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The Cost of Closing the Strait of Hormuz: Energy Bottlenecks and Global Food Security

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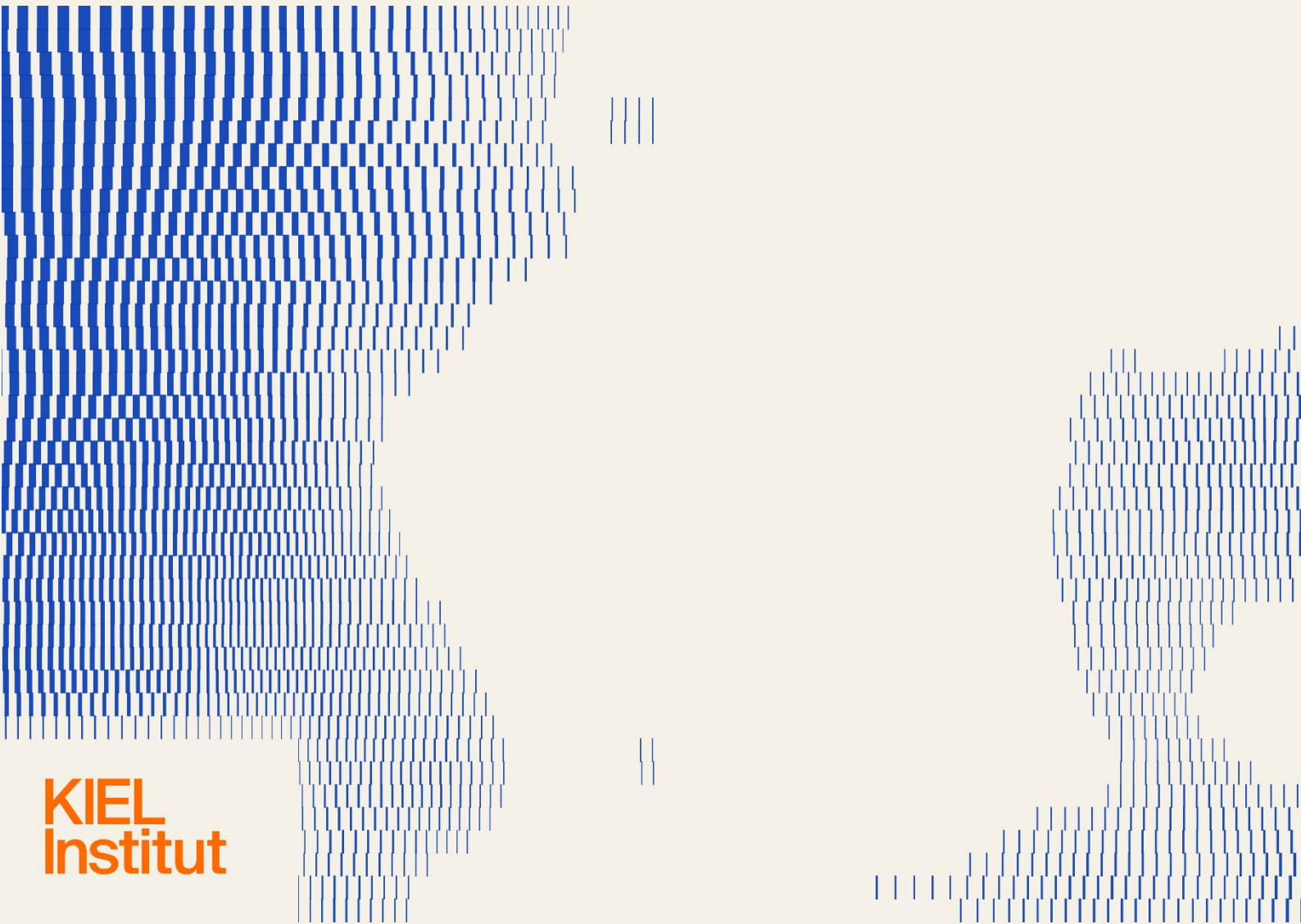

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Overview/Überblick

- In March 2026, the Strait of Hormuz is closed. The shutdown blocks roughly one-fifth of the world's oil and one-quarter of its liquefied natural gas, triggering severe welfare losses in energy-dependent developing countries worldwide.
- Standard trade models underestimate the impact because they miss the bottleneck mechanism: energy disruptions cascade through chemicals and fertilizer production into food prices, amplifying losses for the world's poorest countries.
- Developing countries that depend on imported energy and fertilizers—particularly in South Asia, sub-Saharan Africa, and the Middle East—face the steepest food price increases and welfare losses. The aggregate global costs are moderate, but the burden falls disproportionately on the world's poorest: the USA loses just −0.07%, while countries in South Asia and Africa face losses 10–20 times larger.
- A prolonged closure allows some market adjustment, but structural damage persists—and the timing during peak Northern hemisphere planting season compounds the food security risk

Keywords Strait of Hormuz, Energy Security, Food Prices, Critical Inputs, Bottleneck Effects, Trade Disruption

- Im März 2026 ist die Straße von Hormuz geschlossen. Die Sperrung blockiert rund ein Fünftel des weltweiten Öls und ein Viertel des Flüssiggases, mit schweren Wohlfahrtsverlusten für energieabhängige Entwicklungsländer weltweit.
- Standardmodelle unterschätzen die Auswirkungen, weil sie den Engpassmechanismus übersehen: Energiestörungen pflanzen sich über die Chemie- und Düngemittelproduktion in die Lebensmittelpreise fort und verstärken die Verluste der ärmsten Länder.
- Entwicklungsländer, die auf importierte Energie und Düngemittel angewiesen sind—insbesondere in Südasien, Subsahara-Afrika und dem Nahen Osten—sind am stärksten von Nahrungsmittelpreissteigerungen betroffen. Die globalen Kosten sind moderat, doch die Last trifft die ärmsten Länder überproportional: Die USA verlieren nur −0,07%, während Länder in Südasien und Afrika 10- bis 20-mal höhere Verluste erleiden.
- Eine längerfristige Sperrung ermöglicht gewisse Marktanpassungen, doch die strukturellen Schäden bleiben bestehen—und der Zeitpunkt während der Hauptaussaatzeit auf der Nordhalbkugel verschärft das Ernährungssicherheitsrisiko.

Schlüsselwörter: Straße von Hormus, Energiesicherheit, Lebensmittelpreise, kritische Vorleistungen Engpass-Effekte, Handelsstörungen

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1 Introduction

The Strait of Hormuz is just 21 nautical miles wide at its narrowest point, yet approximately 21% of global petroleum consumption and around 25% of the world's liquefied natural gas (LNG) passes through its waters daily.[1] Eight countries—Iran, Iraq, Kuwait, Saudi Arabia, the United Arab Emirates, Qatar, Bahrain, and Oman—depend on it for the bulk of their hydrocarbon exports, though Saudi Arabia, Oman, and Iran also have port access outside the Strait.

The possibility of a Hormuz closure has been a recurring threat for decades. During the 1980–1988 Iran–Iraq war, attacks on tankers in the so-called "Tanker War" disrupted Gulf shipping and triggered international naval intervention. Today, the threat is more acute. The Traffic Separation Scheme that governs navigation through the Strait routes shipping lanes just outside Iran's 12-nautical-mile territorial waters, placing all transit within range of Iran's coastal artillery, anti-ship missiles, drones, and naval mines.[2] Military analysts have long assessed that just two well-placed attacks would suffice to halt commercial transit—making a forced reopening effectively impossible without a sustained, large-scale military operation. In March 2026, the escalation of the conflict between the United States and Israel on one side and Iran on the other turned this scenario into reality. As Israeli–U.S. strikes on Iran escalated, the strait shut down. Figure 1 documents the collapse in real time: daily tanker passages fell from around 40 to near zero within days, and other shipping followed. Only Chinese-flagged tankers carrying yuan-denominated cargo have been permitted sporadic passage.

When analysts warn about the Strait of Hormuz, they mean oil and gas. But strip away petroleum entirely and a startling picture emerges: six nations behind this single chokepoint—Iran, Iraq, Kuwait, Bahrain, Qatar, and the UAE—are the world's leading suppliers in dozens of products that are not directly derived from crude oil.[3]

In 2024, the top 50 non-mineral products ranked by Gulf export share represented **$773 billion** in combined world trade. Across these products, the average Gulf share stands at **14.9%**. The breadth is striking:

- **Chemicals and fertilizers:** Hydrocarbon derivatives (73.4%), methanol (16.8%), urea fertilizer (14.2%), ethylene glycol (11.7%), and diethylene glycol (12.6%)—inputs that are critical for global agriculture and manufacturing.

[1] U.S. Energy Information Administration (2024), "The Strait of Hormuz is the world's most important oil transit chokepoint."

[2] See International Institute for Strategic Studies, *The Military Balance 2025* and *Iran's Networks of Influence in the Middle East* (2019) for background on Iran's naval and asymmetric warfare capabilities. The Houthi disruption of Red Sea shipping in 2023–2024 demonstrated how quickly chokepoint crises cascade through global supply chains; the Strait of Hormuz is narrower, harder to bypass, and carries far more trade.

[3] Kiel Institute for the World Economy (2026), "Current Trade Issues: Strait of Hormuz." Based on BACI (CEPII), HS 1992 revision, 2024 trade data. Gulf countries defined as Iran, Iraq, Kuwait, Bahrain, Qatar, and UAE. The simulation scenarios in this brief cover the same six states whose oil and gas exports transit exclusively through the Strait. An interactive exploration of the full product-level data is available at `https://trade.ifw-kiel.de/KTTM/current_trade_issues/`.

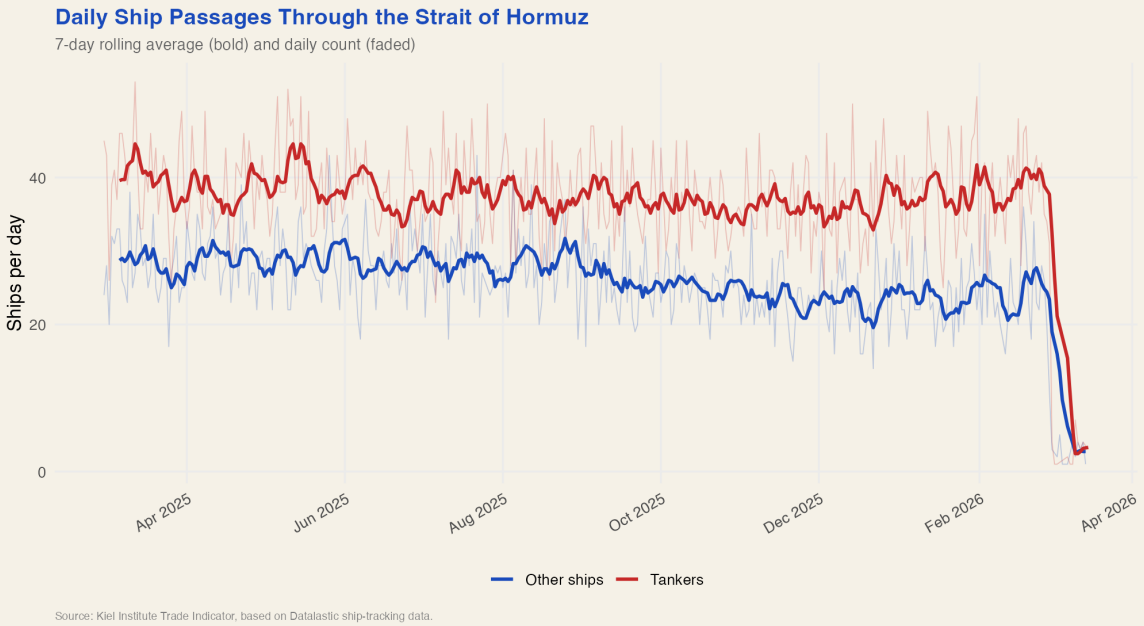

Figure 1: Daily ship passages through the Strait of Hormuz. Tanker traffic (red) and other vessels (blue) with 7-day rolling average. Source: Kiel Institute Trade Indicator, based on Datalastic ship-tracking data.

- **Metals:** Steel structures (27.7%), aluminium alloys (23.5%), steel sections (22.7%), reinforcing bars (11.3%), and unwrought aluminium (9.8%)—products that are energy-intensive to produce and underpin infrastructure development in Africa and South Asia.
- **Agricultural products:** Saffron (40.7%), dates (22.7%), pistachios (16.3%), and black tea (10.5%)—products that depend on climate and soil conditions unique to the region.
- **Precious materials:** Uncut diamonds (25.4%), unwrought gold (12.7%), and gold powder (20.6%), reflecting the UAE's role as a global trading hub (though these could potentially be transported by air).

Many of these products cannot be quickly sourced elsewhere. Iran's saffron and pistachios depend on specific agro-climatic conditions. Qatar's petrochemical output required decades of infrastructure investment. The UAE's diamond and gold trading hub rests on regulatory and logistics ecosystems that cannot be replicated overnight. For many of these products, the world has become *more* dependent on Gulf suppliers over time, not less—an interactive exploration of these product-level trends is available at the Kiel Institute's trade issues platform.[4] Figure 2 shows how the Gulf's global export share has evolved for six key product categories over the past three decades. Hydrocarbon derivatives—the chemical building blocks for detergents, dyes, pharmaceuticals, and explosives—were a negligible Gulf export in the mid-1990s; today, Gulf producers supply nearly three-quarters of world trade. Rare gases, aluminium alloys, steel structures, and methanol all show the same trajectory: decades of investment in energy-intensive production have locked the Gulf into the centre of global supply chains that cannot be rerouted

[4]See footnote 3 above.

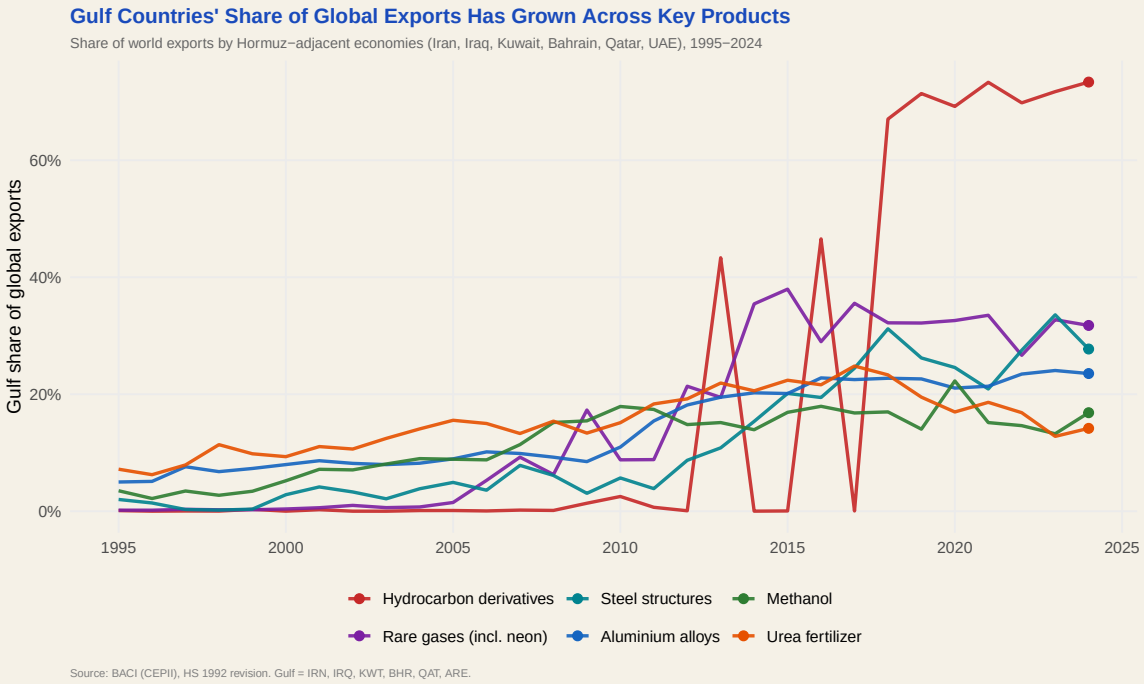

Figure 2: Gulf countries' share of global exports for six key non-mineral products, 1995–2024. In each case, the Gulf's market share has grown substantially, reflecting decades of infrastructure investment in energy-intensive production. Source: BACI (CEPII), authors' calculations.

quickly.

The Fertilizer Pipeline

Most critically for food security, the chemicals flowing through Hormuz are essential inputs to global food production—a vulnerability that standard analyses of chokepoint risk consistently overlook. Qatar and Iran are among the world's largest exporters of urea, the most widely used nitrogen fertilizer. The Gulf's cheap natural gas feeds the Haber-Bosch process that converts methane into ammonia and then into the granular fertilizer that sustains crop yields for billions of people. Iran is one of the world's largest methanol producers,[5] and its mega-plants supply downstream chemistry that feeds into formaldehyde for adhesives, acetic acid for food-grade products, and MTBE for gasoline. Qatar's Ras Laffan industrial complex—the world's largest integrated petrochemical site—produces ethylene, ethylene glycol, and a range of downstream products[6] that flow into polyester fibre for clothing and PET resin for plastic bottles. When these plants shut down, the effects ripple from petrochemical feedstocks through fertilizer supply chains and into the cost of putting food on the table.

[5]Iran's methanol capacity exceeds 20 million tonnes per year across multiple mega-plants on the Persian Gulf coast. See Offshore Technology, "Iran Methanol Plants Overview," and IEA World Energy Outlook reports on Middle East petrochemicals.

[6]QatarEnergy and Chevron Phillips Chemical operate one of the world's largest ethane crackers at Ras Laffan, producing ethylene and polyethylene alongside LNG processing.

Beyond Food: Semiconductors, Steel, and Power Grids

The disruption extends well beyond agriculture. Qatar's LNG processing generates rare gases—neon, krypton, and xenon—as by-products. Neon is essential for the excimer lasers that etch circuit patterns onto silicon wafers in semiconductor fabrication; a Hormuz closure threatens the chip supply chain. Bahrain's Alba and the UAE's Emirates Global Aluminium rank among the world's largest single-site smelters, producing aluminium alloys that are rolled into car body panels, aircraft fuselage sheets, and beverage cans. Gulf steelmakers export the prefabricated beams, columns, and girders that form the skeleton of bridges and buildings across developing economies. Aluminium stranded cable with steel core—the workhorse of electrical grids—flows from Gulf manufacturers to utilities electrifying rural areas in Africa and South Asia.

Quantifying the Cascade

Global food production depends critically on inputs derived from Gulf hydrocarbons—natural gas is the primary feedstock for nitrogen fertilizers, and Gulf chemical exports underpin agricultural supply chains worldwide. When energy supply is disrupted, the effects cascade through chemical production into agriculture, amplifying the welfare costs far beyond what standard trade models predict. This policy brief quantifies these cascading effects using a new trade model specifically designed to capture bottleneck dynamics in global supply chains.

2 The Bottleneck Mechanism

Standard quantitative trade models treat all intermediate inputs symmetrically: if the price of one input rises, firms substitute toward alternatives with smooth adjustment. This assumption works well for many goods but fails badly for *critical inputs*—intermediate products for which substitution is extremely difficult in the short run.

Natural gas is a critical input for the chemical industry. There is no readily available substitute for methane as a feedstock in the Haber-Bosch process that produces ammonia, the basis for nearly all nitrogen fertilizers. When gas prices spike, chemical producers cannot simply switch to alternative inputs; they face sharply higher costs or must curtail production. Similarly, crude oil is a critical input for petroleum refining—refineries are designed for specific crude grades and cannot easily adapt.

The cascade runs as follows:

1. **Energy disruption:** Gulf oil and gas exports are blocked, causing global energy prices to rise sharply.
2. **Chemical bottleneck:** Gas-dependent chemical production (especially fertilizers) faces amplified cost increases because substitution is severely limited.
3. **Food price transmission:** Higher fertilizer costs feed into crop production costs for wheat, cereals, oilseeds, vegetables, and other food products.

To capture this mechanism, we employ a bottleneck extension of the KITE model (Hinz et al., 2025, 2026) that captures asymmetric cost transmission through critical inputs. KITE is a quantitative general equilibrium trade model in the tradition of Eaton and Kortum (2002) and Caliendo and Parro (2015), solving for counterfactual equilibria in prices, wages, trade shares, and output across 160 countries and 65 sectors. The standard framework assumes that when input prices change, producers adjust their sourcing smoothly across all intermediates—an assumption encoded in the Cobb-Douglas aggregation of input cost shares from input-output tables.

The bottleneck extension breaks this symmetry. It introduces a *critical input layer* that distinguishes between ordinary intermediates and bottleneck inputs. For each sector, a *critical input matrix* identifies which upstream sectors behave as bottlenecks for which downstream producers. When the price of a critical input rises faster than the overall intermediate bundle, the affected downstream sector incurs an additional cost penalty that standard input-output elasticities would miss. The penalty is proportional to the sector's *critical exposure*—the degree to which it depends on the bottleneck input—and grows with the gap between the critical-input price index and the general intermediate price index. Crucially, the mechanism is one-sided: when critical inputs become *cheaper*, there is no windfall—the penalty simply disappears. This asymmetry captures the real-world observation that bottleneck costs bite hard on the upside but do not generate symmetric gains on the downside.

For the Hormuz closure scenario, the critical input chain maps gas into chemicals (with high bottleneck exposure), chemicals into food crops (again high exposure), gas into gas distribution, and oil into petroleum products. When all of these links are active simultaneously, a shock to Gulf energy exports is amplified twice—first at the chemical stage and again at the food production stage—generating the cascading food price effects that are the central finding of this brief.

A second dimension of the analysis is the *time horizon*. In the short run, firms cannot easily switch suppliers, reroute shipping, or renegotiate contracts. Refineries configured for Gulf crude cannot retool overnight; LNG terminals need months to secure alternative cargoes; fertilizer buyers locked into annual procurement cycles have no immediate alternatives. We capture these trade adjustment costs by reducing the trade elasticities in the model: lower elasticities mean that importers respond less to price changes, so a given supply disruption produces a larger price spike and a sharper welfare loss. This is not a Keynesian friction—wages and prices adjust freely, and there is no demand shortfall. It is a friction in the reallocation of trade flows: the real-world cost of redirecting supply chains when the infrastructure, logistics, and commercial relationships that support them take time to build. Our short-run scenarios use elasticities that are one-quarter of their long-run values, reflecting the severely limited substitution possibilities in the immediate aftermath of a disruption. The long-run scenario allows full adjustment, showing how markets can partially—but not fully—compensate once supply chains have had time to redirect.

3 Simulation Results

We evaluate two scenarios using the KITE model calibrated to GTAP 11 data covering 160 countries and 65 sectors:

- **Scenario 1: Full Closure (Short-Run).** Six Gulf states whose oil and gas exports transit exclusively through the Strait—Iran, Iraq, Kuwait, UAE, Qatar, and Bahrain—are blocked.[7] Short-run elasticities reflect minimal supply chain adjustment.
- **Scenario 2: Prolonged Closure (Long-Run).** Same shock as Scenario 1, but with long-run elasticities allowing markets to adjust through supply chain reorientation and substitution.

Table 1: Headline simulation results: welfare and price changes (%)

Indicator	S1: Full Closure (short-run)	S2: Prolonged (long-run)
South Korea welfare (%)	-1.37 [-2.38, -0.97]	-0.44 [-0.75, -0.31]
EU27 welfare (%)	-0.40 [-0.76, -0.36]	-0.12 [-0.21, -0.11]
USA welfare (%)	-0.07 [-0.16, -0.04]	-0.01 [-0.03, -0.00]
China welfare (%)	-0.64 [-1.05, -0.45]	-0.18 [-0.30, -0.13]
India welfare (%)	-1.78 [-3.29, -1.24]	-0.47 [-0.90, -0.32]
Japan welfare (%)	-0.65 [-1.13, -0.46]	-0.19 [-0.33, -0.14]
Global oil price (%)	+11.94 [7.39, 30.28]	+2.87 [1.83, 5.86]
Global gas price (%)	+3.76 [2.94, 4.87]	+1.00 [0.80, 1.34]
Global energy price (%)	+5.38 [3.55, 11.48]	+1.36 [0.91, 2.48]
Global food price (%)	+2.75 [2.03, 4.92]	+0.73 [0.55, 1.27]

Notes: SR = short-run (trade elasticities reduced to $\frac{1}{4}$); LR = long-run (standard elasticities). 90% confidence intervals from 100-draw Monte Carlo sensitivity analysis in brackets (see Appendix). Countries directly affected by the conflict (Gulf states, Israel, Jordan, Lebanon) are excluded from welfare reporting. Source: KITE model (Hinz, Mahlkow & Sogalla, 2026).

Who Loses Most?

Figure 3 shows the global distribution of welfare effects under a full Hormuz closure. Countries directly affected by the military conflict—the Gulf states, Israel, Jordan, and Lebanon—are marked separately, as their economic outcomes are dominated by the conflict itself rather than

[7] Saudi Arabia and Oman are excluded from the shock because they have Red Sea and Indian Ocean port access that bypasses the Strait of Hormuz (notably Saudi Arabia's East-West Pipeline/Petroline to Yanbu). If Saudi exports were also blocked—for instance because pipeline capacity proves insufficient or is itself disrupted—the effects roughly double: global energy prices would rise by approximately +10.8% instead of +5.4%, food prices by +5.0% instead of +2.7%, and welfare losses for countries such as South Korea (−2.5% vs −1.4%) and India (−2.5% vs −1.8%) would be substantially larger. The eight-state scenario thus provides an upper bound on the disruption.

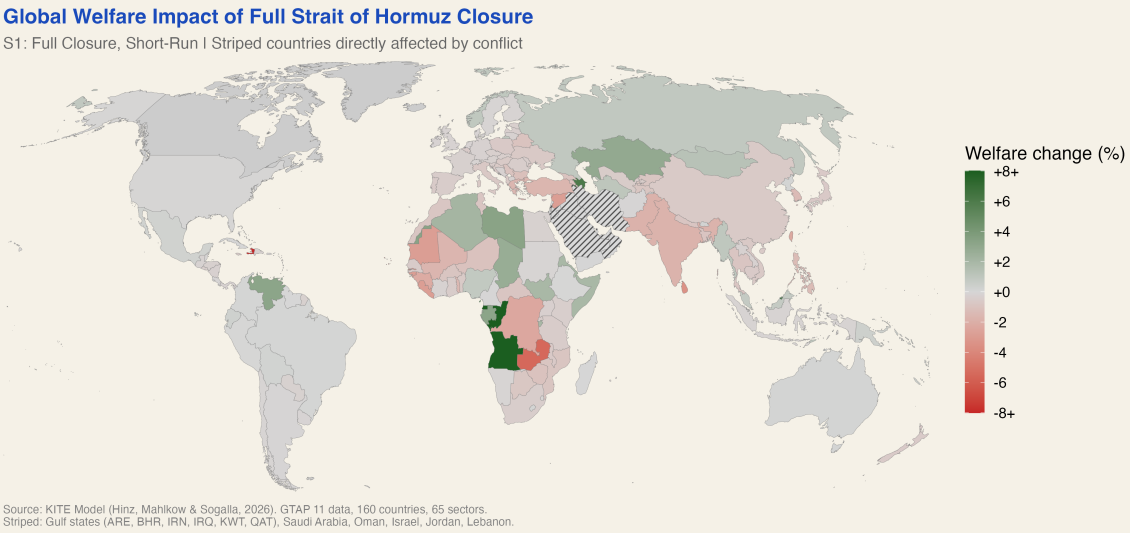

Figure 3: Global welfare changes under full Strait of Hormuz closure (Scenario 1, short-run). Striped countries are directly affected by the military conflict (Gulf states, Saudi Arabia, Oman, Israel, Jordan, Lebanon); their model results are not reported.

the trade disruption modelled here.[8]

Figure 4 ranks the countries experiencing the largest welfare losses, excluding those in the conflict zone.

Energy-importing developing countries face disproportionate losses. Countries in South Asia, sub-Saharan Africa, and the Middle East that lack domestic energy production are exposed through two channels simultaneously: direct energy cost increases *and* the indirect food price cascade described above. For these countries, the Hormuz closure is not merely an energy crisis—it is a food security crisis.

Among advanced economies, Japan and South Korea are particularly exposed due to their heavy dependence on Gulf energy imports. European countries face significant but more moderate impacts, partly reflecting more diversified energy sourcing and pipeline connections to non-Gulf suppliers.

The Price Cascade: From Energy to Food

Figure 5 illustrates the bottleneck mechanism at work. Energy prices rise most sharply, as expected. But the critical finding is how these increases propagate: chemical prices rise substantially due to the gas-to-fertilizer bottleneck, and food prices increase well beyond what standard trade models would predict.

The uncertainty around these estimates varies markedly across the cascade. Oil prices are the most sensitive to parameter assumptions: the 90% confidence interval spans from +7% to

[8]The model captures trade-channel effects only. For countries in the conflict zone, direct damage to infrastructure, capital, and institutions dwarfs the trade effects quantified in this analysis.

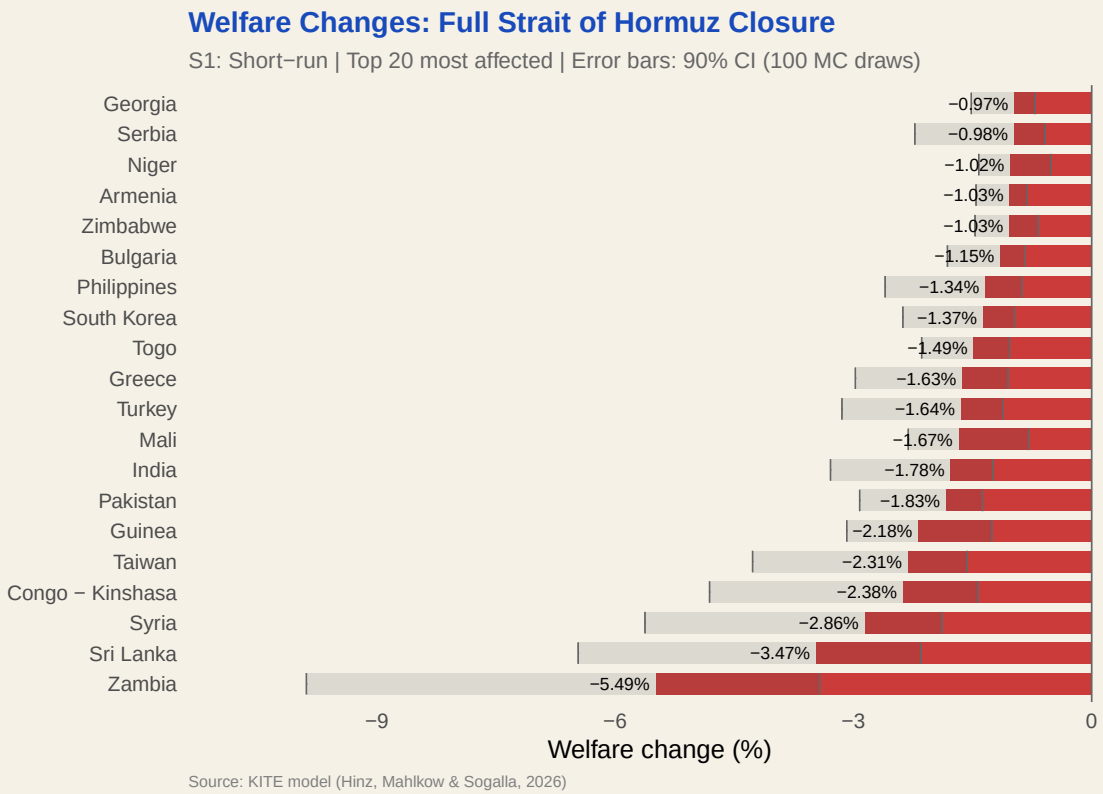

Figure 4: Welfare changes under full Strait of Hormuz closure (Scenario 1, short-run). Countries directly affected by the conflict are excluded. Shaded bands show 90% confidence intervals from Monte Carlo sensitivity analysis (100 draws). Energy-dependent developing countries in South Asia, sub-Saharan Africa, and the Middle East are most exposed.

+30%, reflecting how strongly oil market outcomes depend on trade elasticities and substitution possibilities. Food price increases, by contrast, are more tightly estimated at +2.7% [+2.0%, +4.9%]—the bottleneck mechanism anchors the cascade from energy through fertilizers to food regardless of the precise oil price level. This pattern—wide uncertainty in upstream energy prices, narrower uncertainty in downstream food effects—suggests that the food security consequences of a Hormuz closure are robust even when the exact magnitude of the oil price spike is uncertain.

This cascade is particularly dangerous for food security in developing countries. Figure 6 shows which countries face the largest food price increases. The most vulnerable are countries that simultaneously depend on imported energy, imported fertilizers, and have large agricultural sectors with limited domestic alternatives.

Short-Run vs Long-Run

Figure 7 compares welfare effects across the two scenarios. The contrast between short-run and long-run results illustrates the role of substitution in cushioning the blow. In the short run, refineries configured for specific crude grades cannot retool overnight, LNG terminals need months to secure alternative cargoes, and fertilizer buyers locked into annual procurement cycles have

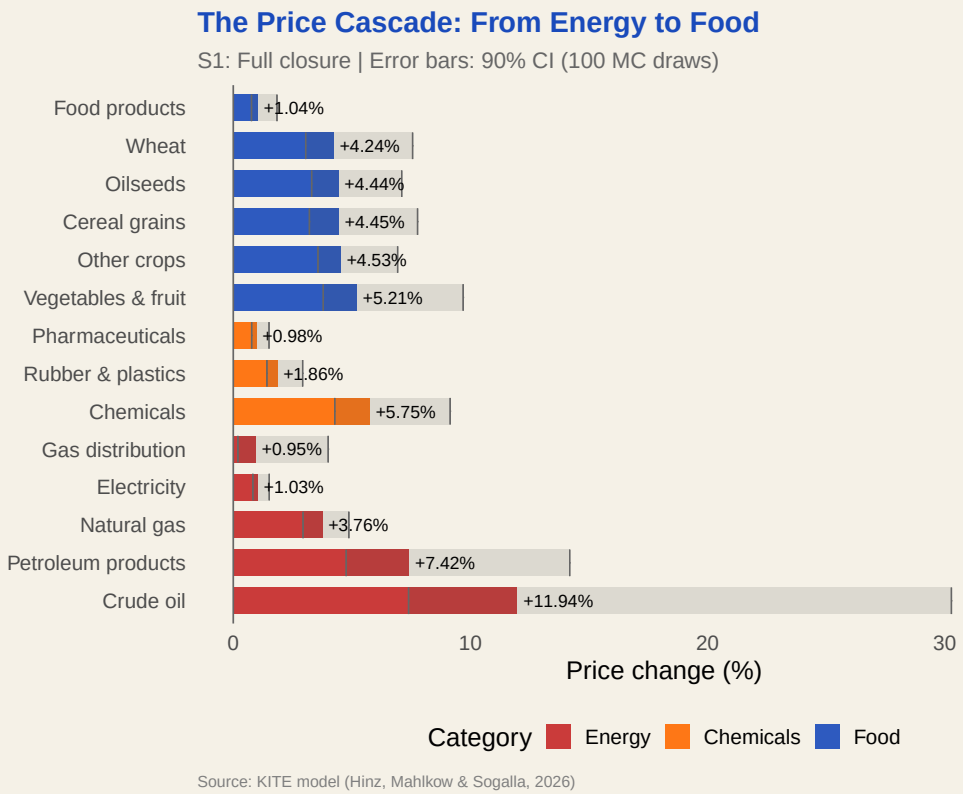

Figure 5: The price cascade under full closure (Scenario 1): energy disruptions transmit through chemicals (fertilizers) to food prices. The bottleneck mechanism amplifies food price increases. Shaded bands show 90% confidence intervals from Monte Carlo sensitivity analysis.

no immediate alternatives. The short-run scenario captures this rigidity: with trade elasticities reduced to one-quarter of their long-run values, the model produces sharply larger price spikes and welfare losses.

The prolonged closure scenario (Scenario 2) shows that long-run market adjustment reduces but does not eliminate the damage. Supply chains can partially redirect—oil and gas can be sourced from alternative producers, shipping can be rerouted, and downstream industries can gradually substitute inputs. At every point in the value chain, some substitution is possible, which is precisely why the long-run scenario shows smaller effects. But in the short run, substitution is severely limited: refineries are configured for specific crude grades, the Haber-Bosch process requires methane as feedstock, and fertilizer procurement operates on annual cycles. The KITE bottleneck extension captures exactly this asymmetry between short-run rigidity and long-run flexibility. Even with full adjustment, welfare losses for energy-dependent developing countries remain substantial.

It is important to note that the model captures general equilibrium trade reallocation effects only. It does not include speculative and financial market dynamics, hoarding behaviour, strategic reserve releases, or commodity futures pricing. Real-world oil prices reflect panic, speculation, and inventory dynamics on top of the structural supply shift. The model results therefore represent the *structural* cost of rerouting supply chains—not the spot-price spike observed in

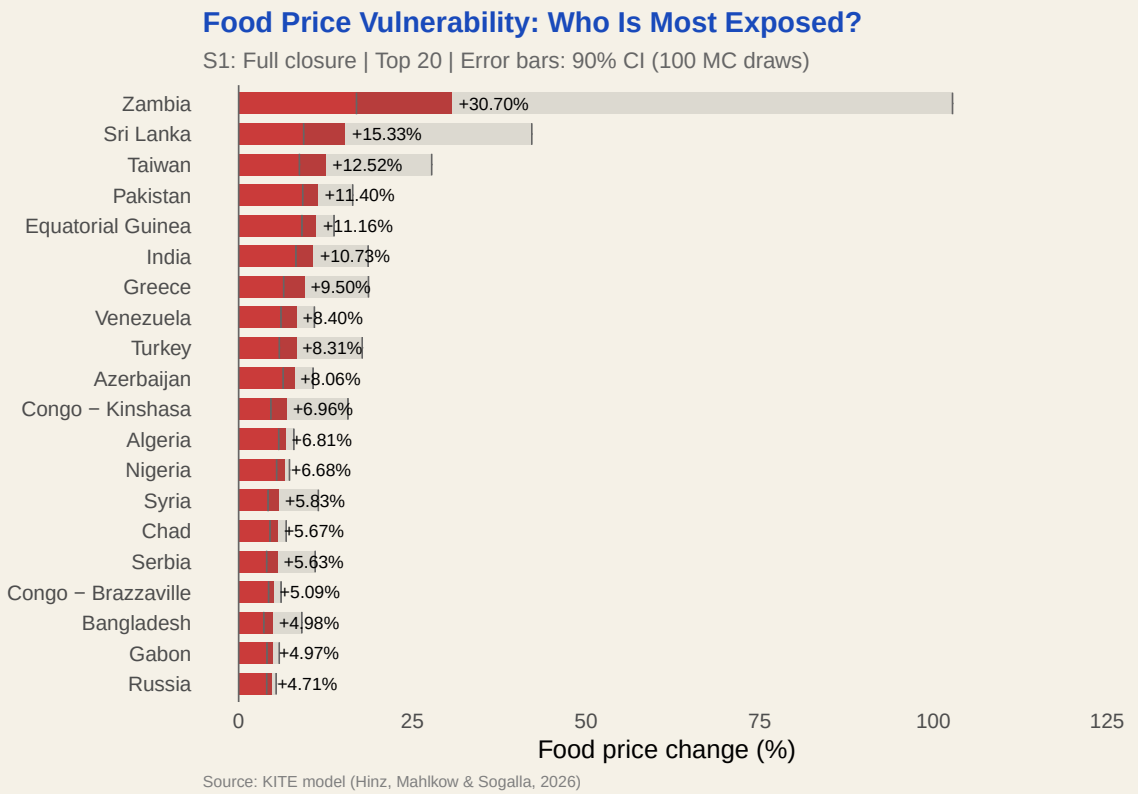

Figure 6: Food price vulnerability: countries facing the largest food price increases under full Hormuz closure (Scenario 1, short-run). Shaded bands show 90% confidence intervals. Developing countries dependent on imported energy and fertilizers are most exposed.

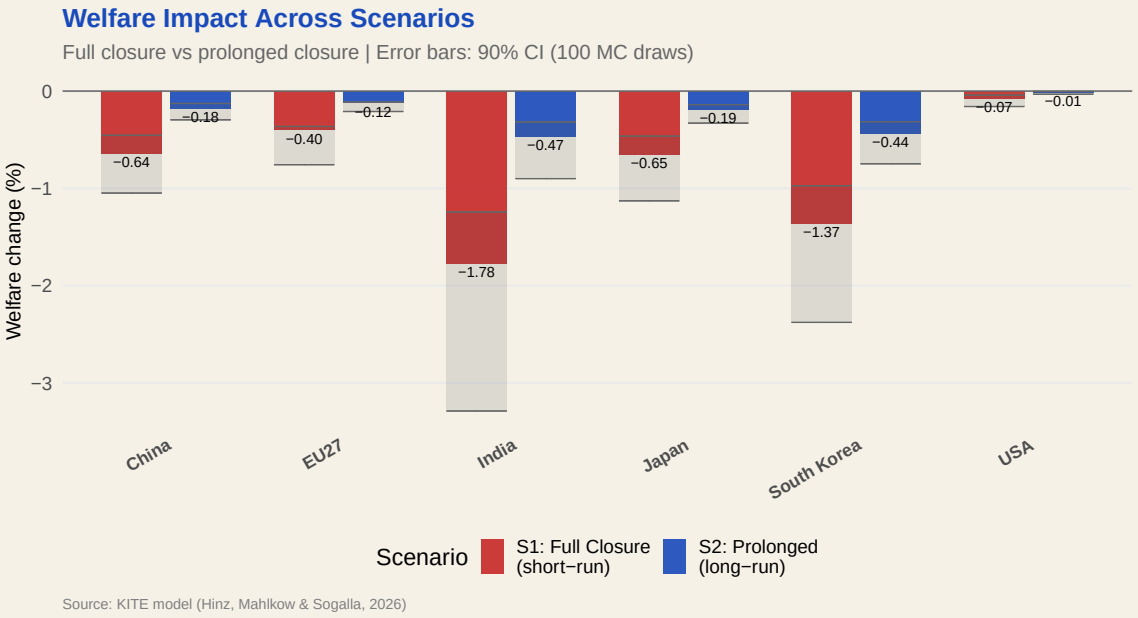

Figure 7: Welfare impact comparison: full closure (short-run) vs prolonged closure (long-run). Shaded bands show 90% confidence intervals. Short-run effects are substantially larger due to limited substitution possibilities.

commodity markets. This means our estimates are a lower bound on short-run price effects but a more accurate picture of the medium-term structural costs that persist once speculative volatility subsides.

4 Policy Implications

The Strait of Hormuz crisis exposes a vulnerability that runs deeper than energy security. The bottleneck mechanism at the heart of this analysis—energy to chemicals to fertilizers to food—means that a chokepoint closure is simultaneously an energy shock, a manufacturing shock, and a food security emergency. Policymakers who treat these as separate risks will underestimate each one.

The most urgent lesson concerns the world's poorest countries. South Asia, sub-Saharan Africa, and parts of the Middle East face the steepest welfare losses not because they consume the most energy, but because their food systems depend on imported fertilizers manufactured from Gulf gas. For these countries, strategic fertilizer reserves—analogous to strategic petroleum reserves—deserve serious consideration. International institutions should develop contingency frameworks for rapid fertilizer and food aid deployment when major energy supply routes are disrupted.

The timing of this closure makes the fertilizer dimension especially acute. The Northern hemisphere spring planting season requires nitrogen fertilizer *now*—March and April are peak demand months for the crop inputs that determine yields for the entire growing season. Fertilizer cannot simply arrive three months late; delayed application means reduced yields or failed planting altogether. This seasonal dimension means that even a relatively brief closure could disrupt an entire growing season, with food security consequences that persist long after the strait reopens.

For energy-importing economies more broadly, the crisis underscores the urgency of diversification. Reducing dependence on Gulf hydrocarbons—through renewable energy deployment, LNG import infrastructure connected to non-Gulf suppliers, and investment in energy efficiency—is the most effective long-term mitigation strategy. The trend data in this brief—and the accompanying product-level analysis at `https://trade.ifw-kiel.de/KTTM/current_trade_issues/`—show that Gulf dominance in energy-intensive products has grown, not shrunk, over the past three decades. Without deliberate policy action, that dependence will deepen further.

Standard quantitative trade models, by treating all intermediate inputs as smoothly substitutable, systematically underestimate the food security consequences of energy disruptions. The bottleneck mechanism documented here illustrates how standard policy models can miss critical transmission channels in energy security scenarios. Models that miss the gas-to-fertilizer-to-food cascade will give policymakers a false sense of resilience.

The central finding of this brief is not the aggregate cost of the closure—it is the *distribution* of that cost. The United States loses just -0.07% of welfare, a figure that barely registers against normal economic fluctuations. But countries in South Asia and sub-Saharan Africa

face losses that are 10–20 times larger in percentage terms, hitting populations with far less capacity to absorb them. African economies are particularly exposed: their dependence on imported fertilizers, limited domestic energy production, and thin fiscal buffers mean that a Hormuz closure transmits directly into food prices and household welfare. The crisis is severe but differentiated—and the differentiation falls along the fault lines of global inequality.

Every week that the strait remains closed, developing countries lose real income that cannot be recovered through subsequent market adjustment. The economic case for de-escalation is not merely strong; measured in food security for hundreds of millions of people, it is overwhelming.

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Appendix: Method

Model

This analysis uses the bottleneck extension of the KITE model (Hinz et al., 2025, 2026), a quantitative general equilibrium trade model in the tradition of Eaton and Kortum (2002) and Caliendo and Parro (2015). The model solves for a new equilibrium in prices, wages, trade shares, and output across all countries and sectors after a policy shock.

The key innovation of the bottleneck extension is the *critical input mechanism*. Standard trade models assume smooth Cobb-Douglas substitution across all intermediate inputs: if one input becomes more expensive, producers shift to alternatives according to fixed input-output shares. The KITE bottleneck model breaks this symmetry by introducing a penalty that applies when critical inputs become scarce.

The Bottleneck Equation

The standard Caliendo & Parro (2015) unit input cost in country d and sector j is:

$$\hat{c}_d^j = \frac{1}{\hat{A}_d^j}\, \hat{w}_d^{\beta_d^j} \prod_k \left(\hat{P}_d^k\right)^{(1-\beta_d^j)\,\gamma_d^{k,j}}$$

where $\hat{A}_d^j$ is the technology shifter, $\hat{w}_d$ is the wage change, β_d^j is the value-added share, $\hat{P}_d^k$ is the price index of intermediate input k, and $\gamma_d^{k,j}$ are input-output expenditure shares.

The bottleneck extension augments this with a **critical-input penalty**:

$$\hat{c}_d^j = \underbrace{\frac{1}{\hat{A}_d^j}\, \hat{w}_d^{\beta_d^j} \prod_k \left(\hat{P}_d^k\right)^{(1-\beta_d^j)\,\gamma_d^{k,j}}}_{\text{standard Caliendo \& Parro (2015)}} \cdot \underbrace{\left(\Lambda_d^j\right)^{\phi^j}}_{\text{bottleneck amplification}} \tag{1}$$

The **critical-input penalty** Λ_d^j captures whether the price of the critical-input bundle rises faster than the overall intermediate bundle:

$$\Lambda_d^j = \max\left(1,\ \frac{\hat{B}_d^j}{\hat{M}_d^j}\right)$$

where

$$\hat{B}_d^j = \prod_k \left(\hat{P}_d^k\right)^{\tilde{\omega}^{k,j}} \qquad \text{and} \qquad \hat{M}_d^j = \prod_k \left(\hat{P}_d^k\right)^{\gamma_d^{k,j}}$$

with $\tilde{\omega}^{k,j} = \omega^{k,j} / \sum_m \omega^{m,j}$ the normalized critical-input weights. The **critical exposure** parameter $\phi^j = \min\left(1,\ \sum_k \omega^{k,j}\right)$ governs how strongly the bottleneck bites for sector j.

The $\max(1, \cdot)$ operator ensures the penalty is one-sided: when critical inputs become more expensive relative to the general bundle, downstream costs are amplified; when they become cheaper, there is no windfall. When $\omega^{k,j} = 0$ for all k (no critical inputs specified), the penalty collapses to 1 and the model reduces exactly to Caliendo & Parro (2015).

Data

The model is calibrated to GTAP 11 data covering 160 countries and 65 sectors. The underlying input-output structure reflects 2017 values. Trade flows and value added are continuously updated to a 2025 base year, ensuring the model reflects current trade patterns and economic structures.

Shock implementation

The Hormuz closure is modelled as a prohibitive non-tariff barrier (NTB = 1000, equivalent to a 100,000% ad valorem tariff) on oil and gas exports from six Gulf states (Iran, Iraq, Kuwait, UAE, Qatar, Bahrain) to all destinations. Saudi Arabia and Oman are excluded because they have port access outside the Strait of Hormuz. This effectively blocks these trade flows while allowing the model to compute the general equilibrium adjustment.

Time horizons

The short-run scenario (Scenario 1) reduces all trade elasticities to one-quarter of their long-run values, reflecting severely limited substitution possibilities when supply chains cannot adjust. The long-run scenario (Scenario 2, prolonged closure) and baseline use standard elasticities, allowing for supply chain reorientation and input substitution. The solver iterates to convergence with a tolerance of 10^{-5}.

Welfare measure

Welfare is measured as the change in real income: the ratio of nominal income change to the consumer price index change. A country's welfare falls when its terms of trade deteriorate or when critical input disruptions raise production costs. The welfare measure captures both direct effects (higher import prices) and indirect effects (the bottleneck cascade through intermediate inputs).

Parameter uncertainty

The bottleneck mechanism introduces parameters—critical input exposures ϕ^j and trade elasticities θ^j—that are estimated with uncertainty. We quantify this uncertainty through a Monte Carlo sensitivity analysis with 100 draws, perturbing two sets of parameters independently in each draw:

1. **Critical input exposure.** For each sector pair in the bottleneck matrix, the exposure parameter ϕ^j is drawn from a uniform distribution over empirically calibrated bounds $[\underline{\phi}^j, \overline{\phi}^j]$.[9]

[9] Critical input exposure bands are calibrated from product-level trade data (BACI/CEPII) by mapping HS6-level Gulf export shares to GTAP sector pairs. The sector-specific lower and upper bounds are documented in the accompanying replication data.

2. **Trade elasticities.** The Fréchet shape parameter θ^j for each sector is perturbed by a normally distributed shock with standard error derived from product-level variation within the corresponding HS section.

For each draw, the full general equilibrium model is re-solved for both scenarios. The resulting distributions yield the 90% confidence intervals reported in Table 1 and the shaded bands in Figures 4–7.

Limitations

The model captures trade-channel effects only. It does not account for financial market disruptions, speculative commodity pricing, strategic petroleum reserve releases, or humanitarian consequences of the conflict. For countries directly involved in the military conflict, the model's trade-based welfare estimates are a lower bound on actual economic damage. Results for conflict-affected countries (Gulf states, Israel, Jordan, Lebanon) are therefore not reported in this brief.

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