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IMPACT OF COAL EXPORT DECLINE ON EAST KALIMANTAN'S MINING AND COAL INDUSTRY

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ABSTRACT

Two of Indonesia's top export commodities are coal and lignite. However, there is a decrease in the value of coal exports in 2023. The province in Indonesia with the biggest coal reserves is East Kalimantan. This study aims to examine the condition of the mining and coal industry and its relationship with other industries, determine the leading sectors, and assess the impact of the decline in coal exports on the economy of East Kalimantan. The input-output and gross regional domestic product tables for East Kalimantan in 2016 and 2023 are used in the analysis. This study found that even though it is not a leading industry, the mining and coal sector is still an important sector for the economy of East Kalimantan. All economic sectors experienced a decline in output due to the decline in the value of coal exports (mining products) in East Kalimantan, and this sector alone felt the greatest impact—around 73.67% of the total impact in all economic sectors. To process and purify coal produced during mining, the government must establish close communication with business owners in the coal mining industry. Apart from that, the development of the downstream coal industry must also be completed immediately.

Keywords: *Coal, Export, Downstream, Input-Output Table, East Kalimantan*

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Introduction

Mineral resources, particularly abundant in Indonesia, are a feature of the nation. There may be economic benefits for Indonesia from this profusion of wealth (Kartiasih et al.,

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2012). Mineral resources found in Indonesia include coal, nickel, tin, copper, gold, bauxite, and gold. Indonesia exports a wide range of mining products, including coal, to fulfill global demand. Indonesia plays a significant role in the global coal market (Baskoro et al., 2021; Purba & Kartiasih, 2014). Indonesia will be the third-largest global producer of coal in 2022, according to the 2023 EI Statistical Review of World Energy, with a production value of 7.81% of global output. Undoubtedly, this has a significant impact on the Indonesian economy. The value of Indonesia's exports, which are primarily made up of non-oil and gas commodities, demonstrates this influence. Indonesia's non-oil and gas export value is expected to reach 242,874.6 million USD in 2023, accounting for 93.85% of the country's total export value, according to BPS. One of the principal commodities in Indonesia's non-oil and gas exports is coal, as the country is one of the biggest producers of this commodity. Out of all the commodities that aren't oil or gas, coal has the highest export value. By 2023, coal exports are expected to be worth 34,592.1 million USD, or about 14.24% of all non-oil and gas exports from Indonesia. With lignite accounting for 3.34% of Indonesia's total non-oil and gas export value, or 8,102.4 million USD, it is also one of the country's principal non-oil and gas export commodities. This demonstrates that one of Indonesia's major mining commodities is coal.

The value of coal and lignite exports will decline in 2023 relative to the year before (y-o-y). Indonesia will export 42694.5 million USD worth of coal and lignite in 2023, compared to 54599.5 million USD in 2022. Figure 1 illustrates the fall in coal prices from 2022 to 2023, which is the cause of the decline in the value of coal exports. Furthermore, all nations are expected to contribute to the fight against climate change under the terms of the 2015 Paris Agreement. Many claim that in order to combat climate change, coal must be phased out (Oei & Mendelevitch, 2019). Because of their commitment to lowering carbon emissions, the G7 countries have boycotted coal as a fuel, which is another factor contributing to the decline in exports (Admi et al., 2022).

Figure 1: Referential Monthly Coal Price (USD/Ton)

The majority of Indonesia's coal exports are upstream goods. This is demonstrated by the fact that in 2023, the export values of coal briquettes and coal products were 155.058 million USD and 546.630 million USD, respectively. The export value of coal products and coal briquettes, which are respectively worth 151.516 million USD and 27.884 million USD, has increased from 2022 to 2023, but it is still far less than the value of exports of coal and lignite. Coal reserves are limited because coal is a type of natural resource that cannot be replenished, so it must be used wisely even though it accounts for the majority of Indonesia's exports. Aside

from that, Indonesia continues to import significant quantities of coal-processed goods like coke, ethylene, methanol, and ammonium sulfate (KESDM, 2021). Promote the use of coal to replace fuel (BBM and BBG) and for the chemical industry (methanol and DME), according to the Ministry of Energy and Mineral Resources, as one of the goals of coal downstreaming. As such, downstreaming coal is a priority for the Indonesian government. All of this is in line with the Road Map for the Development and Utilization of Coal, which identifies environmentally friendly coal use, energy security, and satisfying industrial needs as the three main areas of future coal use.

Prioritizing the downstream coal product target will help meet domestic energy and industrial needs while reducing reliance on imports. Law No. 3 of 2020 also mandates that the added value of coal and minerals be increased, and that holders of IUP or IUPK be obligated to develop and use coal. Yasin et al. (2021) state that the government's coal development program consists of coal upgrading, coal briquette manufacturing, coke making, coal liquefaction, coal gasification, including underground coal gasification, and coal slurry/coal water mixture. Building a Steam Power Plant (PLTU) at the mine's mouth will allow for the utilization of raw coal in the interim. Because of this, coal's place in the energy mix needs to be reevaluated so that it can serve as a natural gas and petroleum substitute while also meeting the needs of the chemical industry and boosting state revenue through exports.

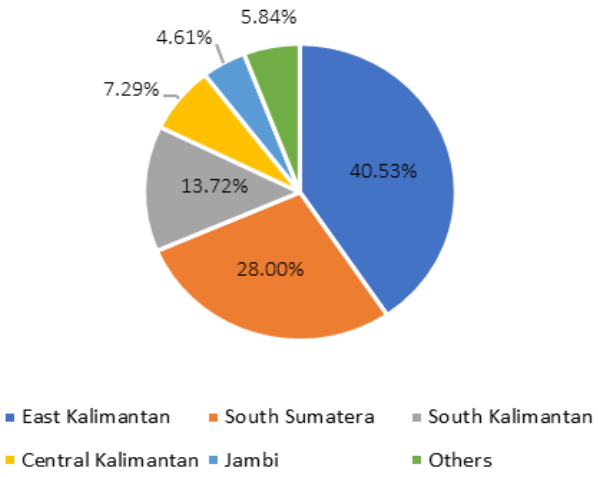

Figure 2: Coal Reserves by Province in 2022

East Kalimantan plays a significant role in the Indonesian coal industry as the province with the largest coal reserves. According to Simanjuntak & Anggara (2022), the mining and quarrying sector—of which coal is the primary commodity—is the engine of East Kalimantan's economy. East Kalimantan's coal reserves are expected to account for 40.53% of Indonesia's total coal reserves by 2022. Beyond that, East Kalimantan is expected to produce 305.48 million tons, or 44.44%, of Indonesia's coal in 2022. In 2023, when coal production in East Kalimantan reaches 338.50 million tons, this production will rise.

East Kalimantan Province is expected to have the highest gross regional product (GRDP) on Kalimantan Island and the seventh-largest in Indonesia in 2023, at 537.6 trillion rupiah (Central Statistics Agency, 2024). The coal industry and mining sectors make up a sizable portion of East Kalimantan Province's GDP. Each of these industries makes up a portion of East Kalimantan's 34.17% and 9.75% GRDP in 2023, respectively (BPS Kalimantan Timur, 2024). The coal mining sector's share of East Kalimantan's gross domestic product (GRDP) is expected to decline in 2022–2023 while the coal industry sector's share is expected to rise. It is therefore

anticipated that the advantages of natural resources will promote the best possible use of the potential that is already there. This was carried out in an effort to strengthen the local economy. The greatest coal deposits on Kalimantan Island are found in East Kalimantan. East Kalimantan's coal content was confirmed to be 36.992 billion tons, while South Kalimantan, North Kalimantan, Central Kalimantan, and West Kalimantan each had 9.992; 1.809; 3.789 billion tons; and 371 million tons, respectively (KESDM, 2021).

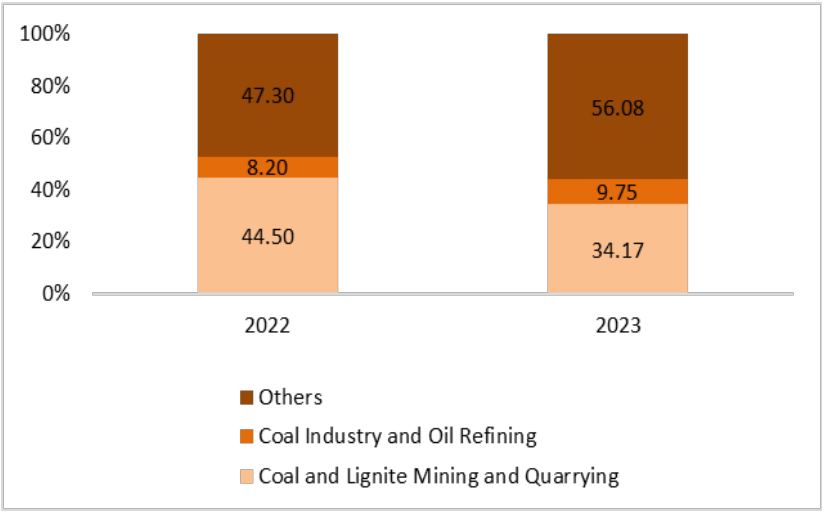

Figure 3: The Business Sector's 2022–2023 Contribution to the GRDP of East Kalimantan

The effect of downstream mining on the economy has been the subject of numerous studies, including those by Paramastri et al. (2019), Agung & Adi (2022), and Ardiyanti et al. (2023). However, there aren't many studies that specifically analyze data from East Kalimantan using the input-output method. This research was done in order to close this gap and provide several novelties that can help East Kalimantan's economy grow. This study updates the Input-Output (I-O) table of the East Kalimantan Province's domestic trade based on producer prices year 2016 using the RAS method so that the I-O table of the East Kalimantan Province's domestic trade based on producer prices year 2023 is obtained with the hope of being able to more fully evaluate the East Kalimantan state in 2023. In this research, a relatedness analysis is also conducted for I-O table years 2016 and 2023 so that changes that have occurred can be seen. In addition, an export simulation is conducted to observe the effects on the economy of the Central Province of East Kalimantan.

This research is critical because raw coal export operations will become more challenging as down streaming regulations tighten with the implementation of Law No. 3 of 2020. This is feared to have a major effect on the economy, particularly in regions like East Kalimantan that heavily rely on the mining industry. This study provides a description of the effects that result from downstream regulations. Furthermore, the input-output analysis conducted in this study can be used to determine the degree of dependence and influence that export policy changes have on other sectors. Analysis of the effects of the export drop will also be helpful in developing strategies to enhance long-term economic sustainability, particularly for areas where the mining industry is a major source of income. As stated above, the purpose of this research is to examine the overall coal mining and industry landscape of East Kalimantan, examine the relationships between different sectors, pinpoint the leading industries, examine the output multiplier of each industry, and assess the implications of the reduction in coal exports for Kalimantan East's coal downstreaming.

Literature Review

Exports are one of the indicators that can influence the rise and fall of a country's economic growth (Ginting & Kartiasih, 2019; Maulana & Kartiasih, 2017; Setiawan et al., 2020). As a result of the issuance of down streaming regulations, Law Number 3 of 2020, coal export activities in Indonesia become more tightly regulated. As a result of these regulations, coal exports have decreased significantly. In the end, this will impact the aggregate demand and the overall related industries. According to Keynesian theory, deliberate reduction in coal exports would decrease overall demand within the economy since exports are pivotal factor of aggregate demand. This decrease leads to reduction in national income and causing a ripple effect throughout the economy, especially in the mining and coal industries.

Aggregate demand is made up of government spending (G), investment (I), consumption (C), and net exports (X-M). Any factor that alters G, I, C, and X-M will cause a shift the aggregate demand curve. This shift would lead to a reduction in national income and output. Lower income levels would reduce consumption and investment that create negative feedback loop that could result in lower overall economic output and higher unemployment. The Keynesian perspective suggests that without compensatory measures, such as increased government spending or targeted fiscal policies, the economy could suffer from reduced growth and potentially enter a recession. According to Abbass et al. (2022), this situation was happening in Pakistan when the COVID-19 pandemic hit the country

One of President Joko Widodo's directives, which is directly tied to Indonesia's mining sector, is to downstream coal and minerals. The process of producing coal and minerals downstream involves transforming them into semi-finished or finished goods that are highly valued in the economy. This added value to coal, Lahadalia et al. (2024) claim that the government is attempting to boost GDP, employment, added value, investment, exports, and GDP in Indonesia through down streaming. Although President Jokowi recently highlighted the consistency of down streaming, there have been regulations concerning this activity since prior to the administration of President Joko Widodo.

Based on studies by Wang & Ge (2020) that employ global input-output analysis as the analytical technique, China is a net exporter of coal that is embodied in products. This indicates that the amount of coal consumed domestically to satisfy demand abroad is higher than the amount consumed abroad to satisfy demand in China. Additionally, based on the decomposition results, it is evident that the growth in embodied coal consumption is primarily driven by the transfer of high external demand and the rapidly expanding global trade in semi-finished goods, whereas the growth of domestic coal consumption is known to be suppressed by China's declining coal use intensity.

Noor and Ibadi (2021) investigated the effects of the export ban policy, a descriptive approach was used in conjunction with simulations and quantitative model analysis of the 2010 Input-Output table using the Indonesian locus. This study included an economic impact simulation as well as a simulation of how the PNBP would affect production contributions and royalties. Three scenarios were used in the simulation, depending on how many product allocations were made both domestically and internationally. It seems that increasing the implementation of the nickel export ban policy, which mandates that all raw coal production be processed and refined domestically, can increase state income, especially in the form of PNBP, based on the findings of the simulation analysis of the impact of PNBP. The added value from processed nickel products yields higher profits than from raw nickel ore, even with lower royalty rates and production volumes. In the meantime, the policy of prohibiting nickel ore

exports has a considerable potential to promote higher economic output and business profits, according to the results of a simulation study of the economic impact. On the other hand, this policy has a negligible effect on raising household income and indirect tax receipts. This is because the nickel mining industry is characterized by a higher capital and technological intensity than a labor intensity.

East Kalimantan Province served as the focal point of Maulina's (2021) study on the effects of the export ban on mining products. Data analysis is based on the provincial interregional input-output (IRIO) table. Numerous analytical techniques were used, including multiplier analysis, intraregional and interregional impact analysis, leading sector analysis, and intersectoral linkage analysis. Two impact simulations were conducted in this study as well: one involved decreasing mining exports and the other involved ending all exports from each province to outside countries. The results of the simulation indicate that the provinces most impacted were not those surrounding East Kalimantan, but rather DKI Jakarta, West Java, and East Java.

Based on our findings, in line with these theories and empirical studies, the following hypothesis is developed for this study:

H1: Due to tighter regulations, the reduction in coal exports will directly decrease aggregate demand in East Kalimantan Timur in turn leading to a decline in province income and overall economic output in the short term.

Data and Research Methods

Data

The 2016 East Kalimantan province Input-Output (I-O) table, which was put together by East Kalimantan BPS, provides the data used in this study. This I-O table covers 19 x 19 sectors and is based on producer prices. 52 x 52 subsectors were used to create this table, which was subsequently combined into 19 sectors plus 2 more sectors. Separated from the Mining and Quarrying sector, the first additional sector is Coal and Lignite Mining and Quarrying. Then, apart from the processing industry, there is the second sector, which consists of the coal and oil and gas refining industries. The East Kalimantan Province's Gross Regional Domestic Product at Constant Prices 2010 according to categories and Business Fields (Millions of Rupiah) in 2016 and the East Kalimantan Province's Gross Regional Domestic Product at Constant Prices 2010 according to categories and Business Fields (Millions of Rupiah) 2023 obtained from BPS are additional data used. The East Kalimantan I-O table will be updated for 2023 using the data provided. The RAS method will then be used to update the 2023 I-O table. This update was made to ensure that the findings of the study accurately reflect East Kalimantan's current economic situation.

Additionally, the aggregated I-O table is coded for 19 sectors to facilitate analysis. From the Agriculture, Forestry, and Fisheries code, which is the first code, to the nineteenth code; Agriculture, Forestry, and Fisheries; Mining and Quarrying, excluding Coal and Lignite; Coal and Lignite Mining and Quarrying; Coal Industry and Oil and Gas Refining; Manufacturing Industry, excluding Coal and Oil Refining; Electricity and Gas Supply, Water Supply, Waste Management, Waste Treatment, and Recycling; Construction; Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles; Transportation and Warehousing; Accommodation and Food Service Activities; Information and Communication; Financial and Insurance; Real Estate; Business Services; Public Administration, Defense, and Compulsory Social Security; Education Services; Health Services and Social Activities; Other Services.

Research Method

This study uses an Input-Output (IO) table analysis, which involves several analyses, including a forward and backward linkage analysis of the connections between the sectors. Next, leading sector identification and multiplier number analysis were also done. Lastly, to determine whether restrictions on coal exports would result in a decrease in the value of coal exports, an impact analysis was conducted following the issuance of downstream regulations. The I-O 2016 table and the I-O 2023 table that resulted from updating were processed in this study using Microsoft Excel and RStudio, two different software programs. Input-output table analysis was chosen because it can show the relationship between economic sectors, thus allowing an understanding of how changes in one sector affect other sectors.

Linkage Analysis

An economy's various sectors depend on one another for support and cannot function independently (Ronalia, 2021). As a result, intersectoral relationships are inevitable in a given region. A linkage analysis is performed to determine the connections between the various economic sectors that exist in a given region. The degree to which shifts in demand within an industry or sector affect both that sector and other sectors is known as an inter-sector linkage. This indicates that one sector's input originates from another's output, or vice versa. There are two types of linkage analysis: forward linkage and backward linkage (Hayuningtyas et al., 2024; Lubis et al., 2025; Sandi et al., 2025). The goal of backward linkages is to identify the production process's requirement for input from other sectors. Analyzing the strength and weakness of connections between sectors that supply input to other sectors is done in the meanwhile using forward linkage. The linkage models were made based on the study by Rasmussen (1956). However, Rasmussen's method can only show the total of direct and indirect linkages increase in output. To show only the direct linkages of both backward and forward output, Chenery & Watanabe (1958) propose a new model.

An increase in output in one sector of forward linkage will result in an increase in output in other sectors through two mechanisms. Initially, improving a sector's output distribution will come from increasing its output. The input available for use in other sectors grows in tandem with the output generated. Consequently, other sectors will experience an increase in production, which will lead to a larger distribution of output.

Direct Forward Linkage (DFL)

$$F(d)_j = a_{1j} + a_{2j} + \ldots + a_{ij} = \sum_{i=1}^{n} a_{ij}; i,j = 1,2,...,19 \quad (1)$$

and

Direct and indirect links make up the total forward linkage.

$$F(d+i)_j = b_{1j} + b_{2j} + ... + b_{mj} = \sum_{i=1}^{m} b_{ij}; i,j = 1,2,...,19 \quad (2)$$

where

a_{ij} : Technological coefficients (Matrix A)
b_{ij} : Elements of an Inverse Leontief Matrix

Additionally, there are two ways to promote a rise in output in backward linkage that comes before a rise in a sector's output. First, the demand for inputs in a given sector will rise in tandem with an increase in output. Secondly, if input in this sector rises, the demand

for input from other sectors will rise as well, leading to an increase in output in those other sectors. This is due to the fact that a sector needs input from related sectors in addition to its own. Included in the backward linkage size is:

Direct Backward Linkage (DBL)

$$B(d)_j = a_{1j} + a_{2j} + ... + a_{ij} = \sum_{i=1}^{n} a_{ij}; i,j = 1,2,...,19 \quad (3)$$

Direct and indirect linkage make up total backward linkage, or TBL.

$$B(d+i)_j = b_{1j} + b_{2j} + ... + b_{mj} = \sum_{i=1}^{m} b_{ij}; i,j = 1,2,...,19 \quad (4)$$

where a_{ij} is technological coefficients (matrix A), and b_{ij} is elements of an inverse Leontief matrix.

Index of The Power of Dispersion (IPD) and Index of Sensitivity of Dispersion (ISD) are computed using these two values. IPD is calculated by averaging the average impact of all industries and comparing the total impact of changes in an industry's final consumption on the output of each sector. When an industry's IPD value exceeds one, it indicates that its final demand can propel production growth that surpasses the average growth of other industries. Because of its potent ability to promote economic growth, this industry is regarded as strategically important.

$$IPD_i = \frac{\sum_{i=1}^{n} b_{ij}}{\left(\frac{1}{n}\right)\sum_{i=1}^{m}\sum_{j=1}^{n} b_{ij}} \quad (5)$$

$i = 1,2,3,...,m; j = 1,2,3,...,n$

where

IPD_i : Index of The Power of Dispersion, i-th

b_{ij} : Element of multiplier matrix, i-th row, j-th column

n : The quantity of economic activity sectors (19)

By dividing the overall impact of changes in the final demand for each sector of an economy by the average impact of all sectors, the Degree of Sensitivity index is calculated. When a sector's ISD value is greater than one, it means that it can comparatively satisfy other sectors' final demand requirements in excess of its average capacity. This indicates that the industry is susceptible to shifts in other industries' production levels.

$$ISD_i = \frac{\sum_{i=1}^{n} b_{ij}}{\left(\frac{1}{m}\right)\sum_{i=1}^{m}\sum_{j=1}^{n} b_{ij}} \quad (6)$$

$i = 1,2,3,...,m; j = 1,2,3,...,n$

where

ISD_i : Index of Sensitivity of Dispersion,i-th

b_{ij} : Element of multiplier matrix, i-th row, j-th column

m : Number of economic activity sectors (based on row: 19)

Leading Sector

The ISD and IPD values previously explained are not only used to analyze linkages between sectors but can also be used to detect sectors that are included in the leading sector category. Using the ISD and IPD values, a quadrant diagram is made to complete this identification.

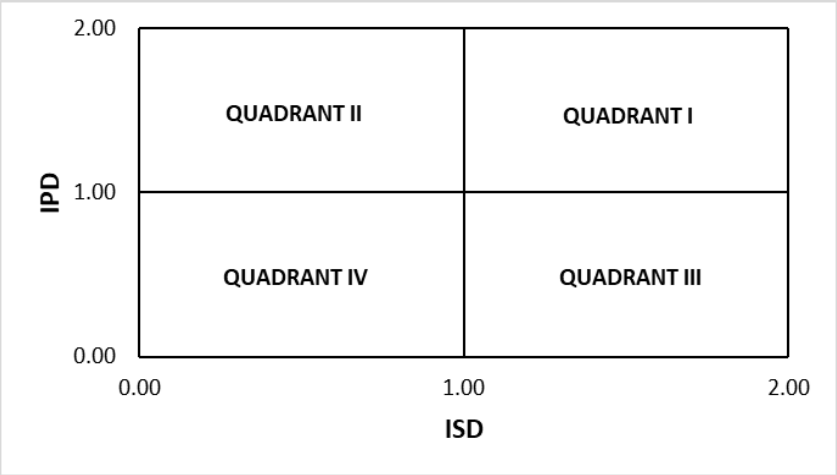

Figure 4: Quadrant Diagrams for ISD and IPD

Figure 4 shows the division of economic sectors into four quadrants, each of which represents a sector's contribution to the regional economy. This quadrant analysis can be summed up simply as follows:

1. Quadrant I (Leading Sector)

   Sectors with ISD and IPD values greater than one can be found in this quadrant. This quadrant's sectors are highly dependent on one another. Subsequently, the majority of this sector's output is utilized as an input to support the expansion of other sectors by enabling them to carry out production activities.

2. Quadrant II (Sector Expands)

   Sectors with an ISD value less than one and an IPD value greater than one are found in this quadrant. This quadrant's sectors are highly dependent on one another. However, this sector is less able to support the expansion of other sectors because only a small percentage of its output is used as an input for other sectors to carry out production activities.

3. Quadrant III (Potential Sector)

   Sectors with an ISD value larger than one and an IPD value smaller than one are found in this quadrant. This quadrant's sectors are not overly dependent on other sectors. To support the expansion of other sectors, the majority of this sector's output is utilized as an input for other sectors to carry out production activities.

4. Quadrant IV (Undeveloped Sector)

   Sectors with ISD and IPD values less than 1 are found in this quadrant. This quadrant's sectors are not overly dependent on other sectors. In addition, this sector is less able to support the expansion of other sectors because only a small percentage of its output is utilized as input by other sectors to carry out production activities.

Multipliers Analysis

In macroeconomics, a multiplier is defined as a change in external factors that results in larger changes in endogenous variables (BPS, 2021). The term multiplier is also used in modeling with the I-O table during its development. Changes in one or more exogenous variables can cause changes in endogenous variables, which can be explained by the multiplier in the I-O table, which takes the form of a multiplier matrix. The multiplier effect, which can be derived from the multiplier matrix, will be used to assess the extent of the impact.

Various impact analysis types are available for review in the I-O table. In addition to the analysis of forward and backward linkages, these impact analyses also include analyses of the impact of labor (employment multiplier), household income (household income multiplier), and output (output multiplier). Multiplier effects can happen directly or indirectly as a result of changes in exogenous variables related to economic activity (Sari et al., 2024; Taridipa et al., 2024). The multiplier matrix in I-O table analysis is obtained through statistical modeling using the Leontief model. Equation (6) represents how all sectors' output allocation is expressed.

$$X = (I - A)^{-1} Y \tag{7}$$

where

X : The Output Vector

Y : The Final demand vector

I : Matrix of identity

A : Matrix of input coefficients

$(I - A)^{-1}$: The Inverse Matrix of Leontief

Analysis of Impact Simulation

In addition to examining the effects on other industries through impact simulation analysis, this study focuses on the fall in coal exports in 2023, particularly in the mining and coal industry sectors. In order to perform this impact simulation analysis, a shock or injection was given to the coal mining industry in East Kalimantan, causing a decline in export value of 86317350 million rupiah. This figure was taken from the East Kalimantan Economic Report 2023 BPS publication. The following format can be used to express this situation:

$$\Delta X = (I - A)^{-1} \Delta Ekspor \tag{8}$$

Where,

ΔX : Vector of Output Change

$\Delta Ekspor$: Coal exports as a vector of change in final demand

I : Matrix of identity

A : Matrix of input coefficients

$(I - A)^{-1}$: The Inverse Matrix of Leontief

Finding and Discussion

The findings and analysis in this study are limited to descriptive analysis; that is, they only examine the overall economic picture of East Kalimantan as shown by the output structure of the East Kalimantan I-O table for 2023, including the coal mining and coal industry sectors. Furthermore, using the 2016 I-O table and the 2023 East Kalimantan I-O table, a comparison

of the sector's forward and backward linkage analysis was also observed. In addition, the leading sectors will be determined by analyzing the output multiplier figures for the 19 East Kalimantan sectors and the ISD and IPD values, particularly for the mining and coal industry sectors. Lastly, a simulation was run to determine how the mining industry's decline in coal exports would affect East Kalimantan's economy.

An Overview of the Economy in East Kalimantan

Distribution percentages were used in a descriptive analysis to get a broad picture of the East Kalimantan economy. The output structure of the coal and lignite mining and quarrying, coal industry, and oil and gas refining sectors—all of which are utilized by other sectors as intermediate consumption—was examined in this analysis. The objective is to determine which of the two sectors contributes the biggest or least percentage to the distribution of production.

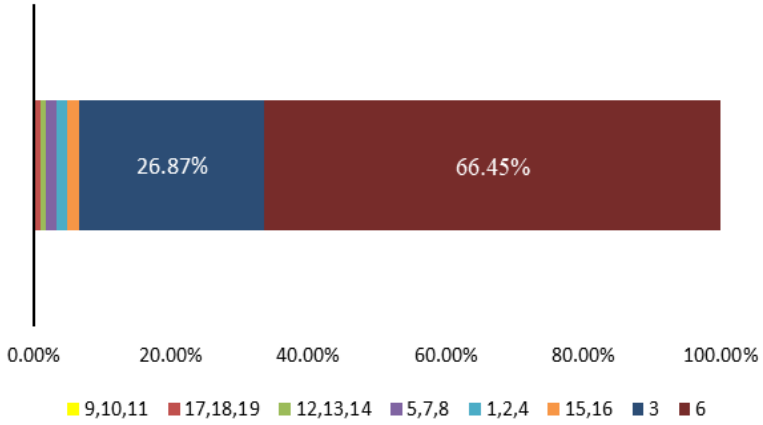

Figure 5: The output structure of the coal mining sector used by other sectors as a percentage distribution (percent)

Figure 5 illustrates how Sector 6 (Electricity and Gas Supply) uses the largest output distribution from Sector 3 (Coal and Lignite Mining and Quarrying), at 66.45%. Sector 3 (Coal and Lignite Mining and Quarrying) comes in second at 26.87%, with the remaining 6.68% utilized by the remaining seventeen sectors. This indicates that the output of Coal and Lignite Mining and Quarrying is used as industrial fuel as well as an input for the Electricity and Gas Supply sector, accounting for 66.45% of the total amount of energy generated. Additionally, the output of coal and lithium mining contributes to the Coal and Lignite Mining and Quarrying sector, which accounts for 26.87% of the total, as well as seventeen other sectors, which account for 6.68%.

Based on Figure 6, it can be observed that the largest distribution of output from the Coal Industry and Oil Refining sector is utilized by Sector 10 (Transportation and Warehousing) at 40.46%. This is followed by Sector 9 (Wholesale and Retail Trade: Repair of Motor Vehicles and Motorcycles), Sector 8 (Construction), sector 5 (Manufacturing Industry excluding Coal and Oil Refining), and the remaining fifteen sectors at 14.27%, 9.49%, 9.03%, and 26.75%, respectively. This means that the output of the Coal Industry and Oil and Gas Refining sector is used as input for the Transportation and Warehousing sector at 40.46%. For example, the railway transportation in East Kalimantan Province still utilizes coal. Furthermore, the output of the Coal Industry and Oil and Gas Refining sector is also used as input for the Wholesale and Retail Trade sector: Repair of Motor Vehicles and Motorcycles at 14.27%, as input for the

Construction sector at 9.49%, as input for the Manufacturing Industry excluding Coal and Oil Refining sector at 9.03%, and as input for the remaining fifteen sectors at 26.75%.

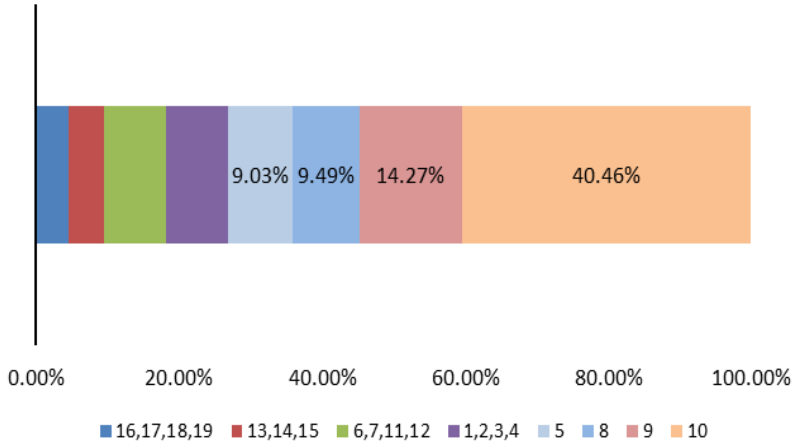

Figure 6: Distribution of the Coal Industry's and Oil and Gas Refining Sectors' Output Structure in Percentage Used by Other Sectors (percent)

Study of East Kalimantan's Inter-Sector Linkages

This study used both forward and backward linkage analysis to analyze linkages. The forward and backward linkage analysis is then broken down into direct and indirect impacts for the years 2016 and 2023. The objective is to determine whether sectors will enhance overall production and also total input in the sector or other sectors in the event of an increase in final demand.

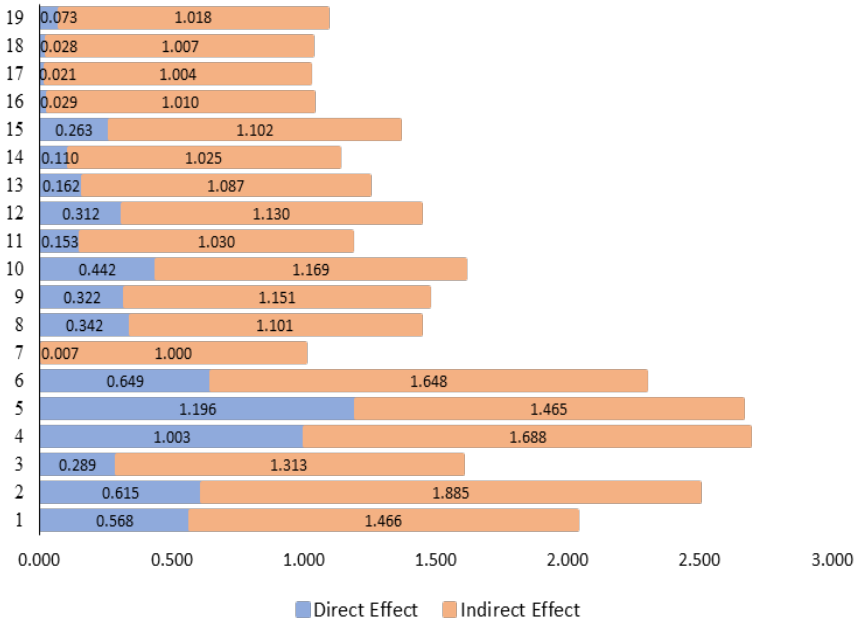

Figure 7: Impacts of Upcoming Links: Direct and Indirect in 2016

Sector 7 (Water Supply, Waste Management, Waste Treatment, and Recycling) had the smallest total forward linkage effect compared to other sectors, with a direct effect of 0.007 and an indirect effect of 1.00 (see Figure 7). Conversely, the largest total forward linkage effect was observed in Sector 4 (Coal and Oil Refining Industry) with a direct effect of 1.003

and an indirect effect of 1.688. This implies that if there is an increase in final demand for the Coal and Oil Refining Industry by Rp1 million, the total output sold or allocated to this sector and other sectors would increase by Rp2.691 million. Of this increase, Rp1.003 million results directly from the allocated output. Furthermore, Sector 3 (Coal and Lignite Mining and Quarrying) has a direct effect of 0.289 and an indirect effect of 1.313. This means that if there is an increase in final demand for Coal Mining by Rp1 million, the total output allocated to this sector and others would increase by Rp1.602 million, with Rp0.289 million directly resulting from the allocated output.

Based on Figure 8, in the year 2023, the sector with the smallest total forward linkage effect remains the same as in 2016. However, there is a change in the sector with the largest total forward linkage effect. In 2023, Sector 6 (Electricity and Gas Supply) will have the largest total effect, with a direct effect of 0.746 and an indirect effect of 1.933. Furthermore, Sector 3 (Coal and Lignite Mining and Quarrying) has a direct effect of 0.279 (decreased by 0.010 compared to 2016) and an indirect effect of 1.372 (increased by 0.069 compared to 2016). Additionally, Sector 4 (Coal and Oil Refining Industry) has a direct effect of 0.839 (decreased by 0.164 compared to 2016) and an indirect effect of 1.630 (decreased by 0.058 compared to 2016). This means that if there is an increase in final demand for the Coal Industry by Rp1 million, the total output allocated to this sector and others would increase by Rp2.469 million, with an increase of Rp0.839 million directly resulting from the allocated output.

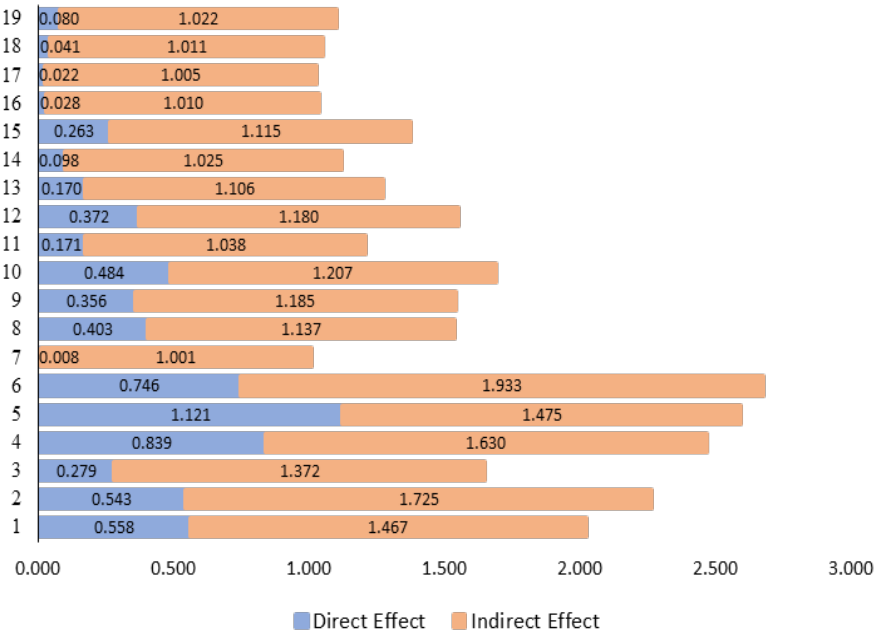

Figure 8: Future Connections in 2023: Direct and Indirect Effects

Based on Figure 9, in the year 2016, Sector 13 (Financial and Insurance Services) had the smallest total backward linkage effect compared to the other 18 sectors, with a direct effect of 0.168 and an indirect effect of 1.087. Conversely, Sector 6 (Electricity and Gas Supply) had the largest total backward linkage effect, with a direct effect of 0.862 and an indirect effect of 2.089. Sector 4 (Coal and Oil Refining Industry) had a direct effect of 0.334 and an indirect effect of 1.097. This means that if there is an increase in final demand for the Coal and Oil Refining Industry by Rp1 million, it would increase the total demand for inputs to this sector and others by Rp1.431 million, with an increase in direct input demand of Rp0.334 million.

Furthermore, Sector 3 (Coal and Lignite Mining and Quarrying) had a direct effect of 0.310 and an indirect effect of 1.154. This implies that if there is an increase in final demand for the Coal and Lignite Mining and Quarrying sector by Rp1 million, it would increase the total demand for inputs to this sector and others by Rp1.464 million, with a direct input demand increase of Rp0.310 million.

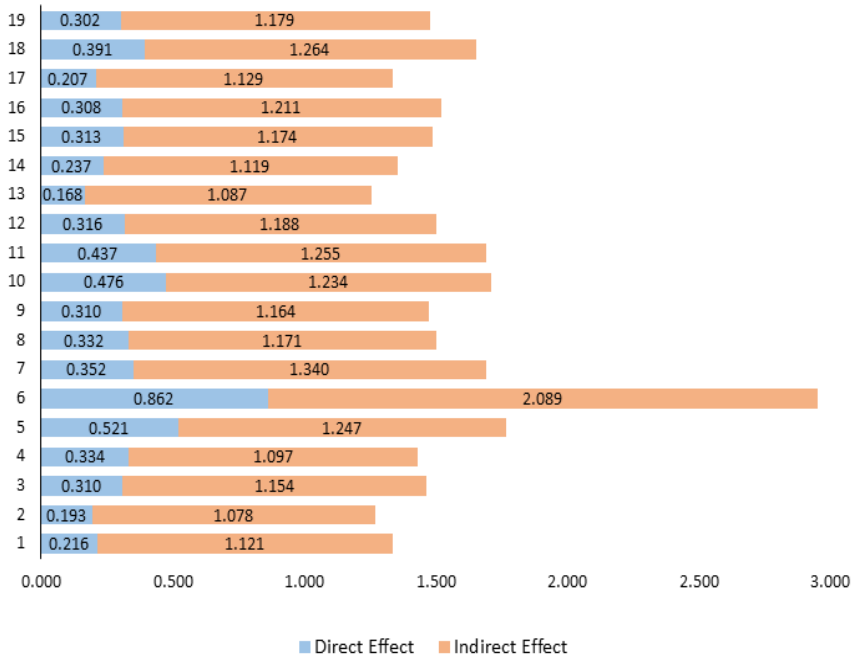

Figure 9: Effects, Both Direct and Indirect, Dating Back to 2016

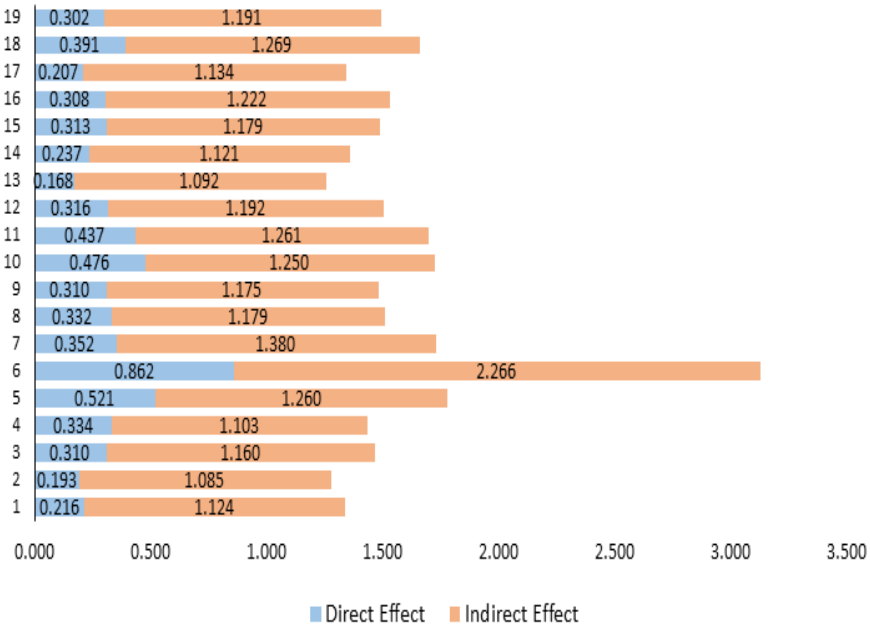

Figure 10: Effects, Both Direct and Indirect, Going Back to 2023

Based on Figure 10, it is observed that in 2023, the direct effects across the 19 sectors remained relatively unchanged compared to 2016. The sector with the smallest total backward linkage effect, similar to 2016, is Sector 13 (Financial and Insurance Services), with an indirect effect of 1.092. Similarly, the sector with the largest total backward linkage effect,

also consistent with 2016, is Sector 6 (Electricity and Gas Supply), with an indirect effect of 1.933. Furthermore, Sector 3 (Coal and Lignite Mining and Quarrying) has a direct effect of 0.310 and an indirect effect of 1.160 (increased by 0.006 compared to 2016). Additionally, Sector 4 (Coal and Oil Refining Industry) has a direct effect of 0.334 and an indirect effect of 1.103 (increased by 0.016 compared to 2016).

It is evident from the aforementioned data that Indonesia's coal industry is generally weakening. This result is in line with Chen & Suk (2023) who stated that in recent years there has been a tendency to reduce the economic impact of the coal sector, as well as the forward and backward relationship between the coal business and other industries. Furthermore, compared to 2005, the two indicators' effect was less in 2020.

Determine the Leading Industries

The inter-sector linkage analysis previously described can be utilized to identify leading sectors. The criteria used to determine leading sectors include the Index of Sensitivity of Dispersion (ISD) and Index of the Power of Dispersion (IPD). Subsequently, plotting is conducted using both indices to display the positions of business fields in the available quadrants. Figure 11 shows four quadrants formed by the values of Index of Sensitivity of Dispersion (ISD) and Index of the Power of Dispersion (IPD) plotted. Quadrant I consists of sectors with values of ISD and IPD greater than 1. This quadrant identifies the leading sectors. There are three sectors classified as leading sectors: Manufacturing Industry excluding Coal and Oil Refining, Electricity and Gas Supply, and Transportation and Warehousing. These sectors are key sectors in the economy of East Kalimantan and need to be prioritized for further development to drive growth in other sectors. This means that these leading sectors have significant impacts on other sectors as they are interconnected.

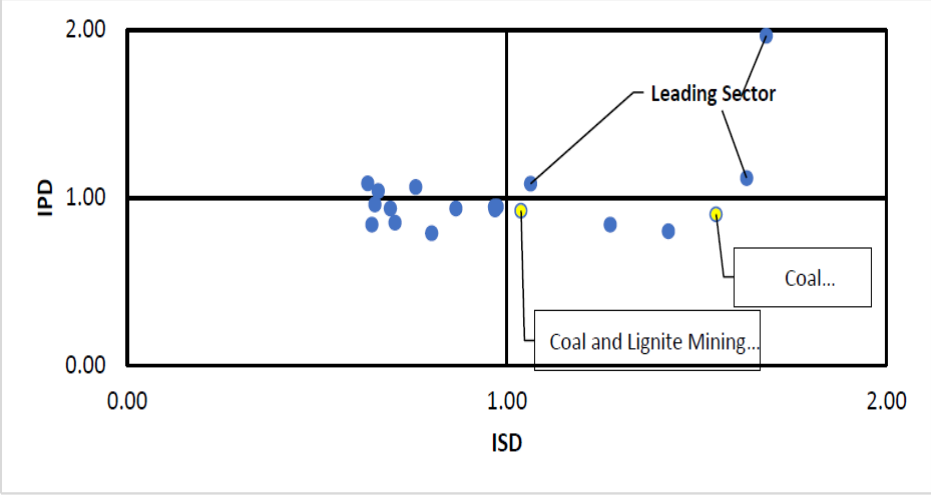

Figure 11: Determine Top Industries Using ISD and IPD Values in 2023

Moving to Quadrant II, there are three sectors; Quadrant III contains four sectors; and Quadrant IV includes nine sectors. Sector 3 (Coal and Lignite Mining and Quarrying) and Sector 4 (Coal and Oil Refining Industry) fall into Quadrant III because they have ISD > 1 and IPD < 1. Therefore, these sectors are considered potential or self-reliant sectors. Although they are not classified as leading sectors, they have low dependency on other sectors. However, their high output can still drive development in other sectors because their outputs are used as inputs in other sectors.

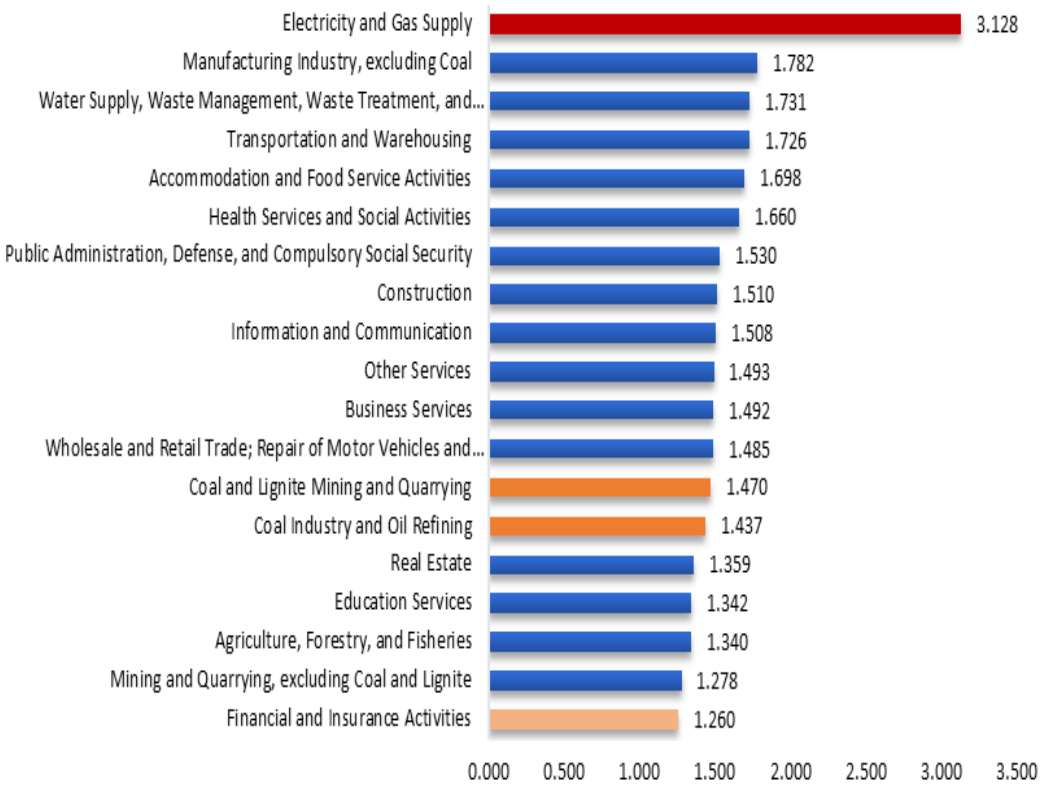

Figure 12: East Kalimantan Province's 19 sectors' output multipliers in 2023

Analysis of Output Multipliers

In the analysis of the output multiplier, the extent to which the output of economic sectors changes as a result of changes in the final demand of a particular sector can be observed. The magnitude of changes in the output of economic sectors is illustrated in Figure 12. It can be seen that in 2023, the sector with the largest output multiplier will be the electricity and gas procurement sector, with a multiplier of 3.128. Conversely, the sector with the smallest output multiplier is financial services and insurance, with a multiplier of 1.26 in East Kalimantan Province. The mining and quarrying of coal and lignite ranks 13th, with a multiplier of 1.47. This means that if the final demand for the coal and lignite mining sector increases by IDR 1 million, the total output of that sector, allocated to itself or other sectors, will increase by IDR 1.47 million. The coal industry and oil refining sector rank 14th, with a multiplier of 1.437. This means that if the final demand for the coal industry and oil refining sector increases by IDR 1.437 million, the total output of that sector, allocated to itself or other sectors, will increase by IDR 1.437 million.

Simulation of the effects of the drop in coal exports on the economy of East Kalimantan

The impact simulation analysis is the following phase of this investigation. This impact simulation analysis was conducted to assess the extent of the impact of a decrease in coal exports on the economic sectors in East Kalimantan Province. The impact of this decrease in exports can be observed in Table 1.

Based on Table 1, all economic sectors in East Kalimantan experienced a decrease in output due to the decline in coal export values in 2023. Sector 3 (Coal and Lignite Mining and Quarrying) was the most affected, with an output reduction of 93,498,581.02 million rupiahs,

accounting for approximately 73.67% of the total impact across all sectors. Sector 4 (Coal Industry and Oil Refining) saw a decrease in output of 5,020,596.016 million rupiahs, or about 3.96% of the total impact across all sectors.

The percentage impact on total output highlights that the Coal and Lignite Mining and Quarrying sector in East Kalimantan remains heavily reliant on coal exports. This indicates that the domestic absorption of raw coal is still very low. Despite clear government policies stipulating that minerals and coal should not be exported before adding value through downstream processing, this reliance persists. These findings align with research conducted by Tui & Adachi (2020), which showed that substantial export values of mining commodities are still derived from raw goods.

Due to several issues, Indonesia is still having trouble implementing the downstream process. Firstly, downstream technology has not kept up with the times and is still not grasped. Second, downstream programs must use clean coal technology due to regulatory requirements to reduce CO2 emissions. Third, it is well-known from an economic standpoint that significant funding is allocated to the downstream program. However, because of the ongoing instability of this downstream project, these capital costs carry a substantial financial risk. To enable this initiative to be implemented right away, the government must support it by offering incentives and drafting laws.

Table 1: East Kalimantan's Economic Sectors' Impact

Sector	Direct Impact	Indirect Impact	Total Impact	% The Overall Impact
1	0	-1252279.23	-1252279.23	0.99%
2	0	-5962601.53	-5962601.53	4.70%
3	-86317350	-7181231.02	-93498581.02	73.67%
4	0	-5020596.01	-5020596.01	3.96%
5	0	-4247268.35	-4247268.35	3.35%
6	0	-625132.89	-625132.89	0.49%
7	0	-2421.61	-2421.61	0.00%
8	0	-4795398.65	-4795398.65	3.78%
9	0	-2609676.13	-2609676.13	2.06%
10	0	-4519739.09	-4519739.09	3.56%
11	0	-257421.37	-257421.37	0.20%
12	0	-961871.51	-961871.51	0.76%
13	0	-1253434.88	-1253434.88	0.99%
14	0	-150445.42	-150445.42	0.12%
15	0	-1426803.59	-1426803.59	1.12%
16	0	-115703.42	-115703.42	0.09%
17	0	-65672.63	-65672.63	0.05%
18	0	-89167.08	-89167.08	0.07%
19	0	-63312.93	-63312.93	0.05%

Conclusion

The Coal and Lignite Mining and Quarrying sector (Sector 3) is primarily used as an intermediate input by the Electricity and Gas Supply sector (Sector 6) due to its dependence on coal-fired power plants. Conversely, the Coal Industry and Oil Refining sector (Sector 4) is

predominantly used as an intermediate consumption by the Transportation and Warehousing sector (Sector 10), which requires oil and gas as fuel. In 2016, Sector 4 demonstrated very high forward linkages, while Sector 3 was lower, though both were able to meet the demands of other sectors. Sector 6 had the highest backward linkages, while the backward linkages of Sectors 3 and 4 were low. This indicates that these two sectors did not require many inputs from other sectors. By 2023, the forward linkages of Sectors 3 and 4 experienced a slight decline, but their backward linkages did not change much. Both sectors fall into Quadrant III, classifying them as independent sectors. This is evidenced by their low dependency on other sectors and their significant influence on East Kalimantan's economy due to their outputs being widely used by other sectors.

According to the output multiplier analysis's findings, Sectors 3 and 4 have relatively low output multipliers. Because of this, a change in final demand in these two industries won't have a significant impact on output. Moreover, the simulation of the drop in coal exports demonstrates that output is declining across the board. Nonetheless, Sector 3 is the most negatively impacted, indicating that the majority of its output is still exported. The third-largest industry, Sector 4, suffered less of an impact in terms of output decline.

Several recommendations might be made in order to reduce the impact of export restrictions, based on the conclusions that have been reached. To ensure that the mining trade system is well-established, the government must develop close communication with business owners in the coal mining sector, particularly with miners and entrepreneurs in the downstream coal industry. The government's second recommendation is that downstream coal industry be developed as soon as possible. Although there is a regulation restricting coal exports, this is meant to enable the coal produced by mining to be treated and refined so that the coal has added value and can still benefit East Kalimantan's economy. Aside from that, more research is required to examine the possibility for creating downstream industries based on coal that are specific to Indonesia's potential.

The scope of this study is restricted to examining how a decrease in exports has affected East Kalimantan's economic sectors. To enhance future research, an examination of the duration taken by East Kalimantan's economic sectors to experience the consequences of the decrease in exports could be included. In addition, it is also necessary to examine how big an impact was felt when the economic sector was first affected by the change in exports.

Declaration

This research is made based on the author's perspective and understanding. Furthermore, the availability of data also supports this research.

Conflict of Interest

This research was carried out with no conflicts of interest, whether financial or personal, that could impact the performance of the results of this research.

Available of Data and Materials

This analysis was conducted using secondary data sourced from the BPS Statistic of East Kalimantan, with the data taking the form of an Input-Output table.

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