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Philips J. Vermonte

Teguh Yudo Wicaksono

Ega Kurnia Yazid

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iifa@uiii.ac.id

Universitas Islam Internasional Indonesia

iifa.uiii.ac.id

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Rima P. Artha[1], Philips J. Vermonte[1], Teguh Yudo Wicaksono[1], and Ega Kurnia Yazid[2]

[1]IIFA, Universitas Islam Internasional Indonesia; [2]DFD Lab, CSIS

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Abstract

Maritime chokepoint disruptions affect Indonesia asymmetrically across three channels that the standard expected-loss framework fails to separate: inbound shipping friction, strategic import dependency, and export-side terms-of-trade. This paper updates the Verschuur et al. (2025) country-by-chokepoint framework to a 2025 Indonesian baseline using Indonesian institutions' data, UN Comtrade, and PortWatch data, and extends it along two dimensions. First, it pairs the annual expected-risk lens with a strategic-dependency overlay for the Strait of Hormuz, where the two metrics diverge by roughly 599 times: baseline expected trade-at-risk is only US$16 million, while direct supplier data show Saudi Arabia alone accounting for 19.8% of crude imports in 2024, rising to 20.5% when UAE is included in the broader Gulf crude set, and Hormuz-exposed LPG imports accounting for 37.1% of LPG imports. Second, it quantifies an export-side energy-windfall channel that earlier Indonesia-focused Hormuz analysis noted only briefly and did not quantify. Indonesia is the world's largest seaborne thermal coal exporter, co-anchors global palm oil supply with Malaysia, and exports LNG; a sustained Gulf-oil shock simultaneously raises these export realisations and partially offsets the fuel-import cost hit. Under the baseline, Bab el-Mandeb (US$2.08bn; 0.144% of GDP), Taiwan Strait (US$2.00bn; 0.138%), and the Suez Canal (US$1.47bn; 0.102%) dominate expected trade-at-risk, while Malacca and Taiwan dominate gross exposure at roughly US$127bn each. This study recasts Indonesian chokepoint exposure as an *asymmetric* problem: vulnerability on the refined-product import leg, strategic dependency on the Hormuz energy leg, and a terms-of-trade tailwind on coal, LNG, and CPO exports when global oil prices spike.

Key Findings

1. **Route risk is concentrated, not diffuse.** Three external chokepoints — Bab el-Mandeb, Taiwan Strait, and the Suez Canal — account for the bulk of Indonesia's expected annual trade-at-risk. In a severe Malacca disruption, US$6.4 billion of Indonesian trade would be directly exposed.

2. **Hormuz matters 599 times more as a strategic dependency than as an annual shipping risk.** Indonesia's Hormuz expected trade-at-risk is only US$16 million per year, but its Hormuz-linked fuel and feedstock dependency reaches roughly US$9.6 billion (0.67% of GDP). Crude (19.8% from Saudi Arabia alone; 20.5% including UAE in the broader Gulf set), LPG (37.1%), and Gulf-supplier sulfur (70.2%) drive the gap.

3. **Indonesia is structurally long the substitutes.** Indonesia is the world's largest seaborne thermal coal exporter, co-anchors global palm oil supply with Malaysia at roughly 84% combined share, and exports LNG from Bontang and Tangguh. A sustained Gulf-oil shock raises these export realisations and partially offsets the refined-product import cost hit. The *net* external-price effect can be positive even when GDP growth and the fiscal balance deteriorate.

4. **Expected loss and tail risk rank chokepoints differently.** Malacca's gross exposure (US$127bn) dwarfs its baseline expected loss (US$17.5 million), but in a severe disruption it becomes one of Indonesia's largest single-corridor exposures because rerouting through domestic straits is feasible but costly and slow.

5. **Indonesia's own straits are strategic infrastructure, not residual geography.** Sunda, Lombok, Makassar, and Ombai together form a rerouting system for regional and domestic trade when external corridors fail.

Contents

Executive Summary

Indonesia's external trade is sufficiently large, concentrated, and route-dependent that maritime chokepoints constitute a macroeconomic variable rather than a narrow shipping concern. Using data from Indonesia Statistics Agency (*Badan Pusat Statistik* or BPS), Bank Indonesia (BI), PortWatch route and disruption layers, and the 2022 companion data from Verschuur et al. (2025), this paper estimates that Indonesia's 2025 merchandise trade reached US$524.8 billion, or 36.4% of GDP. Within that total, the largest route exposures are concentrated in the Taiwan Strait (US$127.5 billion), the Malacca Strait (US$126.9 billion), Bab el-Mandeb (US$66.3 billion), the Suez Canal (US$61.4 billion), and Indonesia's own domestic straits network, especially Makassar and Sunda.

The baseline expected-risk ranking differs from the gross-exposure ranking. On the 2025 base, Bab el-Mandeb has the highest expected value of trade disrupted at US$2.08 billion per year, followed by the Taiwan Strait at US$2.00 billion and the Suez Canal at US$1.47 billion. Malacca presents a distinct pattern: its gross exposure is extremely large, but its annual expected-loss metric is lower because the hazard calibration assigns less annualized disruption probability than for Bab el-Mandeb and Suez. Once the analysis shifts from annual expected loss to a severe stress lens, Malacca becomes one of Indonesia's largest tail risks because rerouting through alternative Indonesian passages remains possible but expensive, congestible, and slow.

The sectoral pattern reinforces these findings. Under the directional-share-transfer method, the strongest sector result concerns scale rather than sharply differentiated corridor mix. Manufacturing remains the largest route-sensitive sector in absolute value, with about US$2.12 billion of expected trade-at-risk across the eight-corridor system, followed by mining and metals (US$1.28 billion), agriculture and food (US$1.10 billion), and energy and fuels (US$0.99 billion). In every broad sector, Bab el-Mandeb, Taiwan, and Suez are the dominant expected-risk corridors.

The Strait of Hormuz requires separate treatment. Under the expected-risk lens inherited from the companion data, Indonesia's 2025 Hormuz trade-at-risk is only US$16.0 million, or 0.001% of GDP. That metric is too narrow for energy security analysis. A second lens based on direct supplier dependence shows much higher vulnerability: Saudi Arabia alone supplied US$2.05 billion of crude oil imports in 2024 (19.8% of the crude total), and the broader Gulf crude share rises to 20.5% when UAE is included; Hormuz-exposed LPG imports reached US$1.41 billion, while Gulf-supplier sulfur imports reached US$0.34 billion. A broad 2025 fuel-dependency overlay implies US$4.63 billion of Hormuz-linked fuel imports, and the weighted strategic-dependency overlay reaches US$9.60 billion, or 0.665% of GDP on a heuristic basis. Hormuz is not Indonesia's largest annual expected shipping-loss risk, but it remains a material supply-security concern.

Policy Implications. The analysis supports targeted recommendations for four Indonesian institutions. *Kemenkeu* should separate fiscal and trade-balance accounting in chokepoint stress assessments, recognizing that export windfalls can partially offset subsidy burdens during oil price spikes. *Bank Indonesia* should incorporate chokepoint disruption scenarios into financial stability assessments and monitor Gulf-supplier sulfur dependency as an industrial input indicator. *ESDM* should evaluate the B40 biodiesel mandate as Indonesia's automatic oil-shock hedge, diversify LPG suppliers to reduce the 37.1% Hormuz concentration, and design strategic reserves against chokepoint scenarios rather than domestic shortfalls alone. *Kemendag* should preserve CPO export flexibility during Gulf oil shocks to capture terms-of-trade gains and coordinate ASEAN engagement on archipelagic waters management during sustained chokepoint crises. Cross-cutting, Indonesia needs a reproducible national chokepoint monitoring system combining BPS customs data with real-time route assignment to close current data gaps and provide policy-makers integrated vulnerability assessment.

1 Introduction

1.1 The Chokepoint Paradox: When Low Probability Meets High Impact

The Strait of Hormuz presents a fundamental paradox in maritime risk assessment that exposes the limitations of conventional chokepoint analysis. Using standard expected-loss frameworks, Indonesia's 2025 Hormuz trade-at-risk appears negligible at just US$16.0 million annually, or 0.001% of GDP—barely registering as an economic concern. Yet when the strait experienced a near-complete transit collapse on 1 March 2026, reducing daily vessel movements from 129 to single digits, the macroeconomic impact was immediate and severe: Brent crude surged to US$91.8 per barrel within two weeks, Dutch TTF gas prices jumped 74%, and Indonesia confronted a strategic dependency worth US$9.60 billion—599 times larger than the expected-risk metric suggested (UN Trade and Development, 2026).

This divergence illustrates a critical flaw in how maritime chokepoints are conventionally understood. The expected-loss approach, while methodologically sound for frequent, moderate disruptions, systematically underestimates the exposure created by low-probability, high-impact events that concentrate dependencies in ways annual averages cannot capture. For Indonesia, Hormuz matters not because ships transit it frequently, but because the country sources 19.8% of its crude oil from Saudi Arabia alone, 20.5% when UAE is included in the broader Gulf supplier set, and 37.1% of its LPG from Gulf suppliers linked to this corridor. A sustained closure simultaneously threatens electricity generation, household cooking fuel, petrochemical feedstock, and fertilizer production across the Indonesian economy.

The Hormuz case reveals three distinct transmission channels that standard vulnerability assessments conflate. The first channel follows conventional logic: net oil importers absorb higher fuel costs, subsidy bills widen, and inflation rises. The second channel reflects strategic dependency: concentrated supplier relationships create supply-security risks that frequency-based metrics miss entirely. The third channel, noted only briefly in earlier Indonesia-focused Hormuz analysis and not yet quantified there, operates in reverse: as Gulf oil shocks elevate global energy prices, Indonesia benefits through higher export realizations for thermal coal (where it holds the world's largest seaborne market share), palm oil (co-anchoring global supply with Malaysia), and LNG from Bontang and Tangguh facilities. The 2022 post-Ukraine commodity cycle demonstrated all three channels simultaneously, yet most chokepoint analysis still treats Indonesia primarily as a vulnerability rather than also as a potential beneficiary through substitute exports.

The Hormuz paradox is not unique—it exemplifies a broader analytical problem affecting Indonesia's exposure to maritime chokepoints. This paper argues that chokepoint risk for Indonesia is fundamentally *asymmetric*, operating through multiple channels that respond to the same disruption along different vectors and time scales. A coherent assessment requires these channels to be separated rather than aggregated, and policy responses must account for offsetting effects that conventional vulnerability frameworks systematically miss.

1.2 From Hormuz to the Global Chokepoint System

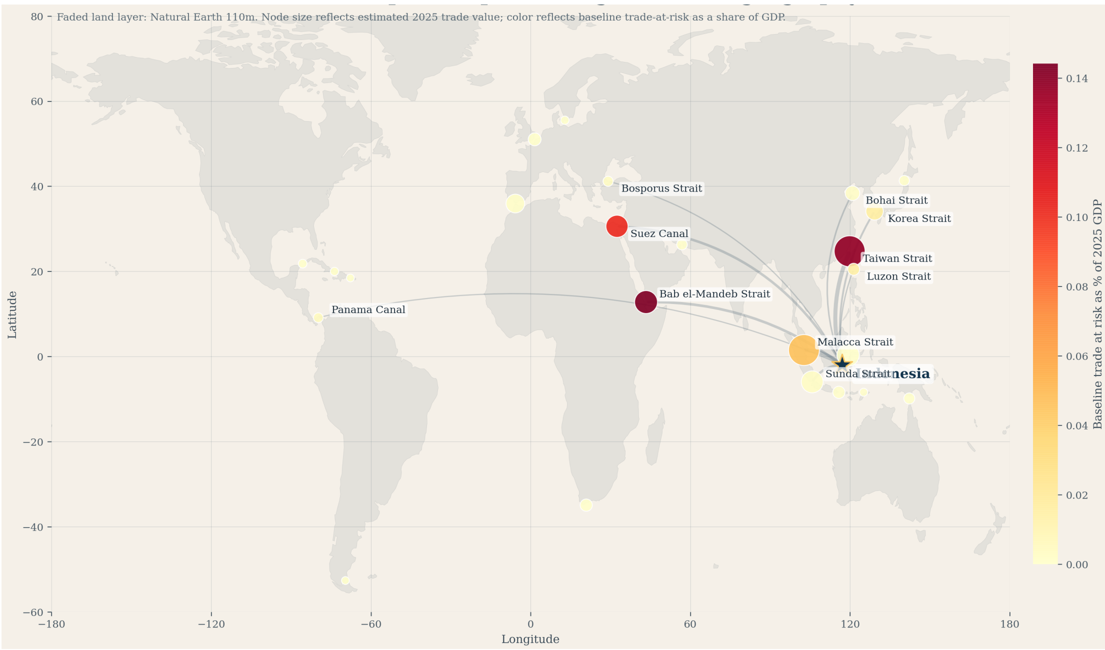
The Hormuz paradox reflects a structural feature of the global trading system: enormous trade volumes compress through a remarkably small number of narrow maritime passages. Verschuur, Lumma, and Hall (2025a) document that just 24 chokepoints globally account for an annual expected value of trade disrupted (EVTD) of US$191.5 billion, equivalent to 0.77% of world trade (Verschuur et al., 2025a). Their methodological contribution—combining hazard probabilities, disruption duration, and route dependence into comparable risk metrics—has proven invaluable for cross-corridor comparison. Yet the Hormuz case demonstrates that this expected-loss approach can obscure precisely the dependencies that matter most for national economic security.

The frequency of major chokepoint crises is accelerating. PortWatch's disruptions layer records the Red Sea tensions beginning 16 December 2023, Panama Canal capacity restrictions from 3 November 2023, and now the 2026 Hormuz escalation—three system-level disruptions in less than three years. Each episode validates the same pattern: countries need not be geographically adjacent to chokepoints for macroeconomic transmission to be severe, and concentrated trade geography creates vulnerabilities that extend far beyond the directly affected shipping lanes.

Indonesia exemplifies this systemic exposure. The country sits at the intersection of external and internal chokepoint networks, depending on passages like Malacca, Taiwan Strait, Suez, Bab el-Mandeb, and Hormuz for export earnings, industrial inputs, and energy security. Simultaneously, Indonesia's domestic straits—Sunda, Lombok, Makassar, and Ombai—function as both bottlenecks and backup routes within the regional maritime system. This dual role makes Indonesia a critical case for understanding how chokepoint exposure operates through both direct dependencies and systemic interactions.

What the Hormuz episode reveals, and what extends to Indonesia's broader chokepoint portfolio, is that the conventional vulnerability narrative captures only part of the economic reality. Maritime disruptions do not simply impose costs; they also redistribute value, create substitution opportunities, and generate asymmetric effects that vary dramatically across sectors, time horizons, and transmission channels. A complete assessment requires frameworks that can separate these countervailing forces rather than collapsing them into aggregate loss estimates.

Figure 1. Global Maritime Chokepoints Relevant for Indonesian Trade



Source: PortWatch chokepoints reference and daily chokepoint transit trade estimates, accessed 28 March 2026 (IMF & University of Oxford, 2026); authors' calculations using the Verschuur et al. (2025) companion exposure base, BPS 2025 trade tables, BPS 2025 GDP, and BI 2025 annual average USD/IDR.

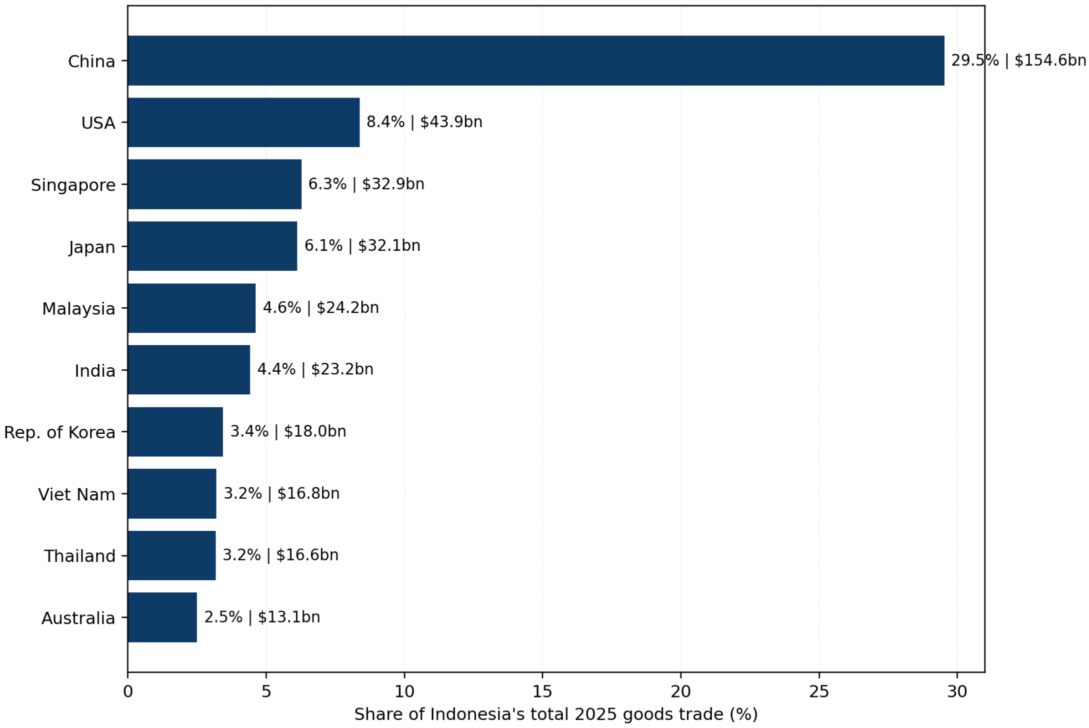
1.3 The Role of Trade in Indonesia's Economy

Indonesia is a relatively open economy. Data from the World Bank's merchandise-trade-to-GDP indicator place Indonesia at 34.0% in 2015 and 35.7% in 2024 (World Bank, 2026b). The ratio fell sharply during the pandemic, surged during the commodity upswing, and eased again as prices normalized (Figure 3). Using BPS data, this paper estimates Indonesia's 2025 merchandise-trade ratio at 36.4%, with exports at 19.6% of GDP and imports at 16.8% (Badan Pusat Statistik, 2026a, 2026b; Bank Indonesia, 2026).

Compared with other ASEAN economies, Indonesia's trade-to-GDP ratio looks moderate. The World Bank's latest 2024 merchandise-trade-to-GDP readings are 35.7% for Indonesia, 45.0% for the Philippines, 115.4% for Thailand, 149.4% for Malaysia, 164.9% for Vietnam, and 176.2% for Singapore. Indonesia is less open than the highly trade-dependent manufacturing and entrepôt economies of mainland and maritime Southeast Asia, yet its exposure is large enough for shipping frictions to matter for inflation, industrial production, and external earnings.

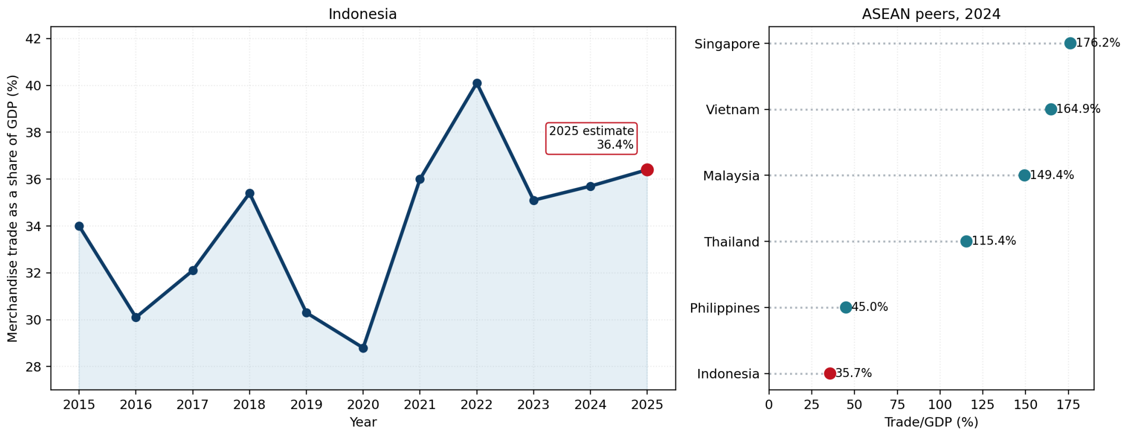
What matters for chokepoint analysis is not just the level of trade, but how trade is embedded in production and consumption. Indonesia exports bulky commodities, semi-processed resource products, and selected manufactures; it imports capital goods, machinery, electronics, fuels, chemicals, and cereals. These categories differ in their time sensitivity, rerouting possibilities, and substitution elasticity. A temporary disruption in an export-heavy route can reduce shipment value and working capital turnover. A temporary disruption in an import-heavy input route can affect electricity generation, petrochemicals, fertilizer production, automotive assembly, food prices, or inventory buffers.

Figure 2. Partner-Country Concentration in Indonesia's Full-Year 2025 Goods Trade



Source: UN Comtrade annual HS final-data preview for Indonesia, accessed 29 March 2026 (UN Comtrade, 2026); authors' calculations.

Figure 3. Indonesia's Merchandise-Trade Openness, 2015–2025



Source: World Bank, World Development Indicators, indicator TG.VAL.TOTL.GD.ZS (last updated 24 February 2026) (World Bank, 2026b); BPS trade release 2 February 2026 (Badan Pusat Statistik, 2026b); BPS GDP release 5 February 2026 (Badan Pusat Statistik, 2026a); BI SEKI December 2025, released 19 January 2026 (Bank Indonesia, 2026).

1.4 Indonesia's Major Trading Partners

China remains Indonesia's dominant trading partner by a wide margin at US$154.6 billion, or 29.5% of total two-way goods trade in 2025. It is followed by the United States at US$43.9 billion (8.4%), Singapore at US$32.9 billion (6.3%), Japan at US$32.1 billion (6.1%), Malaysia at US$24.2 billion (4.6%), India at US$23.2 billion (4.4%), and the Republic of Korea at US$18.0 billion (3.4%) (UN Comtrade, 2026) (Figure 2). These seven partners account for 62.8% of Indonesia's total 2025 goods trade, a high enough concentration for bilateral partner structure to matter directly for chokepoint transmission.

The directional pattern is informative. China supplied 36.2% of Indonesia's 2025 imports and absorbed 23.8% of exports. Singapore accounted for 7.9% of imports, Japan 6.0%, the United States 5.3%, and Malaysia 4.6%. On the export side, the United States took 11.0%, India 6.5%, Japan 6.3%, and Singapore 4.9%. Indonesia's trade geography is neither evenly diversified nor purely China-centric. East Asia dominates, but the United States, India, Singapore, and Malaysia are large enough that route concentration cannot be inferred from a single bilateral relationship alone.

That geography points toward distinct chokepoint bundles. Trade with China, Japan, Korea, and Taiwan loads heavily onto East Asian corridors in which the Taiwan Strait, Korea Strait, Bohai Strait, Tsugaru Strait, Luzon Strait, and Malacca all matter to varying degrees. Europe-facing trade loads onto the Suez–Bab el-Mandeb corridor. Gulf suppliers, while smaller in gross value than East Asian partners, matter disproportionately for energy and chemical inputs and connect directly to the Strait of Hormuz. Singapore and Malaysia are both bilateral partners and transshipment gateways; part of Indonesia's Singapore trade should be read as participation in the broader Malacca-centered logistics system rather than final demand originating in Singapore itself.

The paper constructs a transparent partner-by-chokepoint proxy by merging the full-year 2025 bilateral partner totals with the 24-chokepoint country dependency table from the Verschuur companion data. That proxy covers 99.98% of 2025 imports and 99.96% of exports by value. It is sufficient for ranking bilateral route concentration, but not for claiming voyage-observed route assignment.

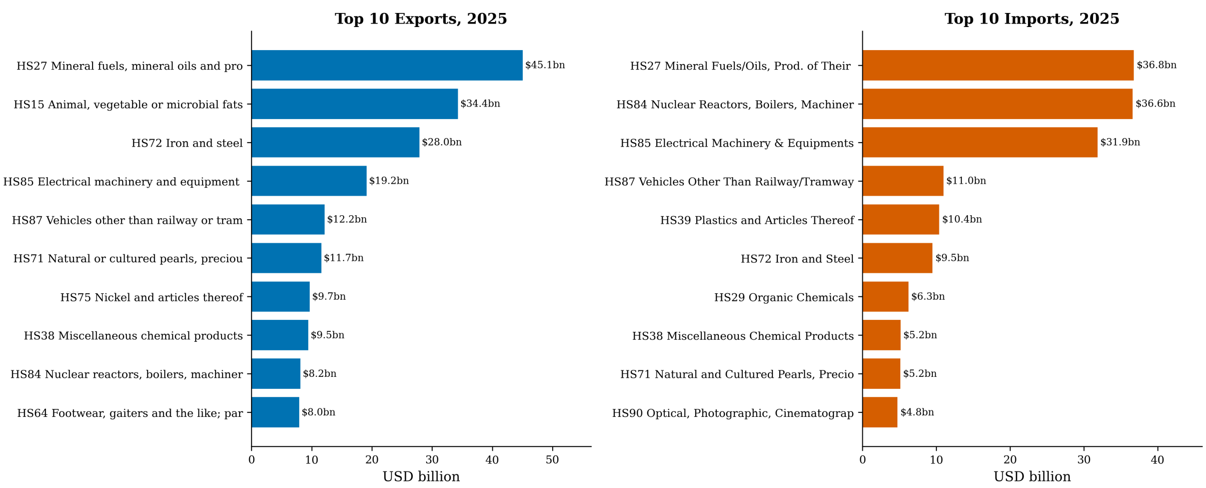
1.5 Product Composition and the Structure of Exposure

Indonesia's 2025 trade basket is wide but unevenly distributed (Figure 4). On the export side, the eight largest HS2 categories are mineral fuels (US$45.11 billion, 15.95% of exports), animal and vegetable oils (US$34.36 billion, 12.15%), iron and steel (US$27.97 billion, 9.89%), electrical machinery (US$19.19 billion, 6.78%), vehicles (US$12.18 billion, 4.30%), precious stones and jewelry (US$11.67 billion, 4.12%), nickel and nickel products (US$9.73 billion, 3.44%), and miscellaneous chemical products (US$9.50 billion, 3.36%) (Badan Pusat Statistik, 2026c). On the import side, the eight largest categories are mineral fuels (US$36.80 billion, 15.22%), machinery (US$36.64 billion, 15.15%), electrical machinery (US$31.88 billion, 13.18%), vehicles (US$11.00 billion, 4.55%), plastics (US$10.43 billion, 4.31%), iron and steel (US$9.53 billion, 3.94%), organic chemicals (US$6.25 billion, 2.58%), and miscellaneous chemicals (US$5.19 billion, 2.15%) (Badan Pusat Statistik, 2026d).

The UN Comtrade 2021–2025 HS2 panel sharpens the trend interpretation. On the import side, the core structure is persistent: HS27, HS84, and HS85 were the three largest chapters in every year from 2021 to 2025, and by 2025 machinery and electrical equipment had both moved above their 2024 values. In broad groups, manufacturing imports rose by 39.3% between 2021 and 2025, energy and fuels imports by 27.6%, and mining and metals imports by 16.0% (UN Comtrade, 2026). On the export side, the cycle is clearer: HS27 exports peaked at US$71.0 billion in 2022 before falling to US$45.1 billion in 2025, while HS15 recovered to US$34.4 billion in 2025 and exports of iron and steel, electrical machinery, vehicles, and miscellaneous chemicals all remained structurally large. Broad-group exports rose by 49.7% for mining and metals, 21.8% for manufacturing, and 16.5% for agriculture and food between 2021 and 2025, while energy exports were broadly flat relative to 2021 after the 2022 commodity spike.

This composition matters because sectoral exposure is routed differently. Resource exports are large in value and heavy in tonnage, but many are less time-sensitive than electronics or parts. By contrast, machinery, electronics, vehicles, chemicals, and refined fuels are more likely to transmit disruption through inventory buffers, input substitution limits, and price pass-through. The same chokepoint can matter very differently across sectors even when gross shipment values are similar.

Figure 4. Indonesia's 2025 Trade Composition by HS2 Chapter



Source: UN Comtrade annual HS final-data preview for Indonesia, 2021–2025 (UN Comtrade, 2026); cross-checked against BPS monthly trade books for December 2025 (Badan Pusat Statistik, 2026c, 2026d).

1.6 Indonesia in the PortWatch Network

PortWatch's ports reference layer identifies 101 Indonesian ports in the current dataset (IMF & University of Oxford, 2026). That count matters because Indonesia is not merely exposed to chokepoints abroad; it is also a distributed maritime system whose own ports and internal passages shape regional resilience. Port-level spillover data indicate that the largest daily capacity-at-risk links into Indonesia are concentrated around Singapore, Tanjung Priok, Tanjung Perak, Makassar, Port Klang, and several other Indonesian trunk ports. Indonesia's maritime economy is a hybrid system in which domestic trunk ports, nearby transshipment hubs, and cross-border corridor links are tightly interlinked.

That network position has three implications. First, disruptions at external chokepoints do not affect Indonesia uniformly; they strike through specific sectors and hubs. Second, domestic straits should be interpreted as part of Indonesia's strategic adjustment capacity. Third, some route exposure is inherently non-additive. A single shipment can pass through Malacca, then the South China Sea, then Taiwan, and later a destination-specific choke. Route totals in this paper should therefore be read as exposure indicators, not as a partition of Indonesia's trade into mutually exclusive buckets.

2 Literature Review

2.1 From Network Structure to Chokepoint Risk

The structural maritime-network literature explains *why* chokepoints matter before the disruption literature explains *how much* they cost. Ducruet and Notteboom (2012) show that liner shipping networks are highly uneven, with strong corridor concentration, hub dependence, and a limited number of passages through which large volumes of global trade are routed (Ducruet & Notteboom, 2012). Their contribution is a network interpretation in which topology, centrality, and traffic concentration create the preconditions for systemic vulnerability. Xu, Wang, Ren, Liu, and Qiang (2020) extend that perspective by linking the global liner shipping network to the trade status of countries (Xu et al., 2020). Together, these studies imply that route concentration should be treated as an economic variable even before specific hazards are introduced.

That structural insight is necessary but insufficient. It explains why chokepoints exist in practice, but it does not reveal what annual risk, crisis loss, or sector transmission looks like. The key advance in Verschuur et al. (2025) is methodological: the paper combines a maritime transport model with hazard-event data and route dependence to derive two related metrics, EVTD and economic risk. That framework moves the literature away from simply noting that chokepoints are important and toward estimating expected disruption value, rerouting penalties, insurance costs, and inventory-sensitive losses in a common framework (Verschuur et al., 2025a).

2.2 Trade Disruption, Time Costs, and Macroeconomic Transmission

The economics of maritime disruption depends critically on time, inventory, and substitution. Hummels' trade-cost work established that transport frictions are not limited to freight rates; time itself behaves like an ad valorem trade barrier, especially for time-sensitive manufactures and intermediate goods (Hummels, 2001). In the more directly estimated formulation by Hummels and Schaur (2013), each day in transit can be valued as a sizable tariff equivalent (Hummels & Schaur, 2013). This result is foundational for chokepoint analysis because it provides microeconomic justification for the delay-cost component of the Verschuur framework and for the broader macro intuition that route disruption affects output even when cargo ultimately arrives.

Recent disruption-specific work reinforces that point. The post-Ever Given and Red Sea literature shows that short-lived route interruptions can create long-lived cost effects through schedule reliability, container imbalances, insurance premia, and inventory depletion. The common conclusion is that shipping disruptions propagate through prices, working capital, inventories, and input availability. This paper adopts that logic, but it uses the country-by-chokepoint structure from Verschuur rather than building a new voyage-level simulation.

2.3 Three-Channel Transmission Mechanisms in Maritime Disruption

The emerging literature on maritime chokepoint disruptions reveals that the economic transmission operates through multiple channels that can reinforce or offset each other, particularly for countries with diversified commodity portfolios. Yet most chokepoint analyses focus on aggregate disruption costs rather than separating these distinct transmission pathways.

2.3.1 Channel 1: Import Cost Absorption for Net Energy Importers

The conventional transmission channel follows straightforward import-price pass-through logic. E3G (2024) demonstrate that maritime chokepoints pose "unavoidable, systemic risk" where energy importers face cascading effects through fuel costs, freight rates, insurance premiums, and input costs simultaneously. This transmission operates with remarkable speed: energy price shocks affect prices and availability within days, spreading through transport, electricity, and industry to impact inflation, trade balances, and fiscal spending (E3G, 2024). The vulnerability is particularly acute for developing economies, where fuel imports represent substantial shares of total import bills and transport costs can exceed half of final staple food prices (Economics Help, 2026).

2.3.2 Channel 2: Strategic Dependency Beyond Expected-Loss Metrics

A second channel reflects concentrated supplier relationships that create supply-security risks independent of disruption frequency. The U.S. Energy Information Administration documents that Hormuz carries 21% of global petroleum liquids consumption, with 84% flowing to Asian markets, yet alternative pipeline capacity remains severely limited—Saudi Arabia and the UAE combined maintain only 3.5-5.5 million barrels per day of bypass capacity (U.S. Energy Information Administration, 2024a). This concentration creates strategic dependencies that frequency-weighted expected-loss metrics systematically underestimate. The March 2026 Hormuz crisis validated this concern: the closure reduced Middle East Gulf exports from 15 million to 7 million barrels per day, demonstrating how low-probability events can trigger supply disruptions far exceeding annualized risk estimates (Kpler, 2026).

2.3.3 Channel 3: Export Windfall Effects for Commodity Substitutes

The third channel, systematically ignored in country-specific vulnerability assessments, operates through terms-of-trade improvements for exporters of energy substitutes. IMF research demonstrates that commodity-exporting economies experience lower sovereign bond spreads during periods of higher commodity terms-of-trade, reflecting reduced financing costs during boom phases (International Monetary Fund, 2019). Terms-of-trade booms trigger sectoral reallocation, shifting labor and capital from non-commodity tradables toward commodities and non-tradables sectors (International Monetary Fund, 2016). Crucially, the same oil shock that creates balance-of-payments strain for energy importers generates "terms-of-trade windfall" for energy-substitute exporters, creating asymmetric global effects that conventional vulnerability frameworks miss (Euronews, 2026).

2.4 What Existing Work Still Misses for Indonesia

The literature remains thin on Indonesia-specific route vulnerability. Do Bagus and Hanaoka (2023) examine interdependent risk factors across Indonesian seaports and show that port-level vulnerability is shaped by multiple interacting operational and institutional factors (Do Bagus & Hanaoka, 2023). That is useful, but it is not a country-by-route macro exposure model. More broadly, the Indonesia and ASEAN literature is rich in port competitiveness, logistics performance, and maritime policy, yet relatively poor in empirical estimates of how external chokepoint disruptions transmit to Indonesian trade, by sector and route, in a form comparable to GDP.

Indonesia is often discussed as a commodity exporter with a large domestic market. That description understates the country's dependence on maritime imports of machinery, fuels, chemicals, and cereals, and it also understates the role of Indonesian straits as regional rerouting options. Existing work usually isolates one of those themes: it either studies domestic ports or external corridors, but rarely both in an integrated quantitative setting.

2.5 Research Gap and Contribution

This paper contributes in four ways. First, it updates the Indonesia-specific exposure calculations from the 2022 base year in Verschuur et al. (2025) to a 2025 trade and GDP baseline using official BPS, BI, World Bank, and UN Comtrade data. Second, it decomposes route exposure into sector-level estimates at HS2 aggregation, explicitly stating the inference step needed because 2025 observed maritime HS2-by-chokepoint data are not available. Third, it adds a second analytical lens for the Strait of Hormuz: the original framework includes Hormuz in the global chokepoint universe, but it does not identify it as a top expected-loss chokepoint for Indonesia. This paper shows that expected annual risk and strategic dependency can diverge sharply. Fourth, it treats Indonesia's internal straits as strategic economic infrastructure.

3 Methodology

3.1 Data Architecture and Replication Logic

The empirical workflow has six layers. The first is the 2022 country-by-chokepoint exposure base from the PortWatch/Verschuur companion data (IMF & University of Oxford, 2026; Verschuur et al., 2025a). The second is the hazard-specific trade-at-risk and economic-loss decomposition from the same framework. The third is official Indonesian 2025 trade data from BPS, extracted at HS2 level for annual exports, imports, and weights (Badan Pusat Statistik, 2026c, 2026d). The fourth is a UN Comtrade layer for Indonesia's full-year 2025 bilateral partner totals and annual HS2 history for 2021–2025 (UN Comtrade, 2026). The fifth is the 2025 macro denominator, constructed from BPS current-price GDP and the BI annual average middle rate for USD/IDR (Badan Pusat Statistik, 2026a; Bank Indonesia, 2026). The sixth is the PortWatch operational layer: the current chokepoints reference, ports reference, daily chokepoint transit trade estimates, and the disruptions and spillover files (IMF & University of Oxford, 2026).

This layered design is necessary because no single dataset directly reports Indonesia's 2025 trade by country, sector, maritime route, and chokepoint simultaneously. The workflow therefore reproduces what is directly observable, scales what can defensibly be updated to 2025, and flags what remains unavailable. Table 1 summarizes the replication assessment.

Table 1. Replication Assessment: Available Inputs, Missing Inputs, and Treatment

Component	Status	Available evidence	Treatment in this paper
2022 Indonesia country × chokepoint values and quantities	Available	Direct PortWatch/Verschuur companion country-level base for 24 modeled chokepoints	Used directly as the structural exposure base.
Hazard-specific trade-at-risk and economic-loss channels	Available	Companion trade-risk and economic-risk layers with rerouting distances and hazard classes	Used directly for baseline risk and for severe-scenario calibration.
2025 HS2 trade values and weights	Available	BPS annual 2025 export and import HS2 tables	Used directly for 2025 product composition and for scaling sector exposures.
2021–2025 HS2 annual history	Available	UN Comtrade annual HS final-data preview for Indonesia	Used for trend figures, sector trend interpretation, and cross-checking the 2025 BPS composition.
2025 bilateral partner totals	Available	UN Comtrade annual HS partner totals for Indonesia	Used directly for the 2025 partner ranking and country-side trade concentration analysis.
2025 GDP denominator and FX rate	Available	BPS 2025 current-price GDP and BI 2025 annual average middle rate	Used directly for all GDP-share metrics.
PortWatch chokepoints, ports, spillovers, daily throughput	Available	PortWatch reference and operational files	Used directly for mapping, port counts, domestic strait context, and disruption history.
2025 direct maritime HS2 × chokepoint observations	Missing	No observed Indonesian 2025 maritime HS2 route table	Estimated by applying 2022 directional chokepoint shares to 2025 BPS HS2 totals.
2025 bilateral partner × chokepoint allocation	Proxy	2025 UN Comtrade bilateral partner totals merged with the 2022 companion country dependency shares	Presented as a transparent proxy, not as a voyage-observed bilateral route matrix.
Post-2024-03-26 direct disruption history	Partial	PortWatch disruptions file ends on 26 March 2024	Used with explicit truncation note; 2026 Hormuz context added from UNCTAD.
Hormuz cargo-route labels for all Gulf suppliers	Partial	Labeled crude/LPG rows and sulfur split; some Saudi cargoes may have non-Hormuz alternatives	Used only in the strategic-dependency overlay with an explicit caveat.

Source: Authors' compilation based on PortWatch (IMF & University of Oxford, 2026), Verschuur et al. (2025) companion data (Verschuur et al., 2025a), BPS (Badan Pusat Statistik, 2026a, 2026b, 2026c, 2026d), BI (Bank Indonesia, 2026), UN Comtrade (UN Comtrade, 2026), and UNCTAD (UN Trade and Development, 2026).

3.2 Core Risk Framework

The paper adopts the EVTD framework from Verschuur et al. (2025). For country i, chokepoint c, and hazard h, the annual expected value of trade disrupted is

$$EVTD_i = \sum_h \sum_c P_{c,h} \cdot \frac{T_{i,c}}{365} \cdot S_{c,h} \cdot D_{c,h}, \tag{1}$$

where $P_{c,h}$ is the annual hazard probability, $T_{i,c}$ is annual trade routed through chokepoint c, $S_{c,h}$ is disruption severity, and $D_{c,h}$ is disruption duration in days.

Economic loss is then decomposed as

$$EL_i = EL_{d,i} + EL_{r,i} + EL_{p,i} + EL_{t,i} + EL_{l,i}, \tag{2}$$

where the terms denote delay losses, rerouting losses, insurance-premium losses, canal-toll losses, and inventory or lost-trade losses. Rerouting is feasible when disruption duration exceeds rerouting travel time:

$$D_{c,h} > \frac{\Delta d_c}{V}, \tag{3}$$

with Δd_c as rerouting distance and V as average vessel speed, set at 16 knots in the original framework.

The present paper does not rebuild the OxMarTrans network model. Instead, it takes the Indonesia-specific exposure, hazard, and loss outputs from the companion data as given, updates the trade base to 2025, and uses those updated route values to construct sectoral and scenario summaries.

Framework Validation. The EVTD methodology has undergone peer review and was published in *Nature Communications* (2025), where Verschuur, Lumma, and Hall validated the approach by modeling expected value of trade disrupted across 24 maritime chokepoints worldwide, estimating USD 192 billion of globally exposed trade and USD 10.7 billion in economic losses, with an additional USD 3.4 billion in increased freight costs (Verschuur, Lumma, & Hall, 2025b). Recent real-world validation has strengthened confidence in the framework: the 2023-2024 Red Sea and Panama Canal disruptions produced observed traffic drops exceeding 50% at both chokepoints, while global vessel demand increased by 3% and container ship demand by 12% due to rerouting, closely matching the framework's predictions of systemic spillover effects (Pratson, 2023). Alternative methodological approaches in the recent literature include agent-based modeling for LNG markets (Meza, Ari, Sada, & Koç, 2022) and network analysis using AIS vessel movement data to identify vulnerabilities between major chokepoints and global ports, providing complementary validation of the route-concentration patterns identified in the Verschuur framework (Wang, Du, & Peng, 2024).

3.3 Updating the Exposure Base from 2022 to 2025

Let M^{BPS}_{2025} and X^{BPS}_{2025} denote Indonesia's 2025 imports and exports from BPS annual totals, and let M^{UN}_{2022} and X^{UN}_{2022} denote the corresponding 2022 all-commodity values from UN Comtrade, used to align with the companion exposure base. The directional scaling factors are

$$\lambda_M = \frac{M^{BPS}_{2025}}{M^{UN}_{2022}}, \qquad \lambda_X = \frac{X^{BPS}_{2025}}{X^{UN}_{2022}}. \tag{4}$$

Using official sources, $\lambda_M = 1.0186$ and $\lambda_X = 0.9689$. Indonesia's 2025 trade through chokepoint c is then estimated as

$$T_c^{2025} = V_{c,M}^{2022}\lambda_M + V_{c,X}^{2022}\lambda_X, \tag{5}$$

where $V_{c,M}^{2022}$ and $V_{c,X}^{2022}$ are the 2022 import and export values through chokepoint c from the companion dataset.

The same logic is used for tonnage, except that 2025 BPS annual weights are scaled by 2022 maritime quantity shares. This is a stronger inference than the value scaling because no direct 2025 maritime-only route tonnage is available. All volume-based statements in this paper should therefore be interpreted as route-exposure indicators rather than observed maritime tonnage accounts. Expected economic loss is scaled separately with the import-side factor,

$$EL_c^{2025} = EL_c^{2022} \cdot \lambda_M, \tag{6}$$

because the companion economic-loss decomposition is import-side in structure even though the trade-at-risk inventory combines import and export exposure.

3.4 Sectoral Allocation

The sectoral matrix requires an additional assumption because the data do not contain 2022 Indonesia HS2-by-chokepoint observations. For direction $d \in \{M, X\}$, define the 2022 directional chokepoint share

$$s_{c,d}^{2022} = \frac{V_{c,d}^{2022}}{V_d^{2022}}. \tag{7}$$

For HS2 sector g, the 2025 sectoral exposure through chokepoint c is then estimated as

$$E_{g,c,d}^{2025} = s_{c,d}^{2022} \cdot B_{g,d}^{2025}, \tag{8}$$

where $B_{g,d}^{2025}$ is the official BPS 2025 import or export value for sector g. Total sectoral chokepoint exposure is $E_{g,c}^{2025} = E_{g,c,M}^{2025} + E_{g,c,X}^{2025}$.

To obtain a sector-level expected trade-at-risk estimate, the paper applies the chokepoint-level disruption fraction

$$\phi_c = \frac{EVTD_c^{2025}}{T_c^{2025}} \tag{9}$$

to each sectoral exposure cell:

$$R_{g,c}^{2025} = \phi_c \cdot E_{g,c}^{2025}. \tag{10}$$

For reporting, the 98 HS2 chapters are aggregated into five broad groups: Agriculture and Food (HS01–24), Energy and Fuels (HS27), Chemicals and Plastics (HS28–40), Mining and Metals (HS25–26 and HS68–83 except HS77), and Manufacturing (all remaining chapters). This step preserves the route ranking and produces an interpretable sector summary, but it assumes that hazard exposure is proportionate across sectors within a chokepoint. Because the allocation transfers common 2022 import and export route shares to every HS2 chapter within a direction, the resulting sector comparison is strongest in absolute value and weaker in claims about sharply different corridor mixes across sectors.

3.5 Scenario Design

Three scenarios are used. The baseline is the annual expected trade-at-risk metric, scaled to 2025. The moderate scenario assumes a 10-day disruption with 20% throughput loss:

$$\mu = \frac{10 \times 0.20}{365} = 0.005479. \tag{11}$$

Chokepoint-level moderate trade disruption is therefore

$$T_{c,\text{moderate}}^{2025} = \mu \cdot T_c^{2025}. \tag{12}$$

The severe scenario is a tail-risk stress case based on the largest hazard-duration-severity fraction present in the companion data for each chokepoint:

$$\sigma_c = \max_h \left(\min \left\{ \frac{S_{c,h} D_{c,h}}{365}, 1 \right\} \right), \tag{13}$$

$$T_{c,\text{severe}}^{2025} = \sigma_c \cdot T_c^{2025}. \tag{14}$$

This scenario is explicitly not a forecast. It is a stress envelope.

To translate the stress scenarios into GDP-equivalent loss ranges, the paper uses a reduced-form elasticity:

$$\eta_c = \frac{EL_c^{2025}}{EVTD_c^{2025}}, \tag{15}$$

and applies it to the moderate and severe trade-disruption values. These scenario GDP-equivalent losses are heuristic extensions of the baseline loss intensity rather than direct model outputs.

3.6 Hormuz Extension: Expected Risk versus Strategic Dependency

The Strait of Hormuz is already present in the 24-chokepoint universe, but its expected annual risk for Indonesia is modest in the scaled 2025 base. That result is not inconsistent with strategic dependency. The baseline model scores Hormuz low for Indonesia because the Indonesia-specific trade base routed through Hormuz is relatively small in the companion data and the hazard-weighted disruption term is modest compared to Bab el-Mandeb, Taiwan, and Suez. Additionally, the companion dataset assigns zero reroute kilometers for Hormuz, meaning that the rerouting-cost component of economic loss is absent. This does not mean Hormuz is unimportant; it means that the standard EVTD framework captures frequency-weighted expected loss but not the structural dependence on a corridor that carries critical energy inputs with limited short-run substitution.

To capture strategic dependency, the paper introduces a second metric. Let C_H^{2024} be 2024 crude imports labeled Hormuz-exposed, L_H^{2024} the corresponding LPG value, S_H^{2024} the Gulf-supplier sulfur proxy, and $\theta_{Gulf,HS27}^{2024}$ the 2024 Gulf share of Indonesia's HS27 imports. If Oil_{2025}^{BPS} is the

BPS 2025 fuel-import baseline, then the broad fuel dependency overlay is

$$B_H^{2025} = \theta_{Gulf,HS27}^{2024} \cdot Oil_{2025}^{BPS}. \tag{16}$$

The weighted critical dependency metric is

$$SD_H = 2B_H^{2025} + S_H^{2024}. \tag{17}$$

This overlay is *not* an expected annual loss. It is a heuristic supply-security exposure measure, designed to sit alongside EVTD rather than replace it.

The rationale for treating Hormuz separately extends beyond the model mechanics. The March 2026 Hormuz escalation documented by UNCTAD illustrates how rapidly conditions in the strait can deteriorate. When daily ship transits fell from 129 to single digits, the immediate effect was felt in energy prices, not in cargo diversion (UN Trade and Development, 2026). For Indonesia, which imports roughly one-fifth of its crude oil and more than a third of its LPG through Hormuz-linked suppliers, a sustained closure would affect electricity generation, household cooking fuel, petrochemical feedstock, and fertilizer production simultaneously. The macro transmission channel is therefore energy-price and input-availability shock, not shipping delay in the traditional Verschuur sense. This distinction motivates the two-lens treatment throughout the results.

4 Results: Chokepoint Exposure and Country Dependency

4.1 Chokepoint Inventory and Risk Map

The current PortWatch reference layer contains 28 chokepoints. The 24-chokepoint analytical base from Verschuur et al. (2025) covers all but four: Balabac Strait, Bering Strait, Kerch Strait, and Mindoro Strait. Those four are retained on maps but excluded from quantified Indonesian 2025 risk estimates. Within the 24 modeled chokepoints, Indonesia's gross route exposure is dominated by the Taiwan Strait, Malacca Strait, Bab el-Mandeb, Suez, Makassar, and Sunda.

Table 2 ranks the most material chokepoints under the baseline expected-risk metric. Two patterns stand out. First, the baseline ranking is driven by hazard-weighted exposure rather than by gross trade value alone, which is why Bab el-Mandeb outranks Malacca. Second, the severe scenario ranking elevates chokepoints with long rerouting distances or full-blockage assumptions, especially Malacca, Panama, and Suez.

Table 2. Top Indonesia-Relevant Chokepoints on the 2025 Trade Base

Chokepoint	Gross exposure (US$ bn)	Baseline risk (US$ bn)	Baseline % GDP	Expected loss (US$ mn)	Moderate disruption (US$ bn)	Severe disruption (US$ bn)
Bab el-Mandeb Strait	66.3	2.08	0.144	47.5	0.36	2.97
Taiwan Strait	127.5	2.00	0.138	14.8	0.70	1.05
Suez Canal	61.4	1.47	0.101	22.1	0.34	4.96
Malacca Strait	126.9	0.67	0.046	17.5	0.70	6.43
Korea Strait	35.3	0.24	0.017	1.2	0.19	0.29
Luzon Strait	12.0	0.20	0.014	1.9	0.07	0.10
Panama Canal	5.3	0.08	0.005	1.2	0.03	5.34
Bosporus Strait	6.2	0.05	0.003	0.8	0.03	0.05
Strait of Hormuz[a]	7.6	0.02	0.001	2.5	0.04	0.07

[a] Hormuz ranks low in baseline expected risk but higher under the heuristic strategic-dependency overlay (0.665% of GDP equivalent); see Section 4.5.

Source: Authors' calculations from PortWatch/Verschuur companion data (IMF & University of Oxford, 2026; Verschuur et al., 2025a), scaled to 2025 using BPS trade totals (Badan Pusat Statistik, 2026b). Gross exposure is total 2025 trade through the chokepoint. Baseline risk is annual expected trade-at-risk. Moderate and severe are stress scenarios and are not additive across chokepoints.

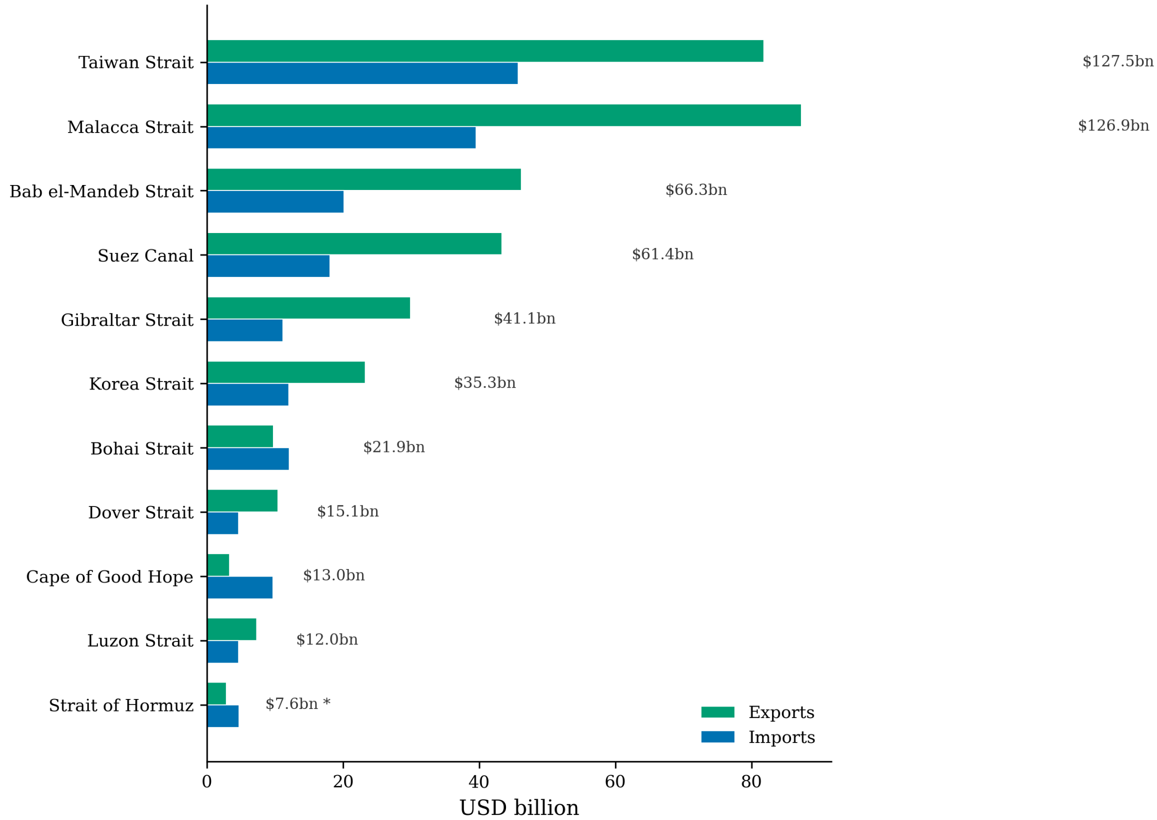
Rerouting logic helps explain why these chokepoints differ. The companion data assign rerouting distances of about 9,000 km for Bab el-Mandeb and Suez, 12,000 km for Panama, 1,500 km for Malacca, 2,800 km for Sunda, 2,700 km for Lombok, and 4,200 km for Makassar. Taiwan is assigned only 1,000 km, which is why it generates very large gross exposure and high EVTD but smaller economic-loss intensity than Bab el-Mandeb or Suez. Hormuz is assigned no meaningful maritime rerouting alternative in the base dataset. Its low EVTD reflects the smaller Indonesia-specific trade base routed through Hormuz and the companion hazard calibration, not the presence of a cheap rerouting option.

The aggregate exposure pattern across Indonesia's major chokepoints reveals sharp concentration in both import and export flows (Figure 5). Taiwan Strait and Malacca dominate gross exposure at approximately US$127 billion each, reflecting Indonesia's heavy trade concentration with East Asian partners, particularly China. However, the import-export decomposition shows that Taiwan Strait exposure is heavily import-weighted (US$89.0 billion imports versus US$38.5 billion exports), while Malacca shows more balanced bidirectional flow (US$70.8 billion imports, US$56.1 billion exports). Bab el-Mandeb and Suez exhibit the opposite pattern, with export exposure substantially exceeding import exposure, consistent with Indonesia's commodity export flows to European and Middle Eastern markets.

PortWatch's direct disruption history records two chokepoint-specific events for the corridors most relevant to Indonesia: Panama restrictions on 3 November 2023 and Red Sea tensions on 16 December 2023, affecting Bab el-Mandeb, Suez, and the Cape of Good Hope rerouting corridor (Figure 6). The timeline demonstrates the accelerating frequency of major chokepoint crises: three system-level disruptions within 30 months, including the 2026 Hormuz escalation that represents the most severe supply shock since the framework's establishment. The disruptions file ends on 26 March 2024; the absence of more recent direct tags should not be read as evidence of low risk.

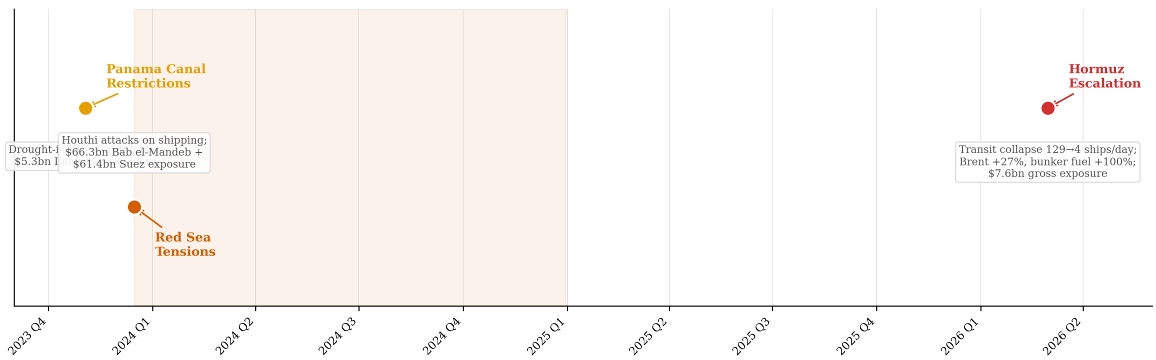
The hazard distribution across Indonesia-facing chokepoints reveals distinct risk profiles that explain the divergence between gross exposure and expected annual losses (Figure 7). Bab el-Mandeb faces the highest concentration of political, conflict, and terrorism hazards, consistent with its elevated position in expected-loss rankings despite moderate gross exposure. Taiwan Strait and Malacca show more balanced hazard profiles including weather, technical, and political risks, while Hormuz exhibits concentrated geopolitical and conflict risks that align with its low-probability, high-impact characteristics. The hazard classification provides empirical foundation for the frequency-weighted disruption probabilities that drive the EVTD calculations.

Figure 5. Import and Export Exposure by External Chokepoint



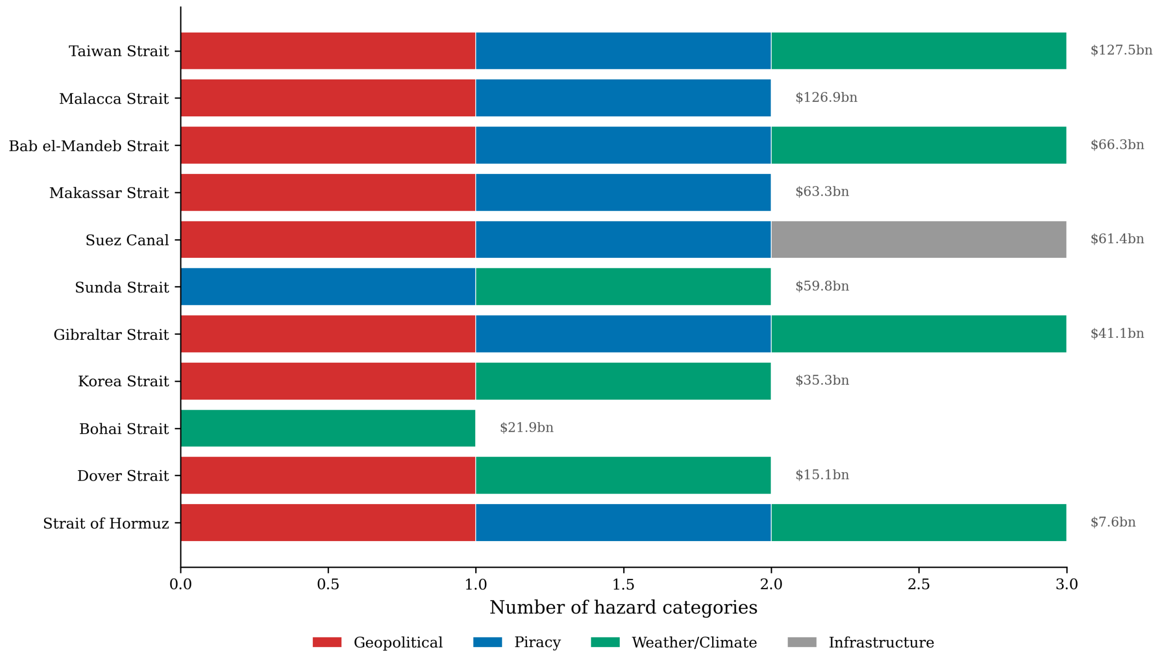
Source: PortWatch/Verschuur companion base (IMF & University of Oxford, 2026; Verschuur et al., 2025a), scaled with BPS 2025 annual trade tables (Badan Pusat Statistik, 2026b); authors' calculations. Domestic Indonesian straits excluded.

Figure 6. Disruption Timeline for Indonesia-Facing Maritime Corridors, 2023–2026



Note: The vertical axis represents individual disruption events positioned by approximate date; it does not denote a quantitative scale. The shaded region indicates the approximate period of Red Sea rerouting disruption.
Source: PortWatch disruptions dataset, accessed 28 March 2026 (IMF & University of Oxford, 2026); UNCTAD Hormuz note, 10 March 2026 (UN Trade and Development, 2026).

Figure 7. Hazard Category Distribution Across Indonesia-Facing Chokepoints



Source: PortWatch/Verschuur companion hazard fields and disruption descriptions (IMF & University of Oxford, 2026; Verschuur et al., 2025a).

4.2 Country-Side Dependency Analysis

Full-year 2025 bilateral partner totals from UN Comtrade, combined with the 24-chokepoint country dependency table from the Verschuur companion data, yield a partner-by-chokepoint proxy covering 99.98% of Indonesia's 2025 imports and 99.96% of exports by value. It is not a voyage-observed route table, but it is strong enough to rank which bilateral trade relationships are most chokepoint-concentrated.

The top partner × chokepoint proxy pairs reveal a highly concentrated system. China dominates: China–Taiwan Strait alone accounts for US$63.9 billion of proxy exposure, followed by China–Malacca at US$45.3 billion, China–Korea Strait at US$29.4 billion, China–Bohai at US$25.4 billion, China–Bab el-Mandeb at US$25.1 billion, and China–Suez at US$23.7 billion. The next tier is structurally familiar: Malaysia–Malacca reaches US$12.4 billion, Singapore–Malacca US$12.3 billion, Japan–Taiwan US$11.4 billion, and Korea–Korea Strait US$10.5 billion. These values are not additive across chokepoints, because the same bilateral trade can traverse multiple passages.

East Asia is the dominant external cluster, tying Indonesia most strongly to the Taiwan–Malacca corridor and, secondarily, to Korea- and Bohai-facing passages. Singapore and Malaysia matter less as final-demand markets than as transshipment and regional production gateways. India matters through both eastern and western corridors: the proxy assigns US$9.2 billion to India–Malacca, US$7.4 billion to India–Bab el-Mandeb, US$6.7 billion to India–Suez, and US$5.4 billion to India–Hormuz, making India one of the clearest examples of a partner whose importance cannot be reduced to a single route.

The main caveat concerns Hormuz. The generic partner-by-chokepoint proxy assigns significant Hormuz exposure not only to Gulf suppliers such as the United Arab Emirates, Saudi Arabia, and Qatar, but also to China and India, because it scales whole-country bilateral trade by national chokepoint dependency shares. The product-specific Hormuz risk still requires the separate crude, LPG, and sulfur lens used in Section 4.5.

Table 3. 2025 Partner × Chokepoint Proxy Lens for Indonesia's Maritime Exposure

Partner cluster	Latest official trade evidence	Likely chokepoint bundle	Interpretation
China	US$154.6bn total 2025 trade; 36.2% of imports and 23.8% of exports	Taiwan (US$63.9bn proxy), Malacca (US$45.3bn), Korea (US$29.4bn), Bab el-Mandeb (US$25.1bn), Suez (US$23.7bn)	China is the single largest bilateral concentration across both eastern and western corridors.
Japan and Korea	Japan US$32.1bn and Korea US$18.0bn total 2025 trade	Taiwan, Korea, Malacca, Tsugaru, Bohai	Northeast Asian manufacturing links are concentrated in the Taiwan- and Korea-facing route bundle.
Singapore and Malaysia	Singapore US$32.9bn and Malaysia US$24.2bn total 2025 trade	Malacca, Sunda, Makassar, Bab el-Mandeb at transshipment margin	Route relevance exceeds final-demand shares because both function as regional logistics and production gateways.
United States and India	United States US$43.9bn and India US$23.2bn total 2025 trade	India loads onto Malacca, Bab el-Mandeb, Suez, and Hormuz; U.S. exposure is more diffuse across Pacific and western routes	India is route-concentrated across multiple chokepoints; U.S. trade is large but less dependent on a single corridor.
Gulf suppliers	UAE, Saudi Arabia, and Qatar are not top overall partners, but dominate product-specific strategic exposure	Hormuz	The generic proxy identifies corridor concentration, but the energy-security interpretation should rely on the product-specific Hormuz overlay in Section 4.5.

Source: UN Comtrade (UN Comtrade, 2026); PortWatch/Verschuur country dependency table (IMF & University of Oxford, 2026; Verschuur et al., 2025a); authors' calculations. Values are partner × chokepoint proxy exposures, not directly observed voyage-level route assignments.

4.3 Sector × Chokepoint Matrix

Based on data at our disposal, we are not able to observe Indonesia's 2025 HS2-by-chokepoint flows directly. The sector results therefore aggregate the inferred HS2 cells into the five broad groups and report only the selected eight-corridor system: Bab el-Mandeb, Hormuz, Suez, Malacca, Lombok, Makassar, Sunda, and Taiwan. Under this design, sector comparisons are strongest in absolute value, not in claims about sharply different corridor mixes.

The 2021–2025 UN Comtrade panel sharpens the interpretation. Manufacturing imports rose from US$78.6 billion in 2021 to US$109.6 billion in 2025. Mining and metals exports rose from US$43.5 billion to US$65.2 billion, while agriculture and food exports increased from US$50.7 billion to US$59.1 billion. Those shifts identify which parts of Indonesia's trade basket remain large enough for inherited route risk to have macro relevance.

Table 4 reports the sector summary. Manufacturing is the largest route-sensitive sector in absolute value: on a US$190.0 billion 2025 trade base, expected trade-at-risk across the selected eight corridors sums to US$2.12 billion. Mining and metals follow at US$1.28 billion, then agriculture and food at US$1.10 billion, energy and fuels at US$0.99 billion, and chemicals and plastics at US$0.79 billion. In every sector, the leading expected-risk corridors are Bab el-Mandeb, Taiwan, and Suez. That stability is a consequence of the directional-share-transfer method, not evidence that every commodity literally uses the same route mix.

The sector exercise identifies which broad parts of Indonesia's trade basket are large enough to transmit chokepoint shocks. The current data do not support strong claims that one sector is routed through materially different corridors than another once trade direction is held constant. The small expected-risk values in Makassar, Sunda, and Lombok should not be misread as economic insignificance; those passages remain important as Indonesia's own continuity and rerouting system during external disruptions.

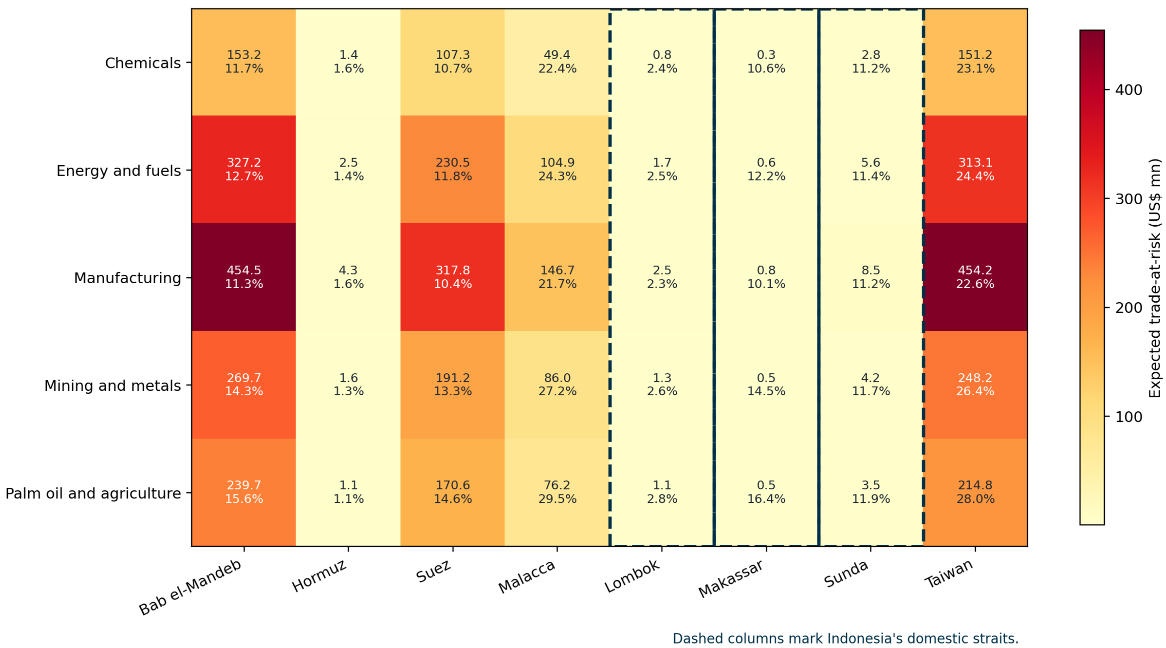
Table 4. Sector Summary Under Directional-Share Transfer

Sector group	2025 trade (US$ bn)	Expected trade-at-risk (US$ bn)	Leading expected-risk corridors within the selected eight-corridor system (US$ mn)
Manufacturing	190.0	2.12	Bab el-Mandeb (698), Taiwan (688), Suez (489)
Mining and metals	99.6	1.28	Bab el-Mandeb (427), Taiwan (399), Suez (302)
Agriculture and food	84.2	1.10	Bab el-Mandeb (368), Taiwan (342), Suez (261)
Energy and fuels	81.9	0.99	Bab el-Mandeb (327), Taiwan (313), Suez (230)
Chemicals and plastics	69.0	0.79	Bab el-Mandeb (260), Taiwan (254), Suez (183)

Source: Authors' calculations from BPS 2025 HS2 trade tables (Badan Pusat Statistik, 2026c, 2026d), PortWatch/Verschuur companion data (IMF & University of Oxford, 2026; Verschuur et al., 2025a). Sector totals are unique 2025 trade values from BPS. Expected-risk values sum only across the selected eight corridors and are not additive to unique national trade because shipments can traverse more than one chokepoint.

The sector-by-chokepoint analysis reveals that while manufacturing dominates absolute risk exposure, the pattern of corridor concentration is remarkably consistent across sectors (Figure 8). Bab el-Mandeb, Taiwan Strait, and Suez consistently rank as the top three risk corridors across manufacturing, mining and metals, agriculture and food, and chemicals and plastics. This consistency suggests that Indonesia's chokepoint vulnerability reflects fundamental trade geography rather than sector-specific routing preferences. The heatmap also demonstrates that Indonesia's domestic straits—particularly Makassar and Sunda—carry meaningful portions of sectoral trade, reinforcing their role as strategic infrastructure within the regional rerouting system rather than marginal alternative routes. As discussed previously, Hormuz, however, has low risk here. This is due to our baseline model based on Verschuur et al. (2025a) framework. In particular, it places Hormuz, in the context of Indonesia, is relatively small in the hazard-weighted disruption term, which is modest compared to Bab el-Mandeb, Taiwan, and Suez.

Figure 8. Sector × Chokepoint Heatmap: Expected Trade-at-Risk and Route Share



Note: Cell values show expected trade-at-risk in US$ millions and the corresponding route share within each sector. Dashed columns mark Indonesia's domestic straits.
Source: Authors' calculations from BPS 2025 HS2 trade tables (Badan Pusat Statistik, 2026c, 2026d) and PortWatch/Verschuur companion data (IMF & University of Oxford, 2026; Verschuur et al., 2025a). Domestic Indonesian straits included for completeness.

4.4 GDP Impact Analysis

The route-based trade-at-risk metrics convert into non-trivial GDP-equivalent losses once shipping frictions, delay, inventory, and war-risk insurance are considered. Under the baseline expected-loss estimates inherited from the companion framework and scaled to 2025, Bab el-Mandeb produces the largest expected economic loss for Indonesia at about US$47.5 million, or 0.0033% of GDP, followed by Suez (US$22.1 million), Malacca (US$17.5 million), Taiwan (US$14.8 million), and

Hormuz (US$2.46 million). These are small relative to gross cargo values exposed, which is the point: the economic-loss metric measures frictional loss, not cargo destruction.

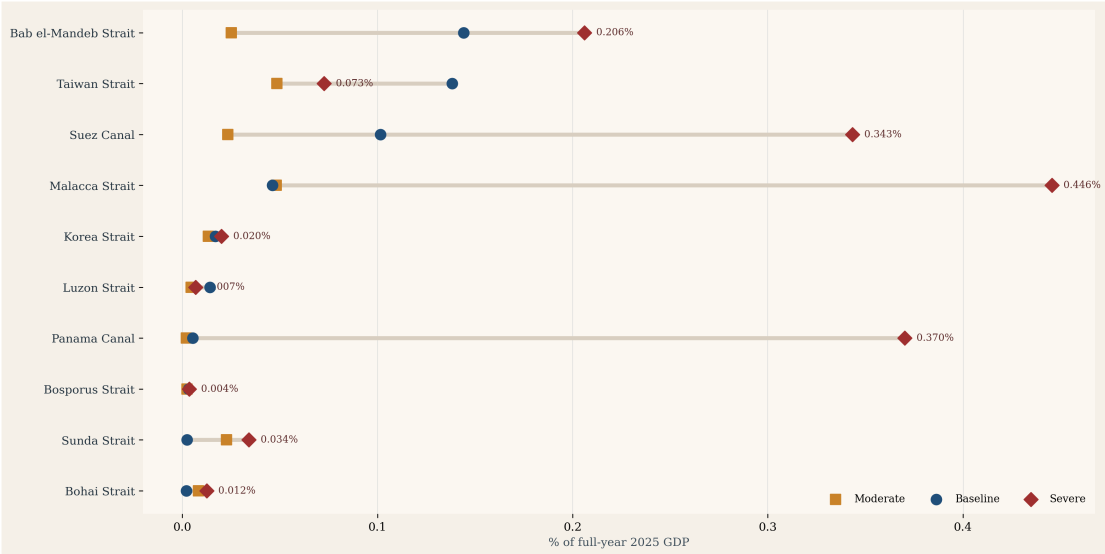
The composition of loss channels differs across chokepoints. In the 2022 economic decomposition that underlies the scaled 2025 estimates, Bab el-Mandeb and Suez are dominated by shipping-price shocks and rerouting costs, while Malacca is dominated by war-risk premia. Taiwan's gross exposure is large, but its economic-loss intensity is lower because rerouting distance is short. Hormuz is different: the expected-loss decomposition is dominated by delay and lost-trade components rather than by rerouting, consistent with the absence of a meaningful rerouting alternative.

For the moderate and severe scenarios, the paper uses the baseline loss intensity η_c as a reduced-form elasticity. The moderate GDP-equivalent loss for the top four chokepoints is approximately US$8.3 million for Bab el-Mandeb, US$5.2 million for Taiwan, US$5.1 million for Suez, and US$18.3 million for Malacca. In the severe stress case, the same extrapolation implies about US$67.9 million for Bab el-Mandeb, US$7.8 million for Taiwan, US$74.6 million for Suez, US$168.8 million for Malacca, and US$80.0 million for Panama. These are scenario translations, not formal re-estimations.

The severe scenario ranking is analytically revealing (Figure 9). Malacca, Panama, and Suez become much more material because the scenario uses the largest hazard-duration-severity fraction observed in the companion data. The figure demonstrates how chokepoint rankings shift dramatically between baseline and severe stress: while Bab el-Mandeb dominates baseline expected losses, Malacca emerges as the largest severe-scenario risk at US$168.8 million GDP-equivalent impact, reflecting its massive gross exposure and the costliness of rerouting through Indonesia's domestic straits. A chokepoint may look manageable on an annualized basis yet still matter for inventories, fuel procurement, or financial-market repricing in a short, severe disruption.

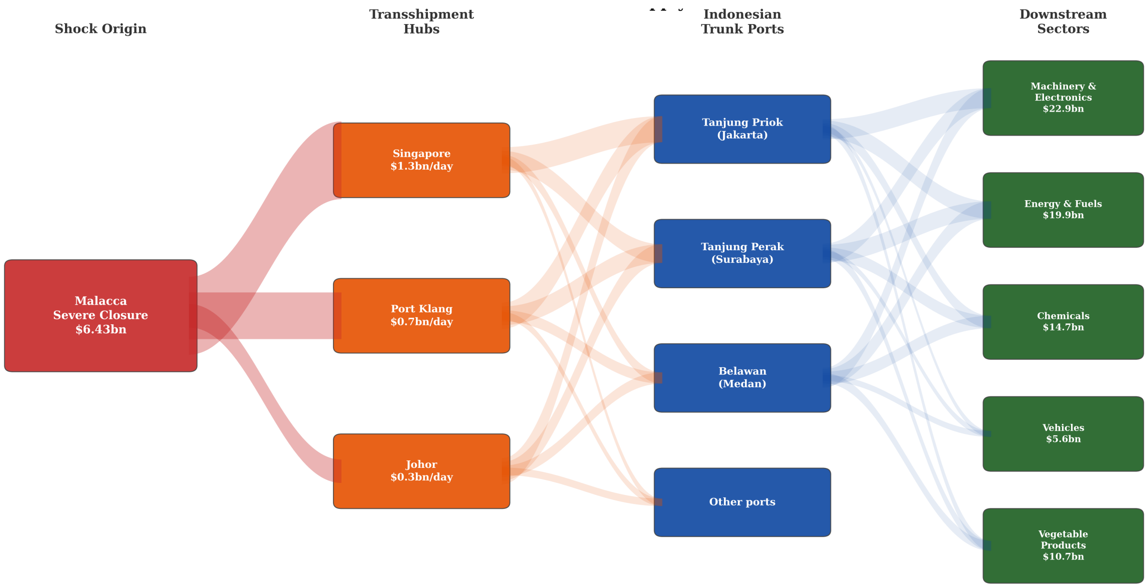
The Malacca case exemplifies how chokepoint disruptions propagate through Indonesia's maritime-logistics system (Figure 10). A severe Malacca closure creates supply chain cascades that reach far beyond the initial shipping disruption. The figure traces how a US$6.43 billion direct trade disruption flows through Indonesian trunk ports—particularly Tanjung Priok, Tanjung Perak, and Belawan—before affecting downstream industries including automotive assembly, electronics manufacturing, and agricultural processing. The cascade analysis reveals that Indonesia's domestic port system, while providing rerouting alternatives, also concentrates bottleneck risks that amplify the economic impact of external chokepoint disruptions. Singapore's role as a transshipment hub creates additional vulnerability, as Indonesian ports depend on Singapore-routed cargo that must itself reroute during Malacca disruptions.

Figure 9. GDP-Equivalent Scenario Comparison for Indonesia-Facing Chokepoints



Note: This figure uses the expected-risk lens only. The Hormuz strategic-dependency overlay is reported separately in Table 5.
Source: Authors' calculations from the 2025 inventory and the economic-risk base scaled to 2025, using PortWatch/Verschuur companion data (IMF & University of Oxford, 2026; Verschuur et al., 2025a) and BPS 2025 trade data (Badan Pusat Statistik, 2026b).

Figure 10. Severe Malacca Disruption: Supply Chain Cascade Through Indonesian Trunk Ports



Note: Port and transshipment nodes, plus middle-stage links, scale to PortWatch daily capacity-at-risk. Downstream industry nodes scale to PortWatch daily industry-output-at-risk. The red shock node annotates the 2025 severe-scenario Malacca trade-disruption estimate of US$6.43 billion. PortWatch spillover files do not isolate palm oil separately; the agriculture-related downstream channel is represented by the vegetable-products bucket.
Source: PortWatch spillover files (IMF & University of Oxford, 2026); authors' calculations using the 2025 route inventory.

4.5 Strait of Hormuz: Expected Risk versus Strategic Dependency

The Strait of Hormuz is the clearest case in which annual expected trade disruption and strategic macroeconomic dependency diverge (Figure 11). In the scaled 2025 base, Indonesia's gross trade exposure through Hormuz is about US$7.60 billion, with a baseline expected trade-at-risk of only US$16.0 million, a moderate disruption value of US$41.7 million, and a severe disruption value of US$66.6 million. On that evidence alone, Hormuz would rank well below Bab el-Mandeb, Taiwan, Suez, or Malacca. However, the strategic-dependency overlay reveals a fundamentally different picture: US$9.60 billion in fuel and feedstock dependency that is 599 times larger than the expected annual risk. The figure demonstrates this dramatic divergence, showing how frequency-weighted expected-loss metrics systematically underestimate concentrated supplier dependencies that create supply-security vulnerabilities regardless of disruption probability.

That is not the whole story. The Hormuz corridor carries critical energy and industrial inputs for Indonesia with limited short-run substitution. Since 2020, Indonesia's crude oil import dependence has grown as domestic production has declined, and the Gulf remains one of the primary sources of crude, LPG, and sulfur (Wicaksono & Artha, 2026). The March 2026 Hormuz escalation — in which daily ship transits collapsed from roughly 129 to single digits, Brent crude surged to US$91.8 per barrel, and European gas prices spiked 74% within two weeks (UN Trade and Development, 2026) — illustrates the speed at which a Hormuz disruption can become a macro event. For Indonesia, the transmission channel is not primarily shipping delay but energy-price and input-availability shock: effects on electricity generation costs, household cooking fuel (LPG), petrochemical feedstock, and fertilizer production (sulfur).

Direct supplier-level data show that crude oil imports labeled Hormuz-exposed were worth US$2.05 billion in 2024, equivalent to 19.8% of Indonesia's crude imports. Hormuz-exposed LPG imports reached US$1.41 billion, or 37.1% of LPG imports. Gulf-supplier sulfur imports reached US$0.34 billion, or 70.2% of sulfur imports. Aggregating the direct crude and LPG bundle gives US$3.47 billion, equal to 10.6% of the BPS 2025 fuel-import baseline. The broader Gulf HS27 overlay raises the 2025 fuel dependency estimate to US$4.63 billion, or 14.1% of the same baseline. Applying the weighted lens yields a strategic-dependency equivalent of US$9.60 billion, or 0.665% of GDP on a heuristic basis.

The comparison is stark. The weighted strategic-dependency overlay is roughly 1.26 times the gross trade exposure through Hormuz and about 599 times the annual expected trade-at-risk estimate. This does not mean the expected-risk metric is wrong. It means it answers a different question. EVTD asks how much trade value is expected to be disrupted each year, after accounting for probability and duration. The strategic-dependency overlay asks how much of a critical input system depends on one corridor if a geopolitical shock occurs. The two answers can diverge sharply when the corridor carries energy, fertilizer, or feedstock imports that are substitutable only slowly.

An important empirical caveat applies, and the paper now quantifies it. Saudi Aramco operates the East-West Crude Oil Pipeline (Petroline), which connects the Abqaiq processing complex to the Yanbu terminal on the Red Sea coast. The US Energy Information Administration lists

Petroline's nameplate capacity at approximately 5 million barrels per day, with some reports citing an expandable ceiling of roughly 7 million bpd under sustained throughput (U.S. Energy Information Administration, 2024c). Historical utilization has been considerably lower, typically in the 2.0–2.5 mb/d range, leaving substantial spare capacity that could be mobilized in a Hormuz closure. In addition, Saudi Aramco operates Yanbu-based LPG handling capacity that allows a smaller but non-trivial share of Saudi LPG cargoes to bypass Hormuz.

A Saudi Red Sea adjustment to the Hormuz overlay treats 10% of 2024 Saudi crude imports (US$205 million) and 5% of Saudi LPG imports (US$19 million) as routable via Petroline and Yanbu, with those tranches reassigned from Hormuz exposure to the Bab el-Mandeb–Suez system. Under that adjustment, the strict Hormuz-exposure overlay falls by roughly US$224 million, about 2.3% of the weighted strategic-dependency equivalent. The Hormuz conclusion is therefore robust: even under a conservative Saudi bypass assumption, the two-lens gap remains roughly two orders of magnitude wide. The overlay should still be read as an upper bound, with the Saudi-adjusted row in Table 5 providing a lower-bound central estimate.

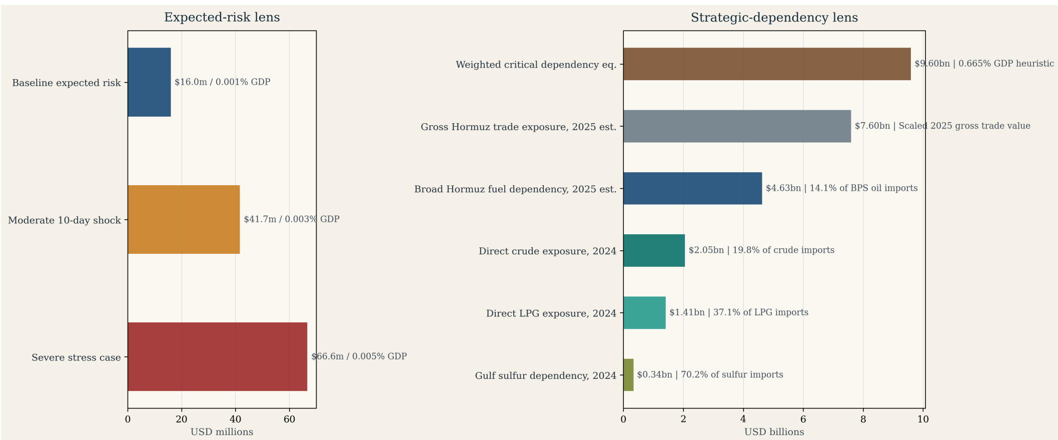
A second caveat concerns the sulfur row: it is a Gulf-supplier proxy rather than a direct Hormuz route label. The 2024 supplier-level data identify four Gulf origins for Indonesian sulfur imports: Saudi Arabia (US$134 million), UAE (US$113 million), Qatar (US$58 million), and Kuwait (US$33 million), for a Gulf total of US$337 million or 70.2% of sulfur imports. Qatar, Kuwait, and most Saudi sulfur are effectively Hormuz-routed with no short-run maritime bypass. UAE sulfur, primarily a by-product of gas processing at Habshan and Ruwais, can partially route via Fujairah terminals on the Gulf of Oman, though no dedicated sulfur pipeline exists to the Fujairah coast. Under a strict-Hormuz classification (Saudi Arabia, Qatar, Kuwait only) the directly Hormuz-exposed sulfur bundle is US$225 million or 46.8% of sulfur imports; under a 50% UAE–Fujairah bypass assumption the strict-Hormuz bundle rises to roughly US$281 million or 58.4%. The paper retains the 70.2% Gulf-aggregate figure as the upper bound, with the 46.8–58.4% strict-Hormuz range now provided as a lower-bound central estimate.

Table 5. Hormuz Two-Lens Comparison

Metric	Value	Share / ratio
Gross 2025 trade exposure	US$7.60 bn	–
Baseline expected trade-at-risk	US$16.0 mn	0.001% of GDP
Moderate disruption	US$41.7 mn	0.003% of GDP
Severe disruption	US$66.6 mn	0.005% of GDP
Hormuz-exposed crude imports, 2024	US$2.05 bn	19.8% of crude imports
Hormuz-exposed LPG imports, 2024	US$1.41 bn	37.1% of LPG imports
Gulf-supplier sulfur imports, 2024[a]	US$0.34 bn	70.2% of sulfur imports
Direct crude + LPG bundle, 2024	US$3.47 bn	10.6% of BPS 2025 fuel-import baseline
Broad Hormuz fuel dependency, 2025 estimate	US$4.63 bn	14.1% of BPS 2025 fuel-import baseline
Weighted strategic-dependency equivalent[b]	US$9.60 bn	0.665% of GDP (heuristic)
Saudi Red Sea–adjusted equivalent[c]	US$9.38 bn	0.650% of GDP (heuristic)
Weighted overlay / expected risk	599.3×	–

[a] The sulfur row is a Gulf-supplier proxy rather than a direct Hormuz route label.
[b] The weighted overlay is a heuristic strategic-dependency equivalent, not a model-estimated loss number.
[c] The Saudi Red Sea adjustment reassigns 10% of 2024 Saudi crude imports and 5% of Saudi LPG imports from Hormuz to the Bab el-Mandeb–Suez corridor, based on EIA's 5 mb/d Petroline capacity and observed Yanbu terminal throughput.
Source: BPS (Badan Pusat Statistik, 2026b); UNCTAD (UN Trade and Development, 2026); EIA (U.S. Energy Information Administration, 2024c); authors' calculations using supplier-level trade data for 2024. The dependency rows are not expected-loss estimates.

Figure 11. Hormuz: Strategic-Dependency Overlay versus Baseline Expected Risk



Source: Authors' calculations using supplier-level trade data, the BPS 2025 fuel-import baseline (Badan Pusat Statistik, 2026b), and UNCTAD's Hormuz note (UN Trade and Development, 2026).

4.6 Validation Against the Red Sea Episode

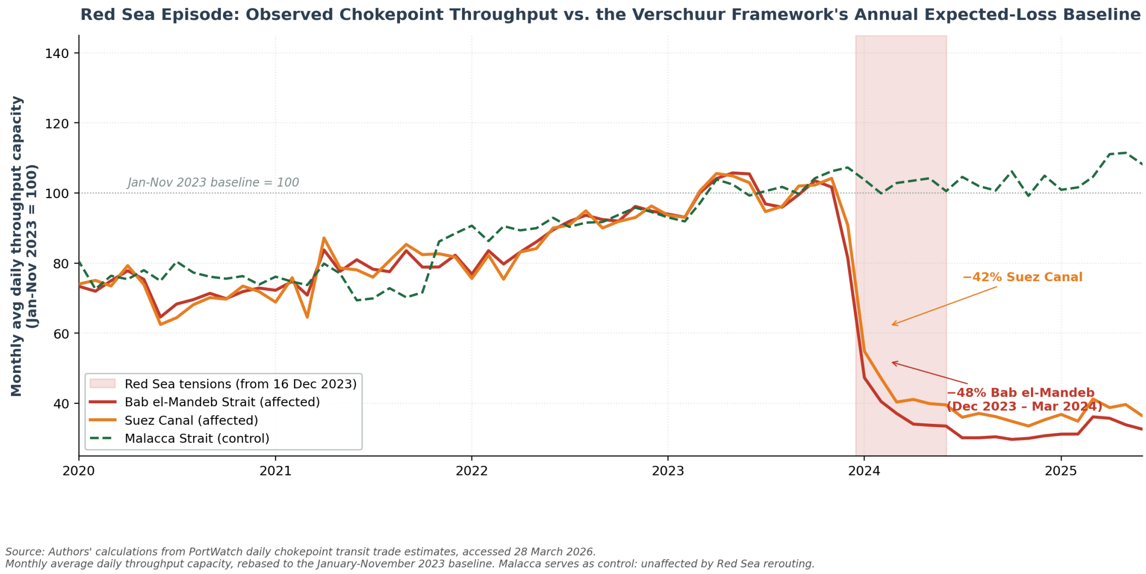
The Red Sea tensions that began on 16 December 2023 provide an out-of-sample test of the Verschuur framework's chokepoint classification. If the framework correctly identifies Bab el-Mandeb and the Suez Canal as Indonesia's most hazard-exposed external corridors, and Malacca as structurally different, then the observed throughput response to the 2023–2024 episode should confirm that ordering.

PortWatch's daily chokepoint-transit data, which tracks vessel counts and deadweight-tonnage capacity by corridor, offers a direct empirical comparison. Figure 12 plots monthly-average daily throughput capacity for three chokepoints, rebased to the January–November 2023 baseline. The episode produced a sharp and sustained capacity reduction at the two Red Sea–adjacent corridors while leaving Malacca essentially untouched. Between December 2023 and March 2024, Bab el-Mandeb daily capacity fell by 48.2%, Suez Canal capacity fell by 41.5%, and Malacca capacity rose by 3.9% — the last consistent with incremental rerouting gains rather than loss.

These observed magnitudes are consistent with the framework's hazard calibration, but they also illustrate the distinction between annual expected loss and single-episode realization. The framework assigns Bab el-Mandeb an annual Indonesia-specific expected trade-at-risk of US$2.08 billion on the 2025 base, reflecting a hazard-probability-weighted average. The Red Sea episode itself, applied to Indonesia's US$66.3 billion Bab el-Mandeb route exposure, implies a single-episode trade-at-risk of roughly US$10.5 billion if the observed 48% throughput reduction is sustained for four months. A single tail episode can therefore deliver three to five times the annualized expected-loss baseline, exactly as the framework's design intends.

The validation is two-sided. First, the ranking of affected versus unaffected chokepoints matches the framework's corridor classification, which supports the ordering used throughout Section 4. Second, the episode confirms that the annual-expected-risk metric understates realized loss during single tail events, which reinforces why the paper pairs baseline EVTD with severe-scenario and strategic-dependency lenses rather than treating the annual metric as a complete vulnerability measure.

Figure 12. Red Sea Episode: Observed Chokepoint Throughput Against Baseline



Note: Monthly average daily throughput capacity at three chokepoints, rebased to the January–November 2023 baseline. Malacca is used as control. Bab el-Mandeb and Suez were the two corridors directly affected by Red Sea rerouting; observed capacity fell by 48% and 42% respectively over the four-month window Dec 2023 – Mar 2024. Malacca capacity was unaffected.
Source: Authors' calculations from PortWatch daily chokepoint transit trade estimates (IMF & University of Oxford, 2026), accessed 28 March 2026.

5 Energy Trade and the Export-Side Windfall Channel

The preceding sections describe how Indonesia absorbs a Gulf-oil shock through refined-product imports and through strategic Hormuz dependency. Both channels operate on the cost side of the economy. A symmetric channel operates on the revenue side and has not yet been quantified in earlier Indonesia-focused Hormuz analysis: Indonesia is the world's largest seaborne thermal coal exporter, co-anchors global palm oil supply with Malaysia, and exports LNG from Bontang and Tangguh. When a Gulf oil shock propagates through global energy markets, these three export streams benefit through distinct but coherent channels. This extension does not overturn the import-shock result: GDP, inflation, and subsidy pressures can still deteriorate even when the external trade ledger partially improves.

The coal channel runs through gas-to-coal substitution in Northeast and South Asian power generation. When LNG and oil flows into Asia are disrupted, the fastest operational lever available to power generators in Japan, Korea, India, and parts of China is to substitute thermal coal for gas at the margin. Indonesia's seaborne thermal coal is well positioned for this substitution: calorific grades cover a wide range, shipping routes to East and South Asia are short, and loading infrastructure at East Kalimantan ports is established. The empirical record from 2022, when European gas-to-coal switching following the Russia–Ukraine shock pulled Asian spot coal prices from roughly US$90 to above US$400 per tonne before stabilizing around US$200–250, provides a clear analog. Indonesia's 2025 coal exports reached US$30.2 billion (524 million tonnes), composed of US$24.5 billion in hard coal (HS2701) and US$5.7 billion in lignite (HS2702) (Badan Pusat Statistik, 2026c). A moderate Hormuz-induced coal price lift of 12–20% on this base maps to US$3.6–6.0 billion in export-revenue gain.

The LNG channel is narrower and more weakly identified than coal or CPO. Indonesia's 2025 LNG exports (HS2711.11) totaled US$5.56 billion (10.9 million tonnes) from Bontang and Tangguh, with Asian buyers dominating the destination mix (Badan Pusat Statistik, 2026c; U.S. Energy Information Administration, 2024b). Public operator disclosures confirm that a material tranche of Tangguh output remains foundation-contracted rather than spot marketed: bp reports that Train 3 raised total Tangguh capacity to 11.4 mtpa, that 75% of Train 3 annual LNG production was sold to PT PLN (Persero), and that the remaining volumes were contracted to Kansai Electric; bp also identifies PLN as Train 3's domestic foundation customer at commercial start-up (bp, 2016, 2023). Pertamina Hulu Energi's 2024 annual report likewise records Badak LNG plant obligations tied to named WBX and NR sales contracts, but published Indonesian disclosures do not provide a unified 2025 national split between spot cargoes and long-term contracts (PT Pertamina Hulu Energi, 2024). The paper therefore does not assign a measured national spot-share percentage. Instead, it treats LNG as a bounded sensitivity channel: the 5–15% realised-price uplift used below should be read as a scenario bound for residual spot exposure plus contract repricing under moderate Hormuz stress, not as an observed 2025 spot-share estimate. Under that bound, the LNG windfall is US$0.3–0.8 billion.

The CPO channel runs through the vegetable-oil–petroleum substitution margin. High petroleum prices strengthen biodiesel economics globally and lift demand for palm oil as a feedstock. Historical CPO–Brent correlations sit in the 0.5–0.7 range at monthly frequency. Indonesia's 2025 HS15 exports of US$34.4 billion (Badan Pusat Statistik, 2026c) concentrate this exposure. Under a 15–20% CPO price uplift scenario, export-revenue gains fall in the US$5–7 billion range on an annualized basis.

Indonesia's B40 biodiesel mandate, effective 1 January 2025, adds a second-order channel that acts as an endogenous hedge (Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, 2024, 2025). The mandate requires 40% palm-oil biodiesel content in domestically consumed diesel fuel; a higher crude oil price raises the threshold at which B50 or B55 becomes fiscally attractive. This reduces refined-product import volume at the margin precisely when refined-product prices are highest. Official ESDM reporting states that the 2025 B40 allocation was 15.6 million kL (7.55 million kL PSO and 8.07 million kL non-PSO), while realized domestic biodiesel utilization in January–December 2025 reached 14.2 million kL, equivalent to 91.0% of the announced allocation and 105.2% of ESDM's 13.5 million kL IKU target (Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, 2025, 2026). On a volume basis, the hedge was therefore substantial but incomplete. No other major Asian economy has a comparable instrument.

Table 6 summarizes the three channels under a moderate Hormuz-stress scenario, defined here as Brent crude sustained at roughly US$95 per barrel for one quarter with proportional propagation to thermal coal, CPO, and spot LNG prices. The scenario is a scaling exercise, not a formal forecast.

Table 6. Export-Side Energy Windfall Under a Moderate Hormuz Stress Scenario

Channel	2025 export base (US$ bn)	Scenario uplift (%)	Revenue gain (US$ bn)	Transmission mechanism
Coal (HS2701+HS2702)[a]	30.21	12–20	3.6–6.0	Asian gas-to-coal substitution; spot-driven
Palm oil (HS15)[b]	34.36	15–20	5.2–6.9	Biodiesel demand; CPO–petroleum substitution margin
LNG (HS2711.11)[c]	5.56	5–15 (weighted)	0.3–0.8	Non-Gulf LNG premium; contract-indexation lag
Total export windfall	—	—	**9.1–13.7**	—
Memo: import cost headwind				
Refined fuel imports (HS27)[d]	36.80	15–25	5.5–9.2	Gulf price pass-through
Subsidy fiscal offset[e]	—	—	1.4–2.8	B40-mandate pass-through relief; RAPBN 2026 sensitivity
Net terms-of-trade effect[f]	—	—	**+5.0 to +7.3**	Positive before fiscal subsidy response

[a] Coal base combines hard coal HS2701 (US$24.48bn, 390.9 Mt) and lignite HS2702 (US$5.73bn, 133.1 Mt), both from the BPS 2025 export book HS8 detail. Total coal-export weight of 524 Mt is consistent with Indonesia's status as the world's largest seaborne thermal coal exporter.

[b] HS15 export value from BPS 2025 export book includes crude palm oil (CPO) and refined palm oil products; the scenario treats the aggregate because biodiesel substitution operates on the broader CPO-derivative complex.

[c] LNG export value is the HS2711.11 row from the BPS 2025 export book (10.89 Mt at US$511/tonne implied average realised price). Public disclosures show that Tangguh Train 3 volumes are foundation-contracted to PLN and Kansai Electric, while PHE's 2024 annual report discusses Badak LNG obligations tied to WBX-NR contracts (bp, 2016, 2023; PT Pertamina Hulu Energi, 2024). Because published Indonesian sources do not disclose a unified 2025 national spot-share split, the 5–15% weighted uplift is treated as a sensitivity bound for residual spot exposure plus contract repricing rather than a measured spot percentage.

[d] HS27 imports from BPS 2025 trade release.

[e] Subsidy fiscal offset reflects B40-mandate volume effect on refined-product import demand. This is a partial offset to the subsidy fiscal burden documented in the Kementerian Keuangan RAPBN 2026 sensitivity (IDR 68 trillion per USD 10/bbl of sustained Brent increase).

[f] The net range pairs low-windfall with low-headwind (mild-shock scenario) and high-windfall with high-headwind (severe-shock scenario), because both sides of the ledger respond to the same underlying Brent price move. Uncorrelated pairings would produce a wider +1.3 to +11.0 range.

Source: Authors' calculations using BPS 2025 HS8 export detail (Badan Pusat Statistik, 2026c), BPS 2025 import book (Badan Pusat Statistik, 2026b, 2026d), EIA (U.S. Energy Information Administration, 2024b), bp Tangguh disclosures (bp, 2016, 2023), PHE annual report (PT Pertamina Hulu Energi, 2024), ESDM B40 regulation and implementation releases (Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, 2024, 2025, 2026), and Kementerian Keuangan RAPBN 2026 fiscal sensitivity. All ranges are scenario multipliers, not estimated elasticities.

Our analytical framework has actually been discussed among policymakers. In a Bloomberg interview on 16 March 2026, during the first two weeks of the Hormuz episode, President Prabowo Subianto identified coal, palm oil biodiesel, and cassava ethanol as the substitution levers Indonesia would activate if Brent remained sustained above US$120 per barrel, while also committing to maintain the 3% fiscal deficit cap (Bloomberg, 2026). The explicit framing that Indonesia's response to a Gulf-oil shock runs through domestic substitute commodities rather than through fuel-import absorption alone is consistent with the asymmetric channel structure developed here.

The asymmetry matters for policy. The conventional analysis treats Indonesia as a net oil importer absorbing a Gulf shock, and concludes that the fiscal cost is the central concern. That reading is correct on the fiscal ledger: a wider subsidy bill, pressure on the rupiah, and imported inflation are all real and have short lag structures. But the trade ledger tells a different story. Indonesia earns more on coal exports, earns more on CPO through the biodiesel margin, earns more on LNG at the spot margin, and reduces net petroleum import volume through the B40 mandate. On the aggregate merchandise-trade account, the terms-of-trade effect is likely positive in a sustained Gulf shock. The correct policy framing is therefore not "oil shock is bad" but "the fiscal and trade channels move in opposite directions, and the fiscal offset depends on how quickly the subsidy formula adjusts and how much of the export windfall is captured through royalties and windfall taxation."

Indonesia's energy trade geography reveals the structural foundation for this asymmetric exposure (Figure 13). The country operates as a dual-node system: import-dependent on Hormuz and Bab el-Mandeb–Suez corridors for crude oil, LPG, and sulfur, while simultaneously export-dominant through Malacca and Taiwan Strait corridors for thermal coal, LNG, and CPO. This geographic duality creates offsetting exposure channels that conventional vulnerability assessments miss entirely. When the same global energy shock affects both import costs and export realizations, the net Indonesian economic impact depends on the relative magnitudes and timing of these countervailing flows.

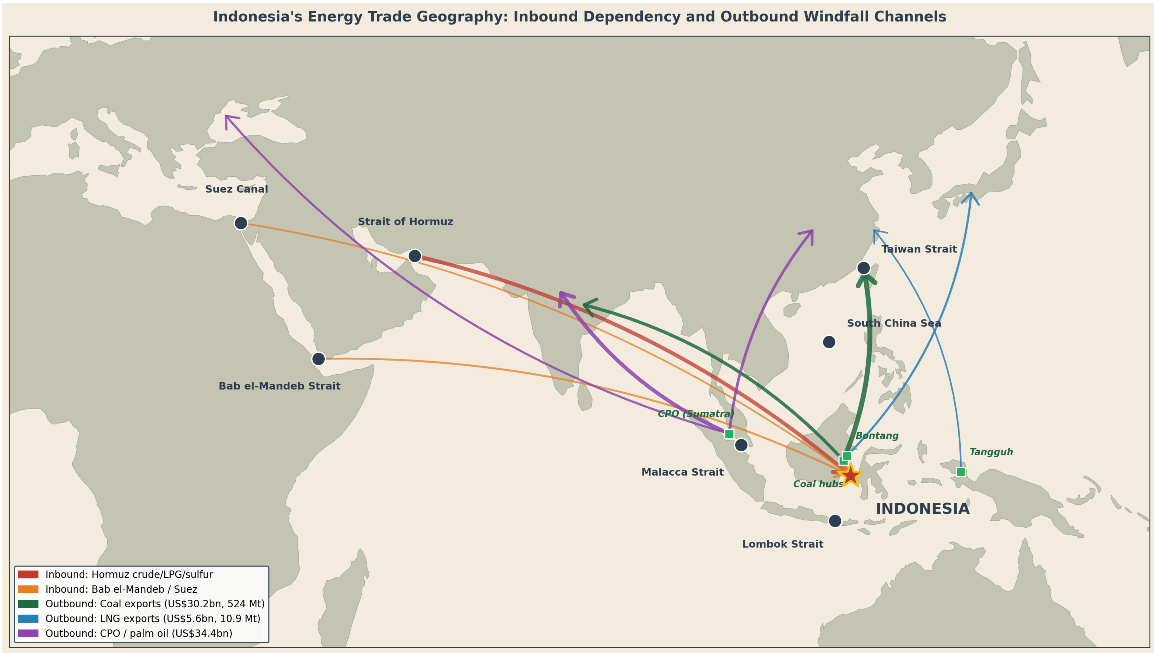
The quantitative asymmetry is striking when visualized at scenario scale (Figure 14). Under a moderate Hormuz stress scenario, Indonesia faces roughly US$2.9–4.1 billion in additional refined-product import costs, but simultaneously captures US$8.7–13.0 billion in export revenue gains from coal, CPO, and LNG channels. Even after accounting for the fiscal cost of maintaining subsidized domestic fuel prices, the net terms-of-trade effect ranges from +US$2.9 to +US$8.2 billion. This asymmetry challenges the conventional framing of Indonesia as simply vulnerable to oil price shocks and suggests a more nuanced policy response that recognizes both cost absorption and revenue capture channels.

The empirical foundation for these scenario estimates derives from the 2022 Russia–Ukraine commodity shock, which provides the closest analog to a sustained Gulf oil disruption (Figure 15). During the February 2022 to December 2022 episode, Brent crude, Newcastle thermal coal, Japan LNG, and palm oil prices moved together with remarkable correlation: coal prices rose from US$90 to above US$400 per tonne, LNG peaked at US$23.7/mmBtu, and palm oil reached historical highs exceeding US$1,400/tonne. This co-movement validates the scenario multipliers used in the windfall analysis and demonstrates that Indonesian export commodities systematically benefit from the same supply shocks that elevate oil import costs. The March 2026 Hormuz episode appears to be following a similar pattern, though full price propagation through thermal coal and LNG spot markets was still unfolding as of the data cutoff.

This analytical asymmetry has three direct implications for the Hormuz analysis. First, the Hormuz strategic-dependency overlay should be read alongside the export-side channel, not in isolation: the same shock that threatens US$9.6 billion of Hormuz-linked inputs could generate

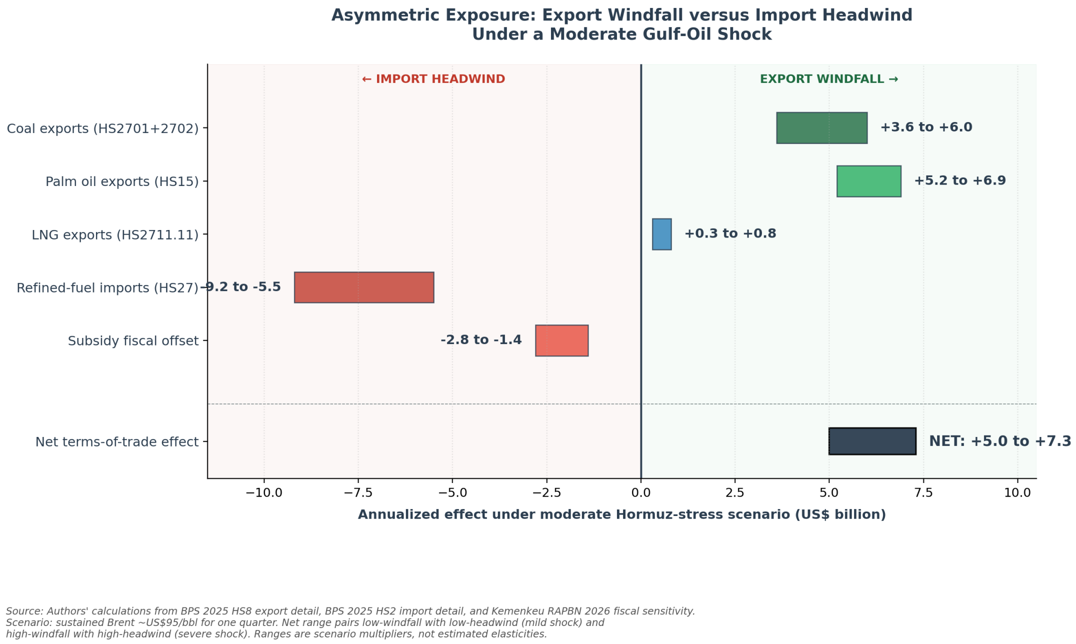
US$9–14 billion of gross export-revenue gains, or a net terms-of-trade improvement of roughly US$5–7 billion after accounting for refined-product import cost pass-through. Second, Indonesia's position differs structurally from Japan, Korea, and Singapore, which face similar or higher refined-product exposure but do not have the coal, CPO, or biodiesel substitution levers. This is not an argument for complacency, but it is an argument against importing the Japan-style energy-security framing wholesale. Third, the net effect depends on policy settings: a subsidy formula that under-passes price changes, a coal-royalty regime that under-captures windfall gains, or a CPO export policy that restricts outbound flows can each turn a neutral or positive terms-of-trade shock into a fiscal headache. Section 7 returns to these policy levers.

Figure 13. Indonesia's Energy Trade Geography: Import and Export Channels by Chokepoint



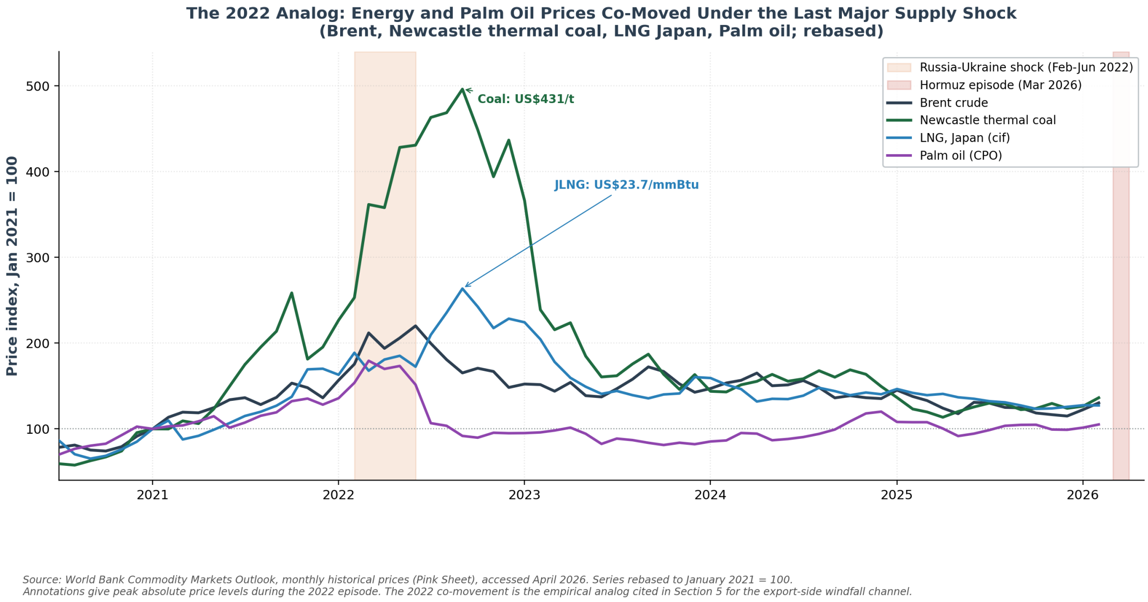
Note: The map shows Indonesia's dual role in global energy chokepoints: inbound Hormuz and Bab el-Mandeb–Suez corridors for crude, LPG, and sulfur imports, and outbound Malacca and Taiwan Strait corridors for coal, LNG, and CPO exports. Arrow weights scale to 2024–2025 trade values.
Source: PortWatch chokepoints reference (IMF & University of Oxford, 2026); BPS 2025 trade tables (Badan Pusat Statistik, 2026c, 2026d); Verschuur companion base (Verschuur et al., 2025a); authors' calculations.

Figure 14. Asymmetric Exposure: Import Headwind versus Export Windfall Under Hormuz Stress



Note: The figure plots the scenario revenue gains from thermal coal, CPO, and LNG export channels against the refined-product import cost headwind and the B40 fiscal offset. Bars show scenario ranges, not point estimates. *Source:* Authors' calculations; see Table 6 for assumptions.

Figure 15. The 2022 Analog: Energy and Palm Oil Prices Co-Moved Under the Last Major Supply Shock



Note: Monthly price indices rebased to January 2021 = 100. Newcastle thermal coal peaked at US$431/tonne and Japan LNG (cif) at US$23.7/mmBtu during the 2022 episode. The co-movement of Brent, coal, LNG, and palm oil during the Russia–Ukraine shock is the empirical analog underlying the scenario multipliers in Table 6. The March 2026 Hormuz shaded band marks the onset of the current episode; full propagation through thermal coal and LNG spot prices was still unfolding as of the data cut-off.
Source: World Bank Commodity Markets Outlook, monthly historical prices (Pink Sheet), accessed April 2026 (World Bank, 2026a).

6 Discussion

The empirical results suggest six broad conclusions. First, Indonesia's vulnerability is concentrated rather than diffuse: a small set of chokepoints accounts for the bulk of expected-risk and gross route exposure. Second, expected annual risk and tail-risk ranking are not the same. Bab el-Mandeb and Suez dominate the baseline expected-risk metric, but Malacca becomes more important in severe operational stress. Third, sectoral exposure is not reducible to commodities alone. Manufacturing, mining and metals, agriculture and food, and energy all remain large enough to transmit route shocks. Fourth, internal straits matter because they are part of the country's buffer system. Fifth, Hormuz is a low baseline EVTD chokepoint but a materially larger strategic-dependency concern under the separate overlay. Sixth, the same Gulf shock that threatens Indonesia's refined-product import bill raises the realised price of its coal, CPO, and (at the margin) LNG exports: Indonesian chokepoint exposure is asymmetric rather than one-sided.

Energy import resilience, especially LPG and sulfur, should be treated as a chokepoint problem and not only as a procurement problem. The domestic straits network should be managed as strategic economic infrastructure, because Sunda, Lombok, Makassar, and Ombai are part of the country's own shock-absorption system. Fiscal, trade, and financial authorities should distinguish between expected annual loss and strategic dependency when assessing external vulnerability.

Energy policy deserves special attention. The Hormuz findings suggest that the main issue is not annual expected cargo loss, but procurement concentration in critical imports. Strategic storage, contract diversification, refinery flexibility, and clearer monitoring of LPG and sulfur dependence would reduce the gap between low expected risk and high strategic vulnerability. The sulfur result is especially important because it links maritime geopolitics to industrial supply chains that are not always framed as energy security, although the sulfur measure is a Gulf-supplier proxy rather than a direct Hormuz route label.

There are also institutional implications for data systems. The paper closes part of the data gap by adding full-year 2025 bilateral partner totals and a transparent partner $\times$ chokepoint proxy. The remaining gap is the absence of a directly observed 2025 voyage-level partner-by-chokepoint table and a 2025 maritime HS2-by-chokepoint route table. Without those, route-country and route-sector allocation still inherits 2022 structural shares. A practical next step would be to build a reproducible national monitoring system that joins BPS customs data, AIS-based route assignment, and selected strategic-input indicators at monthly frequency.

6.1 Limitations

The strongest findings in this paper have high empirical support. These include the 2025 GDP denominator, the 2025 aggregate export and import totals, the full-year 2025 bilateral partner ranking from UN Comtrade, and the overall ranking of Bab el-Mandeb, Taiwan, Suez, and Malacca. The direct Hormuz crude and LPG dependency shares are also reproducible from supplier-level data, while the sulfur proxy is reproducible at the Gulf-supplier level. The sector summary has somewhat weaker support because it relies on directional share transfer rather than observed route-specific commodity data. The country-side route interpretation and the weighted Hormuz dependency overlay are also inferential. The export-side windfall quantification in Section 5 is *scenario-based rather than estimated*: it applies historical price-sensitivity ranges from the 2022 Russia–Ukraine commodity cycle to 2025 trade bases, rather than econometrically estimated elasticities. The coal and LNG channel magnitudes are especially sensitive to unreported contract-vs-spot splits. The weakest area is any claim that would require a directly observed voyage-level 2025 bilateral partner-by-chokepoint allocation. The paper therefore presents a transparent proxy rather than a fabricated route matrix and states the residual gap explicitly.

AIS Data Limitations and Shadow Fleet Underestimation. The PortWatch data underlying this analysis relies on satellite-based AIS tracking, which introduces systematic measurement error for countries subject to trade sanctions. Ships engaged in embargo circumvention can disable AIS transponders, alter vessel identity, clone Maritime Mobile Service Identity (MMSI) codes, or broadcast false locations (Windward, 2026). For Iran specifically, Reuters documented that Iranian vessels routinely conceal oil sale destinations by disabling AIS during sanctions enforcement (Manara Magazine, 2026). Current estimates suggest that Russia and Iran operate a combined "shadow fleet" exceeding 1,900 active tankers supported by over 1,200 gray fleet vessels, with false flagging operations surging from 223 to more than 370 vessels (The Maritime Executive, 2026). This systematic under-detection means that Indonesia's Hormuz strategic dependency estimates may understate true exposure to Gulf suppliers, particularly for Iranian crude oil imports that represent a significant component of Indonesia's energy import portfolio but are systematically excluded from AIS-based trade route assignment. Alternative satellite detection methods combining synthetic aperture radar (SAR), electro-optical imagery, and radio frequency monitoring can partially address AIS gaps, but these are not yet integrated into the PortWatch framework used in this analysis (Windward, 2026).

7 Policy Implications

The analytical results in this paper speak directly to four Indonesian institutions: Bank Indonesia, the Ministry of Finance, the Ministry of Energy and Mineral Resources, and the Ministry of Trade. The recommendations below are organized by agency and by the channel they address.

For the Ministry of Finance (Kementerian Keuangan)

1. **Separate fiscal and trade-balance accounting in chokepoint stress assessment.** The RAPBN 2026 sensitivity document already reports a fiscal subsidy elasticity of IDR 68 trillion per USD 10/bbl of sustained Brent movement. A parallel trade-ledger sensitivity, reflecting the export-side windfall channel quantified in Section 5, should accompany it in future RAPBN releases. The two elasticities can move in opposite directions and should not be aggregated.
2. **Evaluate rule-based counter-cyclical adjustments in the existing coal and CPO royalty bands.** Under the moderate Hormuz scenario in Table 6, coal and CPO export revenues rise by US$9–13 billion. The existing progressive royalty structures already capture a share of windfall gains, but the pass-through to the state during sharp, short-lived oil-price spikes is limited by the royalty-band resets and reporting lags. A pre-announced, transparent adjustment rule — triggered by observable Brent thresholds and calibrated within the current band framework — would smooth fiscal receipts during Gulf-oil shocks and give commodity producers predictable forward guidance. The aim is counter-cyclical stabilization, not a structural increase in the effective tax rate.
3. **Build a chokepoint-contingent reserve facility.** The fiscal absorption capacity required in a sustained Hormuz stress is large enough to warrant a dedicated contingency line, separate from the general BUN reserve.

For Bank Indonesia

1. **Incorporate chokepoint disruption scenarios into financial stability assessment.** The monetary policy transmission channel from shipping freight rates to domestic inflation is documented globally but not formally estimated for Indonesia. A calibrated BI-side pass-through estimate (shipping-cost index → tradable CPI) would sharpen scenario-based monetary policy communication during chokepoint crises.

2. **Monitor the Gulf-supplier sulfur dependency as an industrial-input indicator.** Sulfur is a small-value import but feeds into fertilizer and petrochemical production. A short-duration supply disruption at 70% Gulf concentration would propagate into food and industrial prices with a one-to-two-quarter lag.

For the Ministry of Energy and Mineral Resources (ESDM)

1. **Evaluate B40 on energy-security criteria alongside its existing fiscal and agricultural framing.** The biodiesel mandate is Indonesia's only automatic oil-shock hedge and, at 105% of the 2025 IKU target, the strongest performing mandate instrument in the energy mix (Kementerian Energi dan Sumber Daya Mineral Republik Indonesia, 2026). Maintaining current compliance and evaluating a contingency B50 or B55 trigger during sustained Brent spikes would strengthen the energy-security dimension of the mandate without disturbing its fiscal architecture under BPDPKS.
2. **Diversify LPG supplier geography.** The 37.1% Hormuz-linked LPG share is the single most concentrated fuel exposure in Indonesia's import mix, and it supplies household cooking fuel with short inventory buffers. US LPG already accounts for 53% of LPG imports; a targeted plan to cap Hormuz-linked LPG below one-third through accelerated US and Australian contract diversification would reduce the strategic-dependency overlay by roughly US$0.5 billion.
3. **Strategic petroleum and LPG reserves should be designed against chokepoint disruption scenarios, not against domestic supply interruption alone.** Current reserve sizing is calibrated to domestic shortfall events; a Hormuz-closure scenario requires a different inventory target profile.

For the Ministry of Trade (Kementerian Perdagangan)

1. **Preserve CPO export flexibility during Gulf-oil shocks.** The biodiesel demand channel quantified in Section 5 depends on Indonesia's ability to sell into tight global palm-oil markets when oil prices spike. Restrictive export policies imposed during such windows would foreclose the terms-of-trade gain without necessarily improving domestic food-price outcomes.
2. **Recognize Indonesia's archipelagic sea lane role as a regional public good during chokepoint crises.** A substantial share of Middle East–East Asia energy flows crosses Indonesian territorial waters (Australian Strategic Policy Institute, 2026), which gives Indonesia a proportionate stake in the reliability of regional rerouting options. Coordinated ASEAN engagement on archipelagic-waters management during sustained Malacca or Hormuz disruptions — anchored in Indonesia's existing UNCLOS responsibilities — would reinforce regional maritime resilience and Indonesia's role in it.

Cross-cutting

1. **Build a reproducible national chokepoint-monitoring system.** The paper's residual gap is the absence of a directly observed 2025 voyage-level route table for Indonesian trade. A monthly-frequency dashboard combining BPS customs data, PortWatch AIS route assignment, and selected strategic-input indicators would close that gap and give policy-makers a single view of inbound vulnerability, outbound windfall capture, and tail-risk exposure.

8 Conclusion

Indonesia's exposure to maritime chokepoints is significant, concentrated, and asymmetric. In the 2025 baseline, Bab el-Mandeb, the Taiwan Strait, the Suez Canal, and the Malacca Strait dominate the route-risk hierarchy, while the domestic straits network anchors the country's own adjustment capacity. Merchandise trade equivalent to 36.4% of GDP means that shipping shocks can matter for national output even when Indonesia appears less open than some ASEAN peers.

The central analytical lesson is that expected annual loss and strategic dependency are different metrics, and that both operate alongside a third channel — export-side terms-of-trade — that conventional Indonesia-focused chokepoint analyses omit. Under the baseline EVTD lens, Hormuz is not a leading route risk for Indonesia. Under the strategic-dependency lens, it remains materially important because it underpins imports of crude oil, LPG, and Gulf-supplier sulfur. Under the export-windfall lens, the same Gulf shock that tightens the Hormuz import channel simultaneously raises realised prices on Indonesia's coal, CPO, and LNG exports, with the LNG effect smaller and less directly observed than the coal and CPO channels. The three channels do not collapse to a single number: they move on different time scales, through different institutions, and with different policy levers.

This paper offers a disciplined extension of the current best global framework to an Indonesia-specific setting. It updates the data to 2025, adds a sectoral layer, treats the domestic straits as strategic infrastructure, makes the Hormuz distinction explicit, and introduces an asymmetric framing in which Indonesia's status as a net energy exporter in the commodities that substitute for disrupted Gulf supply partially offsets its refined-product import vulnerability. The next research frontier is to combine customs data with direct maritime route assignment at monthly frequency so that country, sector, route, and risk can be tracked without relying on structural share transfer from a 2022 base year — and to estimate, with formal elasticities rather than scenario ranges, the full terms-of-trade response of Indonesia's export complex to Gulf-oil shocks.

A Appendix A: Data Sources and Access Dates

Source	Description	Access / release date	Use in this paper
BPS	Headline trade press release, December 2025	Released 2 Feb 2026	Headline 2025 trade totals and month-end partner structure.
BPS	Monthly export trade book, December 2025	Released 27 Feb 2026	Annual export HS2 values, month-end partner shares, export composition.
BPS	Monthly import trade book, December 2025	Released 27 Feb 2026	Annual import HS2 values, month-end partner shares, import composition.
UN Comtrade	Annual HS final-data preview for Indonesia, 2021–2025	Accessed 29 Mar 2026	Full-year 2025 bilateral partner totals and annual HS2 trend panel for 2021–2025.
UN Comtrade	Indonesia all-commodities 2022 trade values	Accessed 28 Mar 2026	2022 scaling base for the 2025 country-by-chokepoint inventory.
BPS	GDP press release, full-year 2025	Released 5 Feb 2026	Current-price GDP denominator for 2025.
BI	SEKI December 2025, Table V.40	Released 19 Jan 2026	Annual average USD/IDR conversion.
World Bank	WDI indicator TG.VAL.TOTL.GD.ZS	Updated 24 Feb 2026	Merchandise-trade-to-GDP series and ASEAN comparison.
PortWatch	Ports, chokepoints, daily throughput, disruptions, spillovers	Accessed 28 Mar 2026	Route inventory, operational context, and figure base.
Verschuur et al. (2025)	Country dependencies and systemic risk companion data	Accessed 29 Mar 2026	2022 route structure, hazard fractions, rerouting distances, and economic-loss decomposition.
UNCTAD	Hormuz disruptions information note	Dated 10 Mar 2026	2026 Hormuz crisis context.
Supplier-level trade data	2024 crude, LPG, and sulfur dependency by supplier and route label	Authors' compilation	Strategic-dependency overlay for Hormuz.
EIA	World Oil Transit Chokepoints analysis and Indonesia country brief	Last update 2023–2024	Petroline (East-West Crude Oil Pipeline) capacity; Indonesia refining and LNG indicators.
bp / Pertamina Hulu Energi	Tangguh Train 3 press releases and PHE annual-report note on Badak LNG	2016–2024	LNG contract structure evidence used to bound the windfall channel; no published 2025 national spot-share split.
Kementerian ESDM	B40 regulation plus launch and realization press releases	2024–2026	Mandate effective 1 January 2025; 2025 allocation 15.6 mn kL; January–December 2025 realization 14.2 mn kL.
Kementerian Keuangan	RAPBN 2026 Table 6.1 fiscal sensitivity (IDR 68 trillion per USD 10/bbl)	2025	Fiscal subsidy sensitivity underlying Table 6 offset estimate.

Source	Description	Access / release date	Use in this paper
ASPI Strategist	Indonesia's Sea Lanes and China's Energy Import Dependence	January 2026	ALKI strategic-asset framing; 53% China energy share through Indonesian waters.

B Appendix B: Variable Definitions

Variable	Definition
$EVTD_i$	Expected annual value of trade disrupted for country i.
$P_{c,h}$	Annual probability of hazard h affecting chokepoint c.
$T_{i,c}$	Annual trade of country i routed through chokepoint c.
$S_{c,h}$	Severity of disruption, bounded between 0 and 1.
$D_{c,h}$	Disruption duration in days.
EL_i	Annual expected economic loss.
EL_d	Delay losses.
EL_r	Rerouting losses.
EL_p	Insurance-premium or war-risk losses.
EL_t	Canal toll revenue losses.
EL_l	Inventory or lost-trade losses.
Δd_c	Rerouting distance for chokepoint c.
V	Vessel speed, set to 16 knots in the base framework.
λ_M, λ_X	Import and export scaling factors from the 2022 base to the 2025 BPS totals.
$s_{c,d}^{2022}$	Directional share of Indonesia's 2022 trade routed through chokepoint c.
$E_{g,c}^{2025}$	Estimated 2025 exposure of sector g through chokepoint c.
$R_{g,c}^{2025}$	Implied expected trade-at-risk for sector g at chokepoint c.
ϕ_c	Chokepoint-level expected trade-at-risk fraction, $EVTD_c^{2025}/T_c^{2025}$.
μ	Moderate scenario throughput-loss fraction, equal to $10 \times 0.2/365$.
σ_c	Severe scenario fraction equal to the largest hazard-duration-severity fraction for chokepoint c.
η_c	Reduced-form economic-loss intensity, $EL_c^{2025}/EVTD_c^{2025}$.
Oil_{2025}^{BPS}	BPS 2025 fuel-import baseline (HS27 imports).
B_H^{2025}	Broad Hormuz fuel dependency estimate.
SD_H	Weighted strategic-dependency metric for Hormuz, equal to $2B_H^{2025} + S_H^{2024}$.

C Appendix C: Estimation Methods for Imputed Values

The main imputation in this paper is the 2025 sector-by-chokepoint allocation. Because no direct Indonesian 2025 maritime HS2 route table is available, the paper applies 2022 directional chokepoint shares to 2025 BPS HS2 totals. This preserves the route structure of the 2022 companion model while updating absolute trade magnitudes to the latest official customs data. The reported sector summary then aggregates those HS2 cells into five broad groups.

The volume allocation is weaker than the value allocation because it maps all-trade BPS weights into maritime route shares inferred from 2022. Those volume cells are therefore presented as weaker inferences and are not used for headline claims.

The moderate and severe GDP-equivalent losses are also imputed. The source chain provides moderate and severe disrupted trade values, but not full 2025 economic-loss reruns. The paper therefore applies baseline economic-loss intensity by chokepoint to the stress scenarios. This preserves relative loss intensity across chokepoints while avoiding fabricated direct rerun outputs.

The bilateral country × chokepoint layer is imputed at one remove. Full-year 2025 bilateral partner totals are observed from UN Comtrade, but the actual route taken by each bilateral flow is not. The proxy applies the companion country's chokepoint dependence shares to the 2025 bilateral totals. This is appropriate for ranking bilateral corridor concentration, but it should not be interpreted as a voyage-observed route matrix.

The Hormuz overlay relies on supplier-level data. Its broad fuel dependency metric uses 2024 Gulf supplier shares applied to the BPS 2025 fuel-import baseline. This is appropriate for a strategic-dependency lens, but it should not be interpreted as a directly observed 2025 route flow. The sulfur term is a Gulf-supplier proxy rather than a direct Hormuz route label.

D Appendix D: Full Modeled Chokepoint Inventory

Chokepoint	Gross exposure (US$ bn)	Baseline risk (US$ mn)	Baseline % GDP	Reroute km	Risk tags	Latest disruption note
Bab el-Mandeb Strait	66.3	2080.7	0.144	9000	piracy, geopolitical, weather/climate	2023-12-16 Red Sea tensions
Taiwan Strait	127.5	1996.2	0.138	1000	piracy, geopolitical, weather/climate	None in current file
Suez Canal	61.4	1465.0	0.101	9000	piracy, geopolitical, infrastructure	2023-12-16 Red Sea tensions
Malacca Strait	126.9	667.6	0.046	1500	piracy, geopolitical	None in current file
Korea Strait	35.3	243.7	0.017	1000	geopolitical, weather/climate	None in current file
Luzon Strait	12.0	203.4	0.014	4000	piracy, geopolitical, weather/climate	None in current file
Panama Canal	5.3	77.7	0.005	12000	piracy, geopolitical, weather/climate, infrastructure, congestion	2023-11-03 Restrictions
Bosporus Strait	6.2	46.8	0.003	0	piracy, geopolitical, infrastructure	None in current file
Sunda Strait	59.8	35.6	0.002	2800	piracy, weather/climate	None in current file
Bohai Strait	21.9	29.4	0.002	0	weather/climate	None in current file
Windward Passage	1.5	17.9	0.001	1800	piracy, geopolitical, weather/climate	None in current file
Gibraltar Strait	41.1	16.7	0.001	9000	piracy, geopolitical, weather/climate	None in current file
Strait of Hormuz	7.6	16.0	0.001	0	piracy, geopolitical, weather/climate	None in current file
Tsugaru Strait	6.6	13.1	0.001	500	geopolitical, weather/climate	None in current file
Lombok Strait	12.9	10.8	0.001	2700	piracy, geopolitical, weather/climate	None in current file
Ombai Strait	1.0	9.8	0.001	1200	geopolitical, weather/climate	None in current file
Yucatan Channel	2.5	6.5	0.000	2800	piracy, geopolitical, weather/climate	None in current file
Dover Strait	15.1	4.1	0.000	2500	geopolitical, weather/climate	None in current file
Makassar Strait	63.3	3.8	0.000	4200	piracy, geopolitical	None in current file
Torres Strait	9.1	1.9	0.000	5200	weather/climate	None in current file
Mona Passage	0.3	1.1	0.000	1800	geopolitical, weather/climate	None in current file
Cape of Good Hope	13.0	0.0	0.000	1000	weather/climate	2023-12-16 Red Sea tensions
Oresund Strait	1.5	0.0	0.000	0	–	None in current file
Magellan Strait	0.3	0.0	0.000	12000	–	None in current file

E Appendix E: Top 2025 HS2 Trade Categories

Table 10. Top 15 Export HS2 Categories in 2025

HS2 category	Value (US$ bn)	Share of exports (%)
27 Mineral Fuels/Oils, Prod. of Their Distillation	45.11	15.95
15 Animal-Vegetable Oils/Fats, Their Cleavage Prod.	34.36	12.15
72 Iron and Steel	27.97	9.89
85 Electrical Machinery and Equipment	19.19	6.78
87 Vehicles Other Than Railway/Tramway, Parts	12.18	4.30
71 Natural and Cultured Pearls, Precious Stones	11.67	4.12
75 Nickel and Articles Thereof	9.73	3.44
38 Miscellaneous Chemical Products	9.50	3.36
84 Nuclear Reactors, Boilers, Machinery, Parts	8.16	2.89
64 Footwear, Gaiters; Parts of Such Articles	7.98	2.82
40 Rubber and Articles Thereof	5.82	2.06
26 Ores, Slag, and Ash	5.04	1.78
48 Paper and Paperboard; Articles of Paper Pulp	4.57	1.62
28 Inorganic Chemicals	4.57	1.61
61 Articles of Apparel, Knitted or Crocheted	4.46	1.58

Source: BPS, *Statistik Perdagangan Luar Negeri Bulanan Ekspor Desember 2025*, released 27 February 2026 (Badan Pusat Statistik, 2026c).

Table 11. Top 15 Import HS2 Categories in 2025

HS2 category	Value (US$ bn)	Share of imports (%)
27 Mineral Fuels/Oils, Prod. of Their Distillation	36.80	15.22
84 Nuclear Reactors, Boilers, Machinery, Parts	36.64	15.15
85 Electrical Machinery and Equipment	31.88	13.18
87 Vehicles Other Than Railway/Tramway, Parts	11.00	4.55
39 Plastics and Articles Thereof	10.43	4.31
72 Iron and Steel	9.53	3.94
29 Organic Chemicals	6.25	2.58
38 Miscellaneous Chemical Products	5.19	2.15
71 Natural and Cultured Pearls, Precious Stones	5.16	2.13
90 Optical, Photographic, Cinematographic	4.78	1.98
73 Articles of Iron and Steel	4.32	1.79
10 Cereals	3.75	1.55
28 Inorganic Chemicals	3.70	1.53
23 Residues and Waste From The Food Industries	3.43	1.42
26 Ores, Slag, and Ash	2.98	1.23

Source: BPS, *Statistik Perdagangan Luar Negeri Bulanan Impor Desember 2025*, released 27 February 2026 (Badan Pusat Statistik, 2026d).

Reproducibility Statement

The analytical pipeline is reproducible from the sources listed in Appendix A. Raw data extracts, intermediate CSVs, and figure-generation scripts will be released alongside the published version of this paper in a public archive. Scaling factors ($\lambda_M = 1.0186$, $\lambda_X = 0.9689$), chokepoint-level disruption fractions, and the Hormuz strategic-dependency overlay are calculated inline from the cited sources. The export-side windfall quantification in Section 5 applies scenario multipliers rather than estimated elasticities; all multiplier ranges are disclosed in the footnotes of Table 6. The Saudi Red Sea adjustment uses EIA Petroline capacity at 5 mb/d nameplate and a conservative 10%/5% reassignment of 2024 Saudi crude and LPG cargoes. Readers seeking to replicate the analysis should begin with the data architecture described in Appendix A and follow the methodology steps in Section 2.

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