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TRADE DIAGNOSTIC

Liberia

An assessment of Liberia's trade structure, competitiveness and AfCFTA integration opportunities using multi-region input–output accounting and CGE simulation.

AICTEM TRADE DIAGNOSTIC

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Models: FE-PPML gravity, corridor network, calibrated Armington sourcing, MRIO value-chain analytics, Caliendo–Parro CGE

Key datasets: GTAP Africa V3 (GTAP 11b, 2017; 62 regions, 65 commodities), World Bank WDI and LPI, AICTEM corridor and port network

Scenarios: 2017 benchmark; AfCFTA facilitation and trade-cost counterfactuals

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Executive Summary

Liberia is a coastal African economy of roughly $5.2 bn and 5.7 million people, a founding member of ECOWAS and of the Mano River Union, with a Logistics Performance Index of 2.4/5. It is a signatory of the African Continental Free Trade Area (AfCFTA). This assessment applies an integrated spatial–gravity–MRIO–network–CGE pipeline — the same used at continental level — to diagnose why Liberia under-trades, with whom, through which corridors and sectors, and what to do about it (Maliszewska and Ruta, 2020; UNECA, 2021).

- **Liberia realises about a tenth of its regional export potential.** Actual intra-African exports of $234 m stand against a fitted frictionless potential of $2.5 bn — a missing-trade gap of $2.2 bn and a fill ratio of 0.10, among the lowest on the continent.

- **Its largest regional markets** are Nigeria ($41 m), Ghana ($35 m), Angola ($26 m) and South Africa ($23 m), each a fraction of what size and distance alone would predict. The largest single unrealised gap is South Africa, $343 m of predicted trade that does not happen, ahead of Angola ($186 m) and Algeria ($175 m).

- **Non-tariff and logistics frictions are the levers the model can separate from tariffs.** Liberian cargo pays an average 16.6% of its value to reach an African market, and all six of the gravity model's friction coefficients are correctly signed — positive for shared language and REC membership, negative for distance, transport cost, border crossings and tariffs — though only four are individually significant. The full AfCFTA facilitation package raises intra-African exports by about 99.9%, of which non-tariff-barrier and standards harmonisation alone delivers 68.5%; **port efficiency at the Freeport of Monrovia now adds 29.1%, the second-largest lever**, ahead of corridor upgrading at 4.3%, rail investment at 3.6% and one-stop border posts at 1.4%. Tariff removal, at 1.8%, is small — trade within ECOWAS is already largely liberalised — but imprecisely estimated rather than absent, and on this run it sits above the border-post lever.

- **Import dependence is concentrated** in water transport, air transport and transport equipment, which buy $3.42 bn, $707 m and $588 m of their inputs respectively from outside Africa. Only 2.8% of Liberia's intermediate inputs come from African suppliers against 79.2% from the rest of the world; under the full package the African share of its *imported* input demand moves from 2.77% to 3.37%, among the smallest responses in this group of reports and a direct consequence of the registry line below.

- **The distinctive Liberian fact is that its largest traded sector never calls at its ports.** The world's largest open ship registry is booked in the MRIO as Liberian water transport, and that single commodity accounts for 43% of all intermediate input use and more than half of every dollar of inputs bought outside Africa. Behind it sits a small, concession-built raw-commodity exporter whose regional trade runs through one port, one railway and three land borders.

- **Liberia falls outside the CGE focus set**, but by the same general-equilibrium logic — and consistent with the AfCFTA welfare assessments — intra-African trade-cost reductions would raise its welfare through cheaper imported inputs and improved market access.

Recommended reforms, in priority order: (1) dismantle non-tariff barriers and harmonise standards/SPS; (2) complete one-stop border posts and digital customs; (3) upgrade and climate-proof the priority corridors — Monrovia–Ganta, the Bo Waterside road and the Yekepa–Buchanan railway; (4) build value-chain and energy capacity; and (5) implement AfCFTA tariff liberalisation as the enabling foundation.

1. Introduction

Liberia's trade is shaped by its geography and economic structure. As a coastal economy with direct maritime access and a member of ECOWAS, its realistic market is its African neighbourhood — yet, like most of the continent, it trades far less regionally than its economic size implies (UNCTAD, 2021). Intra-African trade remains a small share of African economies' total, and the gap is not merely statistical: it means producers forgo nearby markets and fail to build the supplier networks that underpin industrialisation.

The candidate explanations are well known but rarely quantified together: geography and distance; thin, port-oriented infrastructure; border and customs frictions; non-tariff barriers and divergent standards; weak and similar productive structures; and missing regional value chains (Limão and Venables, 2001; World Bank, 2020). This assessment runs all of them on one database, so that Liberia's constraints can be measured and ranked rather than asserted.

The central question is therefore *why Liberia under-trades with its neighbours, with whom, through which corridors and sectors, and which interventions deliver the largest gains*. The report answers it through structural diagnostics (Sections 2–9) and forward-looking simulation (Sections 10–11), then ranks the reforms (Sections 12–14). A note on data: monetary values are GTAP gross flows (larger than official merchandise statistics); macroeconomic figures (Section 2) are approximate (World Bank WDI; IMF; national sources); all model-derived results are exact outputs of the pipeline and reproduced in the annex tables.

Liberia's regional-integration agenda runs through the AfCFTA and its RECs (ECOWAS). The AfCFTA — the largest free-trade area by membership in the world — is projected to raise intra-African trade substantially, but the evidence is consistent that the gains come overwhelmingly from trade facilitation and the removal of non-tariff measures rather than from tariff liberalisation, which is already largely accomplished within Liberia's RECs (Maliszewska and Ruta, 2020; UNECA, 2021). This assessment quantifies, for Liberia specifically, where those facilitation gains would accrue and how large they could be.

Liberia is Africa's oldest republic, and its trade economy still carries the imprint of that singular founding. Settled from 1822 by freeborn and formerly enslaved Black Americans under the auspices of the American Colonization Society, and declared independent in 1847, Liberia was never formally

colonised — yet its political economy was shaped by a settler oligarchy, the Americo-Liberian elite, who governed through the True Whig Party for more than a century. That elite built the state on the coast around Monrovia, named for U.S. President James Monroe, and oriented it commercially toward the Atlantic and the United States rather than toward the West African interior. The legacy is twofold and durable: an English-speaking, U.S.-dollar-linked economy whose institutions, legal system and even its dual currency (the Liberian and U.S. dollars circulate side by side) point outward to North America and global markets; and a deep internal cleavage between the coastal settler class and the sixteen indigenous groups of the hinterland, a fracture that fed the violence of the late twentieth century.

The modern economy was constructed as a concession economy, and that structure is the central fact of Liberian trade. From the 1920s the state leased vast tracts to foreign operators in exchange for rents, royalties and infrastructure. The Firestone Tire and Rubber Company's 1926 concession at Harbel — for a time the largest contiguous rubber plantation in the world, on a ninety-nine-year lease — made Liberia synonymous with natural rubber and tied a slice of national income to a single American firm. From the 1950s the "open-door" policy extended the model to iron ore, and by the 1970s Liberia was among the world's leading iron-ore exporters, mining the high-grade deposits of the Nimba and Bong ranges through consortia such as LAMCO and the Bong Mining Company, served by dedicated railways and the purpose-built ore port at Buchanan. Growth in this era was real but enclave-shaped: foreign-operated mines and plantations generated export earnings and royalties with shallow linkages into the domestic economy, employing Liberians as labourers while management, processing and value capture sat abroad. The 1980 coup that ended True Whig rule, and the descent into the civil wars of 1989–1997 and 1999–2003, shattered this edifice. Roughly a quarter of a million people died, infrastructure was destroyed, the iron-ore railways and mines fell silent, and "conflict timber" and other resources financed the fighting, drawing UN sanctions.

Post-2003 recovery rebuilt the concession economy rather than replacing it. Under the 2003 Accra peace agreement, a transitional government and a large UN peacekeeping mission (UNMIL) restored stability; the 2005 election of Ellen Johnson Sirleaf — Africa's first elected woman head of state and later a Nobel laureate — brought debt relief under the HIPC initiative, the lifting of timber and diamond sanctions, and a wave of renegotiated concessions. The centrepiece was ArcelorMittal's iron-ore agreement, which restored mining at Yekepa in Nimba and the railway to Buchanan and became the anchor of the export recovery; Firestone's rubber operations resumed, and new oil-palm and gold investments followed. Yet just as recovery gathered pace, the 2014–2016 West African Ebola epidemic struck Liberia at its epicentre, killing thousands, collapsing services and supply chains, freezing investment and exposing the fragility of an economy with thin domestic buffers. Compounded by the simultaneous collapse of global iron-ore and rubber prices, Ebola pushed Liberia back into crisis and underscored how exposed a narrow commodity exporter is to twin terms-of-trade and health shocks.

One revenue stream stands apart from goods trade entirely: the ship registry. Liberia operates the world's largest or second-largest open registry, or flag of convenience, with several thousand ocean-going vessels and a very large share of global deadweight tonnage flying the Liberian flag

despite almost none of those ships ever calling at a Liberian port. Administered from the United States by a private contractor (the Liberian International Ship and Corporate Registry), the registry generates substantial annual fee and tax income for the government — a maritime-services export that is invisible in merchandise statistics yet materially supports the budget. It is a reminder that Liberia's external accounts are not captured by goods flows alone, and that its comparative advantage includes a globally traded service.

Within its region, Liberia is a committed but lightly integrated member of West Africa's institutions. It is a founding member of the Economic Community of West African States (ECOWAS) and of the Mano River Union (MRU) with neighbours Sierra Leone, Guinea and Côte d'Ivoire — three countries with which it shares borders, conflict histories and overlapping ethnic and trading communities. It is a signatory to the African Continental Free Trade Area. Yet its regional trade remains thin relative to its Atlantic and global orientation, a pattern the model captures in a fill ratio of 0.10: Liberia realises $234 m of the $2.5 bn of intra-African exports the gravity model assigns it, leaving $2.2 bn unrealised. The binding problem is therefore twofold — the small absolute scale and narrow commodity composition of what Liberia has to sell, and the frictions that keep even that from reaching its neighbours. The central trade challenge is structural: to convert an enclave, raw-commodity export base, dependent on imported rice and fuel and exposed to volatile prices, into a more diversified, value-adding economy whose growth pulls regional suppliers and domestic processors along with it.

2. Country Economic Structure

2.1 Macroeconomic Profile

Table 1: Liberia: Macroeconomic profile

Indicator	Value
Capital	Monrovia
GDP (approx.)	$5.2 bn
Population	5.7 million
GDP per capita	$915
Logistics Performance Index	2.4 / 5
Landlocked	No
REC memberships	ECOWAS

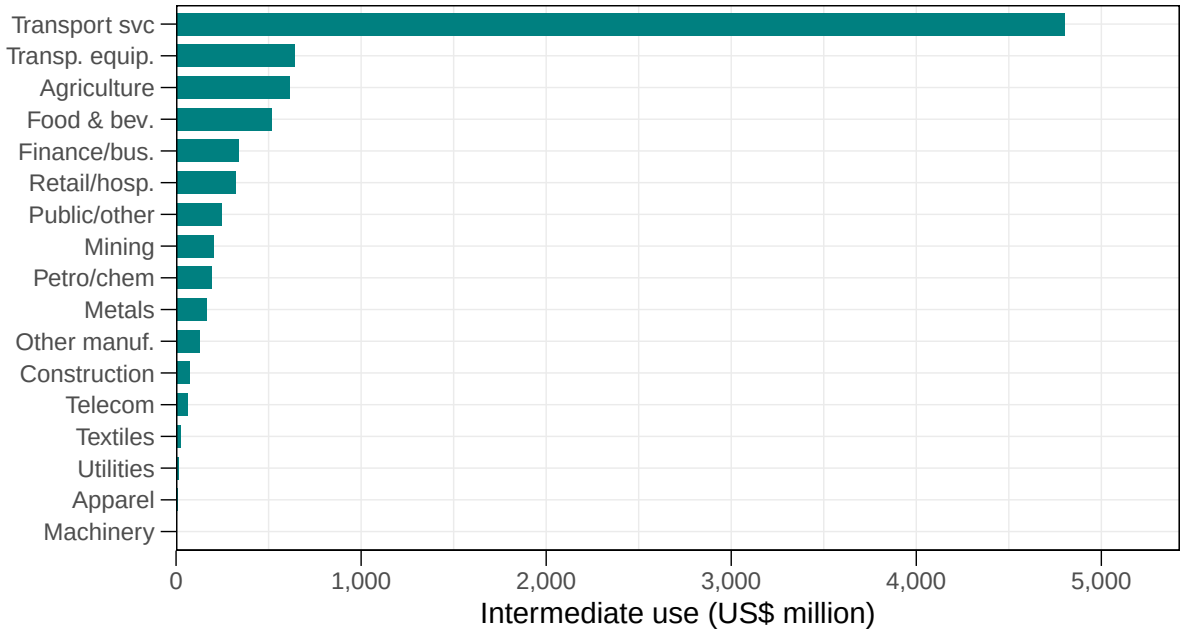
Notes: GDP, population and per-capita figures are approximate external estimates (World Bank WDI, IMF and national sources), not model output.

Two structural facts frame everything that follows. First, Liberia's logistics performance (LPI 2.4/5), and the 16.6% of cargo value its exports pay on average to reach an African market once dwell at the gateway is priced at the value of time, make the cost and reliability of moving goods a first-order constraint rather than a footnote (Arvis et al., 2023). Second, its coastal position gives it direct port access, but its overland links to interior neighbours remain the binding margin for regional trade.

2.2 Sectoral Structure

Liberia's industrial structure is best read through intermediate input use, which ranks sectors by how much they buy from other industries rather than by value added. Figure 1 sets it out.

Figure 1: Liberia: sectors ranked by intermediate input use



Notes: The 65 GTAP commodities are aggregated for display into 17 broad groups, weighted by the underlying levels, so no commodity is dropped; the commodity-level table is in Annex C. US$ million. Intermediate input use is a proxy for activity scale; primary agriculture reads small on this metric because it generates a high share of its value with little purchased input.

Transport services tops the ranking at about $4.6 bn of purchased inputs — water transport alone accounts for $3.60 bn of it, the statistical shadow of the ship registry described above, with air transport at $734 m — ahead of transport equipment at $642 m (Annex C). Below that tier the ranking reads like the real economy: vegetables, fruit and nuts at $316 m, other transport services at $289 m and processed food at $283 m. The ordering matters twice over. The sectors at the top of this chart are the ones whose growth pulls hardest on suppliers, and Section 6.2 shows that today almost all of that pull leaves the continent; but it also means Liberia's measured industrial structure is dominated by a maritime service that generates almost no domestic linkage, so the agro-processing tier beneath it is where a regional-sourcing strategy has to do its work (Hummels et al., 2001).

2.3 Production Geography

Liberia's economic geography is organised around its commercial-and-industrial core (the capital region and main cities), its agricultural belts, and the border gateways through which its regional trade physically passes. Its ports and coastal corridors connect the interior to world markets, while its land borders connect it to regional neighbours. This geography — a producing core feeding goods outward through a ring of border gateways, while drawing imports inward along the main corridors — is the

spatial structure the rest of the report analyses.

3. Trade Profile

Liberia's economic geography is a coastal spine with a resource-rich, poorly connected interior. The country occupies some 111,000 square kilometres on the Atlantic coast of West Africa, fringed by lagoons and mangrove and rising inland through tropical rainforest — Liberia holds the largest remaining block of the Upper Guinean forest — to the highlands of the Nimba range on the Guinean and Ivorian frontiers. Mount Wuteve and the Nimba massif mark the highest ground; Mount Nimba itself, a UNESCO biosphere reserve straddling three borders, sits atop some of West Africa's richest iron-ore deposits. The settlement and production pattern hugs the coast and a handful of interior mining towns, with vast forested districts in between that are thinly served by all-weather roads. This is the spatial root of Liberia's logistics problem: production points and population are real, but the connective tissue between them is weak.

Monrovia and its Freeport are the unrivalled commercial heart. The capital region concentrates the population, government, banking, and the bulk of formal commerce, and the Freeport of Monrovia — built with U.S. assistance during the Second World War — is the country's principal gateway, handling the great majority of containerised and general-cargo imports, fuel, and a share of exports. Operated under a concession by APM Terminals (the Maersk group), the Freeport is the single most important node in the national trade system; its efficiency, draft and landside connections effectively set the cost of imported rice, fuel and machinery for the whole economy. Around Monrovia cluster the country's limited manufacturing and the Roberts International Airport at Robertsfield, the main air gateway, itself adjacent to the Firestone estate.

The iron-ore geography runs along the northern highlands. The richest deposits lie in Nimba County in the north-east, centred on the company town of Yekepa hard against the Guinean border, where ArcelorMittal Liberia mines the ore that anchors the export economy and rail-hauls it south to the coast. A second historic mining district is the Bong range in Bong County, around Bong Mines, exploited in the concession era and the target of renewed interest. Western Liberia, in Grand Cape Mount and adjoining counties, holds further iron-ore prospects (the Western Cluster and the Bea Mountain area). These ranges are remote, road access is poor, and the economic viability of each deposit turns on access to a railway and an export port — which is why ore geography and corridor geography are, in Liberia, inseparable.

The rubber belt and the agricultural lowlands lie in the coastal and near-interior counties. The Firestone estate at Harbel in Margibi County, on the Farmington River near Robertsfield, remains the iconic plantation, but rubber smallholdings and estates spread across Margibi, Bong, Nimba, Grand Bassa and Bomi, and the same well-watered lowlands host the oil-palm concessions (in Grand Bassa, Sinoe and the south-east) and cocoa and coffee smallholdings in the interior. Rice — the national staple — is grown in inland valleys and swamps across many counties but at well below consumption, leaving a chronic import gap. The southeast and the forest belt also hold the timber resource, logged

in concession areas across Sinoe, Grand Gedeh, River Cess and Maryland.

Gold and diamonds are mined, largely artisanally, across the interior. Alluvial and increasingly semi-industrial gold workings spread through the river valleys of the north-west and interior — Gbarpolu, Lofa, Bong, Nimba and Grand Cape Mount — while alluvial diamonds occur in the Lofa and western districts. Bea Mountain's New Liberty mine in Grand Cape Mount represented the first modern industrial-scale gold operation. Much of this output is small-scale, dispersed and prone to informal cross-border movement into Guinea and Sierra Leone, which complicates both revenue capture and the Kimberley-Process controls that Liberia rejoined after the war.

Beyond Monrovia and Buchanan, the secondary ports define the south-eastern economy. Buchanan in Grand Bassa is the dedicated iron-ore export port, the saltwater terminus of the Yekepa railway and a general-cargo harbour. Further down the coast, Greenville in Sinoe and Harper in Maryland are smaller ports historically tied to timber, rubber and oil palm; their shallow draft and limited handling capacity, and the poor coastal road to the south-east, leave the south-eastern counties among the most isolated in the country. The border geography completes the picture: Liberia abuts Sierra Leone to the north-west (with crossings at Bo Waterside and Jendema), Guinea to the north (Ganta–Nzérékoré and the Yekepa area), and Côte d'Ivoire to the east (the Loguatuo and Toe Town crossings toward Danané and Man). These land frontiers — porous, conflict-scarred and bound up with the shared communities of the Mano River basin — are where Liberia's regional, as opposed to oceanic, trade physically passes.

3.1 Export Structure

Liberia's exports combine its primary-commodity and agricultural base with a growing range of regional manufactures and processed goods. In the MRIO gross accounts its productive export base — the part with the clearest regional growth potential — is concentrated in the sectors where it holds comparative advantage (Section 7); its single largest African market is Nigeria.

3.2 Import Structure

Liberia's imports are dominated by goods it does not yet produce at scale — refined fuels, machinery and electrical equipment, vehicles, pharmaceuticals, chemicals and fertilisers, iron and steel, and (for many economies) staple foods. By origin these come overwhelmingly from outside Africa — China, India, the Gulf and Europe — plus a few regional partners. This import structure is the source of the import-leakage that the MRIO analysis (Section 6.2) identifies as a regional-sourcing opportunity, and it ties Liberia's production costs to extra-African supply chains and shipping margins, so that cheaper logistics act like an economy-wide productivity gain.

3.3 Intra-African Trade

Liberia's regional exports are small, widely spread and far below potential on almost every route. Table 2 and Figure 2 rank them, each against the gravity model's frictionless potential:

Table 2: Liberia: Intra-African export partners: actual, gravity potential and missing trade

Partner	Actual	Potential	Missing	Ad-valorem cost
Nigeria	$41 m	$149 m	$107 m	14.4%
Ghana	$35 m	$99 m	$64 m	11.5%
Angola	$26 m	$212 m	$186 m	13.3%
South Africa	$23 m	$365 m	$343 m	17.9%
Cote d'Ivoire	$13 m	$39 m	$26 m	12.1%
Algeria	$9 m	$185 m	$175 m	20.1%
Morocco	$8 m	$77 m	$69 m	14.6%
Ethiopia	$6 m	$109 m	$103 m	18.5%

Notes: Gravity potential is the frictionless benchmark; missing trade is the difference. Ad-valorem cost is delivered transport cost as a share of cargo value. Values are GTAP gross flows and exceed official merchandise statistics.

Liberia's merchandise exports are a short list of primary commodities, dominated by iron ore. The recovery of ArcelorMittal's Nimba operations restored iron ore to its historic place as the single largest goods export by value, shipped as direct-shipping ore and, increasingly, concentrate from an expanding processing plant, almost entirely to overseas markets — European steelmakers and Asian buyers — rather than to African neighbours, since the continent has limited blast-furnace demand. Natural rubber is the second pillar, exported as latex and sheet from the Firestone/Harbel estate and the smallholder sector to tyre manufacturers and processors abroad. Gold has risen to rival or exceed rubber in some years as artisanal and semi-industrial output has grown and as high prices lifted values; much of it is exported, refined or sold onward through international bullion channels, though informal leakage to neighbouring countries understates the official figure. Round and sawn timber from the forest concessions, palm oil from the newer estates, cocoa from interior smallholders, and small volumes of diamonds complete the export basket. The common thread is rawness: Liberia exports ore, latex, logs and unrefined metal, capturing the lowest-margin link in each chain and leaving smelting, vulcanising, milling and machining to others.

Export destinations are overwhelmingly extra-African. Iron ore, rubber and gold flow to Europe, North America and Asia; Liberia's traditional ties to the United States and the post-war investment from India (ArcelorMittal) and elsewhere reinforce that orientation. Within Africa the gravity accounts place Nigeria first at $41 m and Ghana second at $35 m, with Angola and South Africa close behind at $26 m and $23 m and a long tail of markets worth single-digit millions each; no African partner takes as much as a fifth of Liberia's modest regional total. The pattern is telling: Liberia's regional exports are small, broadly spread and dominated by re-exportable or fungible commodities rather than by genuine regional value-chain trade with its immediate Mano River and ECOWAS neighbours, with whom complementarities are limited because they produce similar goods.

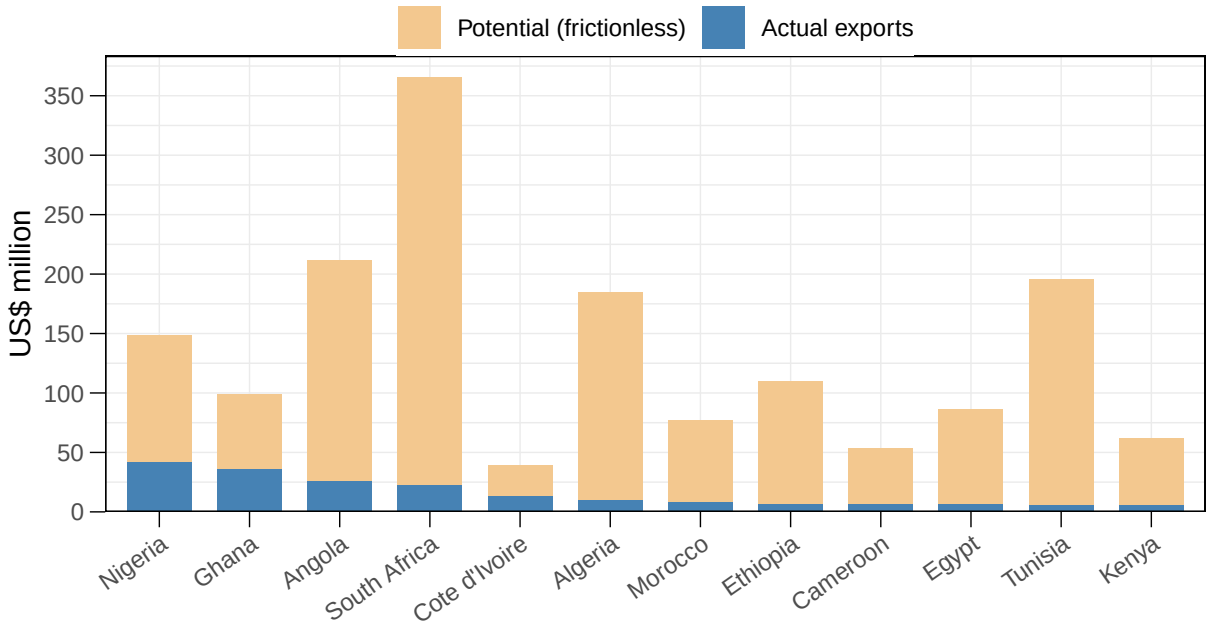
Imports are large relative to exports, concentrated in fuel, food, machinery and vehicles, and sourced from outside the continent. Liberia refines no petroleum and imports all of its refined fuels; it imports the machinery, electrical equipment, vehicles, iron and steel, pharmaceuticals, chemicals and construction materials that its narrow industrial base cannot supply. By origin these come

predominantly from East Asia, Europe, North America and the Gulf, with regional suppliers — Côte d'Ivoire, Nigeria, Ghana, Senegal and Guinea — providing a smaller share of fuel, foodstuffs and consumer goods. The report's import-leakage diagnostics show the largest extra-African input bills falling in water transport ($3.42 bn), air transport ($707 m) and transport equipment ($588 m), and then in public administration ($174 m) and insurance ($163 m) — sectors where rest-of-world sourcing dominates and where regional substitution is, for now, limited.

No import dependence is more politically charged than rice. Rice is the Liberian staple, and domestic production has long fallen far short of consumption, leaving the country reliant on imported parboiled rice from Asia — historically the United States, and now overwhelmingly India, Thailand, Vietnam and other Asian suppliers. This dependence is not merely an economic vulnerability but a recurring source of political instability: the 1979 "rice riots" over a proposed price increase helped precipitate the fall of the True Whig regime, and the price and availability of imported rice remain among the most sensitive issues in Liberian politics. Any external shock to global rice markets or to shipping costs transmits directly to the most basic component of the household budget, and the chronic food-import bill is a permanent drain on foreign exchange that more diversified or food-secure economies do not carry.

Finally, Liberia's external earnings cannot be read from goods trade alone, because of the registry. The open ship registry generates a stream of fee, tonnage-tax and corporate-registration income that, while modest beside the gross value of iron-ore exports, is a significant and relatively stable contribution to the government budget — a services export delivered by a fleet that almost never touches Liberian waters and that therefore leaves no trace in the merchandise statistics or in the MRIO goods accounts. Set against a goods trade that is volatile (hostage to iron-ore and rubber prices), structurally in deficit (because of the fuel and rice import bills), and thinly diversified, the registry's fee income is one of the few external revenue lines that does not depend on a commodity cycle. The composite picture is of an economy that earns its foreign exchange from a handful of mines and plantations and from a global shipping flag, while spending it on fuel, food and manufactured goods bought largely outside Africa — a structure that makes cheaper logistics and a broader, higher-value export base the twin priorities of trade policy.

Figure 2: Liberia: largest intra-African export markets



Notes: Actual exports (blue) against frictionless gravity potential (orange), US$ million. The orange extension is unrealised potential.

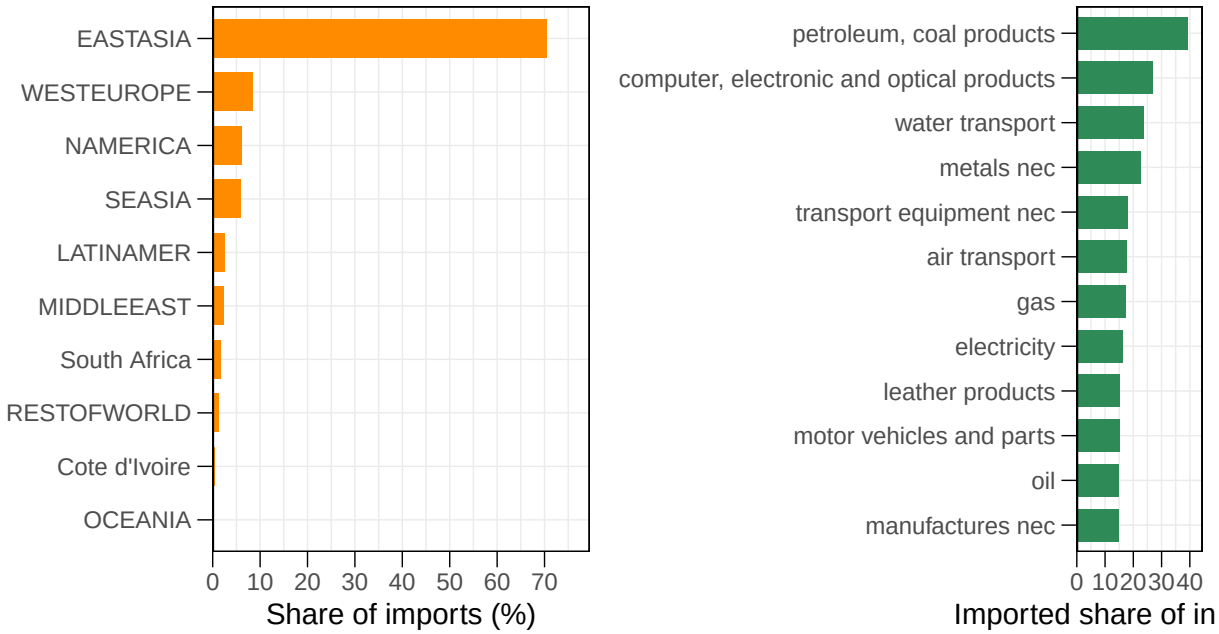
3.4 Extra-African Dependence

Liberia is not in the 18-economy GVC-resolution set, so a full world-region export decomposition is not computed here; its extra-African orientation is captured instead by the import-dependence and value-added diagnostics of Section 6 and the accessibility analysis of Section 4.

3.5 Trade Dependency Analysis

Liberia's import dependence is extreme on both margins the model measures: where its imports come from, and how much of each sector's input bill is bought abroad. Figure 3 sets out both.

Figure 3: Liberia: import dependence by partner and by sector



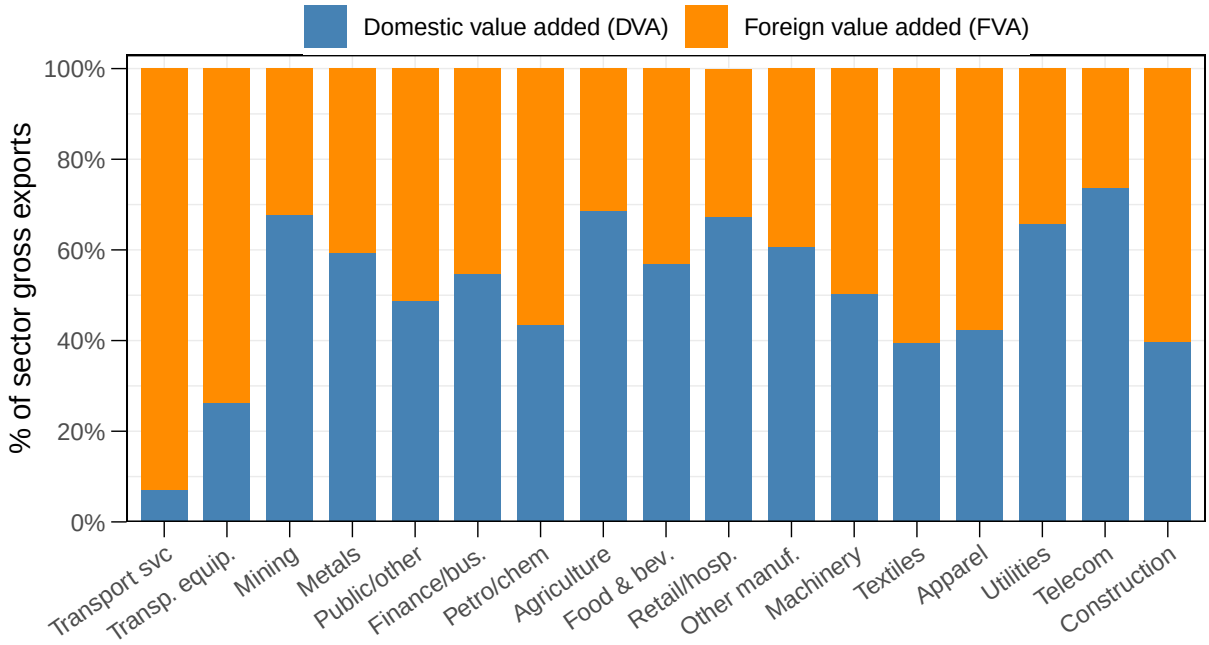
Notes: Left: the ten largest import-source partners as a share of total imports. Right: the twelve GTAP commodities of the 65 with the highest imported share of intermediate inputs.

East Asia alone supplies 70.4% of Liberia's imports, with Western Europe (8.4%), North America (6.1%) and South-East Asia (5.8%) taking most of the remainder; South Africa and Côte d'Ivoire are the only African origins large enough to reach the top ten. On the right-hand panel the most import-dependent commodities are petroleum and coal products, computers and electronics, water transport, metals and transport equipment — the fuel, capital goods and maritime inputs that an economy with no refinery and almost no engineering base must buy abroad.

3.6 Value-Added Decomposition of Exports

Splitting gross exports into the value added at home and the value added abroad shows how little of each export dollar Liberia keeps. Figure 4 does so by broad sector.

Figure 4: Liberia: domestic and foreign value added in gross exports



Notes: The 65 GTAP commodities are aggregated for display into 17 broad groups, weighted by the underlying levels, so no commodity is dropped; the commodity-level table is in Annex C. Domestic value added (DVA, blue) and foreign value added (FVA, orange) by broad sector. The foreign share is the sector's backward GVC-participation rate.

Transport services keeps barely 7% of its gross export value as domestic value added, and transport equipment 26% — the registry and the ore railway both run on bought-in foreign content — while telecommunications (74%), agriculture (68%) and mining (67%) retain the most. That ranking is Liberia's value-capture problem stated in national-accounts terms: the sectors that dominate its measured exports are precisely the ones whose value is created elsewhere, and the sectors that keep their value are small (Koopman et al., 2014).

4. Spatial Connectivity and Market Access

4.1 Domestic Transport Network

Liberia's freight moves predominantly by road; rail is typically thin and only partly operational, and modal options such as inland-water and air carry niche flows. The quality of the trunk network to the border gateways, and of the feeder roads that connect production to those trunks, is the first-mile determinant of its regional competitiveness (Teravaninthorn and Raballand, 2009).

4.2 Regional Corridors

Liberia's external trade moves on the regional corridor network and the gateway ports that serve its sub-region, linking it to gateway ports and to its interior neighbours. Its own ports anchor several of these corridors, giving it a gateway role for parts of the interior.

4.3 Travel Time and Logistics Costs

The spatial model puts Liberia's average delivered transport cost to African markets at 16.6% of cargo value — higher than earlier rounds reported, because dwell time at the gateway is now priced at the value of time and carried into delivered cost — on an average transit of 350 hours and 0.6 border crossings per destination. Those continental averages conceal a wide range: Ghana is reachable at 11.5% of cargo value and Côte d'Ivoire at 12.1%, while South Africa costs 17.9%, Ethiopia 18.5% and Algeria 20.1% (Table 2). Figure 12 makes the pattern explicit — cheap, fast links to the immediate neighbourhood and expensive, multi-day maritime links to everything else.

4.4 Market Access

The Freeport of Monrovia is the master node of Liberia's trade geography, and its performance conditions everything else. As the principal deep-water gateway, it lands the fuel, rice, machinery and consumer goods on which the economy runs and a share of its exports, and its concession to APM Terminals has brought investment in handling capacity. But the Freeport is also a single point of failure: congestion, draft limits, equipment downtime or industrial disruption at this one facility ripple through the entire import-dependent economy, raising the delivered cost of the staple basket. The landside connection from the port into Monrovia and onward to the interior trunk roads is the first-mile bottleneck that determines whether efficiency gains at the quay actually reach inland consumers and producers — but the quay itself is no longer a footnote in this assessment. With dwell time priced at the value of time and carried into delivered cost, port efficiency is worth 29.1% to Liberia's intra-African exports, more than three times corridor upgrading, rail and the border posts combined, and second only to standards reform. For a country whose regional accessibility surface (Section 8) shows a cheap inner ring of neighbours and an expensive oceanic periphery, the Freeport is simultaneously the cheapest route to the rest of the world, the largest operational lever the model identifies, and a chokepoint whose resilience is a national-security concern.

The iron-ore corridor — the Yekepa-to-Buchanan railway and the dedicated ore port — is the country's only heavy-haul logistics asset and a contested piece of shared infrastructure. The railway, originally built by LAMCO and rehabilitated by ArcelorMittal, runs roughly 250 kilometres from the Nimba mines at Yekepa down to the purpose-built ore terminal at Buchanan in Grand Bassa, and it is the spine of the export economy. Its strategic importance now extends beyond Liberia: the same Nimba range straddles the Guinean border, and Guinea's enormous iron-ore deposits — including parts of the Simandou and Nimba complexes — have an obvious natural outlet through Liberian territory to Buchanan rather than through Guinea's own longer routes. The question of "multi-user" access to the railway and port — whether ArcelorMittal must share the line with Guinean ore and other Liberian miners (such as those in the Western Cluster), and on what terms — has become one of the most consequential infrastructure-policy disputes in the country, pitting the original concessionaire's control against the national interest in turning the corridor into a shared regional export channel. Resolving it could make Buchanan a transit gateway for Guinean ore and a source of transit revenue; failing to could leave the corridor an under-used single-shipper asset.

The road network, not rail, carries Liberia's regional and domestic freight, and it is the binding margin for intra-African trade. Liberia's freight moves overwhelmingly by road, much of it unpaved and impassable in the long rainy season, and the trunk routes radiate from Monrovia rather than connecting the interior counties to one another. The most important regional axis runs north-east from Monrovia through Gbarnga to Ganta, the bustling commercial town on the Guinean frontier, where the corridor splits toward Nzérékoré in Guinea and continues to the Ivorian border. This Monrovia–Ganta road is Liberia's principal land artery to the interior and to two neighbours at once, and its condition governs the cost of cross-border trade with Guinea and Côte d'Ivoire. A second axis runs north-west from Monrovia toward the Sierra Leonean border at Bo Waterside, linking into the Freetown trade. The long coastal road to the south-east — toward Buchanan, Greenville and Harper — is the weakest trunk, leaving Sinoe and Maryland counties among the most isolated and their ports under-served.

The named land borders are the friction points where Liberia's regional trade is made or lost. The principal crossings are Bo Waterside and Jendema on the Sierra Leone frontier in the north-west; Ganta and the Yekepa-area crossings into Guinea in the north; and Loguatuo and Toe Town toward Côte d'Ivoire in the east. These posts sit within the Mano River Union and ECOWAS free-movement space, and the communities astride them trade intensively and informally; yet customs procedures, documentation, and the absence of fully operational one-stop border posts add cost and delay, and the model identifies precisely these border-and-corridor frictions, rather than tariffs, as the levers that would convert Liberia's missing trade into realised trade. The borders are also security-sensitive — the same routes carried fighters and arms during the regional wars — so that facilitation and stability are intertwined.

The corridor chokepoints, in the network's own terms, are the Freeport and the regional gateway ports that serve West Africa. Liberia's own betweenness in the continental network is modest; its external trade leans on its single Monrovia gateway and, for some flows, on neighbouring hub ports such as Abidjan and Conakry that appear among the higher-centrality nodes. The strategic implication is twofold. First, redundancy: an economy that funnels almost all of its imports through one port and almost all of its ore through one railway is acutely exposed to disruption at either, so building alternative capacity (a functioning Buchanan general-cargo role, upgraded south-eastern ports, and reliable road redundancy) is a resilience priority, not a luxury. Second, opportunity: by upgrading the Yekepa–Buchanan corridor for multi-user, cross-border ore traffic and by improving the Ganta and Bo Waterside roads, Liberia can shift from being a pure end-point to playing a transit and gateway role for parts of the Guinean and Sierra Leonean interior — the clearest route to capturing corridor revenue rather than only paying corridor costs.

5. Gravity Model Analysis

The gravity model estimates how much Liberia *should* trade with each African partner given size and frictions, by fixed-effects Poisson pseudo-maximum-likelihood — the best-practice specification that absorbs size and multilateral resistance and identifies the friction effects from bilateral variation (Anderson and van Wincoop, 2003; Santos Silva and Tenreyro, 2006; Head and Mayer, 2014).

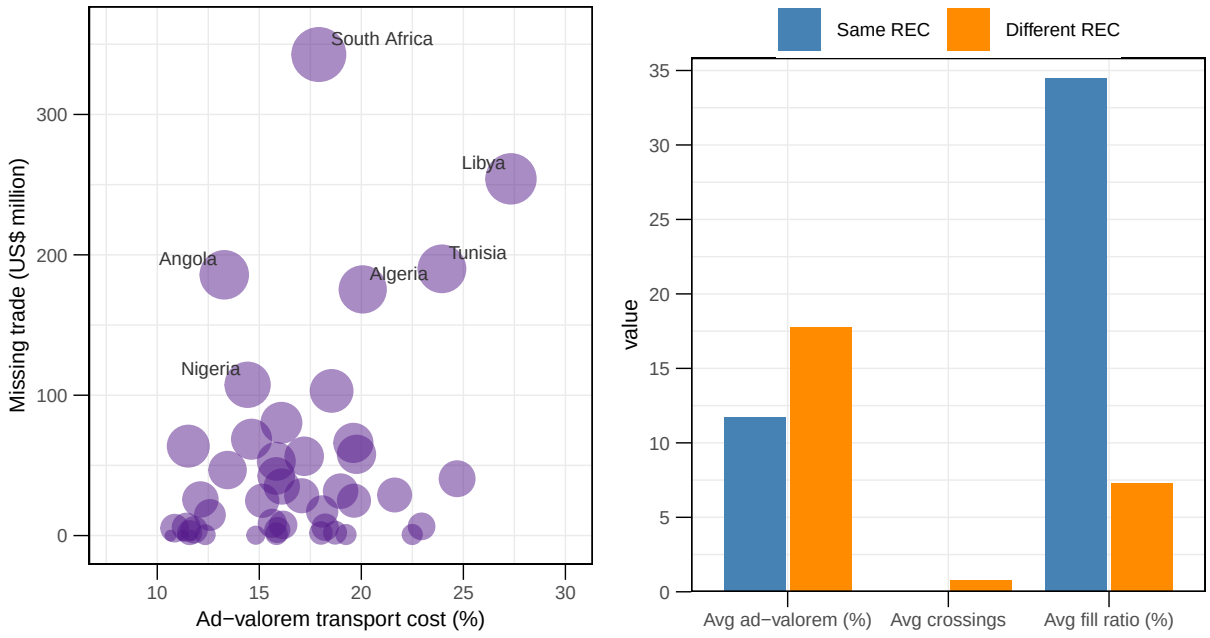
5.1 Actual vs Potential Trade

Aggregated across partners, Liberia's actual intra-African exports of $234 m fall far short of a frictionless potential of $2.5 bn — a missing-trade gap of $2.2 bn and a fill ratio of 0.10. The benchmark is higher than earlier rounds reported because dwell time at the gateway is now priced at the value of time and sits inside the estimated friction, so the frictionless counterfactual removes more cost than it used to. No partner is realised even halfway: Ghana comes closest at 0.36 and Côte d'Ivoire follows at 0.34, while South Africa sits at 0.06 and Algeria at 0.05 (Table 2). The gap is concentrated on the large, distant, high-friction markets rather than on the neighbours (Figure 2).

5.2 Missing Trade

Plotting each partner's missing trade against the friction that separates Liberia from it shows where the gap is concentrated. Figure 5 does this on the left, and decomposes the same relationship into cost, border crossings and REC membership on the right.

Figure 5: Missing trade and the frictions behind it



Notes: Left: missing trade by partner (US$ million) against the transport friction to that partner; bubble area is gravity potential. Right: average transport cost, border crossings and fill ratio for partners inside and outside the same Regional Economic Community.

The largest bubble is South Africa, where $343 m of gravity-predicted trade goes unrealised at a 17.9% ad-valorem cost and one border crossing, followed by Angola at $186 m and 13.3%, Algeria at $175 m and 20.1% and Ethiopia at $103 m and 18.5% — a southern, northern and eastern tail that is expensive to reach by sea and, on current volumes, essentially unserved. Nigeria is the instructive contrast: at 14.4% cost, no border crossing and shared ECOWAS membership it is Liberia's largest African market and still leaves $107 m unrealised, which is what a gap looks like where friction is moderate rather than prohibitive (Novy, 2013).

5.3 Drivers of Under-Trade

The right-hand panel of Figure 5 splits Liberia's partners by whether they share a Regional Economic Community with it.

The ECOWAS partners are cheaper to reach, need no border crossing and are better realised: Ghana at 11.5% ad-valorem cost is 36% filled and Côte d'Ivoire at 12.1% is 34% filled, against 0.06 for South Africa at 17.9% and 0.05 for Algeria at 20.1% (Table 2). That is the empirical fingerprint of the gravity model's common-REC effect, at $+0.91$ (p = 0.003) tied with common language as the most precisely estimated term in the specification: shared bloc membership bundles lower friction — mutual recognition, simpler procedures, proximity — and translates into more realised trade (Carrère, 2006; Baier and Bergstrand, 2007). The drivers, in order of measured effect, are non-tariff and standards barriers, the delivered cost of transport including dwell at the gateway, and border frictions; the tariff term is small and weakly measured rather than demonstrably absent, which is why extending the facilitation that bloc membership bundles to Liberia's non-bloc partners remains among the cheapest ways to raise realised trade.

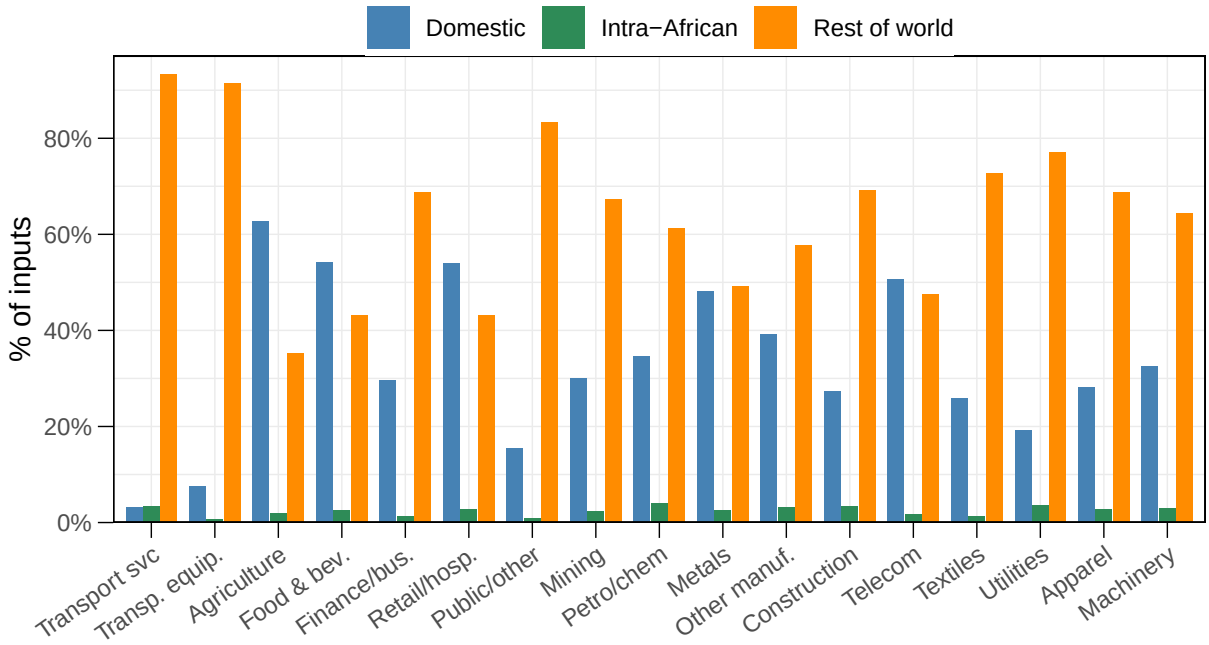
Taken together, the gravity results identify Liberia's missing trade as predominantly a standards-and-logistics problem, and the estimates are worth reading with their own precision in view. All six friction terms are correctly signed: distance, delivered transport cost, border crossings and the applied tariff enter negatively, common language and shared REC membership positively. Four, however, are estimated sharply enough to stand on their own — common language ($+0.66$, p = 0.003), common REC membership ($+0.91$, p = 0.003), the delivered ad-valorem transport cost (-0.09, p = 0.006) and border crossings (-0.28, p = 0.035). Distance (-0.35, p = 0.16) and the tariff (-0.004, p = 0.79) are not individually significant. Two readings follow. Border crossings clears significance for the first time on this run, because pricing the second port call raised cost on the maritime routes without touching the crossing count and so separated the two variables; even so, the term is not "the border effect": the delivered-cost variable already prices border waiting at the value of time and carries roughly 60% of it, which is why cost and crossings are jointly significant (Wald p = 0.013) — so most of the friction at Bo Waterside, Ganta and Loguatuo still shows up in Liberia's cost term rather than in its crossing count. And the tariff term, now identified from GTAP's own bilateral duty data rather than from a proxy the fixed effects absorbed, sits close to zero with a confidence band wide enough to admit a substantial gain, so the defensible statement is that non-tariff and standards reform and port efficiency are the two levers measurably larger than tariff removal, not that tariffs do not bind. These coefficients are the empirical engine behind the counterfactual scenarios of Section 10, which hold Liberia's economic structure fixed and ask what its trade would be under different frictions (Anderson and van Wincoop, 2003; Head and Mayer, 2014).

6. MRIO Value Chain Analysis

6.1 Domestic and Regional Linkages

Liberia's sectors mostly source inputs domestically or from outside the continent, with a thin regional layer in between. Figure 6 sets out the split.

Figure 6: Liberia: input sourcing by sector



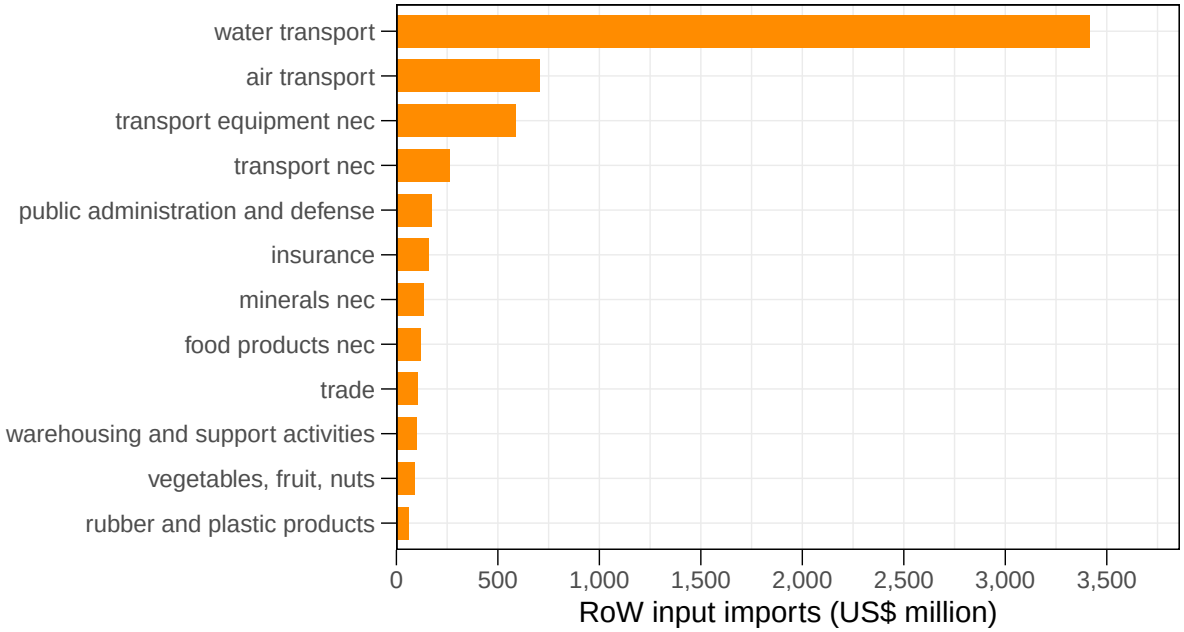
Notes: The 65 GTAP commodities are aggregated for display into 17 broad groups, weighted by the underlying levels, so no commodity is dropped; the commodity-level table is in Annex C. Domestic (blue), intra-African (green) and rest-of-world (orange) shares of intermediate input use.

Water transport buys $3.42 bn of its $3.60 bn input bill from outside Africa and only $132 m from African suppliers; air transport $707 m against $16 m; transport equipment $588 m against $5 m (Annex C). Economy-wide the split is 18.0% domestic, 2.8% intra-African and 79.2% rest-of-world — the intra-African (green) bars are thin in every sector, the direct MRIO counterpart of the concession-enclave structure described in Section 7. Liberia's value chains run domestic-then-global, all but skipping the regional layer, and Section 6.2 quantifies the rest-of-world segment that a regional-sourcing policy could in principle redirect (Foster-McGregor et al., 2015).

6.2 Import Leakage

Water transport carries Liberia's largest extra-African input bill by an order of magnitude — $3.42 bn, more than half of every dollar the economy buys outside Africa — followed by air transport at $707 m, transport equipment at $588 m, other transport services at $264 m, public administration at $174 m and insurance at $163 m (Annex C). Figure 7 ranks the full sector list.

Figure 7: Liberia: extra-African input imports by sector



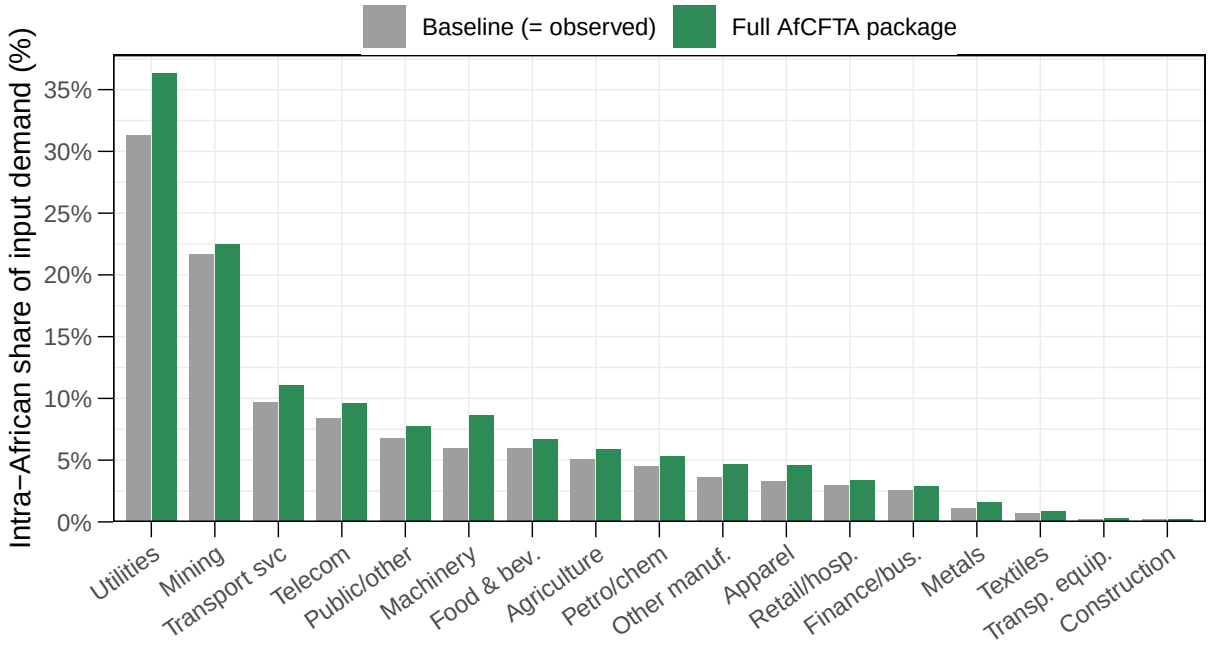
Notes: The twelve largest of the 65 GTAP commodities are shown, ranked on the plotted quantity; the full 65-commodity table is in Annex C. US$ million. This is the addressable regional-sourcing opportunity: demand currently met from outside Africa that a regional supplier could in principle capture.

Not all of this is equally addressable. The registry-driven maritime bill is bought on world shipping markets and is not a regional-sourcing opportunity in any practical sense, and sophisticated machinery has thin African substitutes; but the minerals, food-products, warehousing and rubber-and-plastics lines further down the ranking plausibly have suppliers among Liberia's ECOWAS and Mano River Union neighbours. Those are where a regional-sourcing strategy could convert import leakage into intra-African trade (World Bank, 2020).

6.3 Regional Sourcing and its Response to Facilitation

The import leakage of Section 6.2 raises a question about sourcing: how much of the input demand Liberia currently meets from outside Africa would move to African suppliers if regional frictions fell? The `TradeFuture` sourcing layer answers it with an **Armington CES expenditure share**: for each of the 65 commodities it splits imported input demand between **African suppliers** — priced at the corridor friction of Section 4 — and a **rest-of-world backstop**, at GTAP's own import-source substitution elasticity (ESUBM) for that commodity. The backstop is priced per destination from GTAP's observed international transport margin plus dwell time at the gateway and the inland haul from the Freeport, so it responds to the same port and corridor levers as the regional option does. Both margins are calibrated cell by cell to the observed 2017 pattern, so **the model's baseline equals Liberia's observed sourcing by construction** and there is no "optimal versus actual" gap to report. What the model produces, and what Figure 8 plots, is the *response*.

Figure 8: Liberia: regional sourcing at baseline and under the full AfCFTA package



Notes: Baseline (grey, equal to observed by construction) against the full AfCFTA package (green), intra-African sourcing share by sector.

Across the 65 commodities, the share of Liberia's imported input demand met from African suppliers rises from **2.77% to 3.37%** under the full package — **+0.60 percentage points, +21.6% in relative terms** (Annex C). Both the level and the movement are among the smallest in this group of reports, and the registry is the reason. The allocation is calibrated and smooth — nothing pins at either end of the feasible range, and every supplier the CES gives a finite weight keeps a positive share — but water transport, which alone buys $3.42 bn of inputs outside Africa, moves only +1.2 pp, and air transport ($707 m) the same; transport equipment nec ($588 m) does not move at all. These are bunkers, charter, insurance and vessel services bought on world markets by a fleet that never calls at Monrovia, and no reduction in West African freight friction makes an African supplier of them. Where the response does appear it is in the ordinary economy behind the flag: crops nec (+6.6 pp), raw milk (+6.3 pp), electricity (+5.1 pp), sugar cane and sugar beet (+4.4 pp), machinery and equipment (+4.2 pp), accommodation and food services (+3.2 pp), other transport services (+2.0 pp on a $264 m bill) and food products nec (+1.7 pp on $122 m). Read Liberia's aggregate figure, in other words, as two numbers averaged into one: a large, inelastic maritime bill and a small, responsive domestic input base. Note the denominator: this is the share of *imported* input demand, not of total intermediate use, and it is not the 2.8% intra-African figure quoted in the executive summary, which is measured on all intermediate absorption including domestic supply.

One thing this chart cannot show. The sourcing model's friction matrix is built from delivered *transport* cost alone; tariffs enter the gravity model next door and have no channel here at all. AfCFTA tariff removal therefore registers no movement in this figure, and that zero is a structural blind spot in the sourcing model, not evidence that tariffs are irrelevant to where Liberia buys its inputs.

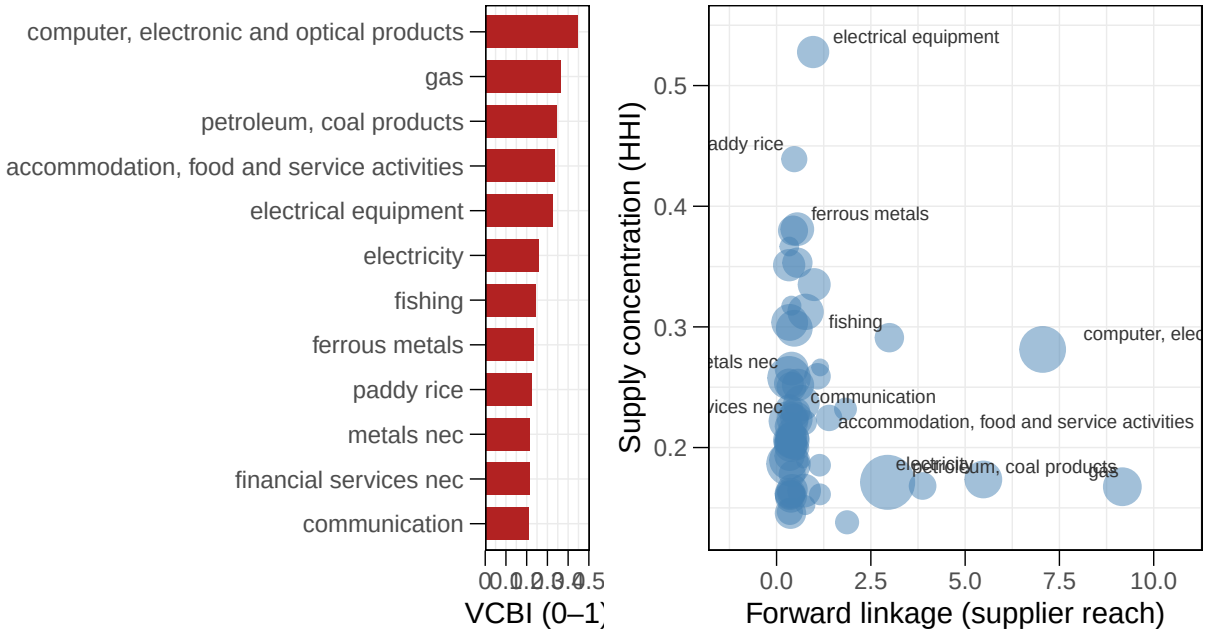
A second result worth stating plainly. Port-efficiency reform raises Liberia's intra-African export

volumes by 29.1% in the gravity model (Section 10) while very slightly *lowering* the regional sourcing *share* here. Both are correct, and the mechanism is not mysterious: every import crosses a quay once, so shorter dwell at the Freeport helps the Asian and European supplier at least as much as the Ivorian one, whereas the overland trade with Guinea, Sierra Leone and Côte d'Ivoire gains less; the gravity model, which contains no rest-of-world alternative, sees only the volume effect. The implication is not to leave the Freeport alone — it is the largest operational lever Liberia has — but to pair dwell reform with the border work at Bo Waterside, Ganta and Loguatuo and the standards agenda that favour the regional option specifically.

6.4 Value-Chain Bottleneck Index

The Value-Chain Bottleneck Index combines a commodity's forward linkage — how many downstream users depend on it — with how concentrated its supply is and how much of it is imported. Figure 9 ranks Liberia's.

Figure 9: Liberia: the Value-Chain Bottleneck Index



Notes: Left: the twelve GTAP commodities with the highest Value-Chain Bottleneck Index (VCBI) of the 65. Right: the underlying drivers for all 65 — forward linkage (supplier reach) against supply concentration (HHI), with bubble area proportional to import dependence.

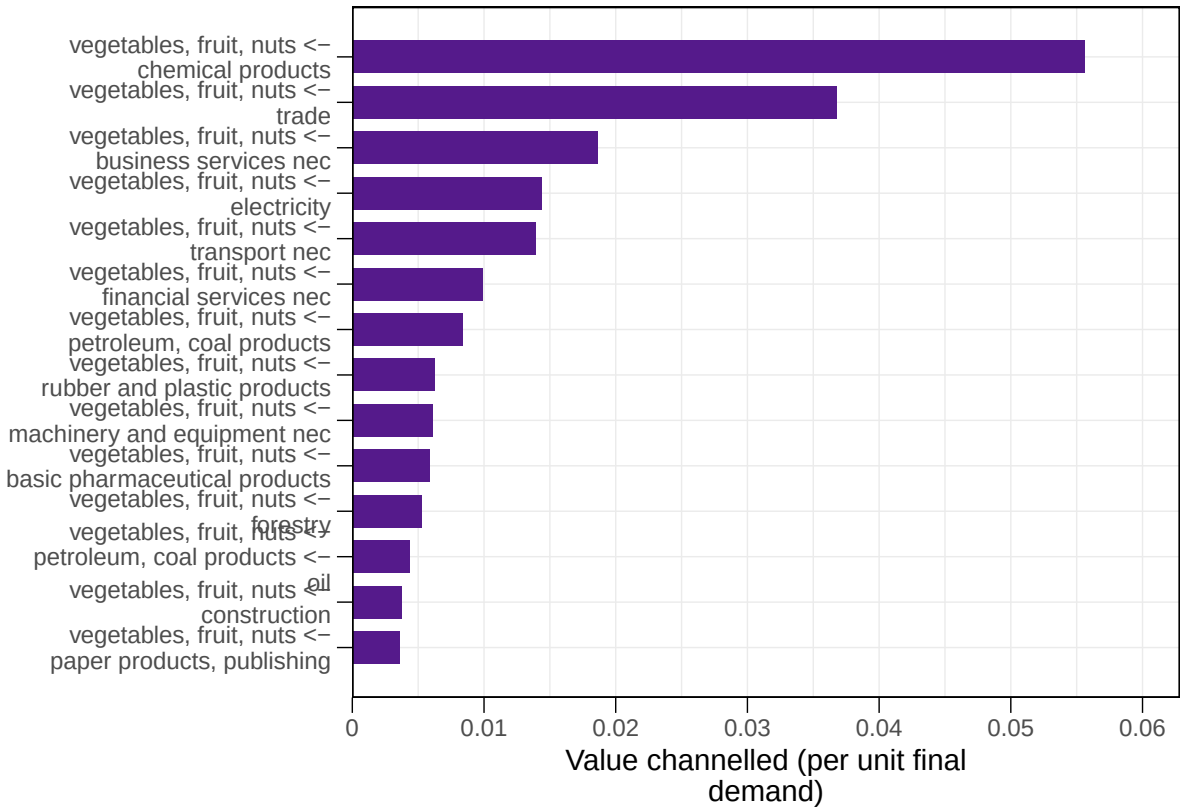
Computers, electronics and optical products top the index at 0.45, then gas at 0.37, petroleum and coal products at 0.35, accommodation and food services at 0.33, electrical equipment at 0.32 and electricity at 0.26. That list is a fair summary of what constrains a Liberian producer: imported fuel and power, imported capital equipment, and the service inputs that sit on top of them. The right-hand panel shows that they arrive at the top of the ranking by different routes — gas has the widest supplier reach of any commodity in the table but unconcentrated supply, computers and electronics combine wide reach with both concentration and heavy import dependence, while electrical equipment is the

most concentrated input of all and reaches comparatively few users. The first two are systemic and the third is a procurement problem.

6.5 Structural Path Analysis

Structural path analysis traces the individual supply chains that deliver inputs into a sector, ranking each by the value it channels per unit of final demand. Figure 10 does it for vegetables, fruit and nuts, the largest agricultural user of intermediate inputs in the Liberian table.

Figure 10: Liberia: structural path analysis of the leading sector



Notes: The dominant supply paths delivering inputs into the sector, ranked by the value each channels per unit of final demand. Each step "A ← B" reads "A draws inputs from B".

The dominant path is chemical products — fertiliser and crop chemicals — followed by trade, business services, electricity and transport. Almost every path is a single step, and the one two-step path that registers runs from oil through petroleum and coal products, which is the fuel bill working its way in. For a horticultural base that is meant to anchor agro-processing, the diagnosis is that its inputs are bought rather than made, and Annex C shows that they are bought almost entirely outside Africa: each of those top paths is a candidate for regional substitution.

7. Priority Value Chains

Across the portfolio, Liberia's priority value chains are its **agro-processing and food** chains (where regional demand and comparative advantage are strongest), its **construction-materials and basic-manufacturing** chains (large regional demand, import-substitutable inputs), and the **enabling services** (transport, logistics, ICT, finance) whose friction raises the cost of trading everything else. For each, the binding constraints recur — standards and SPS, border and corridor friction, energy cost, finance and scale — which is why the cross-cutting reforms of Sections 10 and 12 benefit the whole portfolio rather than any single chain.

Iron ore is the flagship chain, and the prize is moving from ore to concentrate and pellet rather than from ore to steel. Liberia's high-grade Nimba deposits, the rehabilitated Yekepa–Buchanan railway and the dedicated ore port give it a globally competitive position in raw iron ore, anchored by ArcelorMittal and with further deposits in the Western Cluster and Bong range awaiting viable logistics. The realistic upgrading opportunity is not a domestic steel industry — Africa's blast-furnace demand is thin and energy and capital requirements are prohibitive — but beneficiation: building concentration and, eventually, pelletising capacity at Buchanan so that Liberia exports a higher-value, higher-margin product and captures more of the chain at home. The binding constraints are power (beneficiation is energy-intensive and Liberian electricity is scarce and costly), the unresolved multi-user access dispute over the railway and port, and the enclave structure that has historically kept value capture offshore. The opportunity, conversely, is large: a shared corridor handling both Liberian and Guinean ore could justify processing investment that single-mine volumes cannot.

Natural rubber and latex processing is the oldest chain and the one with the clearest domestic-value-addition path. Built on the Firestone/Harbel estate and a substantial smallholder sector across Margibi, Bong and Nimba, Liberia produces latex and primary sheet rubber for export to overseas tyre and goods manufacturers. The chain's weakness is its rawness — Liberia ships crude and minimally processed rubber and imports the finished tyres and rubber goods it consumes — and its dependence on a single dominant buyer-processor and on volatile world prices. The upgrading opportunities are concrete: expanded crumb-rubber and technically-specified-rubber processing, latex-concentrate production, rehabilitation and replanting of aged smallholder stands (much planted decades ago and past peak yield), and eventually simple rubber-goods manufacturing for the regional market. Constraints are processing capacity, quality and grading standards, smallholder finance and extension, and the energy and logistics costs that erode processing margins.

Oil palm is the newest large-scale agro-industrial chain and the most socially contested. Post-war concessions to operators developing estates in Grand Bassa, Sinoe and the south-east aimed to make Liberia a palm-oil producer, exploiting a climate ideally suited to the crop. The chain's promise is import substitution (Liberia and the region import edible oils) and export to a large West African market led by Nigeria, plus downstream refining and oleochemicals. Its constraints are acute: land-tenure and community-consent disputes that have stalled or shrunk several concessions, the long gestation of plantations, milling capacity, and the reputational and regulatory pressure around forest conversion in a country holding the Upper Guinean forest's largest remnant. A smallholder-inclusive,

deforestation-sensitive model is the opportunity that would make the chain both larger and durable.

Gold has become a major and fast-rising chain, but one that leaks value through informality. Artisanal and semi-industrial gold from the interior valleys, plus industrial operations such as New Liberty in Grand Cape Mount, has lifted gold to rival rubber as an export earner, helped by high world prices. The capacity is real and dispersed; the constraints are the informality and cross-border smuggling that deprive the treasury of royalties and obscure true volumes, weak control over mercury use and environmental damage, and limited domestic refining or assaying. The opportunity is to formalise and aggregate artisanal output, establish credible assay and gold-trading infrastructure, and capture more of the chain through transparent export channels — a governance and finance challenge as much as a geological one.

Timber and wood-processing rest on a genuine resource but a troubled record. Liberia's forests are a substantial asset, and the post-war lifting of "conflict timber" sanctions reopened legal logging under concessions in the south-east. The chain remains overwhelmingly export of round and rough-sawn logs, with minimal domestic milling, kiln-drying or furniture manufacture, so most value escapes. Constraints are forest-governance and legality concerns (Liberia's commitments under voluntary partnership arrangements with the EU and its high-profile conservation pledges), the poor south-eastern road network that raises extraction costs, and weak processing capacity. The sustainable opportunity lies in certified, higher-value processed wood products and in monetising forest conservation itself through carbon and biodiversity finance, which may be worth more standing than felled.

Fisheries, both marine and inland, are an under-developed chain feeding domestic food security and a modest export. Liberia's Atlantic waters and the registry-adjacent maritime domain support artisanal canoe fisheries and an industrial trawl sector, but the chain is constrained by illegal, unreported and unregulated fishing by foreign vessels, weak monitoring and enforcement, limited cold-chain and landing infrastructure, and minimal processing. Strengthening surveillance, landing sites, cold storage and value-adding processing would improve both protein security and export potential.

Finally, the maritime registry is itself a tradable services value chain — Liberia's most successful global export by reach. The open ship registry, administered from the United States, is a sophisticated services business generating fee, tonnage-tax and corporate-registration income from one of the world's largest fleets. Unlike the commodity chains, it is not constrained by domestic logistics or energy; its constraints are reputational and regulatory (flag-state safety and labour performance, sanctions-compliance scrutiny of the fleet) and the fact that almost none of the associated maritime services — classification, crewing, insurance, ship management — are performed in Liberia itself. The upgrading opportunity, ambitious but real, is to capture more of the maritime-services chain onshore: training Liberian seafarers, building domestic maritime administration and legal capacity, and converting the flag into a platform for a broader maritime-services economy rather than a pure rent.

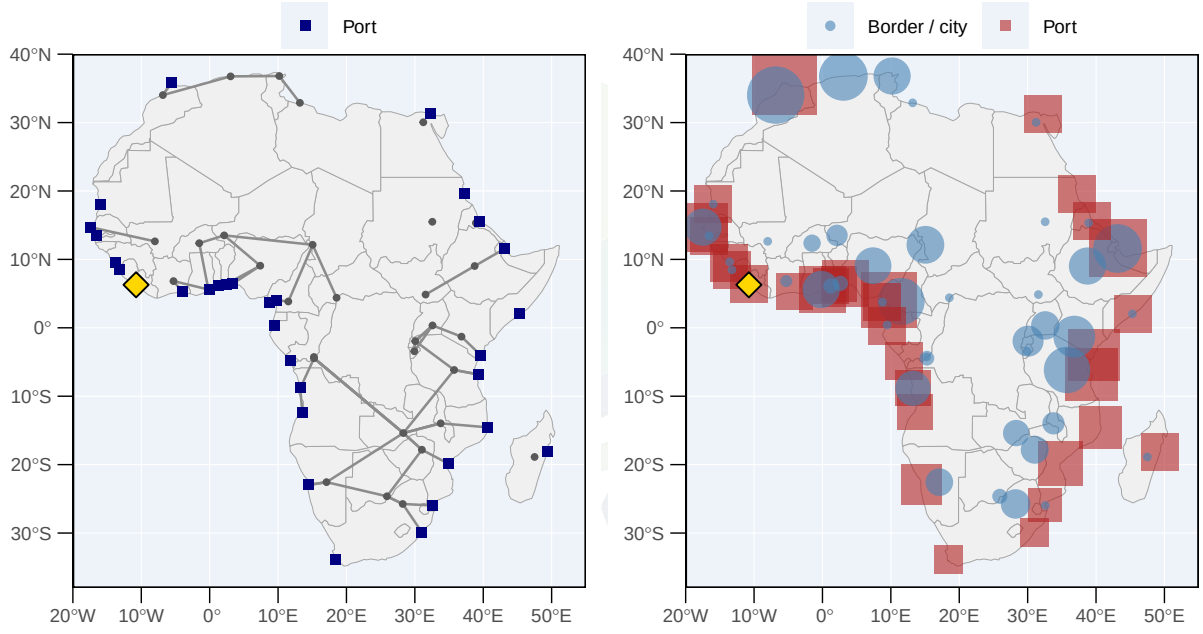
8. Trade Network Position

The corridor-plus-maritime network is assembled by `build_network`; country-to-country reach is computed by the spatial-access function `accessibility` (least-cost Dijkstra routing); and centrality is assessed by betweenness on the same network (Freeman, 1977).

8.1 Country as Trade Node

Figure 11 places Liberia on the modelled corridor-and-maritime network: navy squares mark gateway ports, grey dots capitals, grey lines the corridors, with Liberia's own links highlighted.

Figure 11: Position in the African trade-corridor network



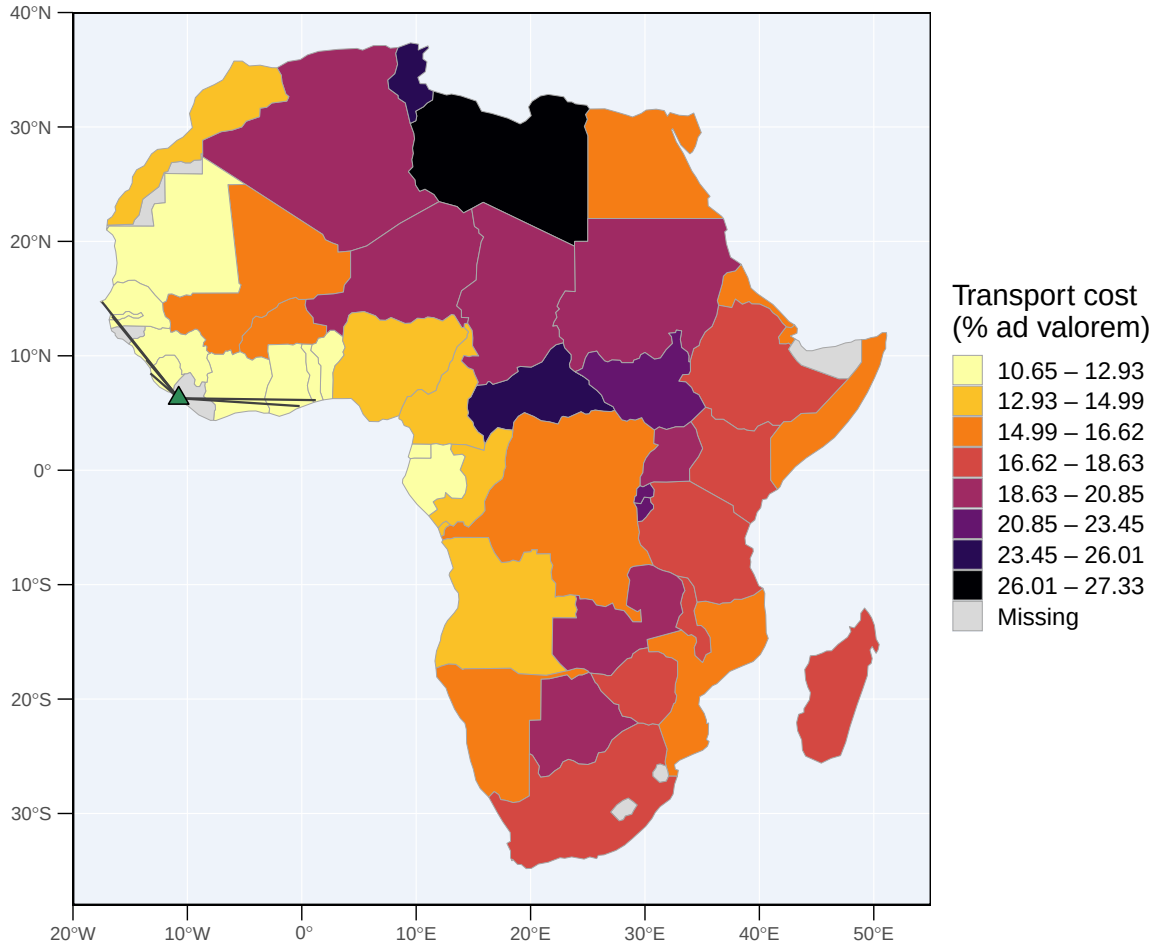
Notes: Left: the corridor network drawn geographically, with this country's corridors highlighted and its capital starred. Right: betweenness centrality of ports and border gateways; marker area is proportional to betweenness.

The left panel shows a radial, port-oriented network in which corridors run from coastal gateways inward to capitals, with few interior-to-interior links; Liberia sits on the coast with the Freeport as its own gateway, but its overland links to Guinea, Sierra Leone and Côte d'Ivoire remain the binding margin for regional value-chain trade. The right panel's betweenness ranking (Table 9) confirms that Liberia's own centrality in the continental network is modest, with neighbouring hub ports such as Abidjan and Dakar carrying more of the region's transit traffic — the corridors highlighted here are nonetheless the physical assets on which Liberia's entire external-trade strategy rests, and therefore the first call on any infrastructure-and-facilitation budget.

8.2 Accessibility and Reach

Figure 12 maps the delivered ad-valorem transport cost from Liberia to every African destination, dark for cheap and bright for expensive.

Figure 12: Liberia: spatial accessibility to African markets



Notes: Delivered transport cost to each destination, from the accessibility calculation.

The surface confirms geographically what Section 5 finds statistically: a dark inner ring of Mano River Union and wider ECOWAS neighbours is reachable relatively cheaply overland, while a bright outer tier can only be reached by a long, expensive sea leg. Deepening trade with the low-cost neighbours — not chasing distant markets — is the efficient strategy this map implies.

8.3 Centrality and Critical Nodes

The right panel of Figure 11 above already shows where betweenness concentrates in Liberia's neighbourhood: at the larger regional gateway ports rather than at Monrovia itself. A node's betweenness measures both its leverage, in that an efficiency gain there propagates to every route using it, and its fragility, in that disruption fragments those same routes. Because Liberia funnels almost all of its imports through the single Freeport gateway and almost all of its ore through the single Yekepa–Buchanan railway, its own exposure is concentrated rather than diffused: the high-betweenness regional nodes it depends on are a source of leverage it cannot capture directly, while its own low-redundancy infrastructure is the single-point-of-failure risk it can and should mitigate directly, as Section 7 sets out.

8.4 Vulnerability

Liberia's network exhibits the vulnerabilities the model is designed to expose: a dependence on its gateway ports and the overland corridors that distribute from them, and exposure to climate and security shocks on those corridors. The resilience implication is to invest in redundancy and climate-proofing alongside efficiency, because the same fragile logistics that constrain trade can, under a shock, surrender years of integration gains (Maliszewska and Ruta, 2020).

9. Bottleneck Diagnostics

9.1 Physical

Road condition and feeder-road gaps; thin and poorly interconnected rail; congested border infrastructure; and, for many sectors, the cost and reliability of power.

9.2 Policy

Non-tariff barriers and divergent standards are the largest friction the gravity model identifies (Section 5), and one of only two it separates from tariff removal at conventional confidence; dwell and clearance at the Freeport, the other, follow at 29.1%; customs procedures, documentation and rules of origin add cost; tariffs, already low within Liberia's RECs, are measured small (1.8%) but imprecisely (Kee et al., 2009; UNCTAD, 2021).

9.3 Productive capacity

Energy cost and reliability; limited access to affordable finance; a shallow technical-skills base; small firm size; and dependence on imported inputs (Section 6.2) that raises costs and exposes producers to supply shocks.

9.4 Institutional

Agency coordination at borders; incomplete one-stop-border-post and single-window coverage; partial electronic customs and cargo tracking; and the capacity of standards bodies and mutual-recognition arrangements.

The deepest bottleneck is structural: Liberia remains a concession-enclave economy in which the leading sectors are foreign-operated islands with shallow domestic linkages. Iron ore, rubber and the larger agro-industrial estates were built as self-contained operations — company towns, dedicated railways and ports, imported inputs, expatriate management — designed to extract a commodity and ship it abroad with minimal connection to the surrounding economy. This architecture, inherited from Firestone in 1926 and LAMCO in the 1950s and substantially reconstituted after 2003, means that export growth does not automatically generate the supplier industries, processing capacity and skilled employment that broaden development. The MRIO sourcing accounts capture the symptom precisely: even input-intensive Liberian sectors source overwhelmingly domestically or from the rest

of the world, with the intra-African layer almost absent, because the enclaves buy their sophisticated inputs offshore and the domestic economy has not been built to supply them. Breaking the enclave structure — through local-content requirements, supplier development, shared-use infrastructure and downstream processing — is the central industrial-policy challenge, and it underlies most of the more specific bottlenecks below.

Infrastructure is thin, war-damaged and incompletely rebuilt. The road network is largely unpaved and seasonally impassable, the trunk roads radiate from Monrovia without good inter-county links, and the south-eastern counties are chronically isolated; the only heavy-haul railway serves a single commodity and a single shipper; and the country depends on one principal port. First- and last-mile connectivity — feeder roads from farms and mines to the trunks, and the landside links from the Freeport into the interior — is the practical determinant of delivered cost, and it is weak. The report's emphasis on transport and border friction as the dominant drivers of under-trade points to infrastructure as a first-order, capital-intensive constraint, consistent with a Logistics Performance Index of 2.4/5 and the 16.6% of cargo value Liberian exports pay to reach an African market once dwell at the gateway is priced in (Section 4).

Energy is among the most binding constraints of all, and it caps every processing ambition. Liberia has some of the lowest electricity access and highest power costs in the world; the Mount Coffee hydropower plant, destroyed in the war and rehabilitated post-2003, restored some capacity but supply remains scarce, concentrated in Monrovia, and expensive, and most firms self-generate from costly diesel. Because every upgrading opportunity in the value chains — ore beneficiation, rubber and palm processing, timber milling, fish cold chains — is energy-intensive, the cost and unreliability of power is the single technical factor most likely to keep Liberia exporting raw commodities. Affordable, reliable energy (regional power-pool integration, hydropower expansion, and grid extension) is a precondition, not a complement, for industrialisation.

Finance is shallow, dollarised and expensive. The dual-currency system and a small, concentrated banking sector leave interest rates high, credit scarce and long-term and trade finance largely unavailable to the smallholders, processors and small firms that a diversification strategy depends on. Without access to affordable working and investment capital, rubber replanting, palm milling, gold aggregation and fish processing cannot scale, and the productive-capacity gap the report identifies persists.

Non-tariff barriers, standards and customs frictions are, in the model, the largest addressable lever, with port-side dwell immediately behind them. Tariffs within ECOWAS are already low, which is one reason the measured tariff lever is small; the costs that bite are divergent standards and SPS requirements, documentation, slow and uncoordinated customs procedures at the Freeport as well as at the land posts, incomplete one-stop border posts at Bo Waterside, Ganta and the Ivorian crossings, and partial single-window and electronic-customs coverage. For an economy whose realistic regional market is its immediate Mano River and ECOWAS neighbourhood, these border and standards frictions are exactly what separate latent regional trade from realised trade, and they are cheaper and faster to dismantle than infrastructure.

Institutions and governance close the list, and they condition everything. Liberia is rebuilding state capacity from a very low post-war base: customs and standards bodies are under-resourced, mutual-recognition arrangements are weak, and the coordination among border agencies needed for one-stop posts is incomplete. Beyond trade administration, the governance of the concession economy — transparent royalty collection, credible contract enforcement, resolution of the multi-user railway dispute, control of gold and timber leakage, and the land-tenure and community-consent disputes that have stalled palm and other investments — determines whether the resource base translates into broad development or remains captured and contested. Corruption, limited technical skills and small administrative scale compound the problem. None of the model's facilitation gains will materialise without the institutional capacity to deliver them, which is why institution-building underpins the whole reform agenda.

10. Scenario Analysis

Ranking Liberia's policy levers by their modelled effect on intra-African exports produces a clear order, set out in Table 3 and drawn in Figure 13 (Maliszewska and Ruta, 2020; UNECA, 2021).

Non-tariff and standards harmonisation alone would lift exports by 68.5%, more than twice the next-largest single lever, port efficiency at 29.1%; corridor upgrading adds 4.3%, rail investment 3.6%, AfCFTA tariff removal 1.8% and one-stop border posts 1.4%.

The port result overturns an earlier reading of this table and deserves to be stated plainly. Dwell time at the Freeport is now priced at the value of time and carried into the delivered cost the gravity model estimates from, rather than moving a transit-time variable that never entered the regression. On that corrected accounting Liberia's binding costs are *not* only landside and regulatory: the quay is the second-largest single lever in the set, worth more than three times corridor upgrading, rail and the border posts combined, and it is an operational reform — gate hours, berth productivity, agency coordination — rather than a capital programme. The tariff figure should also be read with care. Liberia already trades duty-free within ECOWAS, which is a reason its *measured* tariff lever is small, but the estimate is imprecise enough that a substantially larger gain cannot be ruled out, and of the six single levers only non-tariff and standards reform and port efficiency separate from it at conventional confidence; on this run it sits above the border-post lever rather than level with it. One asymmetry belongs with the port result and is developed in Section 6: faster ports raise Liberia's intra-African export volumes here while marginally reducing the share of its inputs bought regionally, because every import crosses a quay once whereas the overland trade with its Mano River neighbours does not gain proportionately.

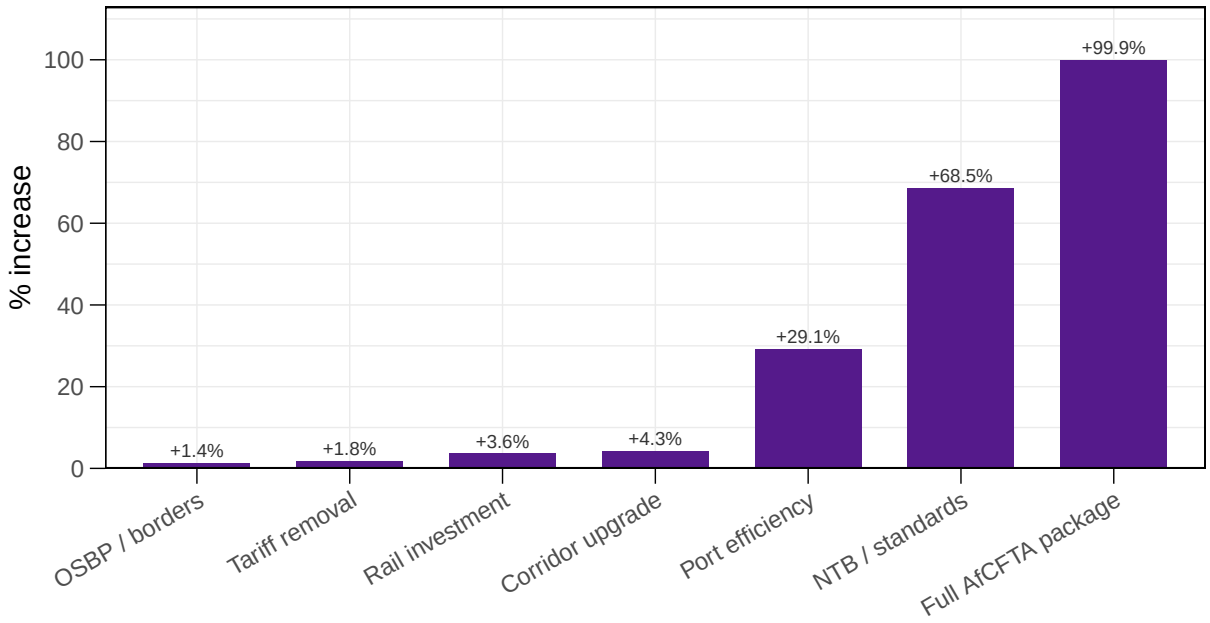
Table 3: Liberia: Projected uplift in intra-African exports by policy scenario

Scenario	Uplift
Full AfCFTA package	99.9%
NTB / standards harmonisation	68.5%
Port efficiency	29.1%
Corridor upgrading	4.3%
Rail investment	3.6%
AfCFTA tariff removal	1.8%
One-stop border posts	1.4%

Notes: Each scenario is a counterfactual on the estimated gravity frictions, holding economic structure fixed. The combined package is sub-additive because the levers overlap. The tariff lever now scales a measured bilateral applied rate rather than a proxy; its estimated effect is small and imprecise, so a low figure here is a weak estimate rather than a demonstrated irrelevance.

The combined package, at 99.9%, is sub-additive — less than the sum of its parts — because the levers overlap: once Liberia's borders are fast and its standards recognised, part of the corridor-upgrade gain is already banked. It still exceeds the largest single lever by more than thirty percentage points, which is the case for pursuing facilitation, standards harmonisation and gateway reform together rather than sequentially. The same machinery runs in reverse: a climate or security shock to the Monrovia–Ganta road or to the Freeport would cut Liberia's regional trade by a comparable double-digit margin, which is the resilience argument for climate-proofing the corridors alongside upgrading them.

Figure 13: Liberia: projected uplift in intra-African exports by policy scenario



Notes: Percentage increase against the calibrated baseline. Each scenario is a counterfactual on the estimated gravity frictions, holding economic structure fixed.

11. Economic Impact Assessment

Liberia falls outside the CGE focus set, so no general-equilibrium welfare path is computed for it here. By the same general-equilibrium logic — and consistent with the AfCFTA welfare assessments — intra-African trade-cost reductions would raise its welfare through cheaper imported inputs and improved market access, with the largest proportional gains accruing to the more isolated, high-friction economies (Maliszewska and Ruta, 2020; Costinot and Rodríguez-Clare, 2014; Dekle et al., 2008).

Through the model's structure and the 99.9% export response of Section 10, a serious facilitation programme would raise Liberia's exports (led by its competitive value chains), lower input costs, expand output and employment in the labour-intensive tradable sectors, and — through the real-wage channel — reduce poverty, while a modal shift to rail and corridor efficiency would lower freight-emissions intensity.

12. Policy Prioritisation

Ranking reforms by **impact** × **feasibility** × **cost-efficiency** × **time** sorts Liberia's options into tiers:

- **Quick wins (0–2 years):** non-tariff-barrier removal and standards/SPS harmonisation (≈68.5%, the largest single lever the model identifies, and institutional and fast); dwell and clearance reform at the Freeport of Monrovia (≈29.1%, the second-largest lever and operational rather than capital-intensive); one-stop border posts and digital customs at Bo Waterside, Ganta and the Ivorian crossings (≈1.4%).

- **Medium-term (2–5 years):** regional-sourcing and local-content coordination; standards-body and customs modernisation; trade-finance and payments integration.

- **Strategic infrastructure (5–15 years):** corridor upgrading (≈4.3%) and multi-user rail on the Yekepa–Buchanan line (≈3.6%), plus the berth, yard and landside capacity at the Freeport without which the quick-win dwell gains cannot be sustained.

- **Industrial policy:** energy-cost reduction, serviced industrial land, and capacity-building in the priority value chains (Section 7).

- **Enabling:** AfCFTA tariff liberalisation — the legal floor, measured at 1.8% on its own; the estimate is imprecise, so its place in this tier reflects weak measurement rather than demonstrated irrelevance.

Two cautions apply throughout: trade-cost-reducing measures raise welfare even where they lower measured GDP and must not be discarded on a GDP test; and financing matters as much as design, since an intervention's growth case can be undone by how it is paid for.

13. Implementation Roadmap

Liberia's policy framework is set by successive national development plans that share a common diagnosis: diversify beyond the enclave commodities and fix the infrastructure, energy and institutional deficits that hold the economy back. The post-war recovery was guided by the Poverty Reduction Strategy and then by the Agenda for Transformation; under the Weah administration the Pro-Poor Agenda for Prosperity and Development (PAPD, 2018–2023) organised priorities around power and roads, human capital, the economy and governance. The current government's flagship is the ARREST agenda — built on the pillars of Agriculture, Roads, Rule of law, Education, Sanitation and Tourism (with health) — which restates the same structural priorities: raise agricultural productivity and food self-sufficiency (above all in rice, to break the politically charged import dependence), build the road network that is the binding logistics constraint, and strengthen the rule of law and governance on which investment and concession credibility depend. For trade policy specifically, the operative implication of these plans is consistent with the model's finding: the gains lie in roads, energy, agriculture and institutions far more than in tariff schedules.

Within the region, Liberia's commitments run through ECOWAS, the Mano River Union and the AfCFTA, and the priority is implementation rather than new commitments. As a founding ECOWAS member Liberia is bound by the regional free-movement and trade-liberalisation scheme and is, in principle, integrating toward the ECOWAS common external tariff; as a Mano River Union member with Sierra Leone, Guinea and Côte d'Ivoire it shares a framework for the very borders across which most of its regional trade passes. It has signed and is implementing the AfCFTA. The report's central result — a fill ratio of 0.10, a $2.2 bn missing-trade gap, and intra-African gains driven by standards, gateway efficiency and border facilitation rather than by tariffs — tells Liberia exactly where to concentrate: not on signing further agreements but on operationalising the ones it has, by cutting dwell and clearance time at the Freeport, completing one-stop border posts at Bo Waterside, Ganta and the Ivorian crossings, digitising customs and rolling out a single window, harmonising standards and SPS with its neighbours, and joining mutual-recognition arrangements. These are institutional, low-cost and fast, and they are the quick wins the policy prioritisation places first.

Concession review and renegotiation are the distinctively Liberian instrument of trade and industrial policy, and the multi-user infrastructure question is the test case. Because the economy was built on concessions, the terms of those agreements — royalty rates, local-content and processing obligations, infrastructure-sharing, environmental and community provisions — are the levers through which Liberia can either perpetuate the enclave model or begin to dismantle it. The ArcelorMittal iron-ore agreement and its amendments, and in particular the unresolved question of multi-user, cross-border access to the Yekepa–Buchanan railway and the Buchanan ore port, sit at the centre of this agenda: opening the corridor to Guinean ore and to other Liberian miners would transform a single-shipper asset into a shared regional export channel and a source of transit revenue, while embedding beneficiation obligations would push value capture onshore. The land-tenure and community-consent disputes that have stalled palm and timber concessions, the formalisation of artisanal gold to capture royalties, and the legality and certification commitments in the forest sector

are the other fronts. A credible, transparent and consistently enforced concession-review framework is therefore not a side issue but a core trade-and-development instrument.

The priority sequence that emerges is clear and consistent with the model. First, the cheap, fast facilitation reforms: dismantle non-tariff barriers, harmonise standards and SPS, cut dwell and clearance time at the Freeport, and complete one-stop border posts and digital customs — the largest and most immediate levers for converting Liberia's unrealised regional trade into actual trade, and between them worth more than three-quarters of the full package. Second, the medium-term capacity reforms: develop domestic and regional supplier linkages and local content to erode the enclave structure, modernise standards and customs bodies, and deepen trade finance and payments integration so that smallholders and processors can actually participate. Third, the capital-intensive strategic investments: upgrade and climate-proof the trunk corridors (Monrovia–Ganta, the Bo Waterside road, the south-eastern coastal route), resolve and upgrade the Yekepa–Buchanan corridor for multi-user traffic, rehabilitate the secondary ports, and — above all — expand reliable, affordable power, without which no processing ambition is feasible. Fourth, the enabling foundation: implement AfCFTA and ECOWAS tariff liberalisation as the legal floor — necessary, and measured at 1.8% on its own, an estimate small enough to sit near the bottom of the ranking and imprecise enough that it should be read as weakly measured rather than shown to be inert.

Cutting across all of this, three Liberia-specific imperatives anchor the agenda. Food security and the rice-import problem must be treated as a strategic, not merely agricultural, objective, given its history as a trigger of political upheaval. The maritime registry must be protected and, ideally, leveraged — its fee income is a rare non-commodity, counter-cyclical revenue line, and onshoring more of the maritime-services chain (seafarer training, administration, legal capacity) is a genuine diversification opportunity. And resilience must be built into every corridor and port investment, because an economy that depends on one port, one railway and a narrow set of commodities can surrender years of integration gains to a single climate, price or security shock — the same fragility that the Ebola epidemic and the post-2014 commodity collapse exposed. Pursued together, resiliently, and grounded in a transparent reform of the concession economy, these policies offer Liberia a credible path from a raw-commodity enclave economy toward a diversified, value-adding and regionally integrated trade position.

14. Conclusions and Recommendations

Liberia realises $234 m of an estimated $2.5 bn of intra-African export potential — a fill ratio of 0.10 and a missing-trade gap of $2.2 bn. Beneath that headline the diagnostic ranks four constraints: **non-tariff barriers and divergent standards** (the largest friction the gravity model identifies, worth 68.5% of additional exports on its own, and one of the two levers measurably larger than tariff removal), **gateway and border friction** — dwell at the Freeport of Monrovia, the other, is worth 29.1% by itself, ahead of the corridors, the railway and the land posts — **shallow regional value chains and high extra-African import leakage** (only 2.8% of its inputs are bought in Africa, and the registry's maritime bill barely responds to any of this), and **productive-capacity gaps**. The tariff lever is small

(1.8%) but imprecisely estimated, and should be read as weakly measured rather than as shown to be irrelevant. Liberia's best opportunities lie in deepening trade with its natural neighbouring markets — Nigeria, Ghana and Côte d'Ivoire — and in the large, expensive markets to the south and north, led by South Africa, where $343 m of predicted trade goes unrealised. Its priority reforms, in sequence, are: dismantle non-tariff barriers and harmonise standards; complete one-stop border posts and digital customs; upgrade and de-risk the corridors; lower energy costs and build value-chain capacity; and implement AfCFTA tariff liberalisation as the enabling floor. Done together and built resiliently, these reforms would be expected to raise intra-African exports by about 99.9% and deliver broad-based, progressive welfare gains (Maliszewska and Ruta, 2020; UNECA, 2021).

A. Data Sources and Reproducibility

Built on the GTAP MRIO database and World Bank indicators with the `TradeAnalytics`, `TradeFuture` and `KITEAnalytics` Julia packages, on a GTAP Africa V3 (2017) basis at 65 commodities (Aguiar et al., 2022). Gravity flows (`missing_trade`, `missing_pairs`) are in US dollars; MRIO sourcing and GTAP bilateral values in thousands; all converted to US$ million for display. GTAP records gross flows, so magnitudes exceed official merchandise statistics. Macroeconomic figures (Section 2) are approximate external sources (World Bank WDI; IMF; national statistics). All figures are reproducible from `country_figures.jl`, `country_optimize_all.jl` and `country_report_gen.jl`; every model result is also written as a CSV under `output/`.

Two scope notes apply to the continental aggregates quoted here. First, the model covers 46 African economies; $7.6 bn (9.6%) of GTAP's intra-African trade involves countries outside that set and is counted as extra-African, which is why the model's intra-African total is about $71 bn rather than GTAP's $78.9 bn. Second, an earlier edition of this diagnostic, estimated on a different multi-region input–output basis, returned a degenerate gravity solve for Liberia — a fitted potential at or below observed trade, and therefore no usable missing-trade gap and no scenario results. That defect does not affect the estimates reported here, which are drawn from the GTAP Africa V3 re-estimation.

B. Intra-African trade partners

Table 4: Liberia: top 15 intra-African export partners

Partner	Actual ($m)	Potential ($m)	Missing ($m)	Ad-val %	Crossings	Same REC
Nigeria	41	149	107	14.4	0	Yes
Ghana	35	99	64	11.5	0	Yes
Angola	26	212	186	13.3	0	
South Africa	23	365	343	17.9	1	
Cote d'Ivoire	13	39	26	12.1	0	Yes
Algeria	9	185	175	20.1	1	
Morocco	8	77	69	14.6	0	
Ethiopia	6	109	103	18.5	1	
Cameroon	6	53	47	13.4	0	
Egypt	6	87	80	16.1	0	
Tunisia	5	195	190	24.0	2	
Kenya	5	62	57	17.2	0	
Mozambique	5	47	42	15.8	0	
Mali	4	57	53	15.8	1	
Libya	4	258	254	27.3	3	

Notes: Ranked by value. Values are GTAP gross flows and exceed official merchandise statistics. The full partner list is in the model output under `assets/data/`.

Table 5: Liberia: top 15 intra-African import partners

Partner (origin)	Actual ($m)	Potential ($m)	Missing ($m)	Ad-val %	Crossings	Same REC
South Africa	204	3377	3173	17.9	1	
Cote d'Ivoire	53	158	105	12.1	0	Yes
Morocco	16	149	133	14.6	0	
Ghana	15	41	27	11.5	0	Yes
Senegal	10	27	18	11.4	0	Yes
Egypt	8	83	75	16.1	0	
Nigeria	4	14	10	14.4	0	Yes
Togo	3	8	5	11.6	0	Yes
Tunisia	2	73	71	24.0	2	
Uganda	2	37	35	19.6	1	
Cameroon	2	14	13	13.4	0	
Kenya	2	20	18	17.2	0	
Angola	1	11	9	13.3	0	
Mali	1	18	16	15.8	1	
Tanzania	1	11	10	17.1	0	

Notes: Ranked by value. Values are GTAP gross flows and exceed official merchandise statistics. The full partner list is in the model output under `assets/data/`.

C. Sector diagnostics

Table 6: Liberia: input sourcing, its response to AfCFTA and value-chain indicators by sector

Sector	Domestic	Intra-Af.	RoW	AfCFTA Δ
Water transport	54	132	3416	+1.2 pp
Air transport	11	16	707	+1.2 pp
Transport equipment…	49	5	588	+0.0 pp
Transport nec	15	9	264	+2.0 pp
Public administration…	18	1	174	+1.9 pp
Insurance	59	2	163	+0.3 pp
Minerals nec	60	5	134	+0.8 pp
Food products nec	153	9	122	+1.7 pp
Trade	112	7	105	+0.4 pp
Warehousing and…	72	5	99	+1.6 pp
Vegetables, fruit…	221	5	90	+2.0 pp
Rubber and plastic…	30	4	64	+3.2 pp
Financial services nec	38	2	61	+0.6 pp
Paper products…	35	3	55	+1.6 pp
Construction	21	3	52	+0.0 pp
Metals nec	64	3	50	+1.6 pp
Forestry	20	1	44	+2.9 pp
Cereal grains nec	102	3	42	+1.0 pp
Chemical products	26	3	40	+3.1 pp
Beverages and tobacco…	32	2	38	+0.9 pp
Communication	31	1	29	+1.2 pp
Vegetable oils and…	43	1	29	+0.1 pp
Accommodation, food…	56	2	27	+3.2 pp
Sugar	8	1	22	+0.1 pp
Textiles	6	0	17	+0.2 pp
Metal products	6	0	16	+0.5 pp
Ferrous metals	8	1	15	+0.1 pp
Manufactures nec	8	1	13	+0.4 pp
Human health and…	9	0	12	+1.0 pp
Education	5	0	10	+0.6 pp
Paddy rice	9	0	10	+2.1 pp

continued on the next page

Table 7 (continued)

Sector	Domestic	Intra-Af.	RoW	AfCFTA Δ
Plant-based fibers	4	1	9	+1.3 pp
Processed rice	37	0	9	+0.1 pp
Business services nec	4	0	9	+0.4 pp
Crops nec	3	0	8	+6.6 pp
Dwellings	6	0	8	+0.0 pp
Basic pharmaceutical…	6	0	7	+0.5 pp
Mineral products nec	4	0	7	+1.3 pp
Electricity	1	0	6	+5.1 pp
Oil seeds	11	0	6	+3.8 pp
Recreational and…	6	0	6	+0.7 pp
Wood products	7	0	5	+3.2 pp
Water	2	0	4	+2.4 pp
Leather products	2	0	3	+2.2 pp
Wearing apparel	1	0	3	+0.3 pp
Raw milk	10	0	3	+6.3 pp
Sugar cane, sugar beet	2	0	2	+4.4 pp
Real estate activities	1	0	2	+0.2 pp
Fishing	0	0	1	+0.1 pp
Machinery and…	1	0	1	+4.2 pp
Meat products nec	3	0	1	+0.6 pp
Bovine meat products	5	0	1	+0.2 pp
Dairy products	2	0	1	+1.7 pp
Animal products nec	1	0	1	+0.0 pp
Oil	0	0	1	+0.0 pp
Wheat	1	0	1	+0.0 pp
Motor vehicles and…	0	0	0	+1.6 pp
Electrical equipment	0	0	0	+1.3 pp
Petroleum, coal…	0	0	0	+0.7 pp
Bovine cattle, sheep…	1	0	0	+1.0 pp
Computer, electronic…	0	0	0	+1.4 pp
Coal	0	0	0	+0.6 pp
Wool, silk-worm…	0	0	0	+2.4 pp
Gas	0	0	0	+9.9 pp
Gas manufacture…	0	0	0	+0.0 pp

Notes: Sourcing values are US$ million of intermediate input use. Regional sourcing is modelled as an Armington CES on GTAP's own import-source substitution elasticities, calibrated cell by cell to the observed 2017 pattern, so the model's baseline reproduces observed sourcing exactly and there is no "optimal versus actual" gap to report. The AfCFTA Δ column is the modelled response instead: the change, in percentage points, in the share of the commodity's *imported* input demand met from African suppliers under the full AfCFTA package. That denominator is the model's import demand for the commodity and is not the denominator of the three value columns beside it, so the two should not be reconciled against each other. Economy-wide the same measure moves from 2.77% to 3.37%, +0.60 pp. The sourcing model's friction matrix is transport cost only and carries no tariff channel, so tariff removal produces no response in this column – a limit of the model, not a finding about tariffs. Forward GVC participation, reported in Section 6, is normalised by each commodity's own gross exports, so it exceeds 100% for commodities that barely export; those values are not interpretable as shares.

D. Corridors and network

Table 8: Liberia: regional transport corridors

Corridor	Mode	Reliability	Serves Liberia	Route
Northern Corridor	road/rail	0.60		Mombasa → KEN → UGA → RWA → BDI
Central Corridor	road	0.55		Dar es Salaam → TZA → RWA → UGA → BDI
North-South Corridor	road	0.65		Durban → ZAF → BWA → ZWE → ZMB → COD
Dar-Copperbelt (TAZARA)	rail/road	0.50		Dar es Salaam → TZA → ZMB → COD
Maputo Corridor	road/rail	0.70		Maputo → ZAF
Beira Corridor	road/rail	0.55		Beira → ZWE → ZMB → MWI
Nacala Corridor	rail	0.50		Nacala → MWI → ZMB
Trans-Kalahari Corridor	road	0.75		Walvis Bay → NAM → BWA → ZAF
Walvis Bay-Ndola-Lubumbashi	road	0.60		Walvis Bay → NAM → ZMB → COD
Lobito Corridor	rail	0.50		Lobito → AGO → COD → ZMB
Abidjan-Lagos Corridor	road	0.60		Abidjan → CIV → GHA → TGO → BEN → NGA
Dakar-Bamako Corridor	road/rail	0.55		Dakar → SEN → MLI
Tema-Ouagadougou Corridor	road	0.60		Tema → GHA → BFA → NER
Lagos-Niamey Corridor	road	0.50		Lagos → NGA → NER → TCD
Djibouti Corridor	road/rail	0.65		Djibouti → DJI → ETH → SDS
Douala Corridor	road	0.50		Douala → CMR → TCD → CAF
Trans-Maghreb Corridor	road	0.70		Tanger Med → MAR → DZA → TUN → LBY

Notes: Delivered cost is ad-valorem, as a share of cargo value.

Table 9: Liberia: trade-network nodes by betweenness centrality (top 10)

Rank	Node	Type	Country	Betweenness	Avg delay (h)	Score
1	Tanger Med	port	Morocco	0.10	348	0.22
2	Djibouti	port	Djibouti	0.08	320	0.15
3	Douala	port	Cameroon	0.07	273	0.13
4	Mombasa	port	Kenya	0.06	306	0.12
5	Dar es Salaam	port	Tanzania	0.06	297	0.12
6	Dakar	port	Senegal	0.05	323	0.10
7	Lagos	port	Nigeria	0.05	277	0.10
8	Morocco	city	Morocco	0.08	19	0.09
9	Tema	port	Ghana	0.05	279	0.09
10	Beira	port	Mozambique	0.04	313	0.08

Notes: Betweenness centrality counts the shortest paths through each node; the highest-centrality gateways are the chokepoints where facilitation is most leveraged. The full ranking is in the model output under `assets/data/`.

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