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Enigma of Nickel Export Ban: Understanding Its Impact through Input-Output Analysis

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Abstract

The nickel ore export ban policy has drawn pros and cons in various circles. This study aims to analyze the impact of the nickel ore export ban on other sectors of the economy and the interrelationship between one sector and another. This study uses secondary data in the form of Indonesia's Input Output Table Total Transactions at Basic Prices in 2016 derived from BPS publications and data on the number of Ferro-nickel exports in 2020 derived from UNData publications, which are then analyzed using the input-output method and presented using descriptive quantitative analysis. Based on the research results, electricity and gas procurement are the economic sectors with the most significant backward linkage. In contrast, the manufacturing sector achieves the most significant forward linkage value. In addition, the electricity and gas procurement sector also has the most significant output multiplier value, followed by the construction and manufacturing sectors. The increase in Ferro-Nickel exports due to the nickel ore export ban has considerably impacted the economy regarding both domestic and import output, especially in the manufacturing industry sector. Thus, nickel ore processing activities depend on capital goods and other imported raw materials. The study's implication shows that the export of Ferro-Nickel as part of the mining and quarrying sector impacts the output of other sectors to increase overall economic growth.

INTRODUCTION

Indonesia, one of the world's largest nickel producers, has nickel deposits of 4 million metric tonnes out of a total global reserve of 80 million metric tonnes (Wulandari et al., 2023). This places Indonesia as the sixth-ranked nickel producer globally, with the majority market share in China, the United States, and Japan (Panova et al., 2021). Data from the US Geological Survey cited by Nugroho (2022) shows that Indonesia's nickel reserves reached 21 million metric tonnes in 2022. Therefore, Indonesia's global nickel supply chain position has become increasingly significant.

Within the supply chain framework, nickel, as a part of the mining sector, contributes to the country's economy. Nickel falls into the category of rare natural resources whose presence is often hunted by various countries. On the other hand, nickel-producing countries must be able to maintain this sustainability, given the non-

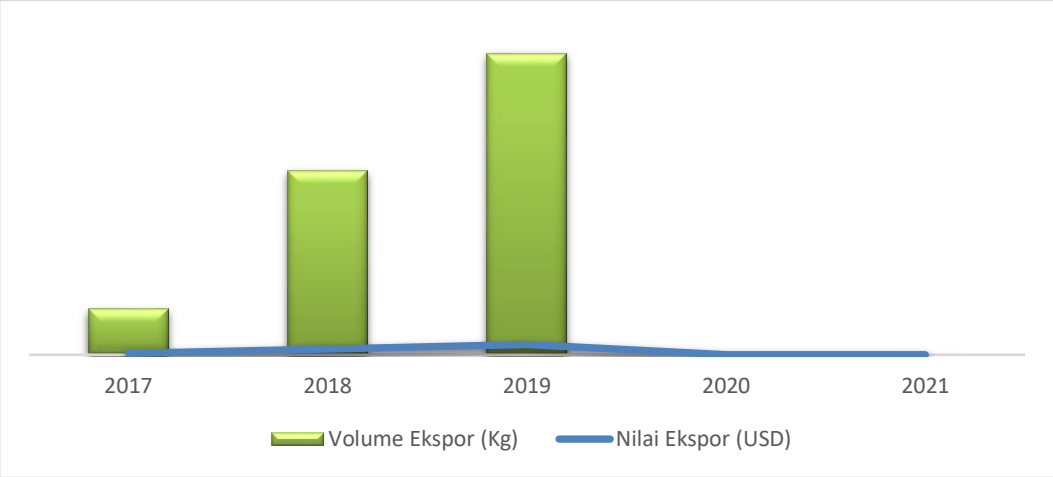
renewable characteristics of nickel (Suryano, 2022). Farrokhpay et al. (2019) added that global nickel consumption reaches 2 million tonnes per year with its increasingly high use value, driving an increase in the value of nickel demand in the global market. However, the global market is experiencing an imbalance between nickel supply and demand, causing bottlenecks in the global supply chain (Zhou et al., 2022). In this case, the turmoil also affects Indonesia, a nickel producer that exports nickel ore to various parts of the world. Moreover, amidst the sizeable domestic nickel reserves, the reserves are, in fact, only able to meet the economic needs for refining facilities for the next 7-8 years when the national nickel ore demand reaches 20 million metric tonnes (Kementerian et al., 2021)

In response to this situation, the government strives to ensure domestic nickel sustainability, promote downstream processing, and enhance the economic value of the nickel commodity through the policy of banning the export of nickel ore starting from January 1, 2020, by the Peraturan Menteri Energi Dan Sumber Daya Mineral Nomor 11 Tahun 2019 Tentang Pengusahaan Pertambangan Dan Mineral Batubara. As a manifestation of the government's commitment and determination to safeguard domestic nickel supply, this regulation prohibits the sale of nickel ore with a grade of <1.7% before processing and refining. Hence, Mining Business Permits (IUP) holders must process nickel ore before exporting it.

The government's stance in implementing the export ban undoubtedly has the potential to yield wide-ranging impacts on the economy and industries and influence international trade. Putri (2020) notes that this regulation has generated criticisms from nickel ore-importing countries, particularly in the European Union, who feel disadvantaged.

Within the country, the policy of prohibiting nickel ore exports has sparked controversy across different segments. According to Ikmal and Noor (2022), the ban on nickel ore exports is an effort to promote downstream processing that will have a broader impact on the economy by adding value, advancing industries, creating job opportunities, and increasing state revenues.

Figure 1 Nickel Ore Export Volume and Value 2015-2021

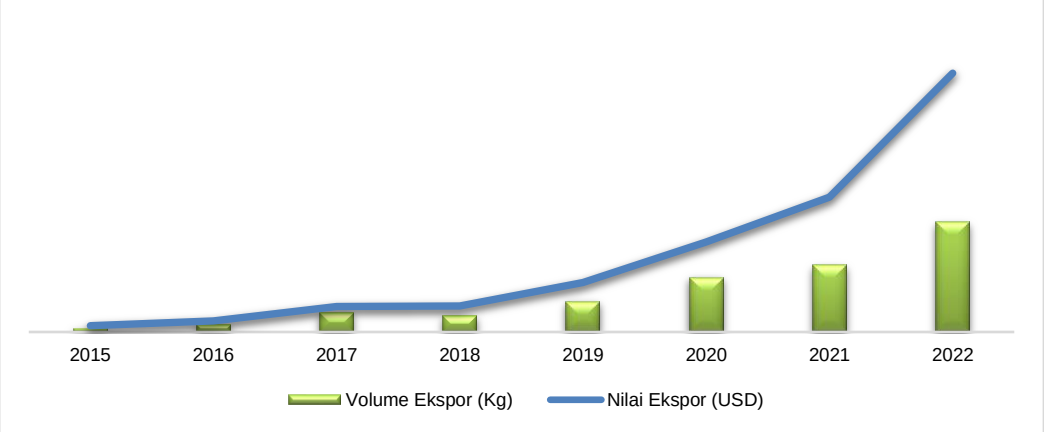


Source: UNData 2023, Data Processed

Figure 1 illustrates the trend in volume and value of nickel ore exports, which initially experienced an upward trajectory from 2017 to 2019. However, following the implementation of the nickel ore export ban on January 1, 2020, the volume of nickel ore exports saw a significant surge. The volume of nickel ore exports in 2019 reached 32.4 million tons, plummeting to 1.4 tons or approximately $117 million. Subsequently, the volume of nickel ore exports was further reduced to 65 kilograms, equivalent to around $43 million. Agus Gumiwang Kartasasmita, the Minister of Industry, stated that this surge indicates the effective implementation of the nickel ore export ban (Sadya, 2022).

In addition to the substantial decrease in the value of nickel ore exports, one direct impact of the export ban is the increase in exports of derivative nickel commodities, such as Ferro nickel. Alongside the export ban on nickel ore, the demand for processed nickel products has risen. The cessation of nickel ore exports since the beginning of 2020 has indeed boosted the value of exports for derivative nickel commodities, reaching around 326 trillion rupiahs in 2021, with an estimated further increase to approximately 468 trillion rupiahs in 2022 (Susilo et al., 2022).

Figure 2 Nickel Ore Export Volume and Value 2015-2022



Source: UNData 2023, Data Processed

Figure 2 illustrates the volume and value trend of Ferro nickel exports, which significantly increased following the implementation of the nickel ore export ban. From 2015 to 2022, the most substantial increase occurred in 2022, with an export growth rate of 92.19% and an export volume of 5.78 million tons. The surge in Ferro nickel exports began in 2020 with an export volume of 2.87 million tons and an export value of $4.74 billion. Furthermore, the volume of Ferro nickel exports is expected to continue increasing during the nickel ore export ban. Recognizing the considerable export potential of Indonesian Ferro nickel, the government plans to impose export taxes on derivative nickel commodities.

On the other hand, the nickel ore export ban is also entering a new phase following a challenge brought by the European Union to the World Trade Organization, alleging violations of specific rules outlined in the General Agreement on Trade and Tariff (GATT). (Pratiwi et al, 2023). Nevertheless, the government remains optimistic about continuing the nickel ore export ban, pursuing appeals, and

planning to implement similar policies on commodities such as tin, copper, bauxite, and coal (CNBC Indonesia, 2023).

Amidst various challenges in implementing the nickel ore export ban policy, research on the impacts of this policy becomes crucial and intriguing to discuss. This study aims to analyze the impacts stemming from an economic shock in the form of the nickel ore export ban policy. Focusing on Ferro nickel commodity export data, this research strives to investigate the ripple effects felt by other sectors within the economy. This phenomenon represents a gap in this research.

Some previous researchers have used input-output analysis as a research method to determine the leading sectors in a region, such as the research by Prasetyo et al. (2021) examining the impacts of hosting the 2018 Asian Games on Indonesia's economy using input-output analysis. Additionally, studies by Widyawati (2017), Adyaharjanti & Harton (2020), Messakh et al. (2021), and dan Zahroo (2022) have utilized input-output analysis as a tool to uncover the impacts of one sector on other economic sectors and identify the leading sectors in specific regions. Notably, input-output analysis specific to the impacts of exports has been conducted by Sukma et al. (2018), investigating the impact of garment and craft exports, and by Wahyuningsih (2019), studying the role of the mining sector in the economy of East Kalimantan Province. Considering previous empirical research, studies on the impact of the ban on nickel ore exports on the economy can use input-output analysis. In the context of the nickel ore export ban, input-output analysis provides insights into the disruptions' effects on economic sectors related to the nickel industry.

This research will examine the effect of the nickel ore export ban on increasing output in each economic sector in Indonesia. Through the multiplier effect, the direct and indirect effects of increasing output in each economy will be known due to increased ferro-nickel volume export. The results of this research are helpful for the government of Indonesia in finding out the impact of the nickel ore export ban on the growth of each economic sector. The research results can be used as a reference for formulating more appropriate policies following economic development goals in Indonesia.

This research aims to explore the impacts of the policy of banning nickel ore exports more thoroughly. First, from the perspective of the research subject, this study is crucial given the limited empirical studies on the impacts of the ban on nickel ore exports. Second, in terms of the methodology employed, the use of input-output analysis as a research methodology for assessing the effects of the policy banning nickel ore exports still needs to be improved. This is particularly intriguing, considering the government's plans to expand the implementation of bans on raw mineral exports to other commodities such as bauxite, copper, tin, and more. Moreover, as one of the world's largest nickel ore producers, Indonesia's policies also have global implications that can influence the nickel market as a whole. Therefore, this research is significant in providing insights into the impacts of the policy banning nickel ore exports on the economy.

RESEARCH METHODS

This research employs a quantitative methodology that emphasizes research data in numerical figures and utilizes statistical analysis (Sugiyono, 2017). According to Creswell (2014), quantitative research aims to test objective theories by examining relationships between variables and measuring the variables using specific instruments, enabling data analysis through statistical procedures. Moreover, this study is a descriptive research aiming to depict or illustrate a phenomenon, event, situation, etc. (Arikunto, 2013).

This research uses secondary data from Indonesia's input-output tables based on basic prices for 17 sectors in 2016, sourced from publications by Badan Pusat Statistik. Additionally, data related to the nickel export ban policy are obtained from the publication of Badan Pusat Statistik. The reduction in nickel exports resulting from the export ban policy is treated as an economic shock, causing changes in total final demand. Data collection involves a literature study encompassing relevant articles, books, news, publications, and other documents related to the research subject. Data processing is conducted using Microsoft Excel.

This study employs the input-output analysis method proposed by Wassily Leontief. Essentially, the Leontief economic model employs matrices to represent a region's economy, depicting the relationships between sectors in meeting the final demand in each sector, thereby creating an input-output equilibrium within the economy (Akbar et al., 2023).

This analysis is presented in the form of matrices illustrating transactions of goods and services among production sectors in a region's economy for a specific period (Rofingah & Madhuri, 2022). This research utilizes tables and graphs to illustrate the research findings. Furthermore, a more in-depth analysis is conducted using Input-Output tables to identify the interrelation between the increase in Ferro-nickel exports and other industries, as well as assess the impact of the increased Ferro-nickel exports resulting from the ban on raw nickel ore exports on the Indonesian economy. The backward linkage (BL) and forward linkage (FL) methods are employed to examine industry interconnections.

In this research, input-output analysis includes Technical Coefficient Matrix analysis, Leontief Inverse Matrix analysis, Backward Linkage Effect analysis, Forward Linkage Effect analysis, Output Multiplier analysis, and Export Reduction Impact analysis.

Technical Coefficient Matrix Analysis

In an Input-Output Table, the technical coefficient matrix represents the relationship between the quantity present in sector i used in sector j (X_{ij}) and the total input in sector j (X_j). As it illustrates the magnitude of input from sector i required to produce one unit of output in sector j, these coefficients are also referred to as input coefficients. Systematically, technical coefficients can be expressed as follows.

$$\alpha_{ij} = \frac{X_{ij}}{X_j}$$

α_{ij} : Coefficient of input of sector j from sector i; X_{ij} : Input use of sector i by sector j; X_j: The total input of sector j

Leontief Inverse Matrix Analysis

The Leontief inverse matrix, also known as the Leontief Matrix Inverse, is a matrix that contains information about the extent to which an increase in production in one sector will lead to the expansion of other sectors in the economy. Through the Leontief inverse matrix, the impact of changes in the production of one sector on the total production of other sectors can be determined using coefficients known as multipliers (Kurniawan & Kristiarini, 2022). Moreover, this matrix also indicates the direct and indirect effects of changes in final demand within the economy. Systematically, the Leontief inverse matrix can be expressed as follows.

$$L = (I - A)^{-1}$$

L : Leontief Inverse Matrix; I : An identity matrix of size n sectors; A : Technical coefficient matrix

Backward Linkage Analysis

Linkage analysis is fundamental in formulating economic development strategies by examining the interconnections between economic sectors (Rahmah & Widodo, 2019). This linkage analysis encompasses direct forward linkage analysis, direct and indirect forward linkage analysis, direct backward linkage analysis and direct and indirect backward linkage analysis.

In input-output analysis, production activities affect other sectors by increasing demand and supply (Negara, 2010). When an increase in production in the sector leads to increased demand for inputs from other sectors, this is a backward linkage. Generally, expansion in sectors with higher backward linkage values compared to other sectors will have a more significant impact on the economy. According to Widyawati (2017), backward linkage consists of direct, indirect, and total backward linkage. Fafurida (2012) defines *direct backward linkage* as adding columns to the technical coefficient matrix, and its formula is expressed as follows. Linkage analysis is fundamental in formulating economic development strategies by examining the interconnections between economic sectors (Rahmah & Widodo, 2019). This linkage analysis encompasses direct forward linkage analysis, direct and indirect forward linkage analysis, direct backward linkage analysis and direct and indirect backward linkage analysis.

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$$B^d{}_j = \sum_{i=1}^{n} \alpha_{ij}$$

B_{dj} : Direct backward linkages for sector j; α_{ij} : Technical coefficient of sector j of sector I

Fafurida (2012) also introduced the concept of total backward linkage, indicated by adding columns from the Leontief inverse matrix, also known as output multipliers. The output multiplier of a sector represents the total value of output generated by the economy in response to a one-unit increase in final demand for that sector (Widyawati, 2017). The formula for total backward linkage is formulated as follows.

$$B^{d+id}{}_j = \sum_{i=1}^{n} \alpha_{ij}$$

Bd+idj : Total backward linkages for sector j; αij : Leontief inverse matrix element or [I-A]-1 matrix element

The value of indirect backward linkage is obtained by subtracting the direct backward linkage from the total backward linkage, formulated as follows.

$$B^{id} = B^{d+id} - B^{d}$$

B_{id} : Indirect backward linkage; B_{d+id}: Total backward linkage; B_{d} : Direct backward linkage

Forward Linkage Analysis

In the context of Input-Output analysis, in addition to backward linkage, there is also forward linkage, which indicates a sector's ability to stimulate the growth of output across all production sectors in the economy, including itself, through the distribution of its output, both directly and indirectly (Rahmah & Widodo, 2019). According to (Negara, 2010), sectors with relatively high forward linkage values can encourage other sectors to use their output as input to enhance their activities. Like backward linkage, forward linkage is divided into three types: direct forward linkage, indirect forward linkage, and total forward linkage.

Sawit et al. (2019) describe direct forward linkage as adding rows to the technical coefficient matrix $A^{\rightarrow}$, which can be formulated as follows.

$$F^{d}{}_i = \sum_{j=1}^{n} \vec{a}_{ij}$$

F_{di} : Direct forward linkages for sector I; α_{ij} : Coefficient of sector's output from sector i

Total forward linkage involves the addition of rows from the Leontief inverse matrix and is referred to as input multipliers (Fafurida, 2012). In brief, the formula for total forward linkage can be expressed as follows.

$$F^{d+id}i = \sum_{j=1}^{n} \vec{\alpha}_{ij}$$

F^{d+id}i : Total forward linkages of sector i; α_{ij} : Leontief inverse matrix elements

To calculate the value of indirect forward linkage, you subtract the direct forward linkage from the total forward linkage, and it can be formulated as follows.

$$F^{id} = F^{d+id} - F^{d}$$

F^{id} : Indirect Forward Linkage; F^{d+id} : Total Forward Linkage; F^{d} : Direct Forward Linkage

Analysis of Output Multipliers

Output multipliers measure the magnitude of change in output resulting from a change in final demand for a specific sector in the economy (Widyawati, Output multipliers are used to assess the impact of policies in development planning. The value

of an output multiplier is obtained by summing the values in a column of the Leontief inverse matrix, and it can be formulated as follows.

$$oneO_j = \Sigma_{i=1}^{n} \alpha_{ij}$$

O_j : Sector j output multiplier; α_{ij} : Leontief inverse matrix elements

RESULT AND DISCUSSION

Inter-sectoral Linkage Analysis

Generally, there are two linkages: backward and forward interconnectedness between economic sectors (Sukma et al., 2018). Additionally, according to (Richardson, 1985), linkage analysis can aid in identifying leading sectors within the economy. Leading sectors can absorb inputs from other sectors in significant quantities and significantly impact other sectors as inputs.

Generally, there are two types of linkages: backward and forward. Sukma et al. (2018) define *backward linkage* as the relationship between a sector and other sectors that provide inputs, while forward linkage is the relationship between a sector and other sectors for which it provides outputs. These two types of linkages are then further divided into three categories: direct linkage, indirect linkage, and total linkage (Nasoetion et al., 2017).

Backward Linkage Analysis

Wijaya et al. (2014) reveal that backward linkage analysis provides insight into the effects of changes in one sector that lead to changes in sectors providing inputs to that sector, making it a concept of attraction. An increase in output in the first sector stimulates output growth in other sectors that provide inputs to the first sector. This process continues in the second sector, third sector, and so on. Two types of direct and indirect backward linkages exist in such a scenario. The ability of the first sector to stimulate output growth in the second sector through input demand signifies direct backward linkage. Meanwhile, the ability of the first sector to drive output growth in the third sector through input demand generated by increased output in the second sector signifies indirect backward linkage.

The summation of direct backward linkage (DBL) and indirect backward linkage (IBL) yields the total backward linkage (TBL) value, reflecting the first sector's capacity to drive output growth across all sectors through direct and indirect input increases. Tanjung et al. (2021) explain that if TBL equals 1, the spreading power of that sector is equal to the average spreading power of the entire economy's sectors. If it is greater than 1, the spreading power of that sector surpasses the average spreading power of the entire economy's sectors. If it is less than 1, the spreading power of that sector is lower than the average spreading power of the entire economy's sectors. Backward linkage analysis within Indonesia's economic sectors can be observed in Table 1.

Table 1. Backward Linkages in Indonesian Economic Sectors

No	Sector	DBL	IBL	TBL		BL Index
				Value	Rank	
1	Agriculture, forestry and fisheries	0,221	1,184	1,405	17	0,775
2	Mining and quarrying	0,324	1,279	1,603	12	0,885
3	Processing industry	0,610	1,502	2,112	3	1,165
4	Electricity, gas, and water supply	0,786	2,037	2,824	1	1,558
5	Water Supply, Waste Management, Waste Recycling	0,293	1,291	1,584	13	0,874
6	Consruction	0,595	1,547	2,142	2	1,182
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	0,294	1,249	1,543	14	0,851
8	Transportation and Warehousing	0,537	1,518	2,055	4	1,134
9	Accommodation and Food Service	0,530	1,441	1,971	5	1,087
10	Information and Communication	0,373	1,326	1,699	10	0,937
11	Financial and Insurance Activities	0,265	1,197	1,462	15	0,807
12	Real Estate Professional	0,226	1,206	1,432	16	0,790
13	Scientific	0,416	1,350	1,766	9	0,974
14	Technical Services Public Administration, Defense, and Compulsory Social Security	0,436	1,428	1,864	7	1,029
15	Education Services	0,321	1,299	1,621	11	0,895
16	Health and Social Activities	0,495	1,457	1,953	6	1,077
17	Other Services	0,416	1,358	1,774	8	0,979

Based on Table 1, all economic sectors have total backward linkage values greater than 1, indicating that the attractive power of processed economic sectors is higher than the average attractive power of all economic sectors in Indonesia.

The three main sectors have the highest values in the total backward linkage values. Firstly, the electricity and gas supply sector has the highest total backward linkage value, reaching 2.824, with a direct backward linkage value of 0.786 and an indirect backward linkage value of 2.037. The value of 0.786 in direct backward linkage indicates that a 1 rupiah increase in the electricity and gas supply sector will lead to a 0.786 rupiah increase in input demand from other sectors (assuming ceteris paribus). Therefore, other sectors will increase their production to meet the increased demand in the electricity and gas supply sector. The value of 2.037 in indirect backward linkage shows that, under ceteris paribus conditions, a 1 rupiah increase in output in the electricity and gas supply sector will result in a 2.037 rupiah increase in input demand

from other sectors indirectly related to the electricity and gas supply sector. This finding strengthens the research results of Armelly et al. (2021) and Utomo (2021), concluding that the electricity and gas procurement sector has excellent potential to encourage the growth of other related sectors.

The electricity and gas supply sector has the highest BLI (Backward et al.) value at 1.558. According to Pitaloka (2022), sectors with high BLI index values can meet domestic input or raw material needs. This aligns with a study by the Pusat Penelitian Badan Keahlian DPR RI (2019), which states that electricity plays a crucial energy source in the production process, particularly in industries and electronics.

The construction sector follows in second place with a total backward linkage value of 2.142, comprising a direct backward linkage value of 0.595 and an indirect backward linkage value of 1.547. The manufacturing industry sector holds the third position with a total backward linkage value of 2.112, consisting of a direct backward linkage value of 0.610 and an indirect backward linkage value of 1.502.

The high values of total backward linkage indicate the dependence of these three sectors on resources used as inputs in the production process. For example, the total backward linkage value of the electricity and gas supply sector, which is 2.824, implies that, under ceteris paribus conditions, each 1 rupiah increase in final demand will increase the upstream production output of the electricity and gas supply sector by 2.824 rupiah.

Forward Linkage Analysis

Forward linkage is the summation of rows in the Leontief inverse matrix (I-A)-1, which indicates a sector's ability to stimulate the growth of the entire production sector's output in the economy, whether it is the sector's output directly or indirectly (Rahmah & Widodo, 2019). Messakh et al. (2021) view forward linkage as a parameter and a foundation for formulating economic development strategies.

In the context of forward linkage, an increase in output in one sector leads to an increase in input in the second sector, which uses the output of the first sector as its input for production. This increased input then causes the output of the second sector to rise, and simultaneously, the input and output of the third sector also increase. This process continues for the fourth, fifth, and so on. In this scenario, two types of forward linkage are direct and indirect. The ability of the first sector to drive the growth of the second sector's output through output demand demonstrates direct forward linkage. On the other hand, the ability of the first sector to stimulate the growth of the third sector's output through output demand generated from the increased output of the second sector indicates indirect forward linkage.

Furthermore, the sum of the values of direct forward linkage (DFL) and indirect forward linkage (IFL) results in the total forward salinkage (TFL) value, which reflects the first sector's capability to boost the growth of output across all sectors through direct and indirect output increases. The analysis of forward linkage in Indonesia's economic sectors can be observed in Table 2.

Table 2. Forward Linkages in Indonesian Economic Sectors

No	Sector	DFL	IFL	TFL		FL
				Value	Rank	Index
1	Agriculture, forestry and fisheries	0,404	1,735	2,139	3	1,180
2	Mining and quarrying	0,416	1,722	2,138	4	1,179
3	Processing industry	2,281	3,223	5,504	1	3,037
4	Electricity, gas, and water supply	0,648	1,743	2,391	2	1,319
5	Water Supply, Waste Management, Waste Recycling	0,044	1,010	1,054	15	0,582
6	Consruction	0,247	1,090	1,337	10	0,738
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	0,564	1,499	2,063	5	1,139
8	Transportation and Warehousing	0,505	1,351	1,856	7	1,024
9	Accommodation and Food Service	0,204	1,069	1,273	12	0,702
10	Information and Communication	0,446	1,339	1,785	8	0,985
11	Financial and Insurance Activities	0,389	1,325	1,714	9	0,946
12	Real Estate Professional	0,197	1,102	1,298	11	0,716
13	Scientific	0,592	1,342	1,933	6	1,067
14	Technical Services Public Administration, Defense, and Compulsory Social Security	0,071	1,047	1,118	14	0,617
15	Education Services	0,034	1,018	1,052	16	0,581
16	Health and Social Activities	0,022	1,012	1,035	17	0,571
17	Other Services	0,078	1,041	1,119	13	0,618

Based on Table 2, the highest values of total forward linkage are successively held by the manufacturing sector, the electricity and gas supply sector, and the agriculture, forestry, and fisheries sectors. This situation implies that when there is an increase in output in the manufacturing sector, the economic impact will be more significant than in other sectors. This is because the manufacturing sector's output generates various derivative products used in the economy.

Firstly, the manufacturing sector has a total forward linkage value of 5.504, comprising a direct forward linkage value of 2.281 and an indirect forward linkage value of 3.223. The magnitude of the DFL value indicates that under the assumption of ceteris paribus, a 1 rupiah increase in output in the manufacturing sector will increase output across all economic sectors by 2.281. This occurs because the increased output in the manufacturing sector is used as input directly by other sectors of the economy. The value of IFL, on the other hand, indicates that a 1 rupiah increase in

output in the manufacturing sector will lead to an increase in the economy's output by 3.223 rupiahs (assuming ceteris paribus). This is due to the manufacturing sector's increased output indirectly affecting other economic sectors.

In the second position, the electricity and gas supply sector has a total forward linkage value of 2.391, with a direct forward linkage value of 0.648 and an indirect forward linkage value of 1.743. In the third position, the agriculture, forestry, and fisheries sectors have a total forward linkage value of 2.139, comprising a direct forward linkage value of 0.404 and an indirect forward linkage value of 1.735. These three sectors have a more significant impact on the economy when there is an increase in output within them. This finding strengthens Armelly et al. 's (2021) and Zahroo's (2022) research results.

The high value of total forward linkage indicates the dependence of these three sectors on resources used as input in the production process. For example, the total backward linkage value of the electricity and gas supply sector is 2.824, meaning that under the assumption of ceteris paribus, every 1 rupiah increase in final demand will result in a 2.824 rupiah increase in upstream production output of the electricity and gas supply sector.

In determining leading sectors based on forward and backward linkages, as in Richardson, 1985 they explained, sectors with index values of forward and backward linkages greater than one are considered leading sectors. Based on Tables 1 and 2 above, the manufacturing sector has the highest index value with a backward linkage index of 1.165 and a forward linkage index of 3.037. Thus, the manufacturing sector is the leading sector in Indonesia's economy. Besides the manufacturing sector, there are two other sectors with index values greater than one, indicating their roles as leading sectors: the electricity and gas supply and transportation and warehousing.

Simple Output Multiplier Analysis

Analysis of the simple output multiplier, or the output multiplier, indicates that every additional rupiah of final demand in a sector will influence the overall economic output (Sukma et al., 2018). This aligns with the research by Perwitasari and Sari (2013), which explains that an increase in final demand in a sector impacts the output of that sector and the output of other sectors. The analysis of the simple output multiplier for the sectors of the Indonesian economy can be observed in Table 3.

Table 3. Simple Output Multiplier in Indonesian Economic Sectors

No	Sector	Simple Output Multiplier
1	Agriculture, forestry and fisheries	1,405
2	Mining and quarrying	1,603
3	Processing industry	2,112
4	Electricity, gas, and water supply	2,824
5	Water Supply, Waste Management, Waste Recycling	1,584
6	Consruction	2,142
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	1,543

8	Transportation and Warehousing	2,055
9	Accommodation and Food Service	1,971
10	Information and Communication	1,699
11	Financial and Insurance Activities	1,462
12	Real Estate Professional	1,432
13	Scientific	1,766
14	Technical Services Public Administration, Defense, and Compulsory Social Security	1,864
15	Education Services	1,621
16	Health and Social Activities	1,953
17	Other Services	1,774

Based on Table 3, the electricity and gas supply, construction, and manufacturing sectors have the highest output multipliers in sequence. Compared to other sectors with output multipliers around one, these three sectors have output multipliers above two. The sector of electricity and gas supply, with an output multiplier of 2.824, indicates that a 1 rupiah increase in final demand in this sector will lead to a total output increase of 2.824 rupiahs, and this output is used as input for other sectors in the economy. This aligns with the research by Zahroo (2022), which proves that an increase in final demand in the electricity and gas supply sector will drive output growth in other sectors.

Regarding the construction sector, with an output multiplier of 2.142, a 1 rupiah increase in final demand in the construction sector will result in a total output increase in the economy of 2.142 rupiahs. The construction sector's role in the Indonesian economy is very significant, as indicated by its contribution of 10.75% to the Gross Domestic Product (GDP) in 2019, which continues to increase yearly (Bangun & Setyono, 2020). According to Berk & Biçen (2016), the construction sector plays a vital role in the economy by stimulating economic growth. In practice, the construction sector impacts the economy through the inputs it uses and generates for other sectors, both directly and indirectly, making it a driver of the national economy. Furthermore, the involvement of various industries in construction activities leads to a multiplier effect that stimulates the economy (Sutjipto, 2001).

Similarly, the manufacturing industry sector, with an output multiplier of 2.112, also has a significant output multiplier above the average value. A 1 rupiah increase in final demand in the manufacturing industry sector will result in a total output increase in the economy of 2.112 rupiahs.

Based on the explanations above, the larger the value of the output multiplier for a sector, the greater its influence on the changes in the output of other sectors in the economy. Therefore, the value of the output multiplier is a reference point in making economic policies or regulations (Takalumang et al., 2018). Regarding the output multiplier value, the mining and quarrying sector, which falls below the value of the manufacturing sector and is not among the top three, indicates that the export of nickel ore has a minor impact compared to the export of processed nickel commodities such as Ferronickel, which have undergone processing and purification within the country.

Thus, based on the output multipliers, the government's policy regarding nickel downstream is a suitable step.

Analyzing the Impact of Shocks on the Domestic Economy

This research utilizes economic shock data originating from the increase in the export value of Ferro-nickel due to the nickel downstream policy that imposed a ban on nickel ore exports starting January 1, 2020. The export volume of Ferro-nickel has experienced a significant increase since the implementation of the nickel ore export ban. Kementerian Perdagangan RI (2023) data indicates that the Ferro-nickel export value increased by 75.26% from 2018 to 2022.

Table 4. Ferro-nickel Export Volume in 2019-2020

Year	2019	2020	Differences
Volume Export	2595,6	4738,9	2143,3

Source: UNData 2023, Data Processed

The shock value used in this study is the difference between the Ferro-nickel export value in 2019 and 2020, as mentioned in Table 4, amounting to 2.143,3 billion US dollars, which is then multiplied by the Minister of Finance Exchange Rate (Kurs Menteri Keuangan or KMK) as of December 31, 2020, which is 14,228 Indonesian rupiah. This calculation results in a total increase in Ferro-nickel exports of approximately 30.494 trillion Indonesian rupiah. Given the characteristics of Ferro-nickel, which has undergone purification and processing, this shocking amount is attributed to the processing industry sector. The impact of this economic shock on other sectors of the economy is presented in the following table.

Table 5. The Impact of Increased Ferro-nickel Exports on Indonesia's Economic Sectors

No	Sector	Indirect Impact	Final Output	% Change
1	Agriculture, forestry and fisheries	6.615.593	1.904.755.205	0,349
2	Mining and quarrying	3.635.889	1.172.716.994	0,311
3	Processing industry	44.860.890	6.863.976.117	0,658
4	Electricity, gas, and water supply	1.079.546	664.334.107	0,163
5	Water Supply, Waste Management, Waste Recycling	40.598	56.493.474	0,072
6	Consruction	201.490	2.910.595.040	0,007
7	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	2.904.763	2.414.306.175	0,120
8	Transportation and Warehousing	1.459.140	1.486.930.519	0,098
9	Accommodation and Food Service	191.759	907.428.575	0,021
10	Information and Communication	823.319	738.281.711	0,112
11	Financial and Insurance Activities	1.126.024	712.212.583	0,158
12	Real Estate Professional	273.674	766.871.057	0,036

13	Scientific	909.064	629.246.275	0,145
14	Technical Services Public Administration, Defense, and Compulsory Social Security	117.034	763.915.524	0,015
15	Education Services	39.585	615.637.926	0,006
16	Health and Social Activities	35.637	287.589.235	0,012
17	Other Services	89.107	399.450.898	0,022
	Total Indirect Impact	64.403.113		

Table 4 illustrates the impact of the increase in Ferro-nickel exports on the domestic output of all sectors of the Indonesian economy. The total change in domestic output resulting from the increase in Ferro-nickel exports in 2020 amounts to 64.4 trillion Indonesian rupiah, a value significantly more significant than the shock given to the processing industry sector, which amounts to 30.4 trillion Indonesian rupiah. With a difference of approximately 34 trillion rupiahs, the export downstream policy has positively impacted the entire economy, leading to a more significant increase in output. This finding is similar to the research of Noor and Ibadi (2021), which reveals the increasing contribution of nickel commodities to the economy.

The processing industry occupies the first position as the sector with the most significant change in output, amounting to 44.86 trillion rupiah or approximately 0.658%. The value of the change in output generated is far greater than the shock value applied to the economy. This implies that the change in domestic output in the processing industry requires the most significant input from the sector. This is consistent with the total coefficient of backward linkage, where the most significant input coefficient for the processing industry comes from the processing industry sector itself.

Furthermore, in addition to affecting the processing industry, other sectors of the economy that are significantly impacted include agriculture, forestry, fisheries, mining, and quarrying. Occupying the second position, the agriculture, forestry, and fisheries sector experiences a change in domestic output of 6.6 trillion rupiah or approximately 0.349%. The relationship between the increase in Ferro-nickel exports and the agriculture, forestry, and fisheries sectors encompasses using Ferro-nickel as a raw material in equipment manufacturing, commonly used in agriculture, forestry, and fisheries. This is further supported by statements from the Ministry of National Development Planning, which revealed that the growth of resource-based processing industries has an impact on increasing demand for output in the agriculture and mining sectors in the Sulawesi region (Kementerian PPN, 2018).

In the third position, the mining and quarrying sector experiences a change in domestic output of 3.6 trillion rupiah, or approximately 0.311%. The increase in Ferro-nickel exports or production also contributes to the change in domestic output in the mining and quarrying sector, as the output in the mining and quarrying sector serves as input for the processing industry sector. In short, the raw material for Ferro-nickel comes from the mining and quarrying industry, specifically nickel ore. Therefore, the more input is available, the greater the Ferro-nickel the processing industry can produce for export to foreign countries.

In addition to the main sectors impacted by the increase in Ferro-nickel exports, the education sector has a minor influence compared to other sectors of the economy, with a domestic output change of 39 billion rupiahs or approximately 0.006%. The increase in Ferro-nickel exports has a limited impact on the education sector. This is due to the differing characteristics of industries as well as the low linkage between the education sector and the processing sector. However, it should be collectively understood that the shock impact within the economy is not uniformly distributed across various sectors, and various other factors also contribute to the economic dynamics.

CONCLUSION

This study examines the impact of the government's policy of nickel downstream in 2020. This research utilizes secondary data from the Input-Output Table of Indonesia's Total Transactions at Basic Prices for the year 2016 sourced from the publication of the Indonesian Bureau of Statistics (BPS), as well as data on the quantity of Ferro-nickel exports in 2020 from the UNData publication. The research findings indicate that the electricity and gas supply, construction, and processing industries are the economic sectors with the most considerable backward linkages, implying their significant influence on the economy's output through input demand. On the other hand, in terms of forward linkages, the three leading sectors are the processing industry, electricity and gas supply sector, and agriculture, forestry, and fisheries sector. This suggests that these three sectors substantially influence the economy's output through output demand.

Moreover, Indonesia's three main sectors with the highest output multipliers are the electricity and gas supply, construction, and processing industries. Consequently, the government's policy of nickel downstream is an appropriate step, given the significant output multiplier of the processing industry sector, which can lead to substantial domestic output. As a result of nickel downstream, changes in the domestic output of the economy experience considerable growth. The three key sectors with the most significant changes in domestic output are the processing industry, agriculture, forestry, fisheries, and mining and quarrying.

This study has certain limitations, including the use of Ferro-nickel export data as a proxy for the ban on nickel ore exports, the lack of consideration for potential environmental impacts resulting from the nickel downstream policy in Indonesia, and the assumption of fixed consumption and production patterns in the input-output analysis. Future research could employ different proxies to interpret the export ban.

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