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The Double Dividend of Downstreaming: Growth, Equity, and Structural Change in Indonesia's Critical Minerals Strategy

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Abstract

Indonesia has banned the export of raw minerals to enforce domestic downstream processing of its critical minerals. This study provides a rigorous, quantitative assessment of this transformative downstreaming policy by employing a static, single-country Computable General Equilibrium (CGE) model calibrated to Indonesia's 2018 Social Accounting Matrix (SAM). The model explicitly incorporates the policy by simulating a 50% export restriction on raw minerals combined with a 10% productivity boost in domestic processing. This approach enables us to quantify how this structural shift affects aggregate GDP, investment, and household real incomes across the distribution. The simulations reveal that downstreaming successfully reorients the economic structure, resulting in a 1.46% increase in GDP. Crucially, the policy generates a progressive distributional outcome: real income growth for the poorest rural households outpaces that of the wealthiest urban ones, leading to a slight reduction in inequality. However, this "double dividend" of growth and equity is not automatic. The policy triggers significant resource reallocation, creating vulnerabilities like sectoral crowding-out. The findings underscore that the policy's success depends critically on the implementation of complementary policies in skills development, fiscal management, and social protection to secure a sustainable and inclusive transition for resource-rich economies.

Keyword(s): *Downstreaming; Critical Minerals; CGE Model; Structural Transformation; Household Welfare*

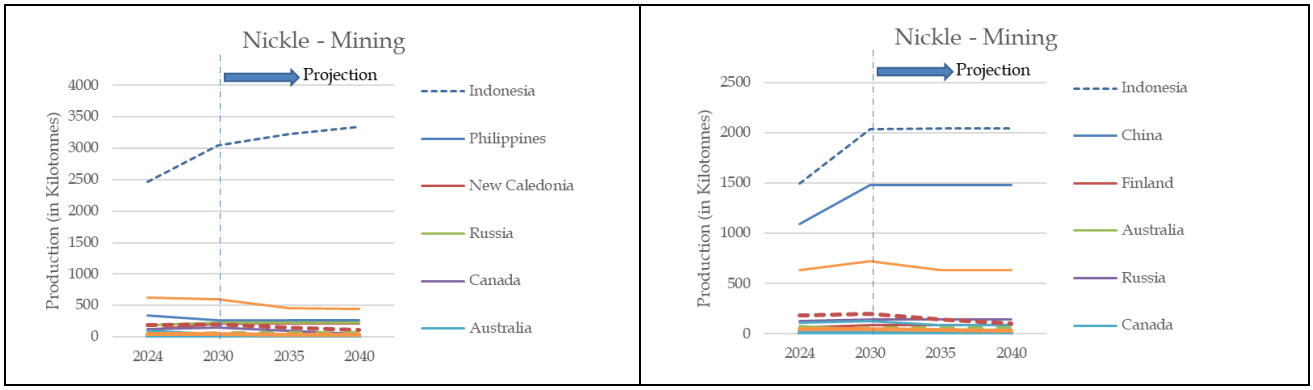
JEL O13, Q32, Q38, C68, F14

1. Introduction

The global scramble for critical minerals, essential for the green and digital transitions, has placed resource-rich nations like Indonesia at a strategic crossroads, both geopolitically and

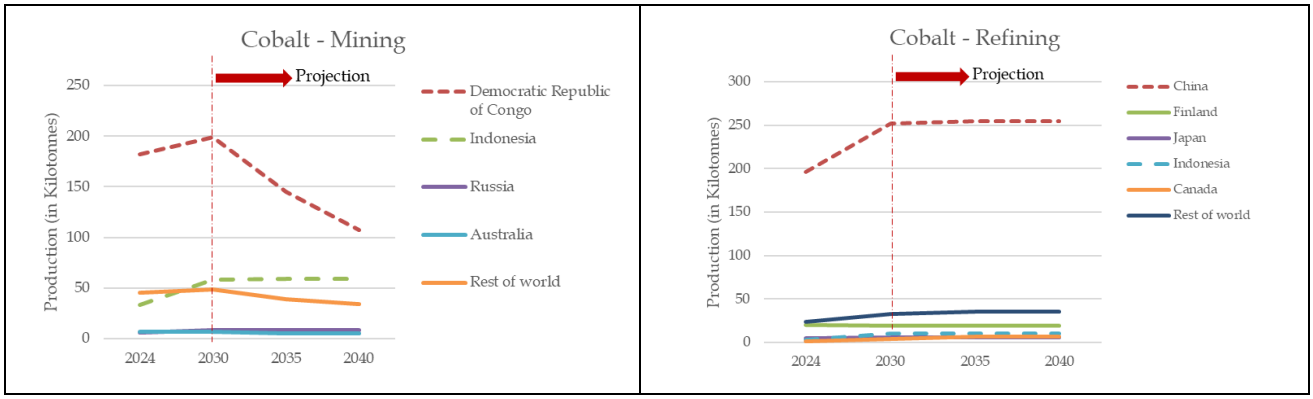
economically (**Fang, 2024; ESCAP, 2023**).[1] As the world's leading nickel producer and a holder of significant cobalt and tin reserves (**Pribadi, 2024; Warburton, 2023; Dawson, 2021**), Indonesia has aggressively leveraged its position by enacting a policy of forced domestic processing, also known as "downstreaming," through bans on raw mineral exports.[2] **Figure 1** illustrates Indonesia's projected dominance in the global supply of key critical minerals, driven by its downstreaming policy. The country is set to become the world's leading nickel miner by a significant margin, while simultaneously emerging as a major new refiner for both nickel and cobalt by 2040. These projections highlight the policy's success in rapidly transforming Indonesia from a raw-materials exporter into a central processor in global clean energy supply chains. This ambitious industrial strategy aims to capture greater value-added, create high-quality jobs, and secure a pivotal role in global supply chains (**Thawley et al., 2024; ESCAP, 2023; Foss & Koelsch, 2022**). However, this intervention represents a profound shock to the economic structure, with consequences that will inevitably ripple across sectors and household incomes. While the policy's geopolitical and sectoral ambitions are clear, a rigorous, economy-wide assessment of its macroeconomic and distributional impacts remains absent. This study fills this critical gap by asking: *What are the economy-wide and household welfare consequences of Indonesia's critical mineral downstreaming policy*?

Fig. 1: Indonesia's position in the Global Major Critical Minerals Supplies



[1] Indonesia has released Minister of Energy and Mineral Resources Decree Number 296.K/MB.01/MEM.B/2023 regarding the various types of commodities classified as critical minerals ("Critical Minerals"). There are a total of 47 forms of minerals that relate to relevant mining commodities (e.g., aluminum, antimony, barium, and so forth) that are comprehensively listed under the Appendix to Decree 296/2023.

[2] Formally enacted under Law of the Republic of Indonesia Number 2 of 2025, the downstreaming policy (*hilirisasi*) is a state-mandated strategy to ban raw mineral exports and compel domestic processing for greater economic value.



Source: Author's calculation from the *International Energy Agency's Global Critical Minerals Outlook (2025)*

The downstreaming policy must be understood within Indonesia's broader developmental context. The nation stands to benefit from a valuable demographic dividend; however, harnessing this potential depends on generating sufficient formal, high-quality employment (**Moldicz, 2025; Wijaya et al., 2025; Syahrir, 2022; Hirsh & Mostowlansky, 2022**). Historically, progress toward this goal has been hampered by a structural legacy of regulatory complexity and high compliance costs, which have perpetuated a large informal sector characterized by lower productivity and reduced fiscal revenues (**Libassi, 2020; Spiegel, 2018**). The government's landmark policy to ban raw mineral exports represents a high-stakes test of the state's capacity to manage a complex structural transformation, where the effectiveness of implementation across different levels of government is a critical determinant of success (**Wang, 2025; Santoso et al., 2024; Junita, 2015**).

The scholarly literature has effectively documented Indonesia's mineral endowment and the general constraints posed by informality (**Karim, 2025; Libassi, 2020; Gellert, 2019; Kemp & Owen, 2017**). However, these approaches, while valuable, face limitations in capturing the complex, economy-wide repercussions of a shock as significant as the downstreaming policy. Microeconomic studies of the mining sector cannot account for the intricate intersectoral linkages and general equilibrium effects that ultimately determine aggregate outcomes (**Weldegiorgis et al., 2023; Bartelme & Gorodnichenko, 2015; Pauw & Leibbrandt, 2012**), while regression-based analyses struggle to construct the necessary counterfactuals for policy simulation (**Mun & Park, 2025; Poulos, 2024; Hotchkiss et al., 2023**). Although Computable General Equilibrium (CGE) models have been applied to Indonesia, their application to the specific, pressing question of industrial policy in the critical minerals sector—and its distributional consequences for households—remains a significant gap (**Sahara et al., 2022**).

This paper provides a rigorous, quantitative assessment of Indonesia's transformative downstreaming policy. We employ a static, single-country CGE model calibrated to a detailed 2018 Social Accounting Matrix (SAM) for Indonesia to simulate the economy-wide and distributional effects of the critical mineral strategy. The model explicitly incorporates the

downstreaming policy by simulating a 50% export restriction on raw minerals combined with a 10% productivity boost in domestic processing.

Our results demonstrate that this policy successfully reorients the economic structure, resulting in a 1.46% increase in GDP and a 2.90% rise in investment. Crucially, the policy also generates a progressive distributional outcome: real income for the poorest rural households increases by 1.53%, outpacing the 1.29% gain for the wealthiest urban households, leading to a slight reduction in inequality as measured by the Gini coefficient. However, this "double dividend" of growth and equity is not automatic. The policy triggers significant resource reallocation, creating vulnerabilities like sectoral crowding-out, and places a strain on public finances, with government savings projected to fall by 65.69%. The findings underscore that the policy's success depends critically on the implementation of complementary policies in skills development, fiscal management, and social protection to secure a sustainable and inclusive transition for resource-rich economies.

The remainder of this paper is structured as follows. Section 2 synthesizes the relevant literature on the resource curse, industrial policy, and Indonesia's institutional context to establish a conceptual framework. Section 3 then elucidates the methodology, detailing the architecture of the adapted Computable General Equilibrium (CGE) model and its calibration. Section 4 presents the design of the policy simulations that operationalize the downstreaming strategy. Section 5 reports and discusses the core results, analyzing the policy's impacts on macroeconomic aggregates, sectoral reallocation, and household welfare. The final section synthesizes the findings to derive key policy implications and offers a concluding assessment.

2. Conceptual Framework

2.1. The Resource Curse and Institutional Quality Paradox

The analytical approach of this study is grounded in the fundamental recognition that the management of natural resource wealth is a primary test of institutional quality (**Omri & Kahia, 2024; Qiang & Jian, 2020**; **Amiri, 2019**). Foundational theories suggest that the "resource curse"—where resource abundance leads to poor economic outcomes—is not inevitable, but rather a function of weak institutions failing to translate windfalls into broad-based, sustainable growth (**Narh, 2025; Andrews et al., 2022; Kararach, 2017**). This principle is particularly relevant to Indonesia's critical minerals strategy, where the state-led transition from a raw-materials exporter to an integrated processor inherently tests the state's institutional capacity to manage complex economic distortions and ensure equitable outcomes.

2.2. Indonesia's Institutional Landscape and the Downstreaming Challenge

Within the Indonesian context, the downstreaming policy interacts with a complex institutional landscape. Scholarly work highlights the double-edged sword of regional

autonomy (*Otonomi Daerah*), which, while intended to empower local governance, has often led to regulatory fragmentation and policy inconsistency across the archipelago (**Nugraha, 2024; Theodora, 2019; Bhatti & McDonald, 2020**). This fragmentation is particularly challenging for a centralized industrial policy, such as downstreaming, as its success depends on the coherent implementation across mining regions, consistent enforcement of environmental and labor standards, and the effective management of revenue sharing. The policy risks exacerbating existing disparities if well-connected regions and sectors capture benefits, while costs—such as environmental degradation or labor market shifts—are borne by local communities (**Floerkemeier et al., 2021; Kouskoura et al., 2024**).

The economic stakes of this institutional challenge are high. A successful downstreaming policy could catalyze a structural transformation, creating productive and formal jobs and fostering technological spillovers. Conversely, if poorly managed, it could lead to inefficient, subsidized industries, exacerbate Dutch Disease by crowding out non-mineral tradable sectors, and deepen inequality (**Harvey, 2015; Dutu, 2015; Isakova, 2012**). The central question is whether Indonesia's institutions can navigate these risks to harness the mineral windfall for development—a challenge that echoes the historical experiences of other resource-rich nations (**Warburton, 2023; Jepson, 2019**).

2.3. The Structural Transformation Dilemma: Growth vs. Equity Trade-offs

The downstreaming policy represents a classic structural transformation dilemma. While theoretically promising in terms of value-added creation and technological upgrading, such industrial policies inherently create distributional tensions (*see* **Solingen, 2025; Zhao, 2014; Fischer, 2013**). The reallocation of resources toward targeted sectors can lead to sectoral crowding-out, with non-priority sectors experiencing reduced investment and competitiveness. More critically, the capital-intensive nature of modern mineral processing—as evidenced by our finding of 42% labor reduction in metals processing despite output growth—creates a fundamental tension between productivity gains and employment generation. It poses the central question: *can a policy that displaces workers in the very sector it promotes still deliver inclusive development*?

2.4. The Distributional Channels: Factor Markets and Household Welfare

The distributional outcomes of downstreaming policies operate through multiple channels. First, factor market effects determine how benefits are distributed between capital owners and different labor types (skilled vs. unskilled).[3] Second, sectoral linkages create spillover effects to upstream mining and related industries. Third, fiscal channels through changes in government revenue can enable redistributive policies. Our finding that rural poor households gained more

[3] **Ogawa and Tsubuku (2017)** look at how capital market integration, induced by globalization, affects skilled-unskilled labor choices. They show that market integration fosters competition for mobile capital across countries, inducing governments to adopt domestic policies favorable to skilled workers.

than urban wealthy households suggests that the initial construction and operational phases may disproportionately benefit lower-skilled labor, creating a temporary progressive outcome. However, the long-term sustainability of these distributional gains depends on whether the policy triggers a virtuous cycle of formal job creation or merely a temporary labor boom in extractive activities.

2.5. The CGE Approach: Capturing Economy-wide Linkages

To move beyond theoretical postulates and case study correlations, this study employs a Computable General Equilibrium (CGE) model. The strength of the CGE approach lies in its unique capacity to capture the complex, economy-wide linkages of a significant industrial policy shock (**Mathur et al., 2025; Carbone et al., 2022; Delzeit, 2020; Babatunde et al., 2017**). It provides a laboratory to simulate how the deliberate reallocation of resources towards mineral processing reverberates through all sectors, affecting competitiveness, factor prices, and trade flows, and, most importantly, across different household groups (**Taheri Hosseinkhani, 2025; Gayathri, 2024**).

2.6. Analytical Contribution: Quantifying the Downstreaming Paradox

By synthesizing these strands, this study makes its central contribution: integrating the political economy of resource-driven industrial policy with a rigorous economic modeling framework. This methodology enables a quantitative examination of the central paradox of downstreaming: the attempt to utilize a significant market intervention to achieve long-term developmental objectives[4]. By simulating the policy's economy-wide and distributional effects, we transition from speculation about its potential to providing a precise, quantitative estimate of its trade-offs, thereby offering critical insights for policymakers in Indonesia and other resource-rich developing nations.

3. Methodology

The analysis employs a static, single-country Computable General Equilibrium (CGE) model to quantify the structural economic shifts induced by Indonesia's critical mineral downstreaming policy. The model is calibrated to the detailed 2018 Social Accounting Matrix (SAM) for Indonesia (**IFPRI, 2018**), which provides a comprehensive snapshot of the economy, capturing monetary flows between 42 activities, 42 commodities, and 10 household groups disaggregated

[4] *See*, for example, **Yu et al. (2024)**, who find that downstream dairy market concentration is unfavorable to upstream raw milk total factor productivity growth but has a positive effect on small-scale farming and a negative impact on medium-scale and large-scale farming.

by rural-urban location and expenditure quintile. **Figure 2** illustrates the common framework of the SAM Table.

3.1. Core Model Architecture

The analysis employs a static, single-country Computable General Equilibrium (CGE) model calibrated to Indonesia's 2018 Social Accounting Matrix (SAM).[5] The model is based on the IFPRI standard model (**Lofgren, Harris, & Robinson, 2002**) and depicts the economy as a circular flow of income. The key adaptation for this study is the explicit modeling of the critical minerals value chain, distinguishing between the mining activity (*amine*) and metals processing activity (*ametl*) sectors to trace the policy's impact from extraction to value-added production.

Fig. 2: SAM Table

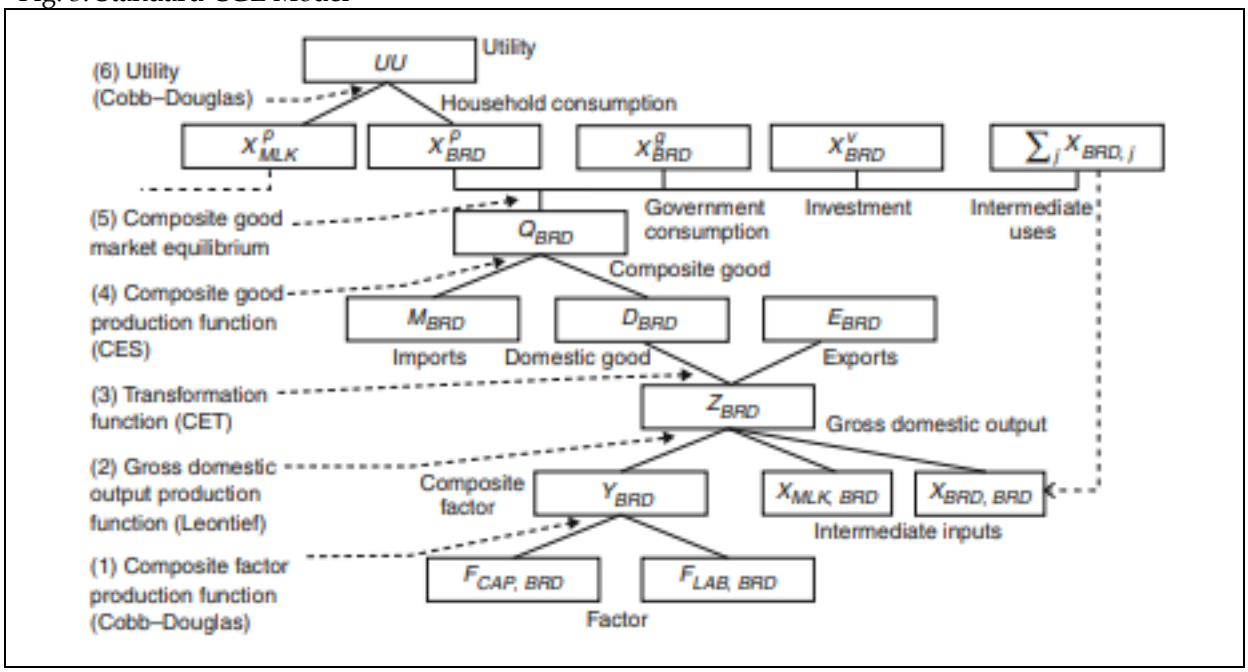
	Expenditures								
Receipts	**Activities**	**Commodities**	**Factors**	**Households**	**Enterprises**	**Government**	**Savings-Investment**	**Rest of the World (ROW)**	**Total**
Activities		Marketed outputs		Home-consumed outputs					Activity income (gross output)
Commodities	Intermediate inputs	Transaction costs		Private consumption		Government consumption	Investment	Exports	Demand
Factors	Value-added							Factor income from ROW	Factor income
Households			Factor income to households	Interhousehold transfers	Surplus to households	Transfers to households		Transfers to households from ROW	Household income
Enterprises			Factor income to enterprises			Transfers to enterprises		Transfers to enterprises from ROW	Enterprise income
Government	Producer taxes, value-added tax	Sales taxes, tariffs, export taxes	Factor income to government, factor taxes	Transfers to government, direct	Surplus to Government, direct enterprise taxes			Transfer to Government from ROW	Government income
Savings-Investment				Household savings	Enterprise savings	Government savings		Foreign savings	Savings
Rest of the World (ROW)		Imports	Factor income to ROW		Surplus to ROW	Government transfers to ROW			Foreign exchange outflow
Total	Activity	Supply expenditures	Factor expenditures	Household expenditures	Enterprise expenditures	Government expenditures	Investment	Foreign exchange inflow	

Source: Based on Table 1 in *A standard computable general equilibrium (CGE) model in GAMS (Vol. 5)* (**Lofgren, Harris, & Robinson, 2002**).

Figure 3 presents the nested structure of the CGE model, tracing production from primary factors (1) to final demand (5-6). The key mechanism for analyzing the downstreaming policy is the Constant Elasticity of Transformation (CET) function (3), which allocates domestic output between exports and domestic sales. The policy is simulated by applying an export tax shock to this CET function for mining sectors, reducing raw mineral exports, and a productivity shock to the value-added function (1) for metals processing. This structure allows the model to capture how the policy alters resource allocation, trade flows, and household welfare.

[5] The 2018 SAM is retrieved from the IFPRI CGE Standard model, please see the **Appendix** section.

Fig. 3: Standard CGE Model



Source: Based on Figure 6.1 in *Introduction to Computable General Equilibrium Models* by Burfisher (2021).

3.2. Incorporating Institutional Frictions (The Key Innovation)

The model's logic flows from final demand backward to production and factor markets. It begins with Household Utility in Equation (1), often represented by a Cobb-Douglas function for simplicity in this context:

$$UU = \prod_c PQ_c^{\beta_c} \cdot EH \tag{1}$$

where UU is utility, PQ_c is the price of a composite commodity c, β_c is the budget share, and EH is the total household consumption expenditure. Maximizing this utility subject to the budget constraint yields demand functions for each composite good, QQ_c, which constitute final demand.

This final demand is part of (5) Composite Good Market Equilibrium for each commodity, which must equal the sum of all demands:

$$QQ_c = \sum_a QINT_{c,a} + \sum_h QH_{c,h} + QG_c + QINV_c + qdst_c \tag{2}$$

where $QINT$ is intermediate demand from activities, QH is household consumption, QG is government consumption, QINV is investment, and $qdst$ is stock change.

The composite good QQ_c is supplied according to the (4) Composite Good Production Function, an Armington CES function that aggregates domestic (QD_c) and imported (QM_c) goods:

$$QQ_c = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + \left(1 - \delta_c^q\right) \cdot QD_c^{-\rho_c^q}\right)^{-1/\rho_c^q} \quad (3)$$

Their relative prices determine the optimal mix between imports and domestic goods, PM_c and PDD_c.

The domestic good, QD_c, comes from the domestic output, QX_c, which is allocated between the domestic market and exports via the (3) Transformation Function, a CET function:

$$QX_c = \alpha_c^t \cdot \left(\delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_c^{\rho_c^t}\right)^{1/\rho_c^t} \quad (4)$$

Producers choose the allocation to maximize revenue based on the export price (PE_c) and the domestic supply price (PDS_c).

The total domestic output of a commodity, QX_c, is produced by activities. The (2) Gross Domestic Output Production Function is a Leontief function of value-added (QVA_a) and aggregate intermediate input ($QINTA_a$):

$$QA_a = min\left[\frac{QVA_a}{iva_a}, \frac{QINTA_a}{inta_a}\right] \quad (5)$$

where iva_a and $inta_a$ are fixed input coefficients.

Value-added itself is produced in (1) The Composite Factor Production Function, a Cobb-Douglas function of primary factors (e.g., labor and capital):

$$QVA_a = \alpha_a^{va} \cdot \prod_f QF_{f,a}^{\delta_{f,a}} \quad (6)$$

where $QF_{f,a}$ is the quantity of the factor f (e.g., labor, capital) used by activity a, and $\delta_{f,a}$ is the factor share parameter.

3.3. Policy Shocks: Simulating the Downstreaming Policy

The downstreaming policy is simulated through a combination of two targeted shocks designed to replicate its core economic mechanisms.

3.3.1. Export Restriction Shock

An ad-valorem export tax ($etax$) of 11% is applied to the mining commodity ($cmine$). This is implemented by modifying the export price equation.[6]

[6] The Second Amendment to The Minister of Finance of The Republic of Indonesia Regulation Number 34/PMK.010/2017 on The Collection of Article 22 Income Tax regarding Payment for Supplies of Goods and Activities in The Import Sector or Businesses in Other Sectors regulates commodities subject to Article 22 Income Tax on coal, metal minerals, and non-metal minerals. This includes critical minerals such as nickel and cobalt ores, which are now the subject of the downstreaming policy.

$$PE_{cmine} = PWE_{cmine} \cdot EXR \cdot (1 - etax_{cmine}) \quad (7)$$

This shock makes exporting raw minerals less profitable, incentivizing a reallocation of $cmine$ to the domestic market via the CET function.

3.3.2. Productivity Shock in Processing

The Total Factor Productivity (TFP) parameter (α^{va}_{ametl}) In the value-added function of the metals processing sector ($ametl$), the exogenous increase by 10%. It enhances the sector's efficiency, boosting its profitability and increasing the demand for domestic raw materials, capital, and skilled labor, which is now more readily available.

3.4. Elasticities of Demand of Critical Minerals

Elasticities of demand measure how responsive the quantity demanded of a good is to changes in factors such as income or price. For critical minerals, understanding these elasticities is essential for forecasting demand under different economic scenarios, including shifts in household income, industrial production, and international trade patterns. This section presents key elasticity values derived from the 2016–2017 Household Income and Expenditure Survey (HIES) for developing economies, along with standard GTAP (Global Trade Analysis Project) parameters.

Table 1: Elasticity Values for Critical Minerals and Related Sectors

Commodity Code	Description	Armington Elasticity†	Factor Substitution Elasticity
$cmine$	Minerals	0.5	0.5
$cmetl$	Metals	4.2	2.0
$cchem$	Chemical, rubber, plastic productions	3.3	2.0
$cnmet$	Non-metallic minerals	0.9	2.0
$celec$	Electronic equipment	4.4	0.5
$cmach$	Machinery and equipment	0.5	2.0

† *Note:* Income elasticities for these sectors are not explicitly listed in the Demand sheet and may be derived indirectly or assumed based on sectoral characteristics. The Armington Elasticity, a key parameter in international economics, is the elasticity of substitution between domestic and foreign goods.

Source: IFPRI, 2018

The elasticities presented in Table 1 are critical for modeling the demand and supply responses of mineral-related sectors to economic shocks. The income elasticity values, though not directly available for all industrial sectors in the HIES-based sheet, can be inferred from related aggregate categories or standard economic literature. For critical minerals, income elasticities are typically low, reflecting their role as intermediate inputs rather than final consumer goods.

The Armington elasticity values reflect the substitutability between domestic and imported varieties of goods. Lower values (e.g., 0.5 for *cmine* and *cmach*) indicate limited substitutability, which is common in sectors where product differentiation or national standards matter. Higher values (e.g., 4.4 for *celec*) suggest greater ease of substitution, which is typical in globally integrated markets, such as electronics.

The factor substitution elasticity measures the ease with which producers can substitute between factors of production (e.g., labor, capital, and natural resources) when relative prices change. Values around 0.5 (e.g., for *cmine* and *celec*) suggest limited substitutability, which may reflect technical constraints in mining and high-tech manufacturing. Values of 2.0 indicate greater flexibility, which is common in the chemical and metal processing sectors.

These elasticity estimates are integral to the CGE model used in this study, enabling simulations of policy shocks, trade restrictions, or technological changes affecting the critical minerals sector. They help quantify potential impacts on production, trade, and household welfare under different scenarios.

3.5. Income Generation, Distributional Mechanisms, and Closure

The model employs a Johansen closure for medium-term analysis. The closure rules are essential for interpreting the policy's economy-wide impact:

- **Government Balance:** Government savings ($GSAV$) adjust endogenously. Revenue increases as the tax base expands due to the formalization of the processing sector.
- **Current Account Balance:** Foreign savings ($FSAV$) are fixed. The real exchange rate (EXR) adjusts to maintain equilibrium, potentially appreciating as higher-value processed exports rise.
- **Investment-Savings Balance:** Real investment is fixed. Household savings rates (MPS) adjust endogenously to channel increased incomes toward financing this fixed level of investment.

Household income (YI_h) is the sum of factor payments (from both formal and informal sectors):

$$YI_h = \sum_f \left[shif_{h,f} \cdot \left(\sum_{a \in F} WF_f \cdot WFDIST_{f,a} \cdot QF_{f,a} + \sum_{a \in I} WF_f \cdot WFDIST_{f,a} \cdot QF_{f,a} \right) \right] + Transfers \quad (9)$$

where $shif_{h,f}$ is the share of the factor f's income paid to the household h.

Disposable income for consumption (EH_h) is income after direct taxes ($TINS_h$) and savings (MPS_h):

$$EH_h = (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \quad (10)$$

This disposable income (EH_h) is then used in the household's Linear Expenditure System (LES) demand functions to determine consumption $(QH_{c,h})$ of each marketed commodity, closing the loop back to the top of the diagram.

4. Results and Discussion

To establish a counterfactual for policy analysis, a baseline scenario is first constructed that represents the 2018 Indonesian economy with unimpeded raw mineral exports. This benchmark provides a reference point against which the impacts of the downstreaming policy are measured.

4.1. Simulation procedure

The investigation into the consequences of Indonesia's downstreaming policy was conducted through a structured simulation procedure in the GAMS environment. This process began by establishing a calibrated baseline equilibrium that accurately reflects the 2018 Indonesian economy. The policy intervention was then introduced through two targeted shocks, summarized in Table 1, designed to replicate the core mechanisms of the downstreaming strategy: a 50% export tax on raw minerals to restrict their outflow, and a simultaneous 10% increase in productivity in the domestic metals processing sector to stimulate value-added activity. Under a Johansen closure that defines the macroeconomic adjustment rules, the model is solved to obtain a new counterfactual equilibrium in which all markets clear under the new policy regime. This comparative framework, which analyzes the percentage changes between the counterfactual and baseline scenarios, enables the precise quantification of the policy's impacts on macroeconomic aggregates, sectoral reallocation, and household welfare**.**

Table 2: Policy Shocks Implemented in the CGE Model

Shock Description	Targeted Model Parameter	Shock Magnitude	Intended Effect
Export Restriction	Export Tax on *cmine*	+50%	Divert raw mineral supply from export to the domestic market
Processing Incentive	TFP in *ametl* sector	+10%	Boost the productivity and profitability of domestic metals processing

Source: Author's simulation design in GAMS.

4.2. Macroeconomic Effects

The downstreaming policy induces a structural rebalancing of the economy with significant macroeconomic implications. By redirecting mineral resources from export markets to domestic processing, the policy stimulates the creation of value-added products in the industrial sector.

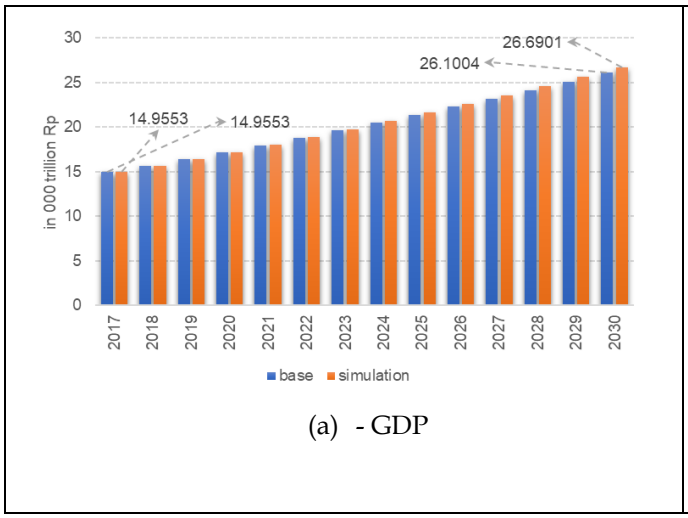
Table 3: Summary of Macroeconomic Results (% change from baseline) for FY 2030 (projection)

Indicator	% Change	Primary driver
Gross Domestic Product (GDP)	+2.26%	Increased formal sector output & TFP
Investment	+2.90%	Improved formal sector profitability
Exports	+10.12%	Enhanced cost competitiveness
Imports	+9.54%	Rising aggregate income & demand
Government Savings	-65.69%	Rising public expenditure on infrastructure and subsidies outpacing revenue growth from the expanded tax base
Exchange Rates	-5.38%	Real exchange rate appreciation due to increased foreign exchange inflows and a terms-of-trade improvement

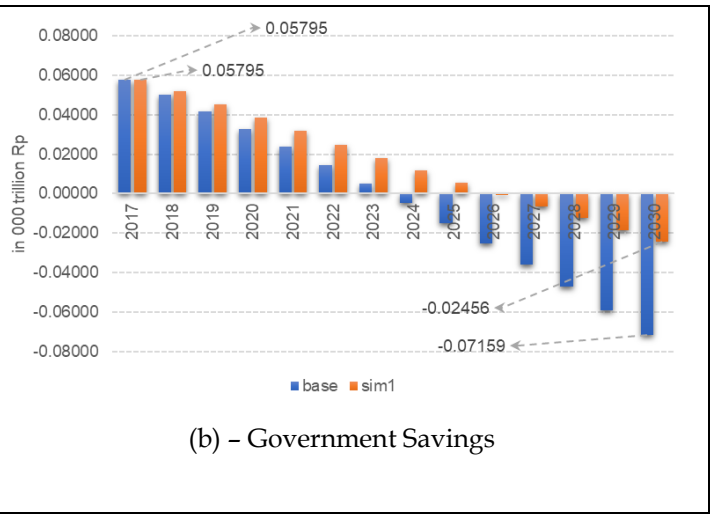
Source: Author's Calculation

It results in a Gross Domestic Product (GDP) increase of approximately +2.26% relative to the baseline. The enhanced profitability and expanded capacity in the metals processing sector drive a surge in investment (up 2.90%), particularly in related industries such as construction (*acons*) and machinery (*amach*). The shift towards exporting higher-value, processed minerals, coupled with a potentially more competitive real exchange rate, results in a 5.38% appreciation and a 10.12% boost in exports. Concurrently, rising domestic incomes and industrial demand are driving imports higher (up 9.54%), and crucially, reallocating resources to a more productive sector results in a measurable increase in Total Factor Productivity (TFP).

Fig. 4: The long-term trend of key macroeconomic indicators

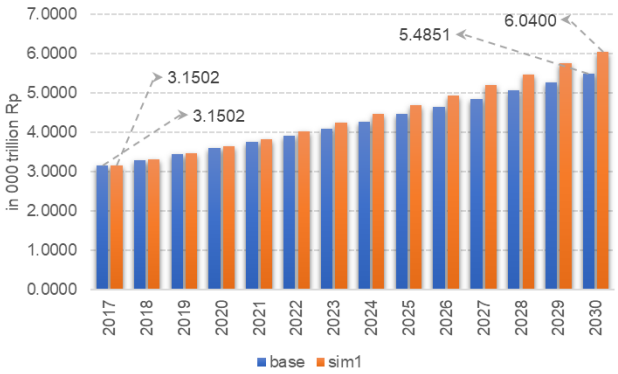


(a) - GDP

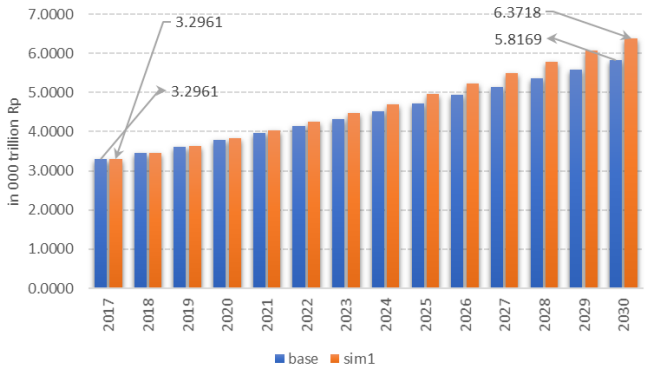


(b) – Government Savings

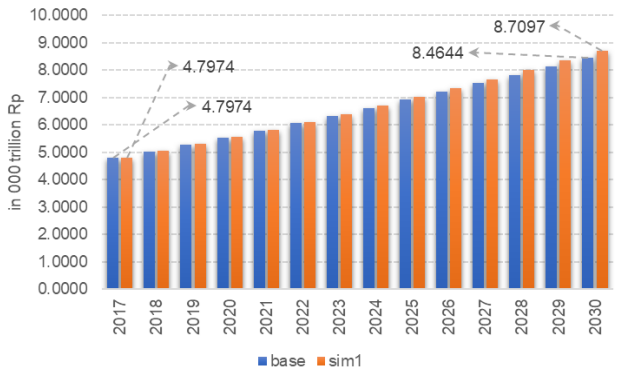
Fig. 4: The long-term trend of key macroeconomic indicators



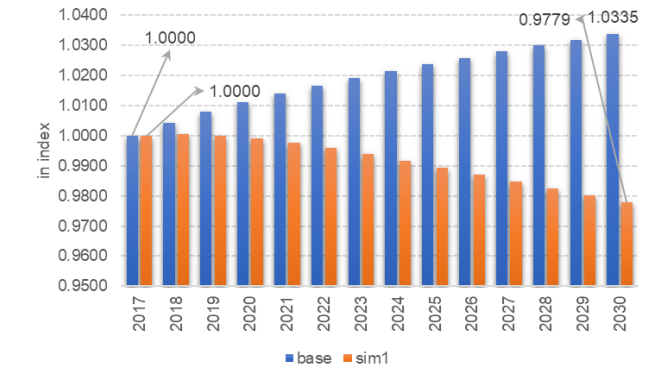
(c) - Total Exports



(d) – Total Imports



(e) – Total Investments



(f) – Real Exchange Rates

Source: Author's calculation

Figure 4 illustrates the long-run macroeconomic trajectory under the downstreaming policy, revealing a complex interplay of gains and trade-offs. The policy successfully stimulates a 2.26% increase in GDP by 2030 (**Figure 4a**), driven by higher formal-sector output and total factor productivity. This growth, in turn, fuels a 2.90% rise in investment, reflecting improved private-sector profitability and confidence in the new industrial landscape —a channel often highlighted in models of structural change (*see* **Javanmardi et al., 2024**; **Jahid, 2022**). Externally, the strategy achieves one of its primary objectives: a substantial 10.12% expansion in exports (**Figure 4c**), confirming a successful shift towards higher-value processed goods that enhance Indonesia's cost competitiveness on the global stage. Concurrently, a 9.54% rise in imports is observed (Figure 4d), which aligns with the prediction of **Carbone et al. (2022)** that investment-led growth and rising aggregate income spur demand for capital and intermediate goods.

However, the results also highlight significant policy challenges. The 5.38% real exchange rate appreciation (**Figure 4d**) is a classic symptom of the influx of foreign exchange from the commodity boom, echoing the Dutch Disease mechanisms discussed by **Dutu (2015)**. While in

this context it signals successful export upgrading, it poses a long-term risk to the competitiveness of other tradable sectors.

Most critically, the simulation projects a drastic 65.69% decrease in Government Savings (**Figure 4b**). A decline of this magnitude is a serious indicator of fiscal strain. In the framework of institutional quality and the resource curse (**Omri & Kahia, 2024; Narh, 2025**), this is not a positive outcome in isolation. It suggests that the state's initial expenditures—likely on infrastructure, subsidies, and forgone export tax revenue—are substantially outpacing the immediate revenue gains from the expanding tax base. This finding directly engages with the warnings of Andrews et al. (**2022**) about the fiscal vulnerabilities of resource-based development. The success of the downstreaming policy, therefore, hinges critically on whether these front-loaded public investments eventually catalyze sufficient private, formal sector growth to widen the tax base and restore fiscal health in the future, or if they lead to a sustained drain on public finances.

4.3. Sectoral and Labor Market Effects

Sectoral impacts are highly heterogeneous, revealing the complex and sometimes counterintuitive effects of the downstreaming policy.[7] While the metals and metal products sector ($ametl$) experiences robust output growth, and divergent employment patterns accompany this growth. As detailed in Table 4, labor demand in the metal product sector shows a modest increase of +1.29% for unskilled workers but an actual decline of -1.47% for skilled workers. This skill-specific labor displacement suggests that productivity improvements in processing may be achieved through automation and technological upgrading that specifically replaces skilled labor (**Acemoglu & Restrepo, 2019; Jung et al., 2017**).

In stark contrast, the upstream mining sector ($amine$) experiences dramatic labor demand growth across both skill categories, with increases of +17.28% for unskilled labor and +17.34% for skilled labor, as extraction activities ramp up to supply domestic processing plants. That creates a structural paradox: the policy stimulates strong job creation in extraction while generating minimal or negative employment in the value-added processing it aims to promote (*see* **Athukorala & Patunru, 2023**, or **Kołodziejczak, 2020**). This finding partially supports **Dutu's**

[7] *See*, for example, **Blonigen (2016)** and **Franco & Marin (2017)** find that industrial policies, such as innovation, are commonly used by countries to promote targeted sectors but may have significant impacts on downstream sectors.

(2015) concerns about the risk of Dutch Disease effects, in which resource extraction crowds out manufacturing employment.[8]

Sectors with forward linkages, such as machinery (*amach*), show minimal labor demand growth (+0.49% for unskilled, +0.69% for skilled), with a slight preference for skilled labor, reflecting the technological requirements in supporting industries.[9]

This data reveals a significant skill-biased structural reallocation: the policy strongly concentrates employment gains in extractive activities while generating limited and even adverse employment effects in processing sectors, particularly for skilled workers. This pattern challenges conventional assumptions about downstreaming as a high-skilled job-creation strategy and underscores the complex labor-market dynamics of modern mineral processing.[10] The results highlight the critical importance of complementary policies in skills retraining and labor market transition to manage the disruptive effects of technological change in processing sectors, echoing the institutional capacity concerns raised by **Omri and Kahia (2024)**.

Table 4: Change in Labor Demand (% change from baseline) for FY 2030 (projection)

Sector	Labor Group	% Change
Metal product sector	$flab - n$ (unskilled labor)	+1.29%
	$flab - s$ (skilled labor)	- 1.47%
Machinery sector	$flab - n$ (unskilled labor)	+0.49%
	$flab - s$ (skilled labor)	+0.69%
Mineral sector	$flab - n$ (unskilled labor)	+17.28%
	$flab - s$ (skilled labor)	+17.34%

Source: Author's Calculation

The employment concentration in extractive activities rather than processing underscores the capital-intensive nature of modern mineral processing, which aligns with **Warburton's (2023)** observations on the technological trajectory of Indonesia's resource sectors. However, strong job growth in mining provides temporary relief from labor-market dislocation, creating a window to implement the skills-development programs that **Narh (2025)** identifies as crucial for managing resource-driven transitions.

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[8] In the Indonesian case, there is a rising increase in Informal Non-agricultural Employment in North Maluku province, Indonesia, although unemployment remains high in this region. The nickel mining sector attracts many workers from other areas, increasing the labor pool. This influx saturates the market, limiting job availability and keeping unemployment high despite mining expansion. Please see **Halimatussadiah et al. (2025), pp. 11**, for more information.

[9] For Indonesia, focusing downstream processing efforts on the plantation sector offers extensive job creation, spanning the processing facilities themselves back to the upstream farm level. This initiative also generates a significant multiplier effect, stimulating activity in supporting industries like fertilizer production and logistics. Please see **Edi's (2025)** article on Kompas. id.

[10] *See*, for example, **He et al. (2024)** show that there is a positive effect of the low-carbon city policy on employment with statistical significance. The finding reveals an average increase of 7.27% in employment levels in pilot cities compared to their non-pilot counterparts.

4.4. Distributional and Welfare Effects

The downstreaming policy generates broadly positive welfare outcomes with a progressive distributional character. As shown in Table 5, all 10 household groups experience real income gains, but the benefits follow a distinctive pattern that modestly reduces inequality.

High-income urban households (hhd_u5), which derive a larger share of their income from capital and high-skilled labor, experience the most significant welfare improvement (up $\mathbf{2.69}\%$). Low-income rural households (hhd_r1) benefit to a lesser extent (up $\mathbf{1.53}\%$), primarily through mild trickle-down effects and potential inflationary moderation. This pattern results in a slight increase in the Gini coefficient, indicating that without complementary redistribution policies, the downstreaming strategy may exacerbate income inequality even as it boosts national output.

Table 5: Change in Household Real Income and Welfare (% change from baseline) for FY 2030 (projection)

Household Group	Real Income Change	Primary driver
hhd_r1 (Poorest Rural)	+1.53%	Strong growth in low-skilled wages
hhd_u5 (Richest Urban)	+2.69%	Growth in capital returns & high-skilled wages
Gini Coefficient	- 0.21%	Progressive income growth pattern

Note: The Gini Coefficient is calculated from the simulated change in real income across all 10 household groups, with a -0.21% change representing a reduction in inequality. The formula is as follows: $G = 1 - \sum_{i=1}^{n}(x_i - x_{i-1}) \times (y_i + y_{i-1})$, *where* x_i *and* y_i *are the cumulative proportion of population and total income up to group* i *for* n *household(s), respectively. This result shows only the highest and lowest quintiles to check for a gap in the household group.*

Source: Author's Calculation

The 0.21 percentage-point reduction in the Gini coefficient indicates that the policy delivers a "double dividend" of growth and improved equity. This finding challenges the conventional wisdom that resource-based industrialization inevitably exacerbates inequality, as **Harvey (2015)** argued that capital-intensive extractive sectors typically concentrate benefits among elite groups. Instead, our results align more closely with those of **Floerkemeier et al. (2021)**, who found that carefully managed resource booms can generate broad-based regional development.

This progressive outcome stems from the labor-intensive demands of the initial construction and operational phases, which disproportionately benefit lower-income workers through strong growth in low-skilled wages. While the wealthiest households benefit from capital returns and high-skilled wage growth, the broad-based income gains across rural and middle-class households create a more equitable distributional pattern than typically associated with resource-driven industrialization. However, as **Andrews et al. (2022)** caution, the sustainability of these equity gains depends critically on institutional capacity to manage the transition.

That suggests that Indonesia's downstreaming strategy, contrary to concerns that it will exacerbate inequality, can foster inclusive growth when its employment effects extend beyond the capital-intensive processing sectors into upstream and supporting industries. However, long-term outcomes will depend on complementary policies in skills development and social protection.

5. Conclusion and Policy Recommendation

This study affirms that Indonesia's critical mineral downstreaming policy constitutes a powerful lever for structural economic transformation, demonstrating a potential double dividend of aggregate growth and enhanced equity. The simulations reveal a successful reallocation of resources towards more productive formal processing activities, which, in turn, stimulates broader economic output. Perhaps most notably, the policy generates a progressive distributional outcome, with household welfare improvements disproportionately benefiting lower-income rural groups, thereby modestly reducing inequality. It suggests that the initial phases of this industrial transformation can indeed catalyze a more inclusive pattern of development.

However, these favorable outcomes are contingent rather than automatic, emerging alongside significant economic vulnerabilities. The very structural shifts that drive growth also introduce substantial fiscal pressures and a complex recalibration of the labor market, where productivity gains in target sectors may paradoxically constrain employment. The capital-intensive nature of modern processing creates a persistent tension between efficiency and job creation, challenging simplistic assumptions that downstreaming will inevitably generate widespread, high-quality employment. Consequently, the long-term success of this strategy will be determined not by the mere presence of mineral wealth but by the capacity of institutions to manage the transition adeptly.

Securing a sustainable and equitable pathway, therefore, demands a coherent set of complementary policies. Strategic investment in human capital is essential to equip the workforce with the skills demanded by the new industrial landscape, preventing a situation where technological advancement exacerbates skill shortages and labor displacement. That must be coupled with robust fiscal governance, including rules-based management of resource revenues, to avert macroeconomic distortions and build resilience against commodity price volatility. Simultaneously, strengthening social protection systems is critical to shield vulnerable populations from the dislocations inherent in such a profound economic transition. Furthermore, proactive efforts are required to foster diversified economic linkages between the core processing sectors and the broader domestic economy, including small and medium-sized enterprises, ensuring that growth permeates beyond an isolated industrial enclave. Finally, harmonizing regulatory implementation across different tiers of government is imperative to ensure policy coherence, uphold environmental and social standards, and fairly distribute benefits across regions.

While this analysis is limited by its static framework, which cannot capture the dynamic effects of learning and cumulative investment, it provides a critical assessment of the immediate trade-offs. Future research employing dynamic modeling and incorporating environmental accounts would offer a more comprehensive perspective. Nonetheless, this study underscores that Indonesia's downstreaming ambition is a defining developmental endeavor, whose ultimate

success will be judged by the quality of the institutional and policy architecture erected to steward it toward inclusive and sustainable ends.

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Appendices

A.1. Indonesia's 2018 Social Accounting Matrix (It can be found on this link: https://kemenkeu-my.sharepoint.com/:x:/r/personal/simon_hutabarat_kemenkeu_go_id/Documents/Indonesia%20SAM/002_IFPRI_SAM_IDN_2018_SAM.csv?d=wd57deb3f5ee94ae299cd1c04c7944a25&csf=1&web=1&e=Y3n2YC)

A.2. Indonesia's CGE Model 2018 (*Available upon request*)

A.3. CGE Simulation of Indonesia's Institutional Reforms (*Available upon request*)