon content. This may result in a decline in production within certain industries. Nevertheless, the income derived from the carbon tax can be utilized to counterbalance these expenses, such as by diminishing other taxes or allocating funds towards sustainable energy initiatives (Fremstad & Paul, 2020; Metcalf & Stock, 2020; Moosavian & Zahedi, 2022). This has the ability to stimulate economic activity in several areas and potentially result in a general increase in output.

A carbon tax can result in employment losses in carbon-intensive industries as a consequence of higher production costs, similar to its effect on output (Metcalf & Stock, 2020). Nevertheless, the income generated from the carbon tax can be utilized to generate employment opportunities in alternative industries. For instance, the funds can be used towards renewable energy initiatives, thereby fostering the creation of fresh job prospects. Most evaluations indicate that the implementation of a carbon price leads to only small decreases in GDP. Based on actual data from a study that examined 25 nations, it is suggested that carbon taxes have had either no effect or a somewhat favorable effect on the overall rate of job growth (Metcalf & Stock, 2020, 2023). Furthermore, the point estimates indicate that there is either no impact or a little positive influence on the growth rates of GDP and total employment.

Studies examining the consequences of the European Union's Emissions Trading System (ETS) on employment, output, and profitability have not discovered any substantial evidence indicating that the EU ETS has noteworthy influence on these factors. The study identified two main effects: employment effects, which were mostly observed in the non-metallic mining sector, and increases in unit material cost and revenues in the power sector. The latter can be attributed to the power industry passing on the costs of emissions prices (Arlinghaus, 2015). Thorough analyses of the effects of carbon pricing schemes on different economic indicators reveal that the implications might vary considerably based on the particular circumstances. The country's economic structures, the carbon pricing mechanism's designs, and other concurrent policies exert greater influence.

Geographic consequences can arise from the implementation of a carbon tax (Conte et al., 2022; Salim & Sidiq, 2022). It has the potential to cause a redistribution of economic activity away from places that rely significantly on industries that produce a large amount of carbon emissions. Nevertheless, if the income generated from the carbon tax is

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returned to the local communities, it has the potential to boost economic activity in these areas. Carbon taxes can result in disparities in the allocation of economic burdens (Känzig, 2021; Känzig et al., 2023). Lower-income households may see a disproportionate impact from increased energy costs. Nevertheless, these impacts can be alleviated by utilizing the proceeds from the carbon tax to finance certain budgetary measures.

The macroeconomic consequences of a carbon tax will be determined by the manner in which the tax income is allocated, as stated by the Congressional Budget Office in 2013. For instance, it could be employed to diminish additional taxes, allocate resources to sustainable energy initiatives, or finance public amenities. The overall impact on output and employment will be determined by the equilibrium between these different influences.

Ultimately, the overall impact of a carbon tax on economic activity is contingent upon several factors, such as the specific structure of the tax, the reactions of businesses and consumers, and the allocation of the tax revenue (Känzig, 2021; Känzig et al., 2023; Metcalf & Stock, 2020; Office, 2013; Perese, 2010). The economic effects of a carbon tax are commonly assessed using computable general equilibrium (CGE) models. These models consider the connections between various sectors of the economy and can offer calculations of the overall economic implications of a carbon tax, including its impact on production and employment.

METHODOLOGY

This study utilizes the primary analytical instrument, specifically the 2016 input-output table, which was released in 2021. This is the most recent input-output table provided by the Central Statistics Agency (BPS) to date. IO analysis is an analytical approach that allows us to examine the interacting links between different sectors in the economy by studying the transaction coefficients that are created within these sectors (Badan Pusat Statistik, 2018; BPS, 2021).

To fulfill the objective of this study, which is to examine the effects of implementing a carbon tax on energy consumption, an Input-Output (IO) table was constructed by incorporating a carbon emissions category into the Other Primary Input section of the IO table framework. The objective is to incorporate carbon emissions resulting from energy consumption into transactions across all 73 economic sectors. The author use the table that was previously created for the ICT carbon research conducted by Imansyah et al (Imansyah et al., 2023) The computation of carbon emissions was conducted by considering energy use in each segment of the business, with the guidance of specialists from the internal BPS.

The potential influence of a carbon price on energy is presented by a sudden change in Final Demand. The magnitude of the shock will be determined by the carbon tax rate imposed on each sector. The values are determined by multiplying the tariff of IDR 30,000 per kilogram by the emissions of each industry. Shocks can potentially lead to simultaneous changes in energy demand and output, which subsequently alter the level

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of carbon emissions. The extent of these alterations will be demonstrated in the outcomes of the energy input-output table analysis, which is computed using the IOW application program.

To demonstrate the potential impact of implementing a carbon price on the level of output and employment, we might refer to the categorization of effects proposed by Sahara (Sahara, 2017).

i) Initial Effect

The initial effect refers to the immediate reaction to an external disturbance. The degree of the shock, as measured in monetary units, might result in either a rise or drop in demand. The initial effect on the output side is equivalent to one unit of currency from sales on final demand. This impacts the primary input, specifically the income component represented by the household income coefficient (hi) and the labor component represented by the labor coefficient (ei).

ii) First Round Effect

The first-round effect is manifested by direct consequences resulting from transactions in each sector as a result of changes in output measured in monetary units. The amount of the effect of the initial output is determined by the direct coefficient value, which is called as the input-output coefficient or αij. The first-round effect, resulting from the effects on the production and revenue aspects, is represented by the equation (Σiαijhi) for the income side and (Σiαijei) for the labor side.

iii) Industrial Support Effect

The impact of industrial support on the output side is the consequence of the subsequent surge in production. Industrial support has a positive impact on income and employment, leading to an increase in both over the second and following cycles. This is attributed to the production of output resulting from industrial support.

iv) Consumption Induced Effect

The consumption induction effect observed on the output side demonstrates the presence of an induction effect, which leads to an increase in household consumption as a result of an increase in household income. The consumption induction effect is derived from the output consumption induction effect, which is multiplied by the household income coefficient and the labor coefficient, representing the impact on consumption from income and labor perspectives, respectively.

v) Flow-on-Effect

Flow-on effects, also known as multiplier effects, refer to the economic impacts that occur across all sectors of a country or region as a result of increased sales in a particular sector. These effects are manifested in terms of output, income, and employment. Cascade effects can be achieved by diminishing the overall impact stemming from the originating cause.

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Table 1: Multiplier Formula for Output and Employment

Value	Multiplier	
	Output	Labor
Initial Effect	1	e_j
First Round Effect	$\Sigma_i\alpha_{ij}$	$\Sigma_i\alpha_{ij}e_i$
Industrial Support Effect	$\Sigma_i\alpha_{ij}$-1-$\Sigma_i\alpha_{ij}$	$\Sigma_i\alpha_{ij}e_{ij}$-$e_J$-$\Sigma_i\alpha_{ij}e_i$
Consumption Induced Effect	$\Sigma_i\alpha^*_{ij}$-$\Sigma_i\alpha_{ij}$	$\Sigma_i\alpha^*_{ij}e_i$-$\Sigma_i\alpha_{ij}e_i$
Total Effect	$\Sigma_i\alpha^*_{ij}$	$\Sigma_i\alpha^*_{ij}e_i$
Flow-on-Effect	$\Sigma_i\alpha^*_{ij}$-1	$\Sigma_i\alpha^*_{ij}e_i$-e_i

Source: Daryanto (1990) in Sahara (2017), adapted

Information:

α_{ij}	: output coefficient
hi	: household income coeffecient
e_i	: labor coefficient
α_{ij}	: Leontief's Inverse matrix open model
α^*_{ij}	: Leontief's inverse matrix close model

There are two types of multiplier analysis, namely type I and type II (Nazara, 2005 in Sahara, 2017). The formulation of these two types of analysis is as follows:

$$Type\ I = \frac{Initial\ Effect + First\ Round\ Effect\ + industrial\ Support\ Effect}{Initial\ Effect}$$

$$Type\ II = \frac{Initial\ Effect + First\ Round\ Effect\ + industrial\ Support\ Effect + Consumption\ Induced\ Effect}{Initial\ Effect}$$

Households are an endogenous component of type II multiplier analysis, sometimes referred to as closed Input-Output analysis model, which shows both direct and indirect effects in changes in exogenous demand factors. Induction effects from household factors are also included in the analysis. This model follows the ideas of the I-O analysis of Miyazawa, which include household institutions as an endogenous variable or into the intermediate demand matrix. To this end, researchers apply Type II multiplier analysis or closed models.

Data extraction is a crucial operation in the creation of the input output table in data processing. The degree of carbon emissions produced by any industry is determined by thorough investigation. After this, the extracted data is combined with information from BPS publications regarding the same carbon emissions statistics. The integrated data serve as the foundation for the estimation of the carbon emissions level during the necessary time frame. A carbon tax shock can be introduced using input output analysis starting with data on carbon emission levels in 2025. Naturally, the analysis results are meant to address issues in line with the goals of the study.

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RESULT AND DISCUSSION

The situation of Output or production, Employment, and carbon emissions in Indonesia is the first thing that has to be understood. The foundation for computing possible carbon tax estimates in Indonesia is information on the state of carbon emissions that happened over the time frame that is accessible. Following that, it will determine how intense the carbon tax affecting the economic indicators especially output and employment.

Economic Production Structure, Employment Structure, and CO2 Emissions Based on Indonesian Input-Output Table 2016

Based on the economic structure found in the Indonesia's input-output table equipped with CO2e from energy in 2016, we can observe the levels of output, labor, and CO2e emissions (from energy) based on economic sectors or activities. Output level represents the total value of goods and services produced in the economy. Labor is one of the input factors or intermediate inputs required in economic activities. The CO2e emissions are generated from energy use in various fields of business, excluding emissions from other sources.

Every economic activity results in negative impacts, one of which is the production of carbon dioxide emissions (CO2) in each economic sector, which is divided into 73 sectors or fields of business. The values of each component per sector group are as shown in the following table:

Table 2: Output, Labor, and CO2e Emission Per Economic Sector

No.	Sector	Output (%)	Employment%	CO2e Emission (%)
A	Agriculture	8.27	31.90	0.04
B	Mining	5.09	1.24	1.19
C	Manufacture	31.52	13.75	89.83
D	Service	55.07	53.10	8.94
	Total	100.00	100.00	100.00

Source: BPS, 2021 (processed)

From the above table, it is evident that out of the total output in the Indonesian economy amounting to Rp. 22,960.69 trillion (BPS, 2021), a significant portion is generated by the service sector at approximately 53.07%, followed by the manufacturing sector contributing 31.53%. The agriculture and mining sectors are the lowest contributors to output at 8.27% and 5.09% respectively.

In terms of their contribution to the output, the service sector also makes the largest contribution to labor absorption at 53.10% out of a total of around 118.4 million job opportunities (BPS, 2021). Despite its lower contribution to output, the agriculture sector plays the second-largest role in providing jobs at 31.90%. The manufacturing sector provides employment with the third largest contribution after agriculture, amounting to 13.75%. Meanwhile, the mining sector, whose output value is not far below agriculture, only contributes 1.24% of the total workforce of 118.41 million people.

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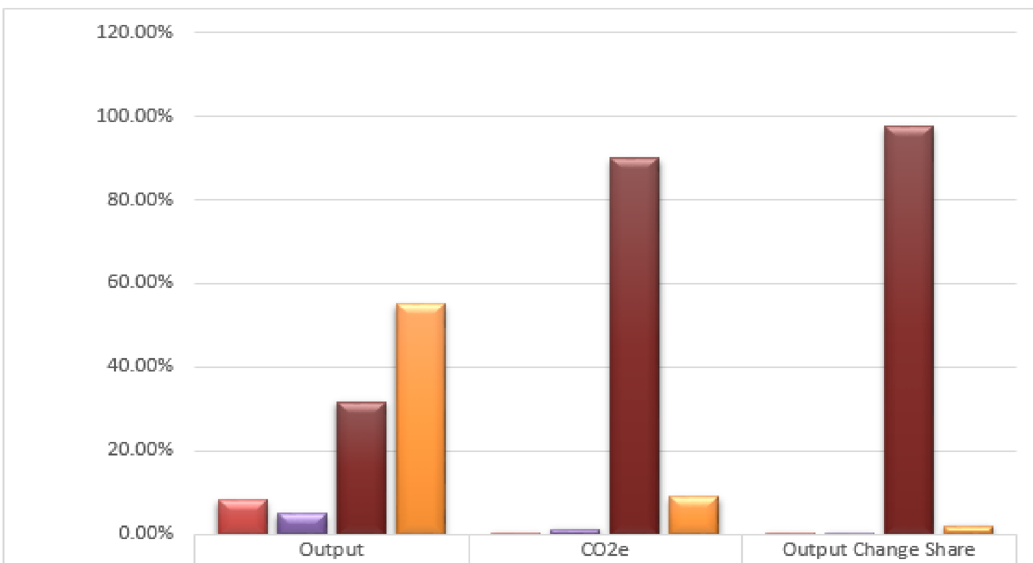
In terms of CO2e emissions, the pattern is significantly different from output and job opportunities. The manufacturing sector is highly dominant, accounting for 89.83% of the total emissions of 538,025 thousand tons. Other sectors are far below, with the service sector contributing 8.94%, mining 1.19%, and agriculture 0.045 of the total carbon emissions. The high carbon emissions in the manufacturing sector reflect the high intensity of energy use in the manufacturing sector. The service sector, despite its dominant role in output and workforce, has relatively low energy use intensity. Implications of the magnitude of these CO2e emissions suggest that proportionally, the carbon tax imposed on the manufacturing sector will be much higher compared to other sectors.

Estimation of the Impact of Carbon Tax Imposition on the Economic Output Level.

The implementation of carbon tax poses potential negative impacts on output across all economic sectors including agriculture, mining, manufacturing, and services. As theoretically explained, carbon emission reduction policies generally have negative impacts on the economy. Carbon tax increases fuel costs, which are part of production costs. The rise in production costs directly burdens the related sectors, systematically leading to direct and indirect impacts on other related business fields. In input-output analysis, the magnitude of this impact is determined by the forward and backward linkages intensity among sectors.



	Output	CO2e	Output Change Share
Agriculture	8.27%	0.041%	0.06%
Mining	5.09%	1.190%	0.37%
Manufacture	31.57%	89.830%	97.46%
Service	55.07%	8.940%	2.11%

Figure 1: Shares of Output, CO2e, and Output Change by Sector based on Indonesia IO Table of 2016

Source: Data Processing

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The graph indicates that the manufacturing sector is potentially the most affected by carbon tax. The decrease in output in the manufacturing sector contributes to 97.46% of the total output decline, amounting to IDR.28.86 trillion.

The service sector contributes 2.11% to the output decline. The mining and agriculture sectors have the smallest contributions, at 0.37% and 0.06% respectively. There is a significant difference between the manufacturing sector and other sectors.

The implementation of carbon tax has the potential to reduce the total output by 0.126%, as shown in the graph. Looking at the intensity of carbon tax impact on output per sector measured by the percentage of changes, the highest intensity is observed in the manufacturing sector with a decrease of 0.388%. Meanwhile, other sectors show significantly lower intensities, with the agriculture sector experiencing the lowest decrease at 0.001%.

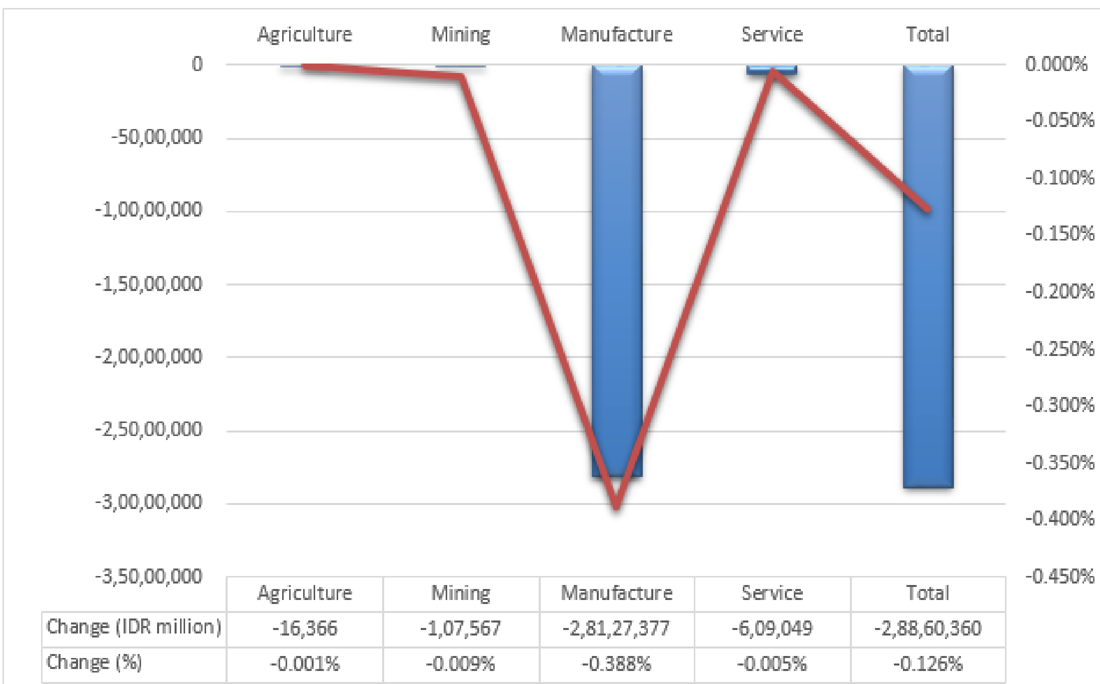

Figure 2: Shares of Output, CO2e, and Estimated Output Change by Sector Due to Carbon Tax

Source: Data Processing

In absolute terms, the carbon tax value is linearly influenced by the amount of carbon emissions generated. However, the decrease in output per sector is highly influenced by the interrelationship of input-output, not directly on the carbon tax value incurred, nor on the scale of production.

The manufacturing sector tends to have extensive and interconnected production chains with other sectors. This is evident in the analysis results of field-specific impacts showing

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that the manufacturing sectors receive relatively significant influence from tax policies in more detail. These findings can also explain why the manufacturing sector is more affected compared to other sectors.

Table 3: Share of Carbon Tax, Output Decline, and Decline Intensity of Some Selected Sectors

	Sector/ Subsector	Carbon Tax		Output Decline		Decline Intensity	
		Share	Rank	Share	Rank	Share	Rank
3.30	Other fabricated metal products	0.11%	42	84.47%	1	-50.17%	1
3.23	Cement	0.01%	53	2.95%	3	-0.97%	2
3.40	Gas supply	0.00%	71	0.77%	6	-0.54%	3
3.22	Plastic products	0.37%	26	3.17%	2	-0.44%	4
3.27	Iron and steel products	0.00%	62	2.93%	4	-0.41%	5
3.32	Oth. elect. machn. and apprts	3.50%	5	0.20%	11	-0.20%	6
3.9	Knitting	0.23%	32	0.11%	21	-0.18%	7
3.26	Iron and steel	0.39%	23	0.82%	5	-0.13%	8
3.11	Leather and leather products	0.22%	34	0.10%	25	-0.08%	9
3.15	Printing and publishing	0.18%	36	0.10%	24	-0.08%	10
	….	….	….	….	….	….	….
3.29	Metallic furniture and accessories	10.21%	3	0.13%	17	-0.05%	11
3.33	Motor vehicle	10.34%	2	0.10%	27	-0.01%	35
3.36	Precision instruments	48.05%	1	0.001%	71	-0.0005%	64

Source: Data Processing

The table above displays the sectors within the top 10 ranks in terms of the magnitude of impact intensity on output, along with the top 3 sectors in terms of the amount of carbon emissions produced. From this table, it is evident that all sectors experiencing the relatively greatest impact from carbon tax consist of manufacturing sectors.

The Other Fabricated Metal Products sector is the business sector experiencing the largest output decline intensity at 50.17% and ranks first. The Cement industry follows in second place with 0.97%, followed by the Gas Supply sector with 0.54%, the Plastic Products sector with 0.44%, and so on until the Printing and Publishing sector ranks tenth with a magnitude of 0.08%. Sectors ranked second and below have percentage values far below the impact intensity experienced by the sector in the first rank.

The top six sectors experiencing the highest impact intensity consistently also rank within the top 10 in terms of contribution to the total economic output decline. The Other Fabricated Metal Products sector contributes 84.47% to the total output decline at the first rank. Following this are the Cement sector (rank 3), Gas Supply sector (6), Plastic Products sector (2), and so forth until the Iron and Steel Products sector ranks fifth. When compared to the amount of carbon tax borne by these sectors, it turns out that the ranking position does not have a strong relevance. The Other Fabricated Metal Products sector, ranking first in terms of impact intensity and contribution to output decline, only bears 0.11% of the total carbon tax value or ranks 42nd.

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Not much different, even more contrasting, is the Cement industry sector that only bears a tax burden of 0.01% or ranks 53rd. This means that the significant decline in job opportunities in each sector is generally not directly related to a high carbon tax. The impact of changes to output is more influenced by the relationships or interactions between sectors through input-output relationships.

The opposite condition is experienced by selected sectors outside of those 10 sectors selected based on their share in the carbon tax value. The Metallic Furniture and accessories sector, ranked third in carbon tax contribution with a share of 10.21%, ranks 11th in the intensity of the impact received at 0.05%. The Motor vehicle sector, ranked second with a share of 10.34%, only ranks 35th in the level of intensity of the impact received at 0.01%. The Precision Instruments sector, ranked first with a share of 48.05%, is even more contrasting as it is only impacted by 0.0005% or ranks 64th.

In terms of contribution to the total output reduction, the Precision Instruments sector ranks much lower at 71 with a share of 0.001%. A similar pattern is experienced by the Metallic Furniture and accessories sector and the Motor vehicle sector. This proves that the level of carbon tax incurred does not directly determine the magnitude of the negative consequences that occur in output. Even though the level of carbon emissions generated is high, resulting in a large carbon tax payment, the level of output produced is not significantly affected.

Estimation of the impact of carbon tax imposition on the level of Employment Absorption.

Tax imposition on various sectors of the economy will result in changes in the level of labor utilization. This is evident from the impact analysis results in this study. The impact calculations indicate a decrease in labor utilization or a decrease in job availability. The most affected sector in terms of its share is the service sector, contributing to a 42.74% decrease in job opportunities totaling 53,732 people.

Alongside the service sector, job opportunities in the agricultural sector have decreased significantly, ranking second with 33.28%, followed by the manufacturing sector with a contribution of 22.31%. The mining sector is the least impacted sector in terms of share, contributing only 1.66%. A more detailed view reveals that the carbon tax impact varies among different economic sectors and is not directly determined by the emission levels and the imposed carbon tax.

The service sector and the agricultural sector, which are the most affected by the decrease in job opportunities, have a relatively small share in carbon dioxide emissions but the largest share in the workforce. The size of each sector in job opportunities is 53.10% and 31.90% respectively in line with the position of the declining job opportunities. A high carbon tax as a consequence of high carbon emissions in the manufacturing sector, at 89.83%, only places this sector in third place in terms of reducing the number of job opportunities.

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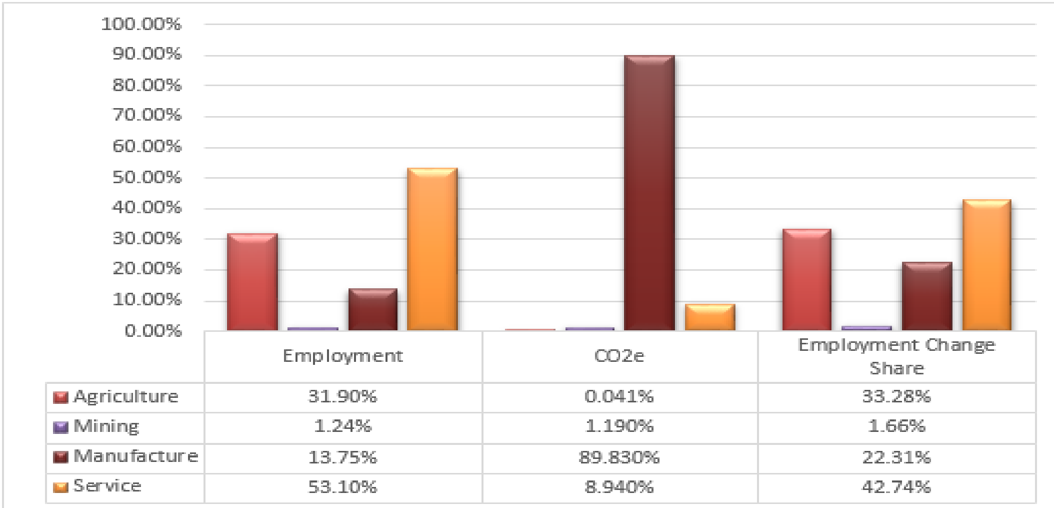

Figure 3: Sectoral Shares of Employment, CO2e Emission, and Estimated Employment Change Due to Carbon Tax

Source: author's calculation

The service sector and the agricultural sector, which are the most affected by the decrease in job opportunities, have a relatively small share in carbon dioxide emissions but the largest share in the workforce. The size of each sector in job opportunities is 53.10% and 31.90% respectively in line with the position of the declining job opportunities. A high carbon tax as a consequence of high carbon emissions in the manufacturing sector, at 89.83%, only places this sector in third place in terms of reducing the number of job opportunities.

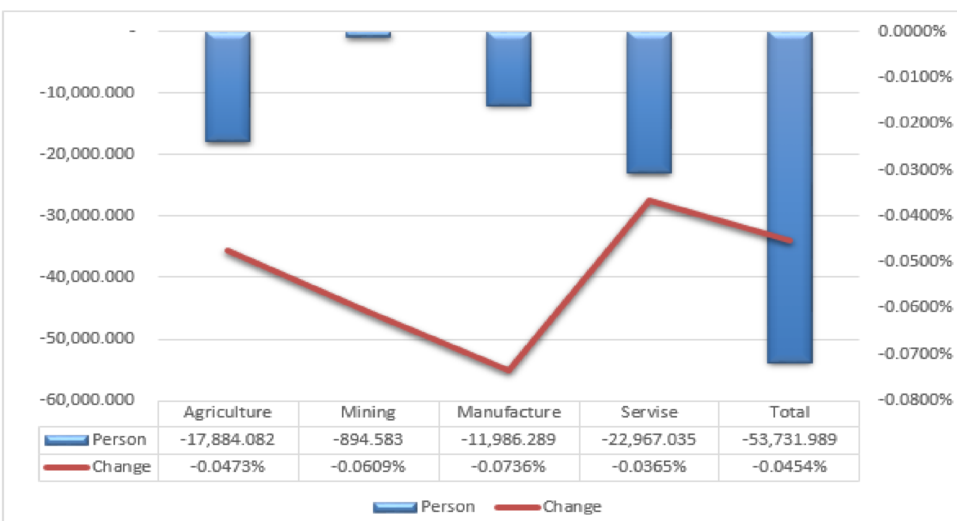

Figure 4: The Estimated Decrease of Employment by Sector Due to Carbon Tax

Source: Data Processing

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The impact intensity of implementing a carbon tax on employment can be seen from the percentage of lost job opportunities compared to the total original workforce. The influence intensity can illustrate how strongly this sector is affected by the policy. Therefore, this indicator can provide a deeper insight into the effects compared to just the absolute influence measure.

From the graph, it can be observed that there is a total decrease in job opportunities of 0.045%. Sector-wise, the manufacturing sector experiences the highest reduction in job opportunities with a decrease of 0.0736%. Following closely is the mining sector with a decrease in job opportunities of 0.0609%, followed by the agricultural and service sectors sequentially with 0.0473% and 0.0365%. Contrary to its share in absolute terms, the service sector experiences the smallest decline in job opportunities. The mining sector moves up to the second position in the intensity of job opportunity reduction, contrary to its position in contribution which is at the bottom. This means that even though this sector has the smallest absolute job loss, it delivers a relatively larger blow compared to others.

Table 4: Share of Carbon Tax, Employment Decline, and Decline Intensity of Some Selected Sectors

	Sector/ Subsector	Carbon Tax		Employment Decline		Decline Intensity	
		Share	Rank	Share	Rank	Share	Rank
3.30	Other fabricated metal products	48.05%	1	0.69%	23	-5.20%	1
3.23	Cement	6.74%	4	5.37%	5	-0.40%	2
3.22	Plastic products	10.21%	3	1.52%	15	-0.37%	3
3.27	Iron and steel products	10.34%	2	2.89%	9	-0.36%	4
3.40	Gas supply	1.89%	8	0.25%	44	-0.35%	5
3.32	Oth. elect. machn. and apprts	0.82%	9	0.03%	69	-0.21%	6
3.29	Metallic furniture and accessories	0.42%	21	0.05%	64	-0.18%	7
3.26	Iron and steel	3.50%	5	0.60%	27	-0.17%	8
3.9	Knitting	0.38%	25	0.25%	43	-0.14%	9
3.39	Thermal power	2.10%	7	0.40%	31	-0.10%	10
	….	….	….	….	….	….	….
1.5	Non-edible crops	0.001%	64	10.53%	2	-0.08%	16
4.3	Commerce	3.377%	6	20.26%	1	-0.05%	29
1.1	Paddy	0.000003%	68	9.19%	3	-0.04%	47

Source: Author's calculation

This phenomenon can be further explored through a more detailed analysis per sector, divided into 73 business sectors. The table above only displays the sectors within the top 10 ranks in terms of the magnitude of impact intensity on output, along with 3 other sectors considered to play a significant role.

All sectors within the top 10 positions experiencing the greatest impact intensity from carbon taxes originate from the manufacturing sector. The Other Fabricated Metal Products sector experienced a decrease of 5.20% from the original output and ranked

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first. This is followed by the Cement, Plastic Products, Iron and Steel Products, Gas Supply industries, and so forth, up to Thermal Power in the tenth position. These sectors have impact intensity levels far below, ranging between 0.10% - 0.40%. Meanwhile, other sectors are below these figures.

There is a tendency of a direct relationship between the amount of carbon tax incurred and the impact intensity. The top four sectors in terms of job opportunity decline intensity are also among the top ranks in terms of the share of carbon tax they bear. These sectors are Other Fabricated Metal Products, Cement, Plastic Products, and Iron and Steel Products. Furthermore, 8 out of the top 10 sectors in these positions are also among the top 10 in terms of carbon tax value, except for the Metallic Furniture and Accessories sector and the Knitting sector.

When compared to the amount of lost job opportunities, it turns out that the top-ranked sector does not all contribute significantly. The sector of Other Fabricated Metal Products, ranked first in terms of job loss intensity, only accounts for 0.69% of the total lost job opportunities or ranks 23rd. In contrast, the Cement sector, ranked second, shows a consistent relationship as it ranks 5th in its contribution to job loss (5.37%) and 4th in the amount of carbon tax borne (6.74%). This indicates varying impacts occurring among the existing business sectors.

Another important finding is regarding the sectoral contribution levels to job loss. The top three sectors in terms of contribution consist of the Non-edible Crops sector, the Paddy sector belonging to the Agricultural sector, and the Commerce sector belonging to the Service sector. The Commerce sector's contribution to job loss is 20.26%, ranking 1st, followed by the Non-edible Crops sector in 2nd position with 10.53%, and the Paddy sector in 3rd position with 9.19%.

From the perspective of impact intensity indicators, the Commerce sector ranks 29th at 0.05%, Non-edible Crops ranks 16th at 0.08%, and the Paddy sector ranks much lower at 47th with 0.04%. Thus, different indicators will yield different ranking results. This highlights the importance of understanding the objective conditions, especially regarding the urgency of the issue and the policy orientation to be taken.

Output Decline as a Result of a Carbon Tax

The Indonesian Input-Output Table 2016 shows the economic structure of the country, with output, labor, and CO2 emissions based on various sectors. The service sector generates a significant portion of the total output, accounting for 53.07%, followed by the manufacturing sector, which contributes 31.53%. The agriculture and mining sectors are the lowest contributors to output, at 8.27% and 5.09% respectively. The service sector also contributes the most to labor absorption, accounting for 53.10% out of 118.4 million job opportunities. The manufacturing sector provides employment with the third largest contribution, amounting to 13.75%. The mining sector contributes 1.24% of the total workforce. The manufacturing sector is highly dominant, accounting for 89.83% of the total emissions, reflecting the high intensity of energy use in the manufacturing sector. The carbon tax imposed on the manufacturing sector may have a greater impact on output

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than other sectors. The manufacturing sector is potentially the most affected by carbon tax, with a decrease in output contributing to 97.46% of the total output decline, amounting to IDR.28.86 trillion. The finding that carbon tax imposition could impact economic output especially in the short-run, as this research's time frame is, is supporting many previous research. Manufacturing sector in particular is the most affected sector in terms of output decline. This sector has high intensity of energy use shown by the degree of its CO2e emission. This happens when the kinds of industries cannot adjust with higher costs shock (Adkins et al., 2012; Arlinghaus, 2015; Ho et al., 2011; Kay & Jolley, 2023; Metcalf & Stock, 2020, 2023).

In the long run some industries can adjust to compensate for the losses over the periods. However, there is a significant outflow of goods or services to foreign markets in certain industries. Studies have shown that energy and carbon taxes have no discernible effect on competitiveness, but they do yield positive environmental consequences. Technological advancements that enable the replacement of carbon-based technologies could help avoid this path. The effect of carbon pricing on US industry across different time periods emphasizes the importance of providing corporations with adequate timeframes to adapt their pricing strategies. Policies aimed at mitigating the decline in output and profit can be more successful.

The implementation of carbon tax has the potential to reduce total output by 0.126%, with the highest intensity observed in the manufacturing sector with a decrease of 0.388%. The decrease in output per sector is highly influenced by the interrelationship of input-output, not directly on the carbon tax value incurred or the scale of production. The manufacturing sector tends to have extensive and interconnected production chains with other sectors, which results in the manufacturing sector receiving relatively significant influence from tax policies.

This research using IO analysis as a tool can elaborate the impacts more deeply into some extent of industrial categories available in the IO table structure. The same tool and its expanded variants like CGE are also utilized in many research with similar purpose (Ho et al., 2011; Kay & Jolley, 2023; Mejean & Schoch, 2023; Metcalf & Stock, 2020, 2023). The top six sectors experiencing the highest impact intensity consistently also rank within the top 10 in terms of contribution to the total economic output decline. The Other Fabricated Metal Products sector contributes 84.47% to the total output decline at the first rank, followed by the Cement industry, Gas Supply, Plastic Products, and Iron and Steel Products sectors.

However, the ranking position does not have a strong relevance when compared to the amount of carbon tax borne by these sectors. The significant decline in job opportunities in each sector is generally not directly related to a high carbon tax. The impact of changes to output is more influenced by the relationships or interactions between sectors through input-output relationships. Sections outside of those 10 sectors selected based on their share in the carbon tax value experience the opposite condition. The Metallic Furniture and accessories sector ranks third in carbon tax contribution with a share of 10.21%, ranks 11th in the intensity of the impact received at 0.05%, and ranks 64th in the level of

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intensity of the impact received at 0.01%. In conclusion, the level of carbon tax incurred does not directly determine the magnitude of the negative consequences that occur in output. Many other factors will also determine the degree of impacts. It's important to note that the actual impact of a carbon tax will depend on a variety of factors, including the specific design of the tax and the characteristics of the economy in which it is implemented (Metcalf & Stock, 2023). For policy making, this is very important to pay attention to considering that detailed policies that touch the root of the problem are very necessary.

Assessing the impact of taxes from a macro perspective apparently requires precision to be able to understand the relatively more complicated specifications. Policy, apart from essentially being able to guarantee a recycling mechanism for tax revenues back to efforts to support green energy, also needs to direct it appropriately to business sectors that need to be given incentives to reduce the negative impacts they receive. In other words, apart from taking into account and supporting macroeconomic performance, for example in the form of cumulative economic output, intensive priorities should be implemented by taking into account the intensity of impacts experienced by business sectors at the micro level.

In the long term, the tax incentive mechanism to support green practices must be guaranteed to be sustainable. The effectiveness of reducing carbon emissions can apparently be paradoxical to the fiscal capacity to provide incentives. A reduction in carbon emissions will also result in a reduction in potential taxes (Prasad, 2022). Therefore, it is important to place a broader basis of principles or general values to ensure the achievement of policy objectives. The right policy formulation will be prudent to enhance low-carbon investment (Wu, 2020). Apart from that, it will also foster organic endogenous change in the composition of economic technology, from polluting technology to clean technology (Shapiro and Metcalf, 2022)

Employment Decline as a Result of a Carbon Tax

The study reveals that the impact of carbon tax imposition on employment absorption varies among different economic sectors and is not directly determined by emission levels and the imposed carbon tax. The service sector and agricultural sector are the most affected, with a 42.74% decrease in job opportunities totaling 53,732 people.

The manufacturing sector experiences the highest reduction in job opportunities with a decrease of 0.0736%, followed closely by the mining sector with a decrease in job opportunities of 0.0609%. The service sector experiences the smallest decline in job opportunities, while the mining sector moves up to the second position in the intensity of job opportunity reduction. As already revealed in many researches in previous section, the decline of business and income along with employment as an impact is more likely to happened in short-run period. This study shows that certain industries or business sectors are more affected with higher intensity in decline of their employment levels. Later on, when there is enough time for adjustment, certain industries will be able to even completely compensate for the losses over time. There will be very minor impacts on

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competitiveness (Arlinghaus, 2015). Energy and carbon taxes have no discernible effect on the competitive position, such as output and employment, of the enterprises under scrutiny. They will even increase productivity in the long run and when green technologies and practices are applied more broadly as happening in the more advanced countries (Adkins et al., 2012; Arlinghaus, 2015; Ho et al., 2011; Kay & Jolley, 2023; Metcalf & Stock, 2020, 2023). The top four sectors in terms of job opportunity decline intensity are also among the top ranks in terms of the share of carbon tax they bear. These sectors have impact intensity levels far below, ranging between 0.10% - 0.40%. There is a tendency of a direct relationship between the amount of carbon tax incurred and the impact intensity.

The top three sectors in terms of contribution consist of the Non-edible Crops sector, the Paddy sector belonging to the Agricultural sector, and the Commerce sector belonging to the Service sector. The Commerce sector's contribution to job loss is 20.26%, ranking 1st, followed by the Non-edible Crops sector in 2nd position with 10.53%, and the Paddy sector in 3rd position with 9.19%. From the perspective of impact intensity indicators, the Commerce sector ranks 29th at 0.05%, Non-edible Crops ranks 16th at 0.08%, and the Paddy sector ranks much lower at 47th with 0.04%. This highlights the importance of understanding the objective conditions, especially regarding the urgency of the issue and the policy orientation to be taken.

When comparing the impact of different sectors on job opportunities, it is observed that the top-ranked sector may not necessarily contribute significantly to job losses. For example, the sector of Other Fabricated Metal Products, which is ranked first in terms of job loss intensity, only makes up 0.69% of the total lost job opportunities, ranking 23rd overall. On the other hand, the Cement sector, ranked second, shows a more consistent relationship by ranking 5th in its contribution to job loss (5.37%) and 4th in the amount of carbon tax borne (6.74%). This indicates that there are varying impacts among different business sectors. Furthermore, the study also reveals the levels of contribution from different sectors to job loss. The top three sectors in terms of contribution are the Non-edible Crops sector, the Paddy sector in the Agricultural sector, and the Commerce sector in the Service sector. The Commerce sector has the highest contribution to job loss at 20.26%, followed by the Non-edible Crops sector at 10.53% and the Paddy sector at 9.19%. When considering impact intensity indicators, the Commerce sector ranks 29th at 0.05%, the Non-edible Crops sector ranks 16th at 0.08%, and the Paddy sector ranks lower at 47th with 0.04%. This suggests that different indicators can lead to varying ranking results, emphasizing the importance of understanding the specific conditions and urgency of the issue when determining policy directions.

The fact that shocks of carbon tax implementation is predicted to lead to decreases in output and employment through increases in prices and production costs along with decreases in supplies of input for production, suggesting that policymakers need to consider the potential economic contraction and inflationary effects when designing carbon tax policies. Furthermore, policymakers should account for broader aspects to mitigate adverse impacts. The varying effects of carbon pricing shocks highlight the need

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for tailored policy approaches that consider the specific characteristics and vulnerabilities of different economies and sectors (Berthold et al., 2023; Parry & Williams, 2012). This is what our study shows more in details, at least in macro contexts. The transition to a low-carbon economy for long term ultimate goal involves macroeconomic costs and requires careful policy planning to balance environmental goals with economic stability and growth.

CONCLUSION AND RECOMMENDATIONS

The Indonesian Input-Output Table 2016 reveals the country's economic structure, with service and manufacturing sectors contributing significantly to output. The manufacturing sector is highly dominant, accounting for 89.83% of total emissions, and the carbon tax imposed on it may have a greater impact on output than other sectors. The manufacturing sector is potentially the most affected by carbon tax, with a decrease in output contributing to 97.46% of the total output decline. The implementation of carbon tax has the potential to reduce total output by 0.126%, with the highest intensity observed in the manufacturing sector with a decrease of 0.388%. The decrease in output per sector is highly influenced by the interrelationship of input-output, not directly on the carbon tax value incurred or the scale of production. The top six sectors experiencing the highest impact intensity consistently also rank within the top 10 in terms of contribution to the total economic output decline.

The impact of carbon tax on employment absorption varies among different economic sectors and is not directly determined by emission levels and the imposed carbon tax. The service sector and agricultural sector are the most affected, with a 42.74% and 33.28% decrease respectively in job opportunities to the total decrease. The intensity in decline of each sector internally discovers manufacturing sector experiences the highest reduction in job opportunities with a decrease of 0.0736%, followed closely by the mining sector with a decrease in job opportunities of 0.0609%. The service sector experiences the smallest decline intensity in job opportunities, which is in contrast to its share in total decline as previously mentioned. The mining sector moves up to the second position in the intensity of job opportunity reduction. The top four sectors in terms of job opportunity decline intensity are also among the top ranks in terms of the share of carbon tax they bear. The top three sectors in terms of contribution to job loss are the Non-Edible Crops sector, the Paddy sector in the Agricultural sector, and the Commerce sector in the Service sector. The Commerce sector has the highest contribution to job loss at 20.26%, followed by the Non-Edible Crops sector at 10.53% and the Paddy sector at 9.19%.

Policymakers need to consider the potential economic contraction and inflationary effects when designing carbon tax policies and account for broader aspects to mitigate adverse impacts. The transition to a low-carbon economy for long-term ultimate goal involves macroeconomic costs and requires careful policy planning to balance environmental goals with economic stability and growth. The level of carbon tax incurred does not directly determine the magnitude of the negative consequences that occur in output. Many other factors will also determine the degree of impacts. Policy making is crucial, as detailed policies that touch the root of the problem are necessary. Assessing the impact of taxes

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from a macro perspective requires precision to understand the more complicated specifications. Policy should direct tax revenues appropriately to business sectors that need to be given incentives to reduce the negative impacts they receive. In the long term, the tax incentive mechanism to support green practices must be guaranteed to be sustainable. The right policy formulation will enhance low-carbon investment and foster organic endogenous change in the composition of economic technology.

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