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ORIGINAL PAPER

Investigating the impacts of salt import tariffs on trade, production, employment, and welfare - the case of Indonesia

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Abstract

Despite being one of the world's largest archipelagic nations with extensive coastal resources and significant salt production potential, Indonesia imports salt in millions of tons yearly due to persistent quality and productivity gaps. This study aims to investigate the impact of salt import tariffs on trade, production, employment, and welfare, and to analyze policy options for developing the salt industry in Indonesia. Using a Computable General Equilibrium (CGE) model and the Analytic Hierarchy Process (AHP), the results indicate that Indonesia's import dependence remains high despite the absence of productivity gains. Tariffs, combined with productivity improvements achieved through technological innovation and improved production methods, yield the most favorable outcomes, enhancing the trade balance, boosting output, and mitigating welfare losses. AHP results further identify the most strategic policy option, maintaining the existing salt tariff policy while providing technological assistance and innovation in salt production. These findings highlight the importance of integrated tariff–productivity strategies to enhance Indonesia's salt industry's competitiveness, resilience, and sustainability.

Keywords Salt import tariffs · Trade performance · Employment · Welfare · Computable general equilibrium · Analytical hierarchy process

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Introduction

Indonesia is an archipelagic nation with the world's second-longest coastline and a maritime area far larger than its landmass. This country has abundant coastal resources and suitable climatic conditions for salt production (Widjaja et al. 2024; Amalyos 2024). In 2023, the land areas that were used for salt production were 29,000 hectares. It spreads across 13 provinces throughout Indonesia (Amalyos 2024). The number of salt farmers who were registered in 2023 was approximately 22,431. The largest concentrations of salt farmers are in the provinces of Central Java (6,430 farmers), East Java (6,418), and West Java (3,138) (KKP 2024).

Despite the advantage of natural resource endowments, the share of domestic salt to the national Gross Domestic Product (GDP) is still relatively small compared to other agricultural commodities (BPS 2025a). Also, the country has to depend on imported salt. As shown in Fig. 1, of the total national salt requirement of 3.86 million tons in 2017, for example, approximately 66.1% was imported salt. This dependency on salt imports also occurred in 2024. However, the volume of salt imports in 2024 declined to 57.3%

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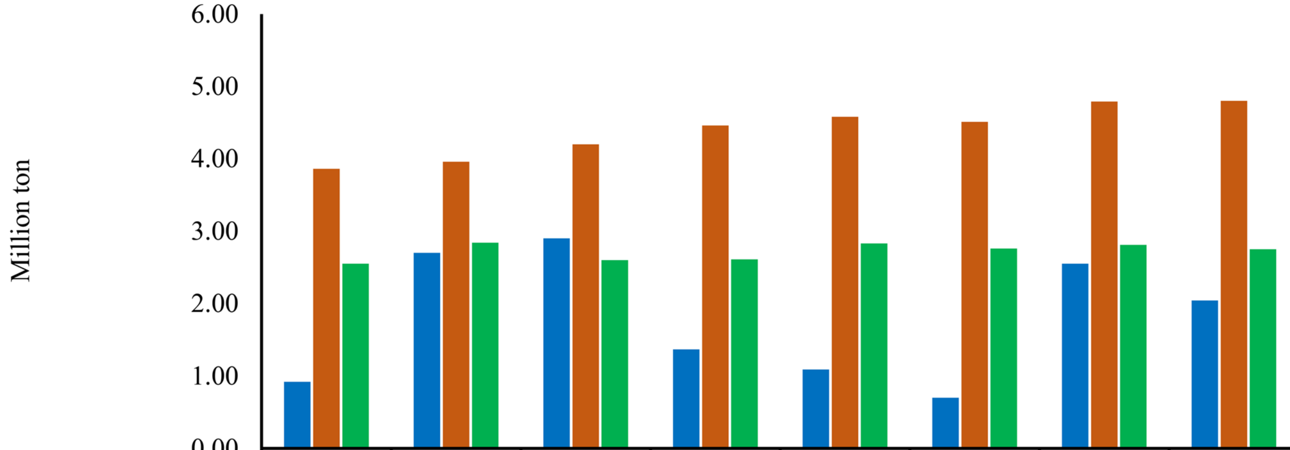

	2017	2018	2019	2020	2021	2022	2023	2024
Production	0.92	2.70	2.90	1.37	1.09	0.70	2.55	2.04
National requirement	3.86	3.96	4.20	4.46	4.58	4.51	4.79	4.80
Import	2.55	2.84	2.60	2.61	2.83	2.76	2.81	2.75

Fig. 1 Indonesia's salt production, national requirement, and import, 2017–2024. Source: BPS (2025a) & KKP (2025a)

of the national requirement (BPS 2025a). These conditions make the sector vulnerable to changes in trade policy (Mardoni 2022; Wiendiyati et al. 2021; Helmi and Sasaoka 2018; FAO 2006).

The salt import dependency has been criticized as counterproductive to the efforts of the Indonesian government to increase domestic salt production. The salt import is against the Minister of Finance Regulation (PMK) No. 26 of 2022 concerning the Determination of the Classification System of Goods and the Imposition of Tariffs on Imported Goods. Also, there have been empirical studies that found the salt import policy has no benefit to salt farmers in Indonesia (Hidayat and Raman 2020; Kurniawati et al. 2020). While others argued that the salt imports positively impact household salt production and salt farmers' income (Jamil et al. 2017).

The different findings of those studies were partly due to differences in geographical focus, methodological approaches, and the periods studied. Also, these are because of differences in the focus of analysis, such as production, income, or trade flows. These indicate that almost no previous studies fully captured the complex inter-sectoral linkages of the salt industry with manufacturing, services, and broader economic activities. This limited analytical depth has resulted in policy recommendations that may not address the problem comprehensively.

To fill this gap, our paper aims to expand the analysis beyond production and income to capture impacts on trade performance, employment, and welfare. We evaluated the potential impact of import tariffs on the salt economy using the Recursive Dynamic Computable General Equilibrium (RDCGE) model. RCDGE was employed because it can simulate economy-wide impacts of tariff changes over time, thus strengthening the literature on the macroeconomic impact of salt import tariffs on Indonesia, previously studied by Lucman and Dewi (2024) and Noviandre and Dewi (2024). Both studies also highlight the role of salt as a critical input for downstream industries, meaning any changes in salt import policy are likely to affect the production of other sectors. Therefore, the RCDGE model was chosen in this study to capture the complex inter-sectoral linkages and distributional effects that characterize the salt sector.

To complement the RDCGE analysis, we also employed the Analytic Hierarchy Process (AHP). This AHP method was applied to examine stakeholder perspectives to prioritize policy options, acknowledging that the salt industry's challenges are multi-dimensional and involve diverse interests. By integrating these two approaches, the study combined macroeconomic simulation with participatory policy evaluation, enabling a comprehensive and policy-relevant assessment of salt import tariffs in Indonesia.

This evidence-based research proposed scientific and policy options for developing the salt industry, addressing the limitations of the current salt import policy, which has been considered ineffective in promoting industry growth (Jamil et al. 2017). The findings are also expected to inform tariff designs that promote fair gains from trade while serving as lessons for other developing countries with abundant salt resources. By providing empirical evidence that simultaneously considers trade, production, employment, and welfare dimensions, this study offers novel insights for policymakers seeking to balance import dependency with domestic industry development. However, before the details of the results of the study are addressed and discussed, we first briefly review relevant studies on salt import advances in the literature.

Literature review

The theoretical view concerning the impact of import tariffs on the economy has been widely highlighted in the literature (Mclaren 2013; Krugman et al. 2014; Krugman and Obstfeld 2018). It was argued that an import tariff has a positive impact on domestic production and increases government revenue. The positive impact on domestic production occurred as import tariffs made imported goods more expensive. This condition further makes domestically produced goods more competitive and encourages the growth of the local industry. Other positive impacts of import tariffs are that the government will receive revenue from tariffs imposed on each imported good. However, import tariffs can negatively affect consumer goods prices. This is because higher import costs are ultimately passed on to consumers, making imported goods more expensive to consumers. This condition further leads to decreasing purchasing power of consumers, especially among lower- and middle-income groups. There are other potential effects of import tariffs, including inflation, trade tensions, and reduced economic efficiency. Judging from this theoretical point of view, import tariffs have a wide impact not only on trade and production, but also on employment and welfare.

Considering those theoretical arguments, several empirical studies concerning the impact of tariffs on the economy have been extensive in the literature (Caliendo and Parro 2015; Kreuter and Riccaboni 2023; Barattieri and Cacciatore 2023). However, previous studies on the impact of Indonesian salt import on trade performance, production, employment, and welfare have not been well documented. The available studies about the salt import covered partial issues related to production, consumption. import, quality, technology, and other macroeconomics and trade issues.

Mardoni (2022), for example, in his study entitled Analysis of Salt Production, consumption, and import in Indonesia, by applying a simultaneous equation model analysis tool with the Two Stages Least Squares (TSLS) method, concludes that consumption of salt, capital, and labor have a significant influence on salt production in Indonesia. Salt production, salt prices, salt imports, and Gross Domestic Product significantly influence salt intake. Salt consumption and Gross Domestic Product have a significant effect on salt imports in Indonesia. This study suggested that the Government of Indonesia, through the Ministry of Agriculture, must issue a policy to encourage capital increase for salt production activities. In addition, the Government is also expected to increase the quantity and quality of workers who work in the industry so that the production of salt itself can be improved.

Regarding the quality and technology of salt production, Jaziri et al. (2018), Haendra et al. (2021), and the Ministry of Marine Affairs and Fisheries (2020) confirmed that the quality of salt is still considered relatively low. This is because most of the salt is produced using traditional methods. Such practices result in salt with NaCl levels below industrial standards (94–97%) with a brownish color, making it unsuitable for meeting the demand of the manufacturing sector.

To solve this problem, the application of technologies, such as geomembranes, prism houses, valve systems, and tunnels, combined with improved water flow techniques and enhanced raw material quality through filtration and salt fertilizers, can significantly increase both the quality and quantity of production. These methods are often perceived as more cost-efficient, requiring less energy and being easier to apply (Wiwoho and Prasada 2024; Susanto et al. 2015; Gozan et al. 2021; Badi'ah et al. 2023; Gozan et al. 2021; Regency et al. 2023). However, among smallholder farmers, the adoption of such technologies has not been widely implemented due to high investment costs, limited infrastructure, and knowledge gaps. As a result, much of the potential for improving salt quality and productivity for the industrial market has yet to be realized.

In the context of the impact of imports on farmers, several studies indicated different findings. Hidayat and Raman (2020) and Kurniawati et al. (2020), for example, explain that salt importation represents a contradictory policy by the government in its efforts to improve local salt production. These studies found that the salt import depresses salt prices at the farmer level and reduces the sustainability of local salt enterprises. The entry of cheaper imported salt tends to push down farm-gate prices, thereby discouraging farmers from investing further in production technologies to enhance productivity. This situation potentially weakens the long-term sustainability of local salt farmers and salt businesses.

However, Jamil et al. (2017) from different perspectives indicate that salt imports can have positive effects. They found that imports play a role in ensuring the supply of salt for downstream industries, thereby helping to stabilize price fluctuations. Also, imports are perceived as a driver for farmers to increase salt production, given the presence of stable market demand. This suggests that imports are not always perceived as negative activities, but rather as opportunities for farmers to engage in a broader and more market-oriented value chain. These findings reflect different views on determining the actual impact of salt imports on farmers' welfare. Hence, a more comprehensive study is required to provide a holistic picture of how salt imports affect salt farmers in Indonesia.

Furthermore, Lucman and Dewi (2024) and Noviandre and Dewi (2024) argue that salt imports are closely linked to GDP growth, exchange rate fluctuations, and money supply, all of which have influenced Indonesia's salt import trends over the past two decades. Specifically, salt functions as a critical production input for downstream industries such as food, pharmaceuticals, chemicals, and textiles. Any changes in salt import policy affect production cost structures, product prices, and export performance in these sectors (Ministry of Industry, 2023). All these preceding studies remain partial in scope, underscoring the urgency of more comprehensive assessments to evaluate the extent to which salt import policies can simultaneously safeguard farmers while meeting the demands of downstream industries.

Data sources and methods

Data sources

The study used both secondary and primary data sources. The principal secondary dataset was the 2016 Input–Output (I–O) table published by BPS–Statistics of Indonesia in 2021, the most recent official table available at the time of the analysis. Although its base year was 2016, reflecting the lengthy compilation process for national I–O accounts, the structural composition of Indonesia's primary, secondary, and tertiary sectors, particularly in salt-related value chains, has not changed substantially since that period. Therefore, the 2016 table remains relevant for representing the current economic structure, especially as no newer officially published I–O data has been released by the Indonesian Central Board of Statistics (BPS) when conducting this study. This dataset serves as the core database for the Computable General Equilibrium (CGE) model used in this analysis, providing the most consistent and comprehensive framework for economy-wide simulation and policy evaluation. Nevertheless, its temporal limitation is acknowledged, as it may not fully capture more recent structural and technological shifts in the Indonesian economy; this issue is discussed further in the limitations section. Moreover, Computable General Equilibrium (CGE) and, in particular, Recursive Dynamic CGE (RDCGE) modeling require the most recent complete I–O table to ensure sectoral consistency, something not possible with partial or unofficial updates (Hosoe et al. 2010; Narayanan and Dimaranan 2009).

For the Analytic Hierarchy Process (AHP), we collected data from 6 experts as key stakeholders, including the Provincial Maritime Affairs and Fisheries Agency of East Java, the Provincial Industry and Trade Agency of East Java, the Surabaya Fish Quarantine, Quality Control, and Fishery Product Safety Agency (BKIPM), and the top management of PT. Garam and salt farmers. These stakeholders were selected because they are directly involved in the governance of salt production and trade at the research location, as per the duties and functions of their respective institutions. Data collection was conducted through interviews to gather qualitative information about the condition of the salt industry in East Java, Indonesia's largest salt-producing region. Data collection was also supplemented with a pairwise comparison questionnaire using Saaty's 1–9 scale to determine respondents' assessments of actors and key success factors in the development of the national salt industry.

Framework for CGE modeling

As mentioned at the outset, to evaluate the broader implications of Indonesia's salt import tariffs, this study employed a Computable General Equilibrium (CGE) framework designed to quantify economy-wide linkages between trade, production, employment, and welfare. The model enables systematic tracing of how changes in import tariffs affect relative prices, resource allocation, and sectoral performance across the economy, thereby expanding the analysis beyond production and income effects to include trade performance, labor outcomes, and household welfare.

The CGE structure builds upon the Indorani and Wayang model and follows the Walrasian general equilibrium principle, in which economic agents optimize behavior under resource constraints while markets adjust to reach equilibrium (Okorie and Lin 2024; Tasneem and Aamir Khan 2024; Wittwer 1999). Simulations were conducted using the General Equilibrium Modelling Package (GEMPack).

To capture both immediate and medium-term dynamics, the study adopted a Recursive Dynamic CGE (RDCGE) approach. This dynamic specification is particularly suitable for Indonesia's salt value chain, which features strong upstream and downstream linkages, from small-scale producers to industrial users in food processing and chemical manufacturing. The RDCGE framework captures short-run price and trade adjustments as well as medium-term effects on capital accumulation, employment shifts, and welfare distribution, allowing for a comprehensive policy evaluation consistent with the study's objectives.

Following standard CGE formulations (Hosoe et al. 2010; Dixon and Rimmer 2002; Zhai 2008), production in each sector was represented by a Constant Elasticity of Substitution (CES) function between labor and capital. Import demand followed the Armington assumption, distinguishing domestic and imported goods. While export supply was represented by a Constant Elasticity of Transformation (CET) function. The household consumption was modeled using a

Linear Expenditure System (LES/Stone-Geary) to capture differentiated consumption behavior across income groups. These behavioral relationships form the analytical basis for quantifying how tariffs that induce price changes influence trade balances, employment, and welfare outcomes.

Further details on the model structure, behavioral equations, and dynamic linkages are provided in Appendix A. Appendix B presents the complete set of elasticity and parameter values, including their descriptions, numerical ranges, and data sources, to ensure transparency, clarity, and reproducibility.

Simulation scenarios

The simulation framework was designed to align closely with Indonesia's prevailing trade policy regime. According to Minister of Finance Regulation (PMK) No. 26 of 2022, the government imposes a 5% import tariff on salt for consumption, which serves as the baseline policy in this study. This tariff rate represents the officially enacted measure and serves as a suitable reference point for evaluating alternative policy configurations.

As shown in Table 1, four simulation scenarios were developed to evaluate the potential effects of tariff and productivity policies on Indonesia's salt industry and the broader economy. The first scenario represents the baseline, maintaining the existing 5% import tariff and reflecting current productivity conditions. The second scenario assumes complete trade liberalization, with the removal of all import tariffs, to examine the pure effects of market openness on production, trade, and welfare. The third scenario combines the 5% import tariff with a 10% increase in domestic salt productivity, capturing the potential synergy between protection and efficiency enhancement. Lastly, the fourth scenario evaluates full liberalization accompanied by a 10% productivity improvement, allowing the model to disentangle the combined and interactive impacts of trade openness and technological advancement.

The 10% productivity increase is a policy-consistent and conservative assumption that reflects realistic gains from technological innovations and government assistance programs. In practice, productivity growth in Indonesia's salt sector remains limited and largely dependent on public interventions, such as the adoption of geomembrane crystallization, tunnel and prism methods, and washing plant technologies, rather than endogenous, market-driven innovation. This reliance on government-supported programs means that productivity improvements cannot yet be treated as endogenous outcomes within the model. Instead, they are modeled as exogenous shocks representing the effect of targeted policy support or technology adoption initiatives. Data from the Central Board of Statistics and the Ministry of Marine Affairs and Fisheries shown in Fig. 1 indicate that national salt production fluctuated between 0.7 and 2.9 million tons from 2017 to 2024, corresponding to an average annual increase of around 12%. Thus, a 10% improvement serves as a realistic and moderate benchmark consistent with empirical trends and policy-driven technological potential.

These scenarios allow the RDCGE model to isolate and compare the short- and long-term impacts of alternative tariff and productivity policies on key macroeconomic and sectoral indicators, including trade performance, production structure, employment, and household welfare. This approach enables the study to go beyond production and income effects, offering a comprehensive assessment of how tariff and productivity strategies interact to shape the future trajectory of Indonesia's salt industry.

Analytic hierarchy process (AHP) implementations

To identify policy options for developing the salt industry, we applied the Analytic Hierarchy Process (AHP), a multi-criteria decision-making framework well suited for integrating expert judgment into policy prioritization (Saaty 2008). AHP decomposes complex decisions into a hierarchy of goals, criteria, and alternatives, allowing pairwise comparisons and consistency checks (Singer and Özşahin 2024; Wu et al. 2024). It has been widely used across fields such as engineering (Faisal et al. 2024), oceanography (Díaz et al. 2022), and transportation (Zaid et al. 2024).

Table 1 Simulation scenarios

No.	Scenario	Tariff Policy	Productivity Assumption	Description
1.	Simulation 1-Baseline	5% import tariff maintained	No productivity change	Reflects the current salt policy under the Minister of Finance Regulation No. 26 of 2022
2.	Simulation 2-Liberalization	Tariff fully removed	No productivity change	Simulates full trade liberalization in the salt sector
3.	Simulation 3-Tariff + productivity	5% import tariff maintained	+ 10% productivity shock (exogenous)	Represents policy continuity with productivity gains through government-supported technologies, such as geomembrane lining, prism drying systems, tunnel methods, and washing plants
4.	Simulation 4-Liberalization + productivity	Tariff fully removed	+ 10% productivity shock (exogenous)	Combines full liberalization with potential technological improvements

In this study, the AHP process began with defining the goal of prioritizing salt-tariff policy alternatives (Fig. 2). The hierarchy was then constructed, starting with the main goal, followed by criteria and sub-criteria (actors and key success factors), and ending with policy alternatives identified through literature review and preliminary stakeholder consultations with the Ministry of Maritime Affairs and Fisheries (KKP), PT. Garam, Indonesian Chamber of Commerce and Industry, and academics from Universitas Indonesia.

In the context of developing the national salt sector, particularly salt farmers, the literature review and key stakeholders' opinions recommend several policy options beyond import tariffs. These include the provision of technology (equipment) and salt innovation, enhancing PT. Garam's role in the domestic market set a base price for salt, and assistance in the form of technology (equipment) and salt innovation. Therefore, AHP is needed to prioritize these policy options, combined with the presence or absence of a salt import tariff policy in Indonesia (Fig. 2). Data collected from questionnaires were aggregated using geometric means. We then calculated the global priority weights, performing all computations with the Super Decisions software. The results of this analysis are reliable because the consistency ratio obtained is 0.058, which meets the requirement of a concentration ratio of less than 0.1 ($CR \leq 0.10$) (Sinha et al. 2023).

Results and discussion

Impact of changes in salt import tariffs on trade

Simulation results from this study show that imposing an average 5% import tariff on salt (HS 25) under Minister of Finance Regulation No. 26 of 2022 could increase Indonesia's national aggregate imports by up to 0.368% (Sim 01) (Fig. 3). Even under a full liberalization scenario (Sim 02), aggregate trade conditions remain largely unchanged, indicating a persistent reliance on imported salt and limited competitiveness of domestic production. Among the four scenarios, the combination of tariff protection and productivity enhancement (Sim 03) generates the most favorable

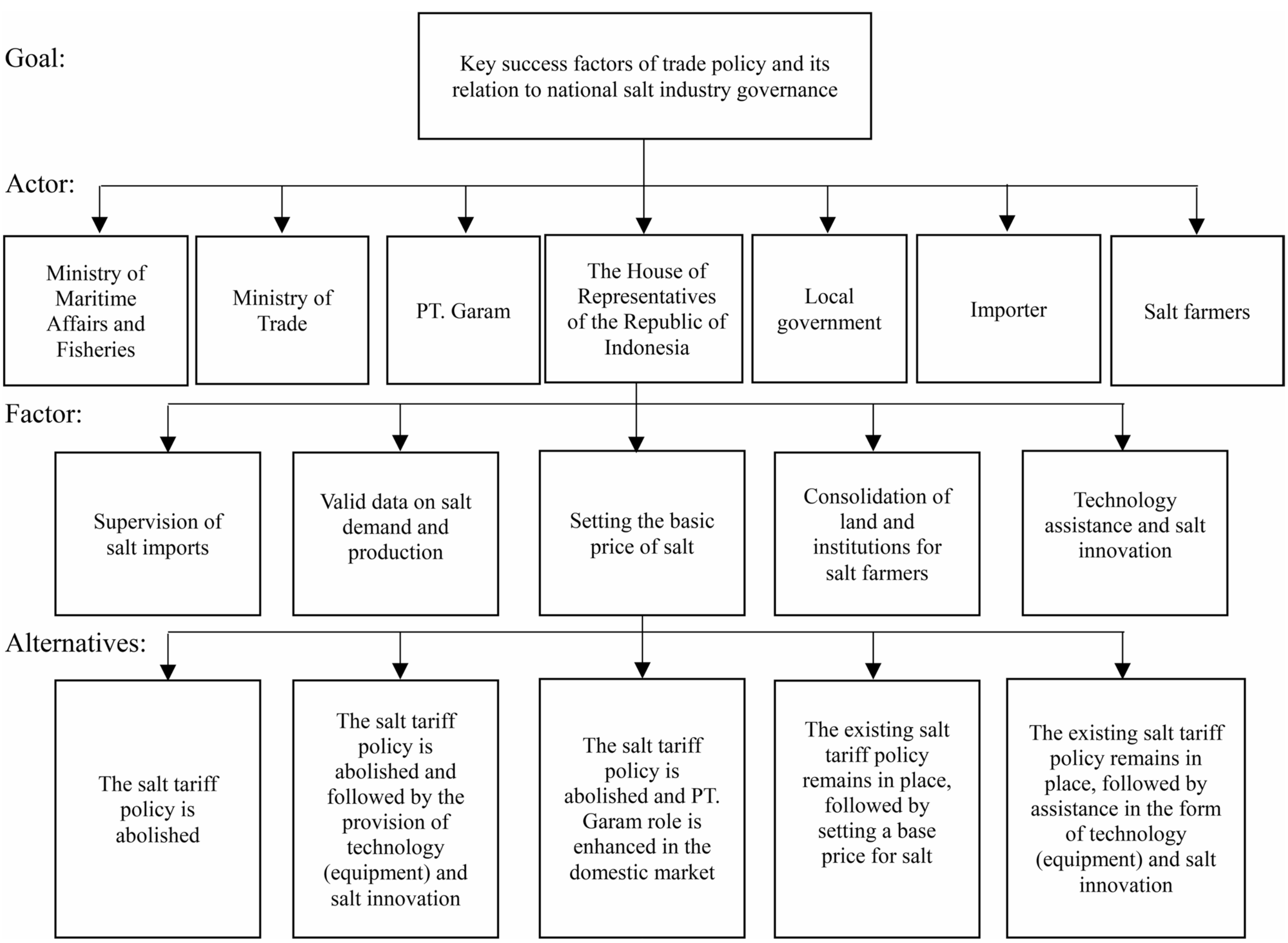

Fig. 2 Structure of the AHP analysis on salt tariff policy and national salt industry governance

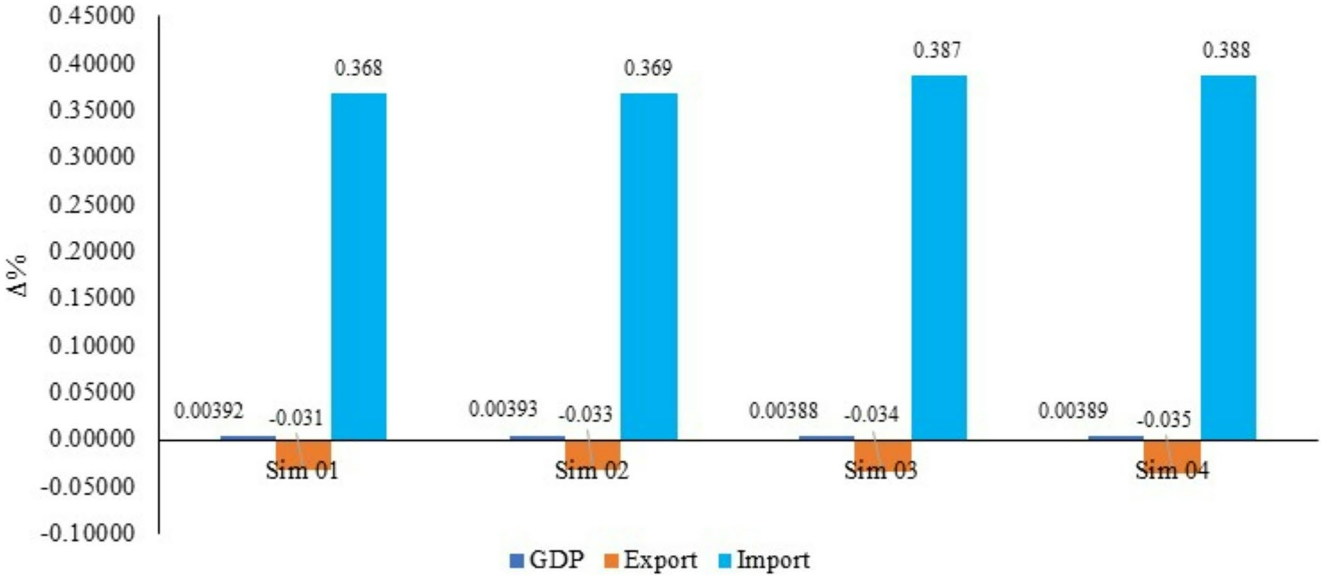

Fig. 3 The impact of changes in salt import tariffs on aggregate trade and the Indonesian economy. Notes: Sim 01: the baseline policy with a 5% import tariff. Sim 02: complete liberalization of salt imports. Sim 03: a 5% tariff combined with a 10% increase in national salt productivity. Sim 04: full liberalization combined with a 10% productivity increase. Source: Authors' calculation.

macroeconomic outcomes, improving the trade balance, increasing sectoral output, and mitigating welfare losses.

At the sectoral level, the largest import increases, around 1.1 to 1.2%, occur in food processing, cosmetics, and chemical industries, reflecting their high dependence on industrial-grade salt. By contrast, sectors such as pulp and paper show minimal change, with import variations of less than 0.02% (Appendix C, Table 5). On the export side, growth is concentrated in machinery, transport equipment, and other manufacturing sectors, while salt-related exports decline slightly but remain offset by stronger import-driven production linkages (Appendix C, Table 6).

These results align with the mechanisms outlined in trade and general equilibrium theory. Krugman and Obstfeld (2018) noted that tariffs raise domestic prices of imported goods, altering both producer and consumer behavior, for intermediate goods such as salt, higher import duties raise input costs in downstream industries, including food processing, chemicals, pharmaceuticals, textiles, and mining, affecting output, employment, and competitiveness (Lloyd and MacLaren 2004). Conversely, trade liberalization can reduce input costs and enhance competitiveness, but it can also expose domestic producers to import pressures, especially where structural productivity gaps persist.

Although Indonesia's salt imports remain high, their broader economic contribution becomes evident when viewed through the lens of value-added and employment linkages. Imported industrial salt often feeds downstream sectors whose outputs are destined for export markets, creating re-export opportunities. For instance, in 2019, industrial salt imports reached USD 108 million, while the exports of products derived from that salt totaled USD 37.7 billion (Ministry of Industry of Indonesia 2023). It highlights that salt imports, when efficiently integrated into domestic value chains, can enhance overall trade performance and contribute to GDP growth. However, these benefits depend on the domestic industry's ability to maintain quality, efficiency, and market access.

Despite policy support, the competitiveness of Indonesian salt remains constrained. Haendra et al. (2021) observed, low productivity, inconsistent quality, and weak market linkages limit import substitution. Technology upgrading, especially via geomembrane-based production methods, has proven effective in improving yield and purity (Wiwoho and Prasada 2024; Susanto et al. 2015). However, adoption remains uneven among small-scale farmers due to high investment costs, limited infrastructure, and knowledge gaps. As a result, potential productivity gains are realized primarily in industrial-grade production, while coarse or consumption salt lags.

Quality concerns further complicate this dynamic. Microplastic contamination in both local and imported salt (Suteja et al. 2025) highlights the need for stronger quality assurance systems to access premium markets. Moreover, Muhandhis et al. (2019) show that integrating trade policy reform with technological innovation and supply-chain improvements can significantly raise national salt self-sufficiency. Taken together, these findings suggest that tariff adjustments alone are insufficient. Only when combined with targeted policies to enhance productivity and quality can Indonesia achieve sustainable competitiveness, improved trade performance, and long-term resilience in its salt industry (Aris et al. 2022).

Impact of changes in salt import tariffs on sectoral production, employment, and welfare

Building on the macro-level findings in the previous section, this part examines the sectoral effects of changes in salt import tariffs on production, employment, and household welfare. Simulation results (Fig. 4) indicate that sectoral output differences are generally small across the four scenarios, with the largest gain observed in bread, biscuits, and similar products, whose output increases by up to 0.39%. Meanwhile, the smallest increase is observed in the pulp and paper sector, at approximately 0.01%.

Under Simulation 01 (a 5% import tariff), the most pronounced gains occur in a limited number of industries, such as pulp and paper, while Simulation 04 (full liberalization with a 10% productivity increase) benefits fertilizer production. Full liberalization alone (Sim 02) generates stronger production gains in food-related industries, cosmetics, traditional medicine, pharmaceuticals, and soap. In contrast, smaller but widespread gains under Sim 03 (a 5% tariff plus a 10% productivity increase) are concentrated in the textiles, yarn, and tanning industries.

Overall, the simulations suggest that trade liberalization (Sim 02) produces the broadest sectoral expansion, while combining it with productivity improvements (Sim 03) balances growth across industries. This pattern supports the empirical consensus that lowering trade barriers yields more widespread production gains than selective protection (Winters et al. 2004).

To understand the employment effects more deeply, it is important to note that salt plays a crucial role as both a raw material and an auxiliary input in a wide range of industries, from food processing, fish salting, and animal feed, to textiles, leather tanning, water treatment, cosmetics, pharmaceuticals, chemical and chlor-alkali production, as well as oil drilling and detergent manufacturing (KKP 2025b). The Ministry of Industry *in* Yogatama (2023) reported that industrial salt demand reached approximately 3 million tons per year, with the largest share (around 2.3 million tons) being absorbed by the chlor-alkali industry, followed by about 600,000 tons for various food industries. This structural dependence means that even minor changes in salt tariffs can have a ripple effect on many labor-intensive sectors.

Differences in labor intensity and salt dependency can thus explain the variation in employment outcomes across sectors (Fig. 5). Food processing industries, which employ a large share of the manufacturing workforce (BPS 2025b), benefit more under liberalization scenarios because lower input costs translate directly into higher production and labor absorption. In contrast, sectors such as textiles and tanning, which use lower-quality salt (<NaCl 90%) and are linked to smallholder salt producers who prioritize

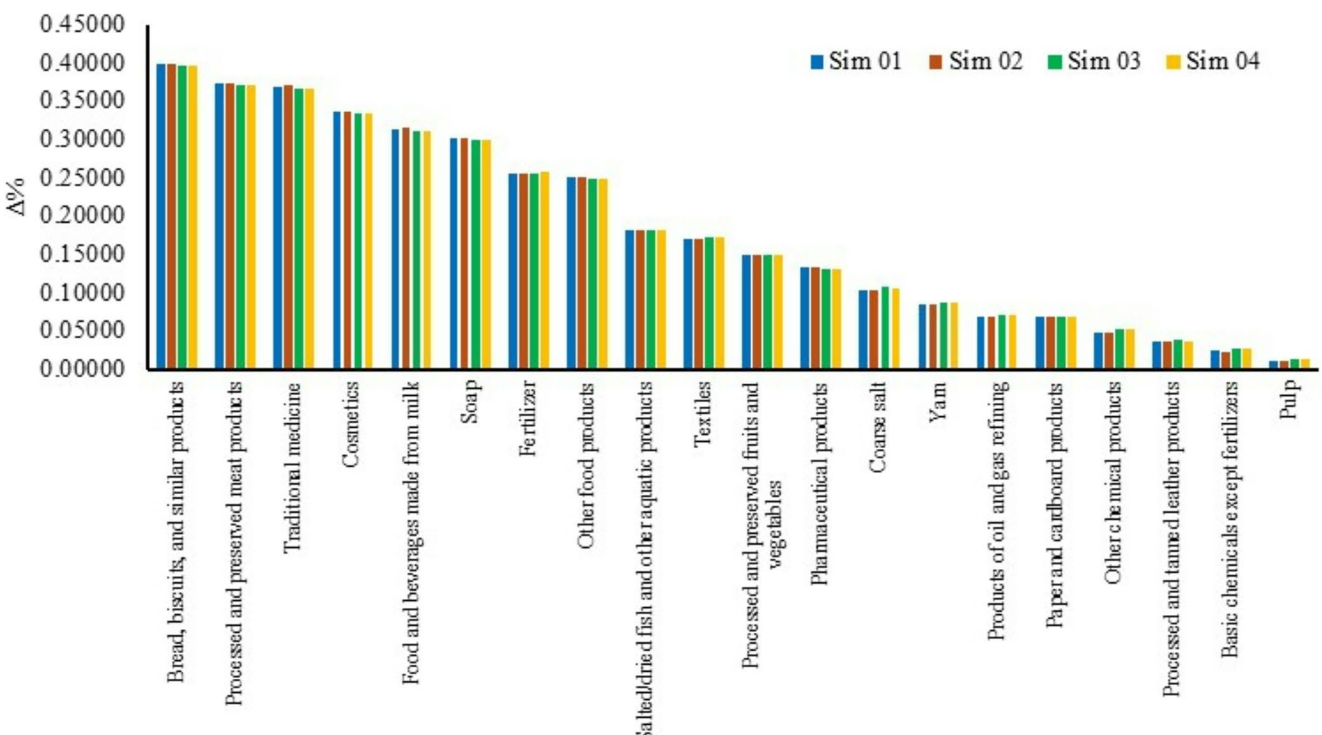

Fig. 4 Impact of changes in salt import tariffs on sectoral production (Δ Percent). Notes: Sim 01: the baseline policy with a 5% import tariff. Sim 02: complete liberalization of salt imports. Sim 03: a 5% tariff combined with a 10% increase in national salt productivity. Sim 04: full liberalization combined with a 10% productivity increase. Source: Authors' calculation

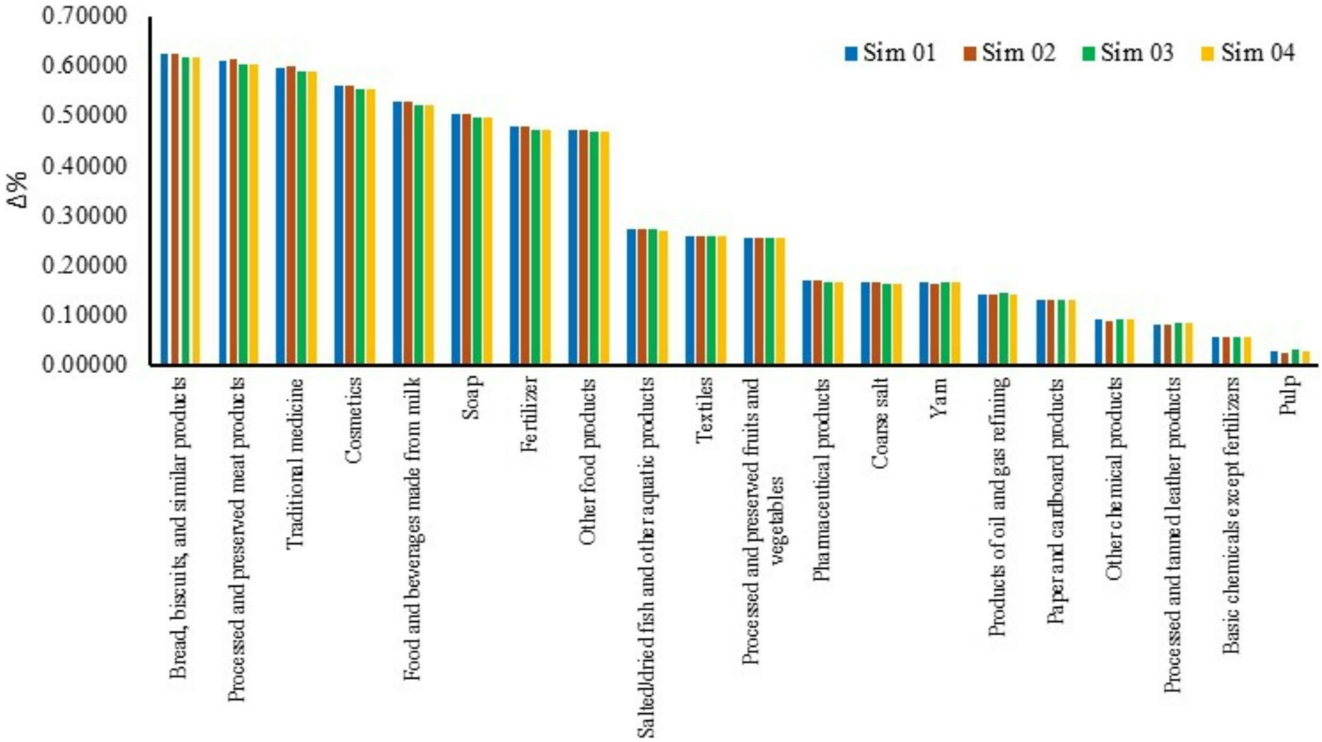

Fig. 5 Impact of changes in salt import tariffs on sectoral employment (Δ Percent). Notes: Sim 01: the baseline policy with a 5% import tariff. Sim 02: complete liberalization of salt imports. Sim 03: a 5% tariff combined with a 10% increase in national salt productivity. Sim 04: full liberalization combined with a 10% productivity increase. Source: Authors' calculation

quick sales over refining, respond better under Sim 03 (tariff + productivity). In this scenario, higher national productivity increases domestic salt availability, stabilizes prices, and makes downstream industries more competitive, thus encouraging additional employment.

Sectoral responses can be grouped into four clusters, namely high (> 0.4% employment gain), medium (0.2–0.4%), low (0.1–0.2%), and very low (< 0.1%). The largest employment gains occur under full trade liberalization, while the 5% tariff (Sim 01) yields notable increases in medium-cluster industries. When combined with productivity enhancements (Sim 03), improvements shift toward low-cluster sectors, such as textiles, yarn, and tanning, suggesting that productivity gains have had modest impacts. Conversely, Sim 04 (liberalization + productivity) appears less efficient overall than Sim 01 and Sim 02, confirming that the employment effects of liberalization are typically concentrated in sectors with pre-existing comparative advantages, whereas productivity-linked policies generate more distributed but smaller changes (Winters et al. 2004; Goldberg and Pavcnik 2007).

In short, the employment impact across scenarios demonstrates how productivity-oriented strategies, particularly those enhancing salt quality and supply consistency through technologies such as geomembranes and brine filtration (Badi'ah et al. 2023; Gozan et al. 2021; Ramly et al. 2022), can improve competitiveness in both labor-intensive and capital-intensive industries. This linkage between upstream productivity and downstream labor absorption reinforces that moderate protection, when combined with technological upgrading, is more beneficial for employment than protectionism alone.

Welfare outcomes (Fig. 6) exhibit mixed effects across household categories. Welfare declines are recorded among rural households (Categories 1–4), while Urban Category 1 experiences modest gains. In contrast, Rural Category 5, Urban Category 2, and Urban Category 3 experience small but positive welfare changes. The largest welfare decline occurs under Sim 01 (tariff only), whereas Sim 04 (liberalization + productivity) yields the smallest reduction. The results are consistent with Arinze and Odior (2023), who found that higher import tariffs tend to reduce household welfare.

These results suggest a clear distributional divide between winners and losers. Rural households, particularly those in Categories 1–3, are the most adversely affected, as their consumption baskets depend heavily on salt-related goods and processed foods whose prices rise under tariff scenarios. Conversely, urban middle-income households benefit modestly under liberalization scenarios (Sim 02 and Sim 04), as cheaper intermediate inputs translate into lower consumer prices and expanded industrial employment opportunities.

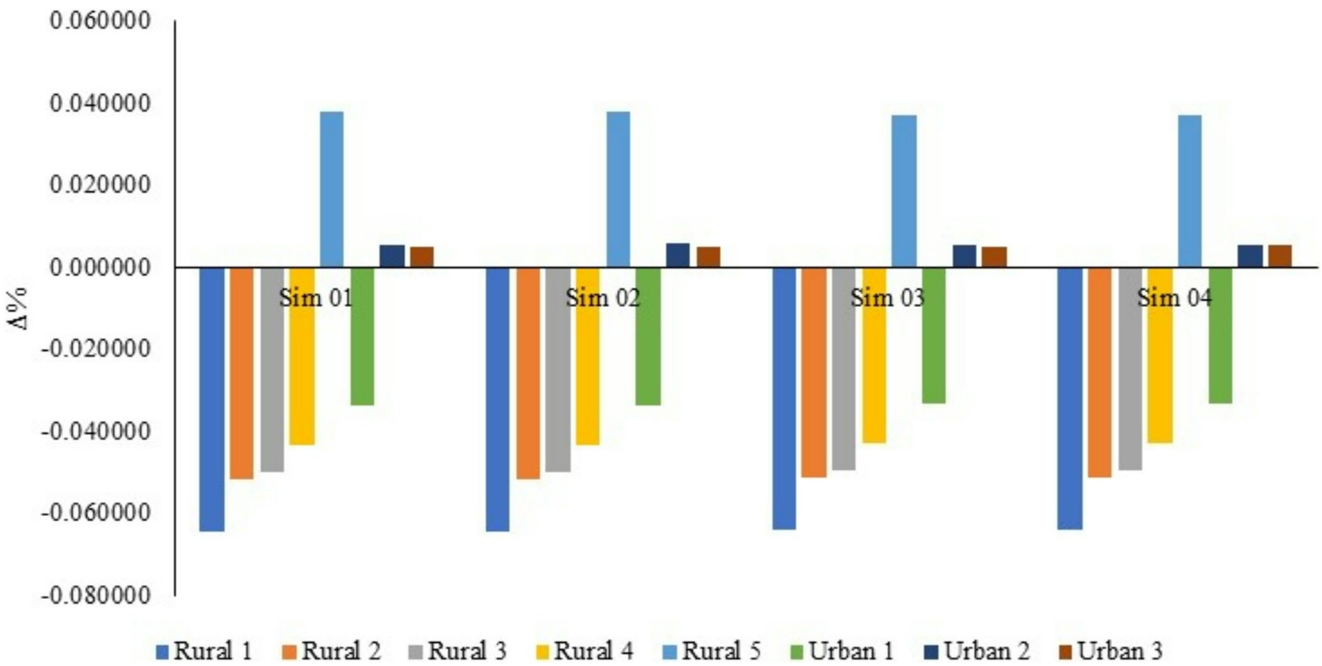

Fig. 6 Impact of changes in salt import tariffs on household welfare (Δ percent). Notes: Sim 01: the baseline policy with a 5% import tariff. Sim 02: complete liberalization of salt imports. Sim 03: a 5% tariff combined with a 10% increase in national salt productivity. Sim 04: full liberalization combined with a 10% productivity increase. Source: Authors' calculation

Figure 6 illustrates that welfare improvements under Sim 03 and Sim 04 are concentrated among urban and semi-urban households integrated into non-agricultural value chains, whereas welfare losses under Sim 01 are borne disproportionately by rural households tied to traditional salt production or low-productivity sectors. This pattern highlights the regressive nature of tariff shocks unless complemented by productivity support or compensatory transfers.

The model's findings reflect how tariffs on key intermediate inputs, such as salt, propagate through production networks. Higher import duties increase input prices for salt-using industries, such as food processing, pharmaceuticals, and chemicals, which in turn raise production costs and consumer prices (Kreuter and Riccaboni 2023). The burden of these price increases falls more heavily on rural households, whose consumption structure includes a higher share of processed food and basic manufactured goods, while their incomes rely on labor-intensive sectors with low wage elasticity. Urban households, particularly those employed in downstream processing and distribution industries, experience smaller welfare losses, or even slight gains, due to improved labor absorption.

This dynamic aligns with broader evidence that tariff shocks on essential intermediates can have regressive welfare effects, disproportionately affect poorer households unless countered by compensatory or redistributive policies (Porto 2006; Winters et al. 2004).

To mitigate these effects, the study integrates the RDCGE simulation with an AHP-based stakeholder analysis, yielding several actionable policy insights. First, targeted productivity enhancements for domestic salt producers, especially through the use of geomembrane systems, prism houses, valve systems, and tunnels, can improve yields and reduce production costs (Badi'ah et al. 2023; Gozan et al. 2021; Regency et al. 2023). Second, a more inclusive compensation mechanism, such as rural income diversification programs and price stabilization measures for salt-intensive goods, is needed to prevent welfare deterioration among smallholders and rural laborers.

The simulations further reveal that a 10% increase in national salt productivity can partially offset welfare declines, particularly when paired with a moderate 5% tariff. This scenario benefits both rural and urban groups by maintaining employment stability and reducing consumer prices. However, without productivity improvements, tariff impositions may raise employment modestly but deepen welfare inequality. This underscores the importance of combining trade liberalization with targeted productivity assistance and social protection policies to ensure that efficiency gains translate into equitable welfare outcomes.

While the preceding subsections have detailed the separate effects of salt import tariffs, liberalization, and productivity improvements, a synthesized comparison helps clarify the trade-offs among the four simulated scenarios. Table 2 summarizes the key macroeconomic and sectoral outcomes,

Table 2 Summary of macro and sectoral impacts across simulation scenarios (Sim 01–04)

Indicator	Sim 01	Sim 02	Sim 03	Sim 04	Remarks
Imports (Δ percent)	0.368	0.369	0.387	0.387	Highest gains in food, cosmetics, and chemicals (≈ 1.1–1.2%)
Exports (Δ percent)	−0.031	−0.033	−0.034	−0.034	Slight decline, offset by import-driven value-chain linkages
Sectoral output (Δ percent)	+ 0.39 (bread & biscuits)	+ 0.37 (food, cosmetics)	+ 0.40 (chemicals, fertilizers)	+ 0.38	Moderate sectoral expansion
Employment (Δ percent)	+ 0.24 (medium industries)	+ 0.32 (trade liberalization)	+ 0.27 (broad-based growth)	+ 0.25	Broader labor absorption under Sim 02–03
Welfare (Δ percent)	−0.05	−0.03	−0.02	−0.02	Smallest welfare loss under Sim 03–04
Overall, Policy performance	Moderate protection, limited gains	Strong output response, some welfare cost	Most balanced outcome	Similar to Sim 03, but weaker employment effects	-

Sim 01: the baseline policy with a 5% import tariff

Sim 02: complete liberalization of salt imports

Sim 03: a 5% tariff combined with a 10% increase in national salt productivity

Sim 04: full liberalization combined with a 10% productivity increase

including imports, exports, production, employment, and welfare, providing a concise overview of how each policy mix performs relative to the others.

The comparative results reveal clear trade-offs between protectionist and liberalization-oriented policies. The 5% tariff alone (Sim 01) yields limited output growth and higher welfare costs, suggesting that protection without productivity enhancement results in diminishing returns. Full liberalization (Sim 02), while stimulating broader sectoral activity, leads to higher import exposure and uneven welfare distribution.

The combined strategy (Sim 03), maintaining moderate tariff protection while improving productivity, emerges as the most balanced policy configuration. It strengthens domestic value chains by lowering input constraints while sustaining incentives for local producers. Productivity-driven efficiency gains also help offset welfare losses that typically arise under tariff regimes.

Finally, Sim 04 (liberalization + productivity) performs comparably to Sim 03 in macro terms but shows smaller employment gains, indicating that full liberalization may dilute domestic market incentives despite improved efficiency. These results collectively suggest that a dual policy approach, combining tariff protection with technological upgrading and productivity enhancement, offers the most sustainable pathway toward salt industry competitiveness and welfare stability. In the subsequent section, these quantitative findings are integrated with stakeholder-based priorities from the AHP analysis to identify actionable strategies for strengthening Indonesia's salt industry.

Policy options for the development of the Indonesian salt industry

Building on the macroeconomic, sectoral, and welfare analyses presented earlier, the AHP was employed to prioritize strategic policy options for strengthening Indonesia's salt industry. The AHP results, as summarized in Table 3, indicate that the most preferred policy strategy is to maintain the existing salt tariff policy while complementing it with technological assistance and innovation in salt production (Policy option 1). This combination scored the highest normalized weight (0.2645) and ideal value (1.000), emphasizing its balanced approach between market protection and productivity enhancement. The second-ranked policy is maintaining the tariff while introducing a basic salt price mechanism (Policy option 2), which aims to stabilize producer income and ensure production continuity throughout the year. Other alternatives, such as full tariff elimination or greater market intervention by PT. Garam received lower priority rankings. It suggests that respondents and stakeholders prefer a gradual and well-managed liberalization process, supported by technological upgrades and price stabilization, rather than abrupt market deregulation, which could disrupt domestic producers and undermine long-term industry resilience.

The AHP results demonstrate a clear policy preference for integrating trade protection with technological upgrading, rather than relying solely on tariff barriers or full liberalization. This outcome resonates with empirical findings from Aris et al. (2022), Jamil et al. (2017), and Gozan et al.

Table 3 Results of the AHP analysis on policy strategies for the development of indonesia's salt industry

Alternative policy strategies	Total	Normal	Ideal	Rank
1. Existing salt tariff policy, followed by technological assistance and innovation in salt production	0.0882	0.2645	1.000	1
2. The existing salt tariff policy, followed by setting a basic salt price	0.0837	0.2510	0.9491	2
3. Elimination of the salt tariff policy	0.0265	0.0796	0.3008	5
4. Elimination of the salt tariff policy, followed by technological assistance and innovation in salt production	0.0666	0.1999	0.7558	4
5. Elimination of the salt tariff policy and increasing the role of PT. Garam in the domestic market	0.0683	0.2050	0.7751	3

Source: Authors' calculation

(2021), all of which identify outdated technology, environmental constraints, and low product quality as the principal barriers to achieving salt self-sufficiency in Indonesia. The prioritization of technology-based support indicates stakeholder recognition that productivity and quality improvements, such as through geomembrane systems, prism houses, washing plants, and filtration technologies, are essential complements to policy protection.

It is worth noting that the government had previously issued Presidential Regulation No. 126 of 2022 on the Acceleration of National Salt Development, introducing the Sentra Ekonomi Garam Rakyat (SEGAR) program, an integrated cluster-based initiative aimed at improving productivity through technological and institutional coordination. However, Indonesia has yet to achieve sustained salt self-sufficiency, indicating that earlier programs have not fully resolved structural and quality constraints.

Building on these experiences, Presidential Regulation No. 17 of 2025 sets a new framework to achieve salt self-sufficiency by 2027 through integrated upstream–downstream development. The Ministry of Marine Affairs and Fisheries (KKP) is developing the Kawasan Sentra Industri Garam Nasional (K-SIGN) in Rote Ndao as a model for industrial-scale salt production, featuring modern ponds, automated monitoring, and refining facilities valued at around IDR 2 trillion. Rote Ndao-East Nusa Tenggara was chosen for its favorable climate and geographic conditions, and the project is expected to create over 13,000 direct jobs while expanding domestic processing capacity.

Lessons from previous programs, such as program Pengembangan Usaha Garam Rakyat (PUGaR) and SEGAR, as well as regional revitalization efforts, highlight recurring challenges, including quality stagnation, weak coordination, and limited community involvement. Addressing these issues is crucial for ensuring that the new initiatives under K-SIGN and the broader Blue Economy agenda of President Prabowo Subianto deliver sustainable, self-reliant, and equitable outcomes, in line with the forthcoming National Medium-Term Development Plan (RPJMN) 2025–2029.

Moreover, maintaining a moderate tariff ensures a degree of market stability for domestic producers while avoiding excessive distortions for downstream industries reliant on imported salt. The introduction of a basic price policy (Policy option 2) addresses the need to safeguard smallholders against sharp price fluctuations, which frequently occur during harvest seasons and undermine production incentives (Erlina and Manadiyanto 2020). Taken together, these findings emphasize that sustainable salt industry development in Indonesia requires a dual-track approach: (1) a protective trade policy (moderate tariffs) to manage import dependence and provide stability, and (2) technological and institutional upgrading to enhance productivity and competitiveness.

Such a strategy aligns with the broader direction of Presidential Regulation No. 17 of 2025, which calls for an integrated effort across ministries, local governments, and industry actors to strengthen domestic value chains and reduce structural reliance on imports. This alignment emphasizes the importance of coherent industrial and trade policies that not only protect domestic producers but also foster innovation and long-term competitiveness in the salt sector. In this context, policy coherence is a must to ensure that tariff protection and productivity enhancement measures work synergistically, enabling Indonesia's salt industry to achieve sustainable growth, greater resilience, and improved welfare outcomes for producers and workers alike.

Conclusions, policy recommendations, and limitations

Conclusions

This study assessed the macroeconomic, sectoral, and household-level impacts of changes in salt import tariffs, alongside a prioritization of policy strategies for strengthening Indonesia's salt industry. The evidence confirms that Indonesia remains structurally dependent on imported salt due to the limited competitiveness of domestic production, particularly in salt industrial-grade markets. Policy simulations indicate that combining a 5% salt import tariff with a 10% increase in national salt productivity yields the most balanced outcome, as it stimulates production and employment growth in non-food manufacturing while mitigating the welfare losses typically associated with tariff measures. The findings highlight a fundamental trade-off between protecting domestic producers and maintaining consumer affordability, suggesting that the most effective strategy lies in striking a balance between tariff protection and productivity enhancement. Conversely, imposing tariffs without productivity gains risks widening welfare disparities across household groups, despite potential employment benefits.

Analyzing policy priorities through AHP reinforces the importance of maintaining the existing tariff framework while coupling it with sustained technological support and innovation incentives for local producers. Technology adoption, such as geomembranes, prism houses, and improved filtration, has proven effective in enhancing quality and yield, but uptake remains uneven due to cost, infrastructure, and knowledge constraints. To ensure that productivity improvements materialize, government intervention should extend beyond tariff policy toward concrete support instruments, such as R&D investment, technology subsidies, and expanded collaboration with PT. Garam, to accelerate adoption and diffusion. These measures can bridge the gap between policy intent and implementation capacity, ensuring that productivity gains are not merely theoretical shocks but grounded in institutional and financial mechanisms. Ultimately, aligning tariff measures, productivity support, and consumer protection within an integrated policy framework is critical to building a resilient, innovation-driven salt sector that supports both producer welfare and national competitiveness.

Policy recommendations

Indonesia's most effective policy pathway is to retain the salt tariff policy while coupling it with sustained technological support, innovation incentives, and decisive market reforms to fortify national salt supply chains. Central to this agenda is revitalizing PT. Garam (Persero) so it can operate with greater efficiency, flexibility, and market agility, even under fiscal constraints, becoming a more dynamic player in stabilizing supply and supporting industrial needs. At the same time, the competitiveness of smallholder salt farmers hinges on market certainty and price stability. It requires building a credible, consolidated National Salt Balance (Neraca Garam Nasional) to provide accurate data on production, imports, and industrial demand, ensuring transparent decision-making for both government and industry.

To drive productivity in a sustainable, policy-driven manner, the government should promote the establishment of salt corporations (korporasi garam) that integrate farmers, cooperatives, and private sector actors. These entities can serve as innovation hubs for introducing and disseminating modern salt technologies, such as geomembranes, prism houses, tunnels, and filtration systems, while also providing platforms to replicate success stories across regions. This institutional approach accelerates the diffusion of technology, improves access to markets and finance, and strengthens the linkages between small producers and industrial users.

Further, targeted R&D funding, technology subsidies, and public–private partnerships should complement these efforts to ensure that productivity gains are not merely theoretical but embedded in sustainable institutional mechanisms. It aligns with the broader policy direction outlined in Presidential Regulation No. 17 of 2025, which aims to accelerate national salt development and Achieve Self-Sufficiency by 2027. It signals a new phase of liberalization, where the Ministry of Marine Affairs and Fisheries plans to gradually phase out industrial salt imports. The policy marks a shift from passive protectionism to active capacity-building, strengthening domestic supply chains while ensuring industrial resilience and competitiveness.

In parallel, a floor price policy under the *Bapokting* framework would secure farm-gate prices during harvest, safeguard rural incomes, and incentivize continued investment in quality and productivity. Together, these measures form a coherent strategy to reform the market structure, shifting from an oligopolistic setting to a more competitive, transparent, and innovation-driven framework, while protecting domestic producers, ensuring consumer access, and positioning the salt industry as a pillar of national food security and industrial competitiveness.

Ultimately, Indonesia's salt policy must strike a balance between trade liberalization and productivity-driven protection. Building robust salt corporations, expanding R&D and innovation subsidies, and ensuring cross-ministerial coordination will determine whether the country can transition from import dependence toward genuine industrial self-sufficiency.

Limitations

This study has several limitations. First, it relies on the 2016 I-O table, the latest official dataset from Statistics Indonesia (BPS). While it remains broadly representative of Indonesia's economic structure, it may not fully capture recent shifts in trade and manufacturing dynamics. Second, the I-O data aggregates salt into a single sector, preventing a clear distinction between industrial and coarse salt. It may obscure differences in demand responses, yet it also reflects Indonesia's real market condition, where imported industrial salt often leaks into the domestic market due to weak oversight. Third, elasticity parameters were adapted from existing literature rather than estimated specifically for Indonesia, introducing some uncertainty in sectoral responses. Finally, the model assumes exogenous productivity shocks. In the future, when the salt ecosystem matures, incorporating market-driven (endogenous) productivity mechanisms would provide richer insights. Future studies should employ updated, disaggregated datasets and integrate primary field data to strengthen empirical relevance and policy precision.

Appendix A. RDCGE model specification and structure

This appendix presents the detailed structure of the Recursive Dynamic Computable General Equilibrium (RDCGE) model developed for this study. The model builds upon the Indorani and Wayang model (Wittwer 1999), with modifications to reflect the structure of Indonesia's salt industry and economy as represented in the 2016 I-O table published by Statistics Indonesia (BPS). The RDCGE model is designed to evaluate both short-run and medium-term effects of import tariff policies on trade performance, production, employment, and welfare, in line with the study's objectives.

1. **Industries**

The RDCGE model comprises 185 industries, each producing a distinct good or service, corresponding to the sectors in the 2016 I-O table. Each industry is assumed to produce one unique commodity, implying that the set of industries equals the set of commodities. This level of disaggregation allows for accurate tracing of inter-sectoral linkages affected by salt import tariffs.

2. **Commodities**

Two types of commodities are represented in the model, producer goods and consumer goods. Producer goods are derived from both domestic and imported sources, and all 185 producer goods are assumed to have the potential to be imported. This specification enables the model to capture substitution between domestic and imported salt in response to tariff changes.

3. **Factors of production**.

Factor mobility plays a central role in the model. Here, mobility refers to inter-industry movement, not geographic movement. High factor mobility enhances the model's responsiveness to economic shocks. The model incorporates four primary factors of production, namely land, labor, capital, and other cost components. Labor is disaggregated into nine occupational categories following the Sakernas 2019 classification by BPS: managers; professionals; technicians and associate professionals; clerical support workers; service and sales workers; skilled agricultural, forestry, and fishery workers; craft and related trades workers; machine operators and assemblers; and elementary occupations. All labor categories are assumed to be fully mobile across sectors. Within each sector, production follows a Constant Elasticity of Substitution (CES) technology with diminishing returns to scale.

4. **Households**

To capture distributional and welfare effects, the RDCGE model disaggregates households into eight representative groups based on the Social Accounting Matrix (SAM) 2008 classification.

Rural 1: Agricultural laborers.

Rural 2: Farm entrepreneurs.

Rural 3: Low-income self-employed, informal service workers, and unskilled laborers.

Rural 4: Non-working and undefined groups.

Rural 5: High-income entrepreneurs, professionals, and managers.

Urban 1: Low-income self-employed, informal service workers, and unskilled laborers.

Urban 2: Non-working and undefined groups.

Urban 3: High-income entrepreneurs, professionals, and managers.

This disaggregation allows the model to trace welfare and employment impacts across both rural and urban populations, consistent with the study's welfare analysis framework.

5. **Elasticity coefficients and parameter estimation**

The RDCGE model calibration requires several behavioral elasticity parameters, including:

(a) Armington elasticity,
(b) Substitution elasticity for labor and primary inputs,
(c) Expenditure elasticity,
(d) Export demand elasticity,
(e) Wage elasticity, and.
(f) Labor trend parameters.

Export demand and wage elasticities were estimated empirically using a log-linear specification of the form:

$$\log Y_t = \log A + \beta \log X_t + \epsilon_t \quad (1)$$

where Y represents export volume or labor quantity, X is export price or wage, and β denotes the elasticity coefficient. To account for potential serial correlation, a partial adjustment model (PAM) specification is employed:

$$\log Y_t = \log A + \beta_1 \log X_t + \beta_2 \log Y_{t-1} + \epsilon_t \quad (2)$$

The long-run elasticity is obtained as $\alpha = \beta_1/(1-\beta_2)$. Other elasticity parameters, such as the Armington elasticity, factor substitution elasticity, and labor substitution elasticity, are specified using the Constant Elasticity of Substitution (CES) function:

$$Y = A[\delta X_1^{-\rho} + (1-\delta)X_2^{-\rho}]^{-1/\rho} \quad (3)$$

where $\sigma = 1/(1+\rho)$ is the elasticity of substitution. This formulation follows Beattie and Taylor (1985) and is applied to capture substitution effects between domestic and imported goods as well as between labor and capital.

The Armington specification for composite demand between imported and domestic goods is expressed as:

$$Q = \alpha[\beta M^{(\delta-1)/\delta} + (1-\beta)D^{(\delta-1)/\delta}]^{\delta/(\delta-1)} \quad (4)$$

and the first-order condition for optimal choice between imported (M) and domestic (D) goods yields:

$$\frac{M}{D} = \left[\frac{\beta}{1-\beta}\frac{P_D}{P_M}\right]^{\delta} \quad (5)$$

which defines the Armington elasticity (δ) as the compensated price elasticity of import demand.

6. **System of equations**.

The theoretical structure of the RDCGE model consists of 18 interrelated equation blocks, following Horridge (1999, 2002), Wittwer (1999), and Oktaviani and Drynan (2000). These blocks include:

(1) Labor demand.
(2) Primary factor demand.
(3) Intermediate input demand.
(4) Composite factor-input demand.
(5) Commodity composition of industry outputs.
(6) Investment goods demand.
(7) Household demand.
(8) Export and final demand.
(9) Margin demand.
(10) Purchaser's prices.
(11) Market-clearing conditions.
(12) Indirect taxes.
(13) GDP from income and expenditure sides.
(14) Trade balance and macro aggregates.
(15) Rates of return and indexation.
(16) Capital accumulation.
(17) Debt accumulation.
(18) Regional extension.

The model is solved in linearized form, where each equation expresses percentage changes in endogenous variables. The dynamic nature of the model is driven by the labor and capital accumulation blocks.

Labor market dynamics are represented by a relationship between real wage adjustments and deviations of employment from its trend, while capital stock accumulation is modeled sequentially to reflect investment-driven growth over time. This dynamic structure allows the RDCGE model to simulate both short-term and long-term adjustments in output, employment, and welfare in response to tariff policy changes.

7. **Link to policy objectives**.

By integrating these components, the RDCGE model captures the economy-wide ripple effects of salt import tariffs across production sectors and household groups. It quantifies:

(a) The direct trade and output responses in the salt industry,
(b) The indirect employment effects across related manufacturing and service sectors, and.
(c) The resulting changes in household welfare and national income distribution.

This comprehensive design enables the model to address the study's primary objective, assessing how salt import tariffs affect trade performance, employment, and welfare outcomes in Indonesia.

8. **Reference to parameter appendix**

The complete set of elasticity coefficients, numerical parameter values, and data sources used in model calibration is presented in Appendix B (Model parameters and elasticities) to ensure transparency and reproducibility.

Appendix B

Model parameters and elasticities

This appendix presents the detailed parameterization of the RDCGE model. Parameter values were adapted from established Indonesian CGE literature (Oktaviani 2000; Warr and Yusuf 2014; Wittwer 1999) to ensure consistency with empirical evidence. These parameters reflect the behavioral responses of producers, consumers, and traders in the salt sector and are used to calibrate the model's dynamic simulations.

Table 4 Parameters used in the RDCGE model

No.	Parameter	Description	Value	Reference
1.	Labor supply elasticity	Change in the quantity of labor supply given the seasonal and low-skilled labor base	0.5	Kleven et al. (2024), Chetty et al. (2011), Keane (2011)
2.	Primary input substitution elasticity	Reflects limited substitutability between labor and capital in a land- and labor-intensive sector	0.7	Mućk (2017), Knoblach et al. (2016)
3.	The Armington elasticity	Imperfect substitution between imported and domestic salt, with industrial preference for high-grade imports	2.0	Bajzik et al. (2020), Saito (2004)
4.	Frisch parameters	Capture subsistence constraints	−3.5 to −2.0	Whalen and Reichling (2017), Chetty et al. (2011)
5.	Expenditure elasticities	Reflects changes in the amount of consumption in response to a change in total income	1.1–1.5	Rozi et al. (2023), Rasyid and Kristina (2021), Khoiriyah et al. (2019)
6.	Export demand elasticities	Reflects changes in a country's export demand in response to changes in prices or income.	−1.6 to −10.0	Alessandria et al. (2021), Riker (2020), Tokarick (2014)
7.	Price sensitivity	Reflecting changes in the price of a product affects consumers' willingness to buy	−2.5	Widarjono et al. (2023), Pangaribowo and Tsegai (2011)
8.	Wage elasticity	Reflects muted adjustments due to seasonal surpluses	0.5	Popp (2023), Del Carpio et al. (2015)
9.	Investment parameter	Captures potential for technology adoption	5	Dixon and Rimmer (2002), Dixon et al. (2019)
10.	Depreciation rate	The rate of decline in the value of a fixed asset that reflects rapid coastal infrastructure wear	0.09	Zhang et al. (2022), Dixon and Rimmer (2002)

Appendix C. Sectoral impacts of salt import tariff changes

Table 5 The impact of changes in salt import tariffs on sectoral imports (Δ percent)

Sectors	Sim 01	Sim 02	Sim 03	Sim 04
Other food	1.16655	1.16803	1.15920	1.16066
Dairy products	1.13421	1.13562	1.12705	1.12844
Fish and other aquatic biota salting/drying products	1.11820	1.11923	1.11388	1.11490
Bread, biscuits, and similar products	0.95195	0.95303	0.94545	0.94651
Processed and preserved meat products	0.92802	0.92916	0.92192	0.92304
Processed and preserved fruit and vegetable products	0.80008	0.80093	0.79493	0.79577
Traditional medicine	0.74529	0.74617	0.74107	0.74194
Cosmetics	0.72998	0.73065	0.72549	0.72615
Fertilizers	0.65495	0.65534	0.65508	0.65546
Soap	0.65349	0.65388	0.65032	0.65070
Preservation and tanning of leather products	0.29461	0.29414	0.29781	0.29735
Textiles	0.29177	0.29158	0.29267	0.29249
Pharmaceutical products	0.24515	0.24552	0.24402	0.24439
Oil and gas refinery products	0.22584	0.22580	0.22387	0.22383
Yarn	0.18213	0.18164	0.18541	0.18493
Basic chemicals except fertilizers	0.17210	0.17202	0.17558	0.17550
Paper and cardboard products	0.13799	0.13792	0.14154	0.14147
Coarse salt	0.12294	0.12278	0.12406	0.12391
Other chemical products	0.04593	0.04594	0.04991	0.04992
Paper pulp	0.01679	0.01619	0.01914	0.01855

Sim 01: the baseline policy with a 5% import tariff

Sim 02: complete liberalization of salt imports

Sim 03: a 5% tariff combined with a 10% increase in national salt productivity

Sim 04: full liberalization combined with a 10% productivity increase

Source: Authors' calculation

Table 6 Impact of changes in salt import tariffs on sectoral exports (Δ percent)

Sector	Sim 01	Sim 02	Sim 03	Sim 04
Other means of transport	0.10505	0.10357	0.10130	0.09985
Glass and glassware	0.06840	0.06704	0.07388	0.07254
Printed matter	0.03700	0.03538	0.04218	0.04058
Sawn wood and wood products	0.03423	0.03278	0.03828	0.03685
Electrical machinery and equipment	0.02630	0.02493	0.03449	0.03314
Clay, ceramic, and porcelain products	0.02546	0.02399	0.03125	0.02981
Non-ferrous base metals	0.02479	0.02200	−0.28465	−0.28738
Other manufactured goods	0.02236	0.02091	0.02775	0.02632
Other electrical equipment	0.02174	0.02039	0.03429	0.03295
Published products	0.01535	0.01363	0.02584	0.02414
Leather goods	0.00167	0.00006	0.00661	0.00504
Paper	−0.00321	−0.00468	0.00129	−0.00015
Textile articles other than fabrics and ready-made clothing	−0.00453	−0.00578	0.00326	0.00203
Coarse salt	−0.00617	−0.00659	−0.00557	−0.00599
Pharmaceutical products	−0.02018	−0.02168	−0.01433	−0.01581
Paper and cardboard goods	−0.02172	−0.02331	−0.01685	−0.01841
Textiles	−0.02178	−0.02299	−0.01402	−0.01522
Paper pulp	−0.02930	−0.03077	−0.02490	−0.02634
Basic chemicals excluding fertilizers	−0.02951	−0.03085	−0.02376	−0.02509
Oil and gas refinery products	−0.04215	−0.04372	−0.03611	−0.03765

Sim 01: the baseline policy with a 5% import tariff

Sim 02: complete liberalization of salt imports

Sim 03: a 5% tariff combined with a 10% increase in national salt productivity

Sim 04: full liberalization combined with a 10% productivity increase

Source: Authors' calculation

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Declarations

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Consent for publication Not applicable.

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