Future Trade Integration, LDC Graduation, and Lao Economic Development: A General Equilibrium Analysis

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Abstract

Lao PDR's 2026 graduation from Least Developed Country status will change the market access conditions facing its exporters. The main risk is not a uniform loss across the economy, but a concentrated shock to the EU-facing apparel corridor that has relied on duty-free access. This paper estimates the likely external market-access loss and then traces how that loss affects domestic exports, output, and welfare. In the headline economy-wide results, an MFN fallback reduces EU exports by 16.916%, lowers equivalent variation by 0.308%, and contracts wearing-apparel output by 22.00%. GSP+ sharply reduces the simulated loss, but only if apparel firms can satisfy double-transformation rules of origin and use the preference in practice. RCEP access helps redirect trade toward regional destinations, yet it does not replace the lost EU apparel preference margin. RCEP plus MFN graduation keeps total exports positive, while welfare remains negative and apparel output falls further. The policy implication is practical: graduation readiness depends on usable fallback preferences, rules-of-origin compliance, regional market access, transport efficiency, and productivity upgrading in the activities most exposed to preference erosion.

Keywords: LDC graduation; GSP/EBA; Lao PDR; structural gravity; GTAP-CGE; RCEP

JEL codes: F13; F14; C68; O19

1 Introduction

Lao PDR's scheduled graduation from the Least Developed Country (LDC) category on 24 November 2026 changes the terms under which its exporters enter preference-granting markets. The main economic issue is not that all Lao exports depend on LDC treatment. Much of the export base is linked to regional commodity, resource, and energy markets. The exposure is narrower and more consequential: a labor-intensive EU-facing manufacturing corridor, especially apparel, has relied on duty-free access under the European Union (EU) Everything But Arms (EBA) scheme. When LDC preferences are withdrawn, Lao exporters move toward fallback regimes such as GSP+, Standard GSP, or Most Favored Nation (MFN) treatment. The size of the shock therefore depends on the usable post-graduation regime, not on graduation status alone.

Recent EU preference data illustrate the concentration. EU imports from Lao PDR reached about EUR 451 million in 2024, of which about EUR 319 million entered under preferential treatment. Around 71% of total EU imports from Lao PDR entered under EBA preferences, and the preference-utilization rate reached 96%. Apparel accounted for 51% of total EU imports from Lao PDR and 71% of preferential EBA imports.[1] Graduation therefore raises a precise policy question: how large is the loss in the preference-dependent export corridor, how much can regional integration offset it, and how do domestic output and welfare adjust once trade is reallocated across sectors and destinations?

This paper answers that question by combining an external market-access simulation with an economy-wide assessment of domestic adjustment. The first step estimates how exports respond when preference margins change. The second step traces how the same policy scenarios affect sectoral production, destination choice, factor incomes, and welfare inside the Lao economy. This sequence keeps two policy issues separate: the size of the market-access shock facing exporters, and the way that shock is absorbed across sectors and households.

The results show that fallback regime choice is central. Lao PDR's EU-facing tariff exposure moves from an EBA baseline of 0.06% to 1.07% under GSP+, 6.27% under Standard GSP, and 8.00% under the MFN fallback. The resulting losses are therefore not driven by graduation status alone, but by the post-graduation regime that firms can

[1] Source: EU GSP Hub, Lao People's Democratic Republic, last updated January 28, 2026, https://gsphub.eu/country-info/Lao%20People's%20Democratic%20Republic.

actually use, especially where apparel exporters must move from single-transformation EBA access toward stricter double-transformation rules of origin.

The economy-wide results provide the headline magnitudes and preserve the same policy ordering while showing where the adjustment is felt. Under MFN graduation, EU exports fall by 16.916%, equivalent variation declines by 0.308%, and wearing-apparel output contracts by 22.00%. Standard GSP reduces the size of the loss but leaves it substantial; GSP+ sharply compresses it. RCEP provides a meaningful regional adjustment margin. RCEP access alone raises total exports and improves welfare, but it does not replace the lost EU apparel preference. When RCEP access is combined with MFN graduation, total exports remain positive, while equivalent variation remains negative and wearing-apparel output declines by 23.95%.

The contribution is threefold. First, methodologically, the paper strengthens trade-policy assessment by bringing granular, time-varying tariff data into a policy scenario ladder for Lao PDR's graduation. The tariff data distinguish MFN, applied, and preferential schemes over time and are mapped into the paper's sector and destination aggregation; the RCEP schedule is mapped separately into the same structure. This design allows EBA, GSP+, Standard GSP, MFN, and RCEP cases to enter the analysis as measured market-access changes rather than as a single average graduation shock. The same tariff variation supports the estimated tariff-response parameter in the structural-gravity stage and disciplines the trade-response inputs used in the GTAP-CGE simulations. Second, substantively, the paper provides a Lao-specific assessment of the potential impact of graduation, tracing how preference erosion affects EU exports, apparel output, factor-income channels, and welfare in a multi-sector CGE setting. Third, it places Lao PDR's graduation in a concurrent market-access environment where regional integration and third-country gains change relative competitiveness. This matters because Viet Nam and India can improve access to the EU market in sectors where Lao exporters lose non-reciprocal preferences.

The policy implication is conditional. GSP+ can greatly reduce the simulated shock, but its effective value depends on meeting double-transformation rules of origin, documenting origin, organizing input sourcing, and using cumulation provisions where available. RCEP can support aggregate trade reallocation, but the gains are concentrated in regional channels that differ from the EU-facing apparel corridor. Graduation is therefore neither negligible nor a macroeconomic collapse. It is a concentrated transition in which market access, origin capacity, transport costs, and sector productivity determine whether formal graduation is matched by productive upgrading.

2 Literature Review

The closest literature is organized around the gap between formal graduation and productive readiness. LDC graduation is assessed through income, human assets, and vulnerability criteria, while the trade literature emphasizes that graduation exposure also depends on export competitiveness, productive capacity, and firms' ability to absorb preference erosion (Razzaque 2020). This distinction matters for Lao PDR because resource and hydropower-led income growth can coexist with a narrow and import-dependent manufacturing base. Lao-specific assessments emphasize that the economy's aggregate use of LDC preferences is modest, while EU-facing apparel remains highly exposed to the withdrawal of EBA preferences (WTO and EIF, 2020; WTO, 2019).

Partial-equilibrium studies locate the tariff shock but cannot fully trace domestic adjustment. Decreux and Spies (2020) provide the closest Lao-specific tariff benchmark, showing that EU garment exports face substantially higher fallback tariffs after EBA withdrawal and that preference erosion can generate sizable apparel losses. The WTO and EIF assessment estimates a smaller aggregate export loss because much of Lao PDR's export base is not equally dependent on LDC preferences (WTO and EIF, 2020). Smooth-transition planning widens the policy lens by connecting preference loss to competitiveness, fiscal fragility, rules of origin, and implementation capacity (LDC Secretariat, Ministry of Foreign Affairs 2023). These studies motivate a sectoral and destination-specific shock, but they do not impose economy-wide closure.

General-equilibrium work explains why the same tariff shock can produce different output and welfare effects. Earlier Lao CGE studies evaluate WTO accession and AFTA, showing that trade-policy changes move through production, household, and factor-market channels rather than only through first-round tariff margins (Kyophilavong et al. 2016, 2010). Regional-integration studies point to possible offsets. Itakura (2022) estimates positive Lao welfare gains from RCEP, while the World Bank's landlocked-to-land-linked assessment shows that infrastructure and trade-facilitation gains become larger when border and logistics frictions fall (World Bank, 2020). These findings support treating RCEP as an adjustment margin, but not as an automatic replacement for EU apparel preferences.

Peer LDC studies clarify both the simulation design and why sectoral export shocks matter for workers. Bangladesh illustrates how a concentrated ready-made garment sector can transmit graduation shocks through exports, output, urban unskilled household income, and consumption; its MyGTAP results report about a 14 percent RMG export decline under the combined standard-GSP and subsidy-removal scenario, with urban unskilled households particularly exposed because garment employment is large and female-intensive (Rahman & Strutt 2024). Cambodia provides a closer policy-brief example of explicit job-loss incidence: UNDP Cambodia's dynamic GTAP/DCGE assessment links losses in garments, rice, and bicycles to lower GDP, a 1.8 percent employment loss, about 168,000 jobs, and a gender-skewed employment effect (UNDP Cambodia, 2024). Lao policy work also highlights competitive pressure from Viet Nam's improving EU access in product groups where graduating LDC exporters lose non-reciprocal preferences (Sobir & Malavong 2023). Nepal shows that destination-market heterogeneity matters because fallback exposure differs across the EU, China, and other markets (Razzaque 2020). These cases are not forecasts for Lao PDR. They show why graduation should be modeled as a set of destination- and sector-specific market-access changes with domestic incidence for employment, household income, and poverty, rather than only as aggregate export losses.

This paper contributes by combining these strands in one policy sequence. Structural gravity estimates the tariff-related market-access response and solves the external trade counterfactual. GTAP-CGE then evaluates output, welfare, and sectoral reallocation under the same scenario ladder. The framework places Lao preference erosion alongside RCEP access and third-country market-access gains, so the analysis captures both the direct loss of EBA treatment and the relative preference erosion created when regional suppliers improve their access to the EU.

3 Data, Empirical Strategy, and CGE Framework

This study links econometric estimation to economy-wide simulation in two steps. The motivation follows T. Hertel et al. (2007), who show that CGE-based assessments of Free Trade Agreements are sensitive to the elasticity of substitution among imports from different countries and conclude that there is substantial potential for combining econometric estimation with CGE-based policy analysis. We first estimate the tariff-response parameter from observed bilateral trade flows using structural gravity. We then use this estimated market-access response as the trade-response input in the GTAP-CGE simulations, instead of relying only on a generic externally imposed parameter. In this sequence, structural gravity identifies the external market-access response to tariff and preference-margin changes. GTAP-CGE then traces how the shock passes through domestic production, sectoral reallocation, factor markets, and welfare under alternative closures.

3.1 Data Sources

The empirical design uses two linked data foundations. The structural-gravity analysis requires a global bilateral panel that links trade flows, output, tariffs, and standard gravity covariates, allowing the tariff response to be estimated from observed trade patterns. The CGE analysis requires a social-accounting benchmark that records production, consumption, bilateral trade, taxes, and factor incomes in a consistent equilibrium dataset. Together, these sources connect the econometric estimate of market access to the economy-wide simulation framework.

For the structural-gravity analysis, we draw bilateral trade and production data from the ITPD-E (Borchert & Yotov 2021), which provides internationally comparable trade and output information, including the domestic-flow anchor needed for structural gravity estimation. The sector-level counterfactual simulations use the ITPD-S simulation structure from the same data family, so that the estimated tariff response is applied to a sectoral trade baseline consistent with the estimation panel. We use BACI (Gaulier & Zignago 2010) as an external validation source for international trade flows. Tariff information comes from the Global Tariff Database of Teti (2024). We use this database because it harmonizes product codes across years, improves longitudinal consistency, and records the interaction between MFN, applied, and preferential tariff schemes across trade agreements. We draw regional trade agreement controls from the Regional Trade Agreements Database

(Egger & Larch 2008), while CEPII gravity controls complete the global panel (Conte et al. 2022). For the RCEP scenarios, we use the project RCEP tariff-schedule input from ITC's Market Access Map (MAcMap), accessed on March 15, 2026,[2] and then map it into the paper's sector aggregation. Table 1 describes sectoral trade values and tariff exposure before domestic flows are added for PPML estimation, and Table 2 summarizes the sectoral tariff ladder used for the graduation and RCEP market-access scenarios.

Table 1: Descriptive Statistics for External Trade by Sector

Measure	Agg.	Heavy	Light	Extr.	Proc.	Grains	Text.	Apparel	Meat	Leather
Panel A. Observation coverage										
Obs.	477,400	477,400	477,400	477,400	477,400	477,400	477,400	477,400	477,400	477,400
Panel B. Trade values										
Trade mean	0.525	0.293	0.101	0.058	0.021	0.015	0.011	0.011	0.009	0.007
Trade SD	5.39	3.28	1.41	0.919	0.192	0.191	0.169	0.216	0.102	0.163
Trade P25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Trade P75	0.034	0.011	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000
Panel C. MFN tariffs										
MFN mean	12.98	6.88	9.90	9.21	17.56	12.65	11.81	19.08	15.68	14.02
MFN SD	7.60	5.12	7.14	7.08	11.55	10.05	7.98	16.35	13.57	10.85
MFN P25	8.17	2.56	3.77	4.38	11.45	6.79	6.71	10.67	9.31	6.52
MFN P75	15.71	10.18	14.09	12.32	20.50	16.52	16.69	24.08	18.56	18.50
Panel D. Preferential tariffs										
Pref. mean	10.82	6.00	8.69	7.95	14.03	10.67	9.94	15.98	12.15	11.94
Pref. SD	8.63	5.51	7.66	7.50	12.08	10.40	8.94	17.26	12.07	11.65
Pref. P25	4.52	0.87	1.54	1.83	6.51	4.11	2.30	3.86	4.15	3.43
Pref. P75	14.82	9.83	13.82	11.77	18.40	14.58	16.18	21.67	16.45	17.71

Note: External trade only, 2000–2019. Trade values are in billions of current USD; tariff statistics are in percent. The sector columns report the aggregate tradable row and nine GE-gravity sector groups, which aggregate detailed product categories from the ITPD-E and tariff-data concordance. Domestic flows are excluded from this descriptive table, giving 477,400 external exporter–importer–year observations per sector; the PPML estimation panel adds domestic flows as the structural-gravity anchor and contains 480,500 observations. Source: Author's calculation.

The descriptive trade and tariff evidence supports two points that guide the later simulations. First, Table 1 shows that the structural-gravity panel is broad and sparse, as expected in a global exporter–importer–year dataset with many small or zero bilateral flows. That feature motivates the PPML estimator and the domestic-flow anchor used in the empirical stage. The same table also shows that tariff exposure differs sharply by sector: wearing apparel has an MFN tariff mean of 19.08% and a preferential-tariff mean of

[2] ITC Market Access Map (MAcMap), data accessed March 15, 2026.

Table 2: Sectoral Tariff Profile for Graduation and RCEP 2027 Scenarios

Sector	EU export share (%)	EBA (%)	GSP+ (%)	Std. GSP (%)	MFN (%)	RCEP 2027 (%)
Wearing apparel	82.7	0.0	0.0	6.1	8.0	0.00
Leather products	10.1	0.0	3.9	4.1	4.3	0.01
Grains and crops	3.5	1.1	8.9	11.0	12.6	0.00
Processed food	2.2	0.0	3.9	12.5	16.9	0.09
Heavy manufacturing	1.1	0.0	21.2	22.8	24.5	0.01
Textiles	0.3	0.0	0.0	6.0	7.7	0.00
Light manufacturing	0.0	0.5	2.2	3.6	4.5	0.00
Livestock and meat	0.0	0.0	29.3	33.6	33.6	0.00

Note: All tariff columns are ad valorem rates in percent. EU export shares report the Lao sectoral distribution of EU-bound trade in the tariff-profile baseline. EBA, GSP+, Standard GSP, and MFN columns report the EU post-graduation market-access ladder used to define Lao graduation scenarios. The RCEP 2027 column is in the same percentage unit, but it refers to a different destination set: trade-weighted Lao export access to RCEP markets after applying the no-worsening rule $t_{new} = \min(t_{2018}, t_{RCEP2027})$. *The column documents a separate RCEP scenario input rather than an EU fallback rate. Source tariffs for the RCEP column are from the project tariff-schedule input derived from ITC Market Access Map data accessed on March 15, 2026. Source: Author's calculation.*

15.98%, while textiles also carry relatively high tariff exposure. Second, Table 2 translates these general tariff patterns into the policy ladder used in the simulations. The EU-facing columns show the graduation ladder from EBA through GSP+, Standard GSP, and MFN treatment, while the RCEP 2027 column records a separate regional market-access scenario. The RCEP entry uses the same percentage unit as the EU tariff columns and measures trade-weighted Lao export access to RCEP destinations under the no-worsening rule. The table therefore brings together scenario inputs from different destination markets, rather than a single EU tariff schedule.

For the CGE block, we use the GTAP 10A database (Aguiar et al. 2019). This dataset provides a globally consistent 2014 benchmark for production, consumption, bilateral trade, taxes, and factor-income linkages. We aggregate the original 141-region, 65-sector structure to 23 regions and 12 sectors according to the policy design of the study. The regional aggregation preserves Lao PDR, the EU, ASEAN+5/RCEP partners, major third-country suppliers, and the peer graduating LDCs needed for the scenario ladder. Bangladesh, Cambodia, and Nepal are retained separately so the model can evaluate synchronized graduation and peer-country market-access channels. The sector aggregation keeps the apparel, textile, light-manufacturing, resource, and transport margins that are central to the LDC graduation shock. Table 3 reports this benchmark structure before the paper turns to the simulation equations.

This aggregation is designed to make the benchmark economically interpretable rather than only compact. On the regional side, the model must separate the EU preference market, RCEP destinations, nearby ASEAN markets, and peer LDC exporters because the scenarios compare changes in relative market access across these groups. On the sector side, the model must keep the EU-facing garment channel visible while retaining the resource, heavy-manufacturing, service, and transport activities that shape economy-wide adjustment. The descriptive benchmark serves a specific role: it shows whether the policy shock is concentrated in a narrow export corridor or aligned with the broader production and factor-income structure of the Lao economy.

The interpretation follows from this separation. A sector can be small in value-added terms but still matter for a particular preference-dependent destination; conversely, a large benchmark sector may be more exposed to regional demand than to the EU preference ladder. The data section separates three descriptive objects before the simulations begin: the gravity sample used to estimate tariff responsiveness, the tariff ladder used to define market-access shocks, and the SAM benchmark used to interpret domestic output, factor-income, and welfare responses.

We first use the GTAP 10A benchmark as an accounting profile for the Lao economy, before it becomes the base equilibrium for simulation. Panel A describes sector scale and export exposure: gross output is largest in grains and crops, extraction, processed food, and services-related activities, while destination-specific export shares differ sharply across markets. Wearing apparel accounts for 5.48% of Lao benchmark exports overall and 26.46% of exports to the EU, but only 3.30% of gross output relative to GDP and 1.64% of value added. This contrast is central to the study's interpretation because EU preference erosion is large for a specific export corridor without implying that the whole benchmark economy is apparel-dominated. The regional channels also differ from the EU channel. ASEAN export exposure is concentrated in heavy and light manufacturing, while RCEP5 exposure is dominated by extraction. RCEP market access represents a structurally different adjustment channel from the EU-facing apparel corridor.

Table 3: Lao PDR Benchmark Structure in the GTAP 10A SAM, 2014

Panel A. Sectoral production and export structure

	Domestic structure		Export shares by destination			
Sector	GO/ GDP	VA share	Total	EU	ASEAN	RCEP5
Grains and crops	42.10	31.66	5.21	6.13	6.32	4.60
Livestock/meat	19.22	7.71	0.16	0.32	0.03	0.13
Extraction	27.75	21.18	28.13	2.38	11.03	59.67
Processed food	27.71	9.90	2.94	5.22	4.24	1.04
Wearing apparel	3.30	1.64	5.48	26.46	0.05	1.75
Leather products	0.45	0.23	0.59	0.60	0.31	1.00
Light mnfc.	7.86	0.52	14.96	0.41	27.18	14.35
Heavy mnfc.	12.31	1.81	21.49	4.02	46.15	11.21
Utilities/cons.	15.63	3.84	7.87	23.62	2.59	1.07
Transport/comm.	19.09	11.52	8.14	21.08	1.32	3.26
Other services	22.38	9.51	4.87	9.59	0.61	1.76
Textiles	1.02	0.49	0.17	0.17	0.18	0.17

Panel B. Primary-factor income and use structure

	Factor income		Distribution across sector groups				
Primary factor	Income	Share	Agric.	Extract.	Garm.	Other mnfc.	Service
Capital	3841.78	40.18	13.64	28.43	4.04	20.40	33.49
Unskilled labor	2841.26	29.72	48.62	20.10	1.77	9.77	19.74
Skilled labor	719.43	7.53	7.82	2.23	2.83	15.56	71.56
Land	1798.97	18.82	100.00	0.00	0.00	0.00	0.00
Natural resources	359.00	3.76	0.00	100.00	0.00	0.00	0.00

Note: The table reports the GTAP 10A benchmark structure for the pre-shock Lao economy. GO/GDP is gross output divided by GDP; VA share is each sector's share of total Lao value added. Export columns are denominator-specific destination shares. RCEP5 denotes China, Japan, Korea, Australia, and New Zealand; ASEAN denotes Cambodia, Indonesia, Malaysia, Thailand, Viet Nam, and residual Southeast Asia in the aggregation. Panel B reports factor income in millions of current US dollars and distributes each factor's earnings across broad sector groups. Source: Author's calculation.

Panel B reports the income side of the same SAM benchmark. Capital accounts for 40.18% of primary-factor income, followed by unskilled labor at 29.72%, land at 18.82%, skilled labor at 7.53%, and natural resources at 3.76%. The sector-use columns show why trade, output, and welfare effects need not move one-for-one. Unskilled labor income is concentrated in agriculture and extraction, skilled labor income is concentrated in services and infrastructure, and natural-resource income is tied to extraction. The apparel, textile, and leather group matters for EU export exposure, even though it is not the dominant source of benchmark factor income. This accounting profile grounds the CGE interpretation that follows: graduation shocks enter through destination-specific market access, but their welfare and income effects depend on the broader production and factor-payment structure of the Lao economy.

3.2 Empirical Strategy

The empirical strategy begins with the paper's first modeling question: how large is the external market-access shock created by LDC graduation, and how is that shock distributed across destinations and sectors before domestic adjustment is modeled in the CGE system? A direct tariff-export calculation would capture the first bilateral price effect, but it would miss the wider relative-access problem. EU buyers substitute among suppliers, Lao exporters face alternative destinations, and preference withdrawal changes the market-access position of Lao PDR relative to other exporters. Structural gravity anchors this first-stage trade shock because it links tariff-inclusive delivered prices to bilateral trade while accounting for the multilateral resistance (MR) terms that summarize access to all markets and suppliers.

The setup proceeds in three steps. It first derives origin-specific demand from Armington-CES preferences, then closes the system with origin-market clearing and multilateral resistance, and finally estimates the tariff response used in the counterfactual simulations. The structure follows the Armington-CES foundation of Anderson and Van Wincoop (2003) and the applied counterfactual framework summarized by Yotov et al. (2016).

The Armington-CES presentation organizes the exposition without narrowing the theoretical interpretation. Gravity equations used for aggregate trade analysis can also arise from Ricardian and heterogeneous-firm settings (Arkolakis et al. 2012; Yotov et al. 2016). This paper uses the Armington-CES derivation because it provides the canonical demand-side route to multilateral resistance and corresponds to the one-sector, full-endowment exact-hat system solved in the *ge_gravity* implementation (Baier et al. 2019; Zylkin 2019).

Let representative consumers in destination j maximize a CES utility function over origin-specific varieties $i \in N$, where N includes domestic and foreign sources:

$$U_j = \left(\sum_{i=1}^{N} \beta_i^{(1-\sigma)/\sigma} q_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \tag{1}$$

where U_j is the destination's CES consumption index, q_{ij} is the quantity of the variety from origin i consumed in destination j, $\sigma > 1$ is the elasticity of substitution across origins, and β_i is an origin-specific preference weight. This first step formalizes the Armington assumption that goods are differentiated by origin: Lao, Cambodian, Viet Nam, Indian, and domestic EU varieties are substitutes, but they are not treated as identical goods. Given total expenditure $E_j = \sum_i p_{ij} q_{ij}$ and delivered price p_{ij} paid by buyers in destination j, the consumer's budget-constrained choice yields demand for variety i:

$$q_{ij} = \beta_i^{1-\sigma} p_{ij}^{-\sigma} P_j^{\sigma-1} E_j \tag{2}$$

where P_j is the CES price index in destination j:

$$P_j = \left[\sum_{i=1}^{N} (\beta_i p_{ij})^{1-\sigma} \right]^{1/(1-\sigma)} \tag{3}$$

Equations (2) and (3) provide the demand-side mechanism. Demand from origin i rises with destination expenditure, falls with its own delivered price, and also depends on the price of alternative suppliers through P_j. The price index is not a simple descriptive average; it summarizes the cost of the whole origin-variety basket available to destination j. Under iceberg trade costs, $p_{ij} = p_i \tau_{ij}$, where p_i is the factory-gate price received by producers in origin i and $\tau_{ij} \geq 1$ is the bilateral trade-cost factor. Multiplying quantities by delivered prices converts the consumer demand equation into bilateral expenditure, $X_{ij} = p_{ij} q_{ij}$, where X_{ij} is the value of trade from origin i to destination j:

$$X_{ij} = \left(\frac{\beta_i p_i \tau_{ij}}{P_j} \right)^{1-\sigma} E_j \tag{4}$$

The next step closes the exporter side of the model. Equation (4) describes destination demand, but structural gravity also requires origin sales to be consistent with origin income. Imposing origin-market clearing, so that origin income Y_i equals total sales across destinations, yields the structural gravity system:

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{\tau_{ij}}{\Pi_i P_j} \right)^{1-\sigma} \tag{5}$$

where Y_i is origin income, E_j is destination expenditure, and world income is $Y = \sum_j E_j$. The outward and inward MR terms, Π_i and P_j, are defined implicitly as:

$$\Pi_i^{1-\sigma} = \sum_{j=1}^{N} \left(\frac{\tau_{ij}}{P_j}\right)^{1-\sigma} \frac{E_j}{Y} \tag{6}$$

$$P_j^{1-\sigma} = \sum_{i=1}^{N} \left(\frac{\tau_{ij}}{\Pi_i}\right)^{1-\sigma} \frac{Y_i}{Y} \tag{7}$$

The outward MR term, Π_i, summarizes the average difficulty faced by exporters from origin i across all markets, while the inward MR term, P_j, summarizes the average difficulty of supplying destination j from all origins. These two terms are jointly determined: destination access depends on the set of available suppliers, and exporter access depends on the set of reachable destinations. A Lao-EU tariff shock changes not only the bilateral trade cost in the affected corridor, but also Lao PDR's relative access to other destinations and the relative position of other suppliers in the EU market.

We estimate the structural parameters of Equation (5) using the Poisson Pseudo-Maximum Likelihood (PPML) estimator (Silva & Tenreyro 2006), which handles heteroskedasticity and zero trade flows:

$$X_{ijt} = \exp\left[\pi_{it} + \chi_{jt} + \mu_{ij} + \beta_1 \ln(1 + t_{ijt})\right] \times \eta_{ijt} \tag{8}$$

Here t_{ijt} is the ad valorem tariff rate, so $1 + t_{ijt}$ is the tariff-inclusive trade-cost factor, and η_{ijt} is the multiplicative error term. This notation distinguishes the observed tariff rate used in the PPML specification from the broader iceberg trade-cost factor τ_{ij} used in the structural derivation above. The exporter-time effects π_{it} and importer-time effects χ_{jt} absorb origin and destination fundamentals, while pair effects μ_{ij} absorb time-invariant bilateral frictions. Because the policy variable enters as $\ln(1 + t_{ijt})$, a tariff increase is expected to reduce trade. The paper reports the positive empirical tariff-response parameter as $\theta = -\beta_1$. This is the market-access response estimated from the trade panel, not a welfare or output result. The CGE framework below then translates this empirical response into the Armington substitution schedule used in the simulations.

To translate the estimated tariff response into a full-endowment general-equilibrium trade counterfactual, we follow the structural gravity solution system developed for applied policy analysis (Anderson et al. 2018; Baier et al. 2019; Yotov et al. 2016). This system endogenizes five variables for each country: outward MR (Π_i), inward MR (P_j), factory-gate prices (p_i), nominal income (Y_i), and aggregate expenditure (E_i). In exact-hat form, the system expresses counterfactual outcomes as proportional changes relative to the observed baseline, $\hat{x} \equiv x'/x$, so unobserved technology and preference levels cancel out. The exact-hat notation also matches the empirical purpose of this paper: the simulations ask how trade changes relative to the observed benchmark when the tariff ladder changes.

The derivation relies on three structural assumptions. First, following the Armington-CES structural-gravity framework, each country produces a unique variety and goods are imperfect substitutes by origin (Anderson & Van Wincoop 2003; Yotov et al. 2016). Second, the model assumes a fixed physical endowment (Q_i) for each country, meaning that any change in nominal income is driven entirely by changes in factory-gate prices ($\hat{Y}_i = \hat{p}_i$) (Yotov et al. 2016). Third, consistent with exact-hat counterfactual analysis, trade imbalances remain constant as a share of nominal GDP (Dekle, Eaton, & Kortum 2008; Yotov et al. 2016).

We compute the counterfactual GE structural-gravity simulations using the exact-hat fixed-point algorithm described by Baier et al. (2019), implemented through the *ge_gravity* software package of Zylkin (2019). The specific simulation algorithm follows the structural gravity application in Baier et al. (2019), while its iterative solution logic is rooted in the fixed-point approach associated with Alvarez and Lucas Jr (2007). In practical terms, the algorithm searches for the counterfactual trade equilibrium by repeatedly updating factory-gate prices, income, expenditure, and multilateral resistance terms until the maximum change in the system falls below the convergence tolerance. These iterations are numerical solution steps, not a historical transition path. They identify the set of trade flows, prices, income, expenditure, and MR terms that can hold simultaneously after the tariff shock. In this paper, the GE-gravity block reports external trade responses, nominal-income adjustments, factory-gate-price changes, and destination-level trade reallocation within each sector-specific full-endowment Armington run. Welfare evaluation is left to the GTAP-CGE stage, where equivalent variation is calculated in a multi-sector economy with production, intermediate-input, factor-market, and closure mechanisms.

The GTAP-CGE model carries the same policy shock into a richer domestic economy.

The gravity stage estimates the market-access response and solves the full-endowment GE trade response to the graduation ladder. The CGE stage uses the estimated response as the trade-response input for the tariff and preference shocks in a multi-region, multi-sector production system. In this second stage, the external export shock becomes a question about sectoral output, intermediate inputs, factor markets, equivalent-variation welfare, and short- versus long-run closure assumptions.

3.3 Computable General Equilibrium Framework

We use a multi-region, multi-sector CGE approach grounded in the GTAP framework to evaluate the economy-wide effects of LDC graduation. The theoretical foundation follows Corong et al. (2017), who present the standard GTAP Version 7 model as a Walrasian general equilibrium system. In this system, firms minimize costs under constant returns to scale and zero-profit conditions, regional households allocate expenditure to maximize utility, and product and factor markets clear simultaneously. While Corong et al. (2017) document the model using a Johansen-style approach, our simulations use the level formulation provided by van der Mensbrugghe (2018).

Implemented within the General Algebraic Modeling System (GAMS) as a Mixed Complementarity Problem (MCP), the levels-form approach keeps the mathematical structure closely aligned with the computational code (Lanz & Rutherford 2016). Because equations are specified directly in non-linear levels, the model can represent large policy shocks without relying on multi-step linear approximations. The GAMS implementation by van der Mensbrugghe (2018) introduces three features that matter for this paper. First, it uses a nested Constant Elasticity of Transformation (CET) structure for allocating output across destinations, relaxing the standard law-of-one-price assumption. Second, it models aggregate factor supply with upward-sloping curves, particularly for natural resources, rather than imposing zero supply elasticity. Third, it allows alternative macroeconomic closures, including a fixed capital-account closure in which regional capital-account balances are held fixed and external adjustment is reflected through the trade balance and relative prices.

We anchor the graduation trajectory through two adjustment horizons that combine macro-closure settings with domestic factor-mobility assumptions. The GTAP-GAMS benchmark does not treat capital as sector-specific by nature: in the standard specification, labor and capital are perfectly mobile across domestic activities, land is partially mobile through a CET allocation frontier, and natural resources are sector-specific (van der Mensbrugghe 2018). In the short-run horizon used here, the *capFix* setting holds regional capital-account balances fixed, so external adjustment operates through the trade balance and relative prices rather than through endogenous cross-border capital flows. As in any global balance-of-payments closure, one residual balance adjusts to satisfy world accounting consistency. Domestic labor and capital remain mobile across sectors, while land adjusts sluggishly under the CET reallocation frontier.

In the long-run horizon, the *capFlex* setting endogenizes the international capital account by allowing savings to be allocated globally in response to risk-adjusted rates of return (van der Mensbrugghe 2018). The *capFlex* case is interpreted as a global investment-equilibrium closure rather than merely a domestic factor-mobility assumption. The model numeraire is the world factor price index, which provides a stable reference for evaluating relative shifts throughout the general equilibrium system.[3]

The model maintains accounting consistency through a Social Accounting Matrix (SAM) that records the circular flow of income and expenditure (van der Mensbrugghe 2018). Production is represented as a multi-stage optimization problem using a nested Constant Elasticity of Substitution (CES) structure (van der Mensbrugghe 2018), where representative firms choose between value-added factors and intermediate inputs. To evaluate whether domestic upgrading can offset preference erosion, the policy-offset scenarios introduce a Hicks-neutral productivity shifter (A^{xp}) (van der Mensbrugghe 2018). This device quantifies how large a broad efficiency gain would need to be to counteract the output and welfare losses generated by graduation-related market-access shocks.

International trade flows follow a hierarchical sourcing structure based on imperfect substitution by country of origin (Armington 1969; van der Mensbrugghe 2018). For this paper, the relevant transmission path runs from a preference shock to delivered prices, bilateral sourcing, government revenue, and welfare. Notation is adapted from the second-level Armington and bilateral price equations in van der Mensbrugghe (2018): i denotes commodity, s source region, and r destination region. $QIM_{i,r}$ denotes aggregate import

[3]In the GTAP-GAMS implementation, the numeraire equation sets $PNUM = PFACT^w$, where $PFACT^w$ is the Fisher world factor-price index. This corresponds to the standard GTAP/GEMPACK variable *pfactwld*.

demand for commodity i in destination r, $PIM_{i,r}$ denotes the aggregate import price index, $XW_{i,s,r}$ denotes bilateral import demand from source s to destination r, $PM_{i,s,r}$ denotes the tariff-inclusive bilateral import price paid in the destination market, and $PCIF_{i,s,r}$ denotes the CIF border price before the import tariff is applied.[4]

The graduation shock enters first through the bilateral import-price wedge. A loss of EBA or other preferential access raises the relevant ad valorem import tariff, $t^m_{i,s,r}$, converting the CIF border price into the tariff-inclusive bilateral import price paid in the destination market:

$$PM_{i,s,r} = PCIF_{i,s,r} \cdot (1 + t^m_{i,s,r}) \tag{9}$$

Here $t^m_{i,s,r}$ is the ad valorem bilateral import tariff applied by destination r to commodity i imported from source s. The notation uses t^m for the CGE tariff rate to keep it distinct from the iceberg trade-cost factor τ_{ij} in the structural-gravity derivation. The CIF price, $PCIF_{i,s,r}$, includes the FOB export price plus international transport and insurance margins. The tariff-inclusive price, $PM_{i,s,r}$, is the destination-market bilateral import price after the border tariff has been applied. For example, a 10 percent tariff converts the CIF price into 1.10 times the CIF price. Domestic sales taxes on the aggregate import bundle are applied later in the GTAP-GAMS price sequence. In the full implementation, the bilateral price block also allows uniform tax shifters for policy experiments; equation 9 reports the core tariff channel for exposition.

The tariff-inclusive bilateral price is the point at which an external preference shock becomes a change in foreign demand for Lao exports. Destination markets source a commodity from competing foreign suppliers through a second-level Armington import nest. In that nest, $QIM_{i,r}$ is the destination's aggregate import bundle and $PIM_{i,r}$ is the corresponding composite import price; both are generated by the standard CES quantity

[4] The manuscript uses harmonized commodity-source-destination notation for readability. The corresponding GTAP-GAMS arrays are documented in van der Mensbrugghe (2018), especially the concordance tables linking theoretical objects to internal model variables. In that notation, aggregate import demand and import prices are commonly ordered by region and commodity, while bilateral trade variables use source-destination-commodity ordering.

aggregator and its dual price index.[5] Conditional bilateral import demand is:

$$XW_{i,s,r} = \alpha^W_{i,s,r} \cdot QIM_{i,r} \cdot \left(\lambda^m_{i,s,r}\right)^{\sigma^m_i - 1} \cdot \left(\frac{PIM_{i,r}}{PM_{i,s,r}}\right)^{\sigma^m_i} \tag{10}$$

In equation 10, $XW_{i,s,r}$ is the source-specific import demand from exporter s. The ratio $PIM_{i,r}/PM_{i,s,r}$ compares the destination's composite import price with the tariff-inclusive price of that source. If Lao exports become more expensive after preference withdrawal, the model reduces Lao sourcing according to the import-source substitution elasticity σ^m_i. The preference shifter $\lambda^m_{i,s,r}$ is included to preserve the GTAP-GAMS sourcing structure, but the graduation scenarios operate mainly through the tariff wedge in $PM_{i,s,r}$.

The Armington block provides the link between the gravity estimate and the CGE substitution structure. The PPML stage estimates the empirical tariff-response parameter $\theta = -\beta_1$; the coefficient does not measure CGE welfare, output, or closure effects directly. In the GTAP-CGE simulations, the baseline calibration translates θ into the standard GTAP Armington schedule (Corong et al. 2017; T. W. Hertel 1997). The second-level import-source elasticity, ESUBM, is set as ESUBM $= \theta + 1$, while the top-level domestic-import elasticity, ESUBD, is set as ESUBD $= (\theta + 1)/2$. This preserves the GTAP rule of two, ESUBM $=$ 2ESUBD, used in GTAP parameterization and discussed in the CGE trade-elasticity sensitivity setting by T. Hertel et al. (2007). The mapping is an applied calibration convention, not an additional estimated coefficient. With this mapping in place, a tariff increase on Lao exports raises $PM_{i,s,r}$ in the affected market and reduces the relative attractiveness of Lao sourcing. The resulting export-demand shock feeds back into the Lao economy through sectoral output, intermediate-input demand, factor returns, household income, and the trade balance. Tariff revenue is still recorded in the importing region's public account inside the GTAP accounting system, but the Lao policy question is the domestic output and welfare response to the loss of external market access.

Aggregate welfare impacts are evaluated using Equivalent Variation (EV), defined as the change in income at base-year prices that would give the representative regional

[5] The implementation uses the GTAP-GAMS second-level Armington CES nest documented by van der Mensbrugghe (2018). The exact primal and dual CES formulas are not shown in the main text because the policy mechanism is the conditional sourcing response in equation 10. The calibrated import-source share parameter is $\alpha^W_{i,s,r}$, the source-specific import preference or efficiency shifter is $\lambda^m_{i,s,r}$, and the import-source substitution elasticity is σ^m_i.

household the post-shock utility level:

$$EV_r = e_r(p_r^0, u_r^1) - e_r(p_r^0, u_r^0) \tag{11}$$

where $e_r(\cdot)$ is the regional expenditure function, p_r^0 is the base-year price vector, u_r^0 is benchmark utility, and u_r^1 is post-shock utility. This is the standard EV interpretation used in the GTAP-GAMS documentation: welfare is measured as the expenditure necessary to reach the counterfactual utility level at base prices (van der Mensbrugghe 2018). Because the GAMS implementation does not provide the full GEMPACK additive welfare-decomposition tool, we interpret welfare channels using post-processed diagnostic indicators informed by the GTAP welfare-decomposition logic of Huff and Hertel (2001) and Corong et al. (2017). These diagnostics distinguish allocative-efficiency, terms-of-trade, and technology-related channels where the relevant model outputs permit such attribution. The terms-of-trade channel is interpreted as the movement in export prices relative to import prices, including the role of international transport margins. This general-equilibrium loop links trade-induced revenue changes to domestic demand, factor returns, and regional accounts.

3.4 Simulation Architecture and Scenario Pillars

The simulations apply the same scenario ladder to the structural-gravity and GTAP-CGE blocks. Their structure follows three points from the Lao smooth-transition and regional-integration literature: graduation withdraws non-reciprocal preferences, regional agreements may offer a partial adjustment margin, and third-country market-access gains can change Lao PDR's relative position (Decreux & Spies 2020; Itakura 2022; Sobir & Malavong 2023; WTO 2019). The experiments evaluate three channels: graduation-related preference erosion, regional integration as a possible offset, and third-country market-access gains that create relative preference erosion. The first channel contains two sets of scenarios because Lao PDR's direct fallback regime and synchronized peer graduation answer different questions: S1 isolates Lao PDR's own post-graduation treatment, while S2 shows how comparable shocks among peer LDC exporters affect the regional comparison.

Pillar 1: graduation and preference erosion (S1 and S2). This pillar models the withdrawal of LDC preferences through the post-graduation fallback ladder. The direct

Lao scenarios compare MFN, Standard GSP, and GSP+ treatment for Lao PDR. The peer scenarios apply the same ladder to comparator graduating LDC exporters, with Bangladesh, Cambodia, and Nepal retained separately in the regional aggregation. The separation matters because the Lao shock identifies domestic exposure, while the peer shock shows how the same institutional transition varies across countries with different apparel concentration and EU dependence.

Pillar 2: regional integration as an offset (S3). The RCEP scenarios test a central claim in Lao PDR's smooth-transition strategy: deeper regional integration may absorb part of the market-access loss from graduation (WTO 2019), but it cannot fully substitute for the EU apparel preference margin (Decreux & Spies 2020). This design is consistent with Lao and regional CGE evidence showing positive effects from RCEP and trade-cost reductions, with gains concentrated in regional value chains and destinations that differ from the EU-facing apparel corridor (Itakura 2022; World Bank 2020). S3A introduces the regional-integration channel without graduation. S3B combines RCEP with the graduation shock. Separating the two cases identifies the difference between a pure regional trade-cost reduction and the interaction between regional reallocation and EU preference erosion.

Pillar 3: third-country market-access gains and relative preference erosion (S4). The final pillar models the external market-access environment facing Lao exporters after graduation. Other suppliers may secure better EU access while Lao PDR loses non-reciprocal preferences. In the available evidence, the clearest example is Viet Nam: under the EU-Viet Nam Free Trade Agreement, apparel tariffs for Viet Nam fall while graduating LDCs face less favorable terms (Sobir & Malavong 2023). Sobir and Malavong also identify European negotiations with India and Indonesia as a further source of pressure for non-signatory exporters. This concern has become more concrete since EU-India Free Trade Agreement negotiations concluded on 27 January 2026, although legal revision, signature, and internal procedures are still required before entry into force.[6]

More generally, Bekkers and Cariola (2025) show that graduation can generate trade shifting and indirect third-country substitution effects, because a tariff change for one exporter changes relative market access in both preference-granting and non-preference-

[6]European Commission, "EU-India agreements," accessed May 25, 2026, https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/india/eu-india-agreements_en.

granting markets. In S4A, the main third-country market-access case, modeled suppliers including Viet Nam and India improve their market access while Lao PDR loses non-reciprocal preferences. The scenario applies a 50% reduction in the residual EU preference wedge for Viet Nam and India and evaluates whether other suppliers' improved access compounds Lao PDR's own graduation shock.

The GTAP-CGE simulations are evaluated under the short-run and long-run adjustment horizons described above. The short-run horizon emphasizes fixed capital-account adjustment and a more limited supply response, while the long-run horizon allows broader global investment adjustment through the *capFlex* closure. Parameter sensitivity enters as a separate check around the policy scenarios: the Armington substitution settings are perturbed around the baseline schedule to test whether the sign and ranking of the main graduation results depend on a narrow parameter choice. The policy scenarios define the tariff and market-access changes, while the closure and sensitivity exercises test how stable the CGE results are under alternative adjustment assumptions.

4 Empirical Results

The results point to a concentrated graduation risk in the EU-facing apparel corridor rather than a uniform loss across the economy. The structural-gravity estimates recover the market-access response to tariff-inclusive trade costs, and the GE counterfactuals show how this response varies across destinations and sectors. The GTAP-CGE simulations carry the same graduation ladder into economy-wide outcomes, including sectoral output, welfare, and sensitivity to model assumptions. Across these steps, regional market access cushions part of the aggregate trade effect, but it does not remove the sectoral loss associated with EU preference erosion.

The reporting sequence separates the policy shock, the behavioral trade response, and the simulated outcomes. Table 2 defines the tariff and preference ladder used in the scenarios; Table 4 reports the estimated tariff-response parameter used for calibration; Appendix Figure 4 reports the corresponding sectoral confidence-interval diagnostic and CGE substitution-parameter convention. The remaining GE and GTAP-CGE results then report the associated export, output, and welfare effects.

4.1 Baseline Gravity Estimates and Calibration Parameter

The first empirical step is to estimate the tariff response that anchors the later simulations. Table 4 reports the current PPML estimates across ITPD-E and BACI specifications. The preferred national ITPD-E specification is Column (2), which uses domestic and international trade flows and distinguishes the major forms of regional trade agreement. The estimated tariff coefficient on $\log(1+t)$ is -6.217 with a standard error of 0.743. Because the tariff variable enters in tariff-inclusive log form, the negative coefficient is reported as the positive empirical tariff-response parameter, $\theta = -\beta_1 = 6.217$. This estimate provides the empirical bridge into the counterfactual simulations; the welfare and output implications are evaluated later in the GTAP-CGE block.

The alternative specifications in Table 4 help interpret this estimate. Across ITPD-E and BACI specifications, the tariff coefficient remains negative, although the magnitude varies with the treatment of domestic trade, regional-agreement controls, and pair fixed effects. The stability of the sign supports the study's design because a single control set does not drive the estimated direction of the tariff response. At the same time, we retain the preferred specification for calibration because it combines the ITPD-E domestic-flow anchor required for structural gravity with a more detailed treatment of overlapping trade agreements. The BACI specifications provide a cross-source check on international flows, but they do not contain the domestic trade observations needed for the same structural closure.

The preferred estimate also defines the parameter convention used for the CGE handoff. The raw gravity coefficient and the GTAP-CGE substitution parameters are related but not identical: the former identifies the export response to tariff-inclusive trade costs, while the latter govern Armington substitution inside the CGE system. Appendix Figure 4 reports the sectoral confidence-interval diagnostic and the mapping used to construct the central CGE Armington schedule, while the sensitivity analysis below checks whether the main rankings survive alternative substitution-parameter choices.

Table 4: Baseline Structural Gravity Estimates with Full Control Coefficients

	ITPD-E				BACI	
	(1)	(2)	(3)	(4)	(5)	(6)
Tariff, $\log(1+t)$	-6.791	-6.217	-2.787	-5.457	-3.004	-0.372
	(0.741)	(0.743)	(0.543)	(0.641)	(0.770)	(0.425)
Distance, log	-0.490	-0.484			-0.638	
	(0.043)	(0.043)			(0.032)	
Contiguity	0.489	0.507			0.455	
	(0.103)	(0.105)			(0.071)	
Common official language	0.260	0.284			0.236	
	(0.091)	(0.093)			(0.068)	
Colonial relationship	0.571	0.606			0.481	
	(0.142)	(0.140)			(0.132)	
Domestic-trade dummy	2.017	2.082				
	(0.159)	(0.148)				
RTA	0.013		0.115	0.004	0.134	0.043
	(0.076)		(0.057)	(0.055)	(0.067)	(0.032)
Free trade agreement		0.067				
		(0.095)				
Customs union		-0.093				
		(0.120)				
Economic integration agreement		0.131				
		(0.107)				
Partial scope agreement		-0.183				
		(0.098)				
Observations	480,500	480,500	472,220	463,020	437,488	429,368
Pseudo R^2	0.966	0.966	0.990	0.994	0.922	0.972
Exporter-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Importer-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Pair FE	No	No	Symmetric	Directional	No	Symmetric

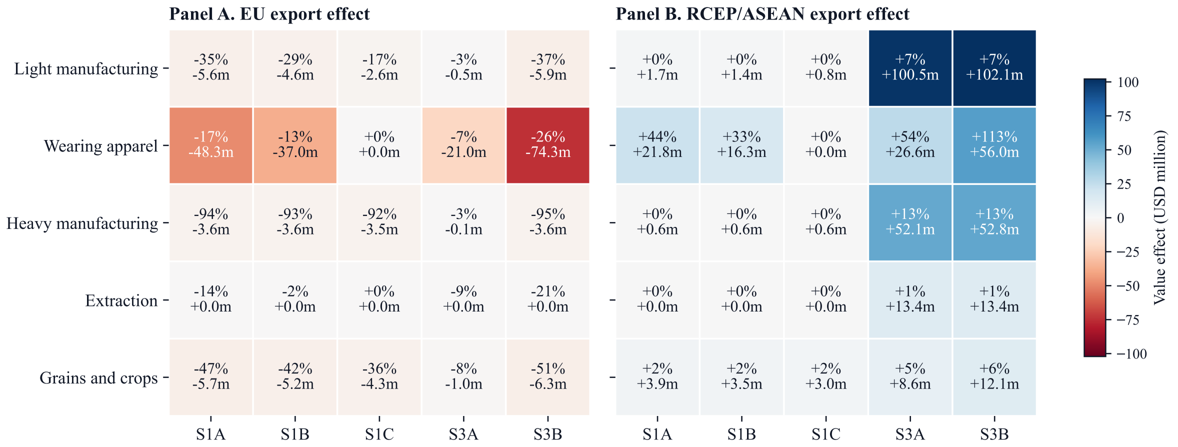
Note: Estimates are obtained with the Stata command ppmlhdfe. The dependent variable is bilateral trade, and the tariff variable is $\log(1+t)$*, where t is the ad valorem tariff rate. All specifications absorb exporter-year and importer-year fixed effects; pair fixed effects are added only in the columns marked in the table. Blank coefficient cells indicate controls that are absorbed by pair fixed effects or replaced by a different trade-agreement specification. Standard errors are clustered by directed exporter-importer pair. Column (2) is the preferred national specification for calibration because it combines the ITPD-E domestic-flow anchor with international flows and detailed trade-agreement controls. BACI specifications provide a cross-source check using international flows, but they cannot support the same structural-gravity closure because they exclude domestic trade.*

4.2 GE Counterfactual Results

The GE counterfactuals show how the market-access shock is distributed across export destinations and sectors. Figure 1 compares the main sectoral export responses across the simulation ladder. Under the MFN fallback in S1A, the external GE-gravity counterfactual implies that Lao exports to the EU fall by about 27.8%. This number is used to locate the external market-access pressure and its sectoral concentration; the headline economy-wide export, output, and welfare effects are reported in the GTAP-CGE results below. The sectoral pattern is the central point: the loss is carried disproportionately by wearing apparel and related light-manufacturing channels, the activities most directly exposed to the withdrawal of EU preferences.

The figure also illustrates the limits of regional integration as an offset. The RCEP

Figure 1: Sectoral GE-Gravity Export Effects across Main Simulation Scenarios



Note: The figure reports structural-gravity export counterfactuals by sector and destination under the corrected scenario design. Effects are changes relative to the relevant benchmark equilibrium and describe external export exposure and sector incidence. The RCEP treatment applies the corrected Lao export market-access rule, $t^{new} = \min(t^{2018}, t^{RCEP2027})$, for eligible RCEP destinations. Welfare, output, and factor-reallocation mechanisms are evaluated separately in the GTAP-CGE block. Source: Author's calculation.

scenarios expand regional export opportunities, but the sectoral gains occur mainly outside the EU-dependent apparel corridor. Regional gains do not restore the original preference-dependent activities. The structural-gravity pattern instead points to a destination-sector mismatch: EU preference erosion falls most sharply on apparel-related exports, while RCEP market-access gains are concentrated in other tradable sectors and regional destinations. The scenario design keeps graduation, regional integration, and relative preference erosion separate for this reason, rather than treating all tariff changes as a single export shock.

These GE results also define the boundary of the gravity exercise. The structural-gravity block captures the external trade response under full-endowment general-equilibrium adjustments in multilateral resistance, prices, income, and expenditure. Sectoral production, intermediate-input use, and factor-market reallocation inside Lao PDR enter only in the GTAP-CGE stage. The grid identifies the external market-access shock that the next subsection carries into domestic production and welfare channels.

4.3 GTAP-CGE Results

The GTAP-CGE simulations carry the same policy scenarios into the domestic economy. The preceding GE results identify how external market access changes trade flows by destination and sector. The CGE model then traces how those shocks affect production, intermediate demand, factor markets, government revenue, and household welfare. The scenario ladder is unchanged, but the outcome space shifts to equivalent variation, real GDP, terms of trade, and destination-specific export responses.

Table 5: Headline CGE Results: Welfare, Macro Effects, and Export Responses

Scenario and policy shock	Welfare and macro			Export response			
	EV	RGDP Δ (%)	ToT	Total	EU Δ (%)	ASEAN	RCEP5
Panel A. Lao graduation scenarios							
S1A: Lao MFN	-0.308	0.012	-0.451	0.082	-16.916	3.943	3.252
S1B: Lao Standard GSP	-0.251	0.009	-0.365	0.155	-13.003	3.180	2.605
S1C: Lao GSP+	-0.058	0.000	-0.079	0.015	-2.845	0.643	0.557
Panel B. Peer-LDC graduation scenarios							
S2A: Peer LDCs MFN	-0.302	0.011	-0.443	0.079	-16.400	3.812	3.156
S2B: Peer LDCs Standard GSP	-0.245	0.009	-0.357	0.153	-12.546	3.064	2.519
S2C: Peer LDCs GSP+	-0.058	0.000	-0.079	0.016	-2.848	0.642	0.558
Panel C. RCEP 2027 market-access scenarios and interactions							
S3A: RCEP 2027 access	0.174	0.025	0.207	1.300	-1.983	0.174	4.615
S3B: RCEP 2027 + Lao MFN	-0.121	0.037	-0.228	1.426	-18.493	3.998	7.364
S3C: RCEP 2027 + Lao Std. GSP	-0.067	0.034	-0.145	1.489	-14.673	3.258	6.800
S3D: RCEP 2027 + Lao GSP+	0.118	0.025	0.131	1.322	-4.768	0.807	5.105

Note: Values are percentage changes from the pre-shock equilibrium. Results are simulated in the GTAP-GAMS levels model as a mixed-complementarity problem, following van der Mensbrugghe (2018). Panel A reports Lao graduation scenarios, Panel B reports peer-LDC graduation scenarios, and Panel C reports strict RCEP 2027 market access and combined RCEP–graduation cases. Results use the short-run fixed-capital-account (capFix) macro closure for the headline simulations; this closure fixes regional current-account balances, so external adjustment operates through the trade balance and relative prices rather than through endogenous capital flows. It does not restrict the mobility of capital across domestic sectors. EV denotes equivalent variation and is the preferred welfare measure. RGDP denotes real GDP, measured as the Fisher market-price volume index, not a welfare measure. Export response columns report Lao exports by destination: total, EU, ASEAN, and RCEP5. ASEAN is reported separately. RCEP5 denotes China, Japan, Korea, Australia, and New Zealand. The strict RCEP 2027 CGE overlay applies to Lao export market access only and uses the no-worsening rule $t_{new} = \min(t_{current}, t_{RCEP2027})$. *ToT denotes terms of trade. Source: Author's calculation.*

Table 5 reports the headline short-run CGE results. The ranking follows the gravity evidence, but the interpretation is wider because the CGE model allows the trade shock to pass through production, intermediate demand, factor returns, and welfare. Among the direct Lao graduation scenarios, MFN fallback remains the most adverse case. Under S1A, EU exports fall by 16.916%, equivalent variation declines by 0.308%, and the terms of trade deteriorate by 0.451%. Standard GSP softens but does not remove the adjustment cost: S1B reduces EU exports by 13.003% and EV by 0.251%. By contrast, GSP+ produces a much smaller headline shock, with EU exports falling by 2.845% and EV by 0.058%. The ladder shows that the cost of graduation depends not only on leaving LDC status, but also on the fallback preference regime that Lao exporters can use.

Panel B provides a consistency and comparison check within the same CGE structure.

The peer-LDC cases apply the fallback-preference ladder to comparator graduating exporters, so the Lao magnitudes remain close to the direct graduation cases. The main evidence is the stability of the sign and ranking across S1 and S2: harder fallback regimes generate larger EU export and welfare losses, while GSP+ greatly compresses the shock.

The small positive RGDP entries in the direct graduation cases are accounting outcomes, not welfare gains. Equivalent variation is the welfare measure in this table, while Fisher real GDP is a market-price volume index of production. Under the short-run fixed capital-account closure, external adjustment can involve lower export prices and small changes in physical trade volumes, so RGDP can remain near zero or slightly positive even when EV declines. In these cases, the positive RGDP entries reflect closure-specific movements in prices and quantities rather than welfare gains from graduation.

The RCEP cases show why regional integration is an offset channel rather than a full replacement for EU preferences. S3A, the RCEP 2027 market-access case without graduation, raises total exports by 1.300%, improves EV by 0.174%, and increases exports to RCEP5 by 4.615%. These S3 scenarios model Lao export market access to RCEP destinations only, isolating the regional export opportunity without imposing reciprocal Lao import-tariff liberalization. Once the same regional-access shock is combined with Lao MFN graduation in S3B, total exports still rise by 1.426% and real GDP increases by 0.037%, but EV turns negative at -0.121% and EU exports fall by 18.493%. RCEP helps redirect trade toward regional markets, but it does not fully offset the welfare and destination-specific costs of losing EU preference access. The production-side table below shows where this aggregate pattern is located inside the domestic economy.

Table 6 reports the production-side incidence of the same shocks. Graduation does not contract all sectors evenly; the adjustment is concentrated in the preference-dependent manufacturing base. Under the MFN fallback in S1A, wearing apparel output falls by 22.00% and textiles by 7.80%. The Standard GSP case remains severe, with apparel contracting by 18.24% and textiles by 6.49%. By contrast, GSP+ largely removes the sectoral contraction in this short-run closure: apparel rises slightly by 0.79% and textiles by 0.81%. This ranking is consistent with the headline CGE table, but the production table locates the domestic adjustment more directly.

Table 6: Sectoral Output Incidence under Graduation and RCEP Scenarios

		Lao graduation			RCEP and interactions			
Sector	Base	S1A	S1B	S1C	S3A	S3B	S3C	S3D
Wearing apparel	3.30	-22.00	-18.24	+0.79	-2.50	-23.95	-20.29	-1.77
Textiles	1.02	-7.80	-6.49	+0.81	-1.51	-9.03	-7.77	-0.75
Heavy manufacturing	12.31	+3.19	+3.12	+0.47	+6.42	+9.73	+9.63	+6.91
Light manufacturing	7.86	+2.53	+2.01	+0.40	-1.15	+1.28	+0.78	-0.76
Transport/comm.	19.10	+0.67	+0.57	+0.08	+0.12	+0.77	+0.67	+0.20
Processed food	27.71	-0.23	-0.26	-0.35	-0.18	-0.42	-0.44	-0.52
Grains and crops	42.10	-0.12	-0.10	-0.11	+0.12	+0.01	+0.03	+0.02
Extraction	27.75	+1.08	+0.90	+0.14	-0.48	+0.57	+0.39	-0.34
Livestock and meat	19.22	+0.47	+0.36	+0.01	-0.33	+0.11	+0.00	-0.33
Other services	22.39	+0.01	+0.01	-0.04	+0.05	+0.06	+0.06	+0.01
Utilities/const.	15.61	+1.06	+0.89	+0.17	-0.08	+0.95	+0.79	+0.09
Leather products	0.45	+0.95	+0.68	-0.37	+11.88	+13.22	+12.88	+11.58

Note: Scenario columns report percentage changes in Lao sectoral output relative to the benchmark equilibrium for all 12 sectors in the paper's GTAP aggregation. The Base column reports benchmark sector output as a percentage of GDP, providing the scale for each sector before the shocks are applied. S1A–S1C report Lao graduation scenarios; S3A–S3D report strict RCEP 2027 market access and RCEP–graduation interaction scenarios. RCEP scenarios model Lao export market access only and do not include reciprocal Lao import tariff liberalization. Leather products have a small benchmark base, so large percentage changes in that row correspond to a limited initial scale. The table focuses on production incidence; welfare channels are reported through EV and terms-of-trade indicators. Source: Author's calculation.

The RCEP interaction scenarios sharpen this sectoral interpretation. RCEP access alone in S3A raises heavy manufacturing output by 6.42% and leather products by 11.88%, but it does not reverse the decline in the EU-dependent apparel corridor, where output still falls by 2.50%. The pattern is consistent with a reallocation mechanism: regional market access expands activities linked to RCEP destinations, while EU-facing apparel remains constrained by the loss of its original preference margin. When RCEP access is combined with MFN graduation in S3B, the production reallocation becomes stronger: heavy manufacturing expands by 9.73%, while wearing apparel falls by 23.95% and textiles by 9.03%. Appendix Table 9 reports the GTAP65 benchmark composition used to interpret the broad CGE sector groups. The heavy-manufacturing aggregate is mainly an industrial and resource-processing bundle: non-ferrous metals account for 44.4% of Lao heavy-manufacturing output and 58.7% of the aggregate's exports, followed by petroleum and coal products, electronics, chemicals, and rubber and plastics. This composition suggests that the RCEP gain is mainly an expansion in a regional industrial and resource-processing bundle, rather than a recovery of the EU-facing apparel channel.

Light manufacturing provides an informative contrast because it is also a regional manufacturing aggregate, but its benchmark composition is narrower and its output response is more modest. In Table 3, light manufacturing accounts for 14.96% of Lao total exports, with much stronger exposure to ASEAN and RCEP5 destinations than to the EU. The GTAP65 benchmark shows that this aggregate is dominated by wood products, which account for 78.1% of light-manufacturing output and 95.2% of light-manufacturing exports. Miscellaneous manufactures account for 15.0% of output but only 2.3% of exports, while metal products, transport equipment, motor vehicles, and paper products each account for small residual shares. This composition helps explain why light manufacturing does not behave like the apparel corridor and also why it does not generate the same strong RCEP expansion as heavy manufacturing: it represents a wood-processing and light resource-based export channel rather than a broad-based manufacturing upgrading effect.

The sectoral changes in Table 6 are best evaluated alongside initial scale. A large percentage increase in leather products, for example, applies to a small base of 0.45% of GDP. The table reports production incidence, while welfare effects are reported through EV and the terms-of-trade channel in the headline table. The appendix diagnostics then check whether the main ranking survives alternative closure, labor-mobility, elasticity, and productivity-offset assumptions. The production evidence points to a clear sectoral result: regional access can support selected industrial activities, especially heavy manufacturing and some light resource-based manufacturing, but it does not remove the apparel-centered adjustment created by the loss of EU preferences.

4.3.1 Solution Diagnostics and Sensitivity Analysis

The CGE diagnostics test whether the interpretation depends on numerical or parameter choices. These exercises document whether the model solves cleanly, whether the results depend on a narrow Armington substitution setting, and whether the CGE transmission remains directionally consistent with the preceding GE-gravity evidence. The GAMS-MCP simulations solve without reported infeasibility problems and satisfy the model's accounting checks, including Walras' Law. This supports treating the reported counterfactuals as solved general-equilibrium outcomes.

Appendix Figure 5 examines parameter sensitivity by varying the trade-substitution parameters around the gravity-calibrated baseline and external benchmark values. The Hertel case is the central specification used for the headline results: it takes the structural-gravity estimate, $\theta = -\beta_1$, and maps it into the GTAP Armington structure with ESUBM $= \theta + 1$ for the second-level import-source nest and ESUBD $= (\theta + 1)/2$ for the first/top domestic-import nest. The GTAP case provides the model's default parameterization, while the Fontagne case draws on the product-level tariff-response evidence of Fontagné et al. (2022). These checks examine whether aggregate exports, EU-facing losses, and welfare rankings move substantially when the CGE trade-substitution parameters vary around the central mapping.

The sensitivity pattern supports the central interpretation, while also placing reasonable bounds around the magnitudes. In Panel B, EU exports remain negative in every reported scenario and under every substitution-parameter specification. For S1A, the EU export loss ranges from 9.862% under the Fontagne case to 19.465% under the gravity upper case, with the Hertel central case at 16.916%. For S3B, where RCEP market access is combined with MFN graduation, the EU export loss remains negative across the same range of specifications. The destination-specific EU loss does not depend on a single Armington parameter choice.

Panel C gives the corresponding welfare check. Equivalent variation remains negative for MFN and Standard GSP graduation cases, close to zero under GSP+, positive for RCEP access alone, and negative when RCEP access is combined with MFN or Standard GSP graduation. The welfare ranking is stable even though the exact magnitudes change with the assumed substitution elasticities. Panel A is less informative for the pure graduation cases because total-export effects are small and sometimes near zero. The stronger evidence comes from the joint sign stability of EU export losses and the broad welfare ranking across the scenario ladder.

Additional CGE sensitivity checks vary the macroeconomic capital-account closure and domestic labor mobility. The long-run flexible capital-account closure does not overturn the ranking of the graduation ladder, but it changes the macro interpretation: in the direct graduation cases, real GDP becomes slightly negative under MFN and Standard GSP, while EV losses remain negative. The labor-mobility check produces small welfare differences, but the real-side gaps show that labor mobility raises physical adjustment in RGDP, exports, and gross output. The headline results remain anchored in the gravity-calibrated short-run specification, while these diagnostics show that the main interpretation is not driven by one closure or factor-mobility assumption.

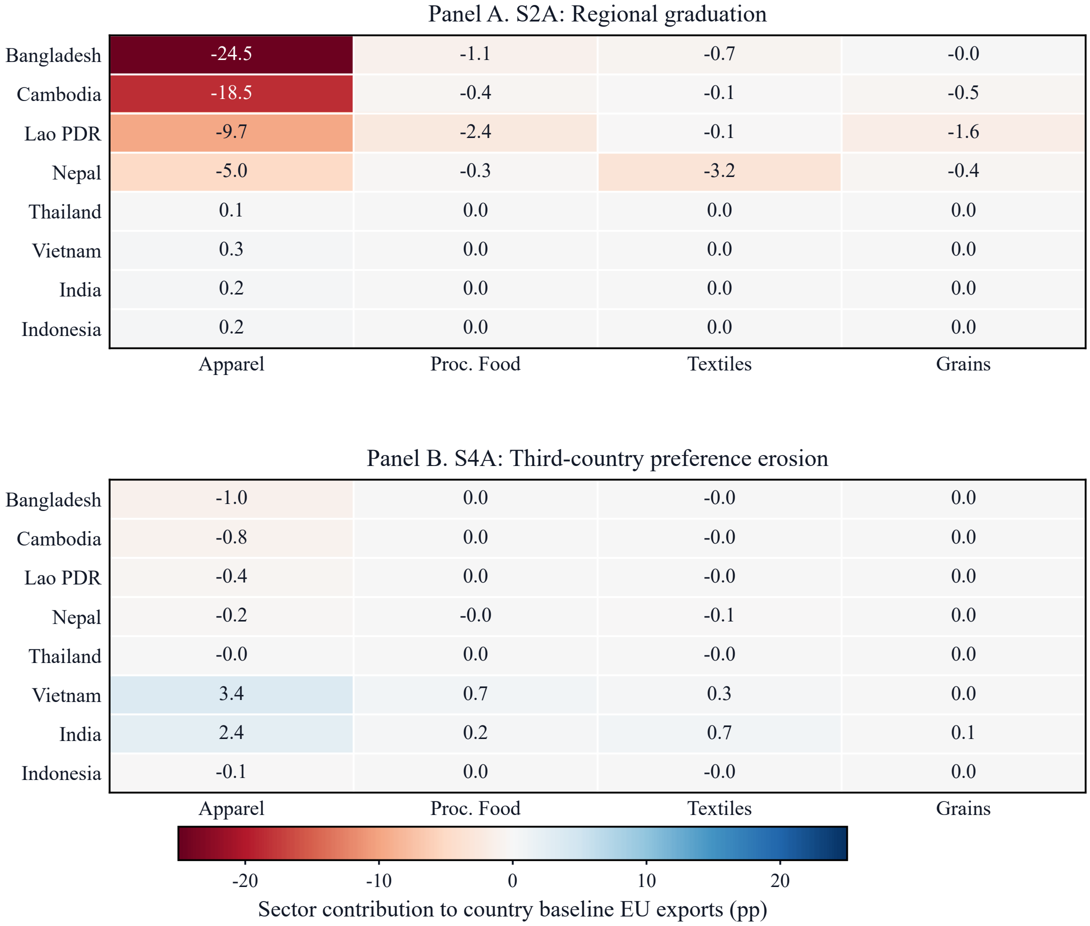
The sensitivity results narrow the interpretation of the CGE evidence. The exact total-export response is more responsive to the substitution-parameter and closure settings, especially when aggregate effects are small. The EU-facing export losses and the welfare ranking are more stable across the same checks. Appendix Figure 6 provides a supplementary GE-CGE export bridge after scope alignment, comparing total goods exports, EU exports, and RCEP5 exports across the two model blocks. For direct destination-specific export effects, especially the EU-facing graduation shock, similar signs and broad magnitudes indicate that the GE-gravity block provides an informative estimate of the external market-access shock carried into the CGE simulations. The comparison is less mechanical for total goods exports because the CGE model reallocates output across sectors, uses intermediate inputs, and clears factor markets. After scope alignment, the sign of the export response matches across all ten compared scenarios in each panel; the reported fit statistics are $R^2 = 0.99$ for total goods exports, 0.99 for EU exports, and 0.94 for RCEP5 exports. These descriptive measures support using the gravity results as an external export-response benchmark, while welfare, real GDP, and terms-of-trade effects remain CGE-specific outcomes.

4.4 Peer Graduation and Third-Country Market-Access Effects

The remaining scenarios place Lao PDR's graduation shock in a wider market-access setting. Appendix Figure 7 reports the aggregate EU export effects for comparator graduating LDCs and for third-country suppliers whose EU market access improves, comparing GE-gravity and GTAP-CGE result blocks where the country-scenario scope overlaps. The peer panel summarizes the exposure of comparator graduating LDC exporters, while the third-country panel summarizes the relative-preference channel when Viet Nam and India improve their own EU market access. The comparison keeps aggregate export exposure separate from welfare, output, and factor-market outcomes. The main third-country case is S4A. In this scenario, Viet Nam and India receive a 50% reduction in the residual EU preference wedge, so the experiment captures a relative market-access improvement for these suppliers while Lao PDR's own tariff treatment remains unchanged. Figure 2 shifts attention from aggregate country-scenario effects to the sectoral source of those effects. The heatmap decomposes each country's EU export effect by sector, with each cell measured as a contribution to that country's own baseline EU exports. It shows which sectors account for the country-level EU export effect, so the emphasis is on composition rather than sector-specific percentage changes.

The decomposition shows that peer and third-country exposure is concentrated in the same narrow part of the export structure: EU-facing apparel and related light manufacturing. For graduating suppliers, this means that preference erosion is uneven across the export basket. Under S2A, apparel accounts for most of the country-level EU export effect in Bangladesh, Cambodia, and Lao PDR, contributing -24.5, -18.5, and -9.7 percentage points, respectively, to each country's own baseline EU exports. Nepal has a smaller apparel contribution (-5.0 percentage points), but textiles also matter (-3.2 percentage points). For third-country suppliers, improved market access matters for the same reason. Under S4A, the positive contribution is concentrated in apparel for Viet Nam and India, with an additional textile contribution for India. The third-country case is a relative EU market-access experiment in sectors where Lao PDR also faces post-graduation exposure. The implication is comparative: Lao PDR's post-graduation adjustment depends on its own fallback tariff treatment and on how other suppliers' access changes within the same EU-facing manufacturing space. Figure 2 connects the peer and third-country cases to the paper's earlier sectoral result: the relevant pressure remains centered on labor-intensive EU-facing manufactures, separate from the broader regional export base.

Figure 2: Country-Sector Contributions to Peer and Third-Country EU Export Effects



Note: Each cell reports a country-sector contribution to the total EU export effect, in percentage points, scaled by that country's own baseline total exports to the EU. Negative cells indicate sectoral contributions to EU export losses; positive cells indicate gains. S2A is the peer MFN graduation case. S4A is the main third-country market-access case, in which Viet Nam and India receive a 50% reduction in the residual EU preference wedge. The denominator is country-specific total EU exports, not sector-specific exports and not Lao-only exports. Source: Author's calculation.

5 Discussion and Policy Implications

5.1 Comparative Vulnerability and the Decoupling Thesis

This study shows that Lao PDR's graduation risk is more sectoral and destination-specific than aggregate trade accounts suggest. Relative to larger graduating peers such as Bangladesh or Cambodia, Lao PDR does not face the same scale of aggregate export loss. Much of its productive structure remains anchored in regional commodity and energy markets, particularly Thailand and China, which moderates the national trade response to preference erosion. This aggregate resilience, however, is only partly connected to the country's labor-intensive industrial base. Once the analysis shifts to destination-specific and sectoral exposure, the vulnerability becomes more visible. The shock is concentrated in the EU-facing manufacturing segment, especially wearing apparel and textiles, which remain central channels for non-resource diversification.

This divergence is consistent with the concern raised by Alonso (2016) that LDC graduation can treat income progress as though it were equivalent to broad productive-capability upgrading. In the Lao context, sustained growth, supported in part by capital-intensive hydropower and mining revenues, has enabled progress toward the income criterion even as labor-intensive manufacturing remains exposed to preference-dependent market access. The simulated results illustrate this distinction. RCEP integration on its own improves aggregate welfare and regional export opportunities, but when RCEP access is combined with MFN graduation, equivalent variation remains negative and wearing apparel output contracts further. Graduation risk is more fully assessed by combining aggregate export shares with the dependence of established production activities on a narrow and conditional preference regime.

5.2 Regional Market Access and the Conditional Value of GSP+

Graduation unfolds within a changing regional market-access environment. Other suppliers, including Viet Nam and India, are strengthening their own access to major destination markets at the same time that Lao PDR faces preference withdrawal. The third-country access scenario (S4A) captures this relative preference-erosion channel. As Lao PDR's apparel tariffs move toward 8.0% under the MFN fallback, Viet Nam's preferential access under the European Union-Viet Nam Free Trade Agreement (EVFTA) widens the relative market-access gap (European Union 2020; Sobir & Malavong 2023). For Lao PDR, the cost of graduation reflects both the withdrawal of its own duty-free status and the changing position of nearby Asian suppliers that have secured more durable bilateral frameworks.

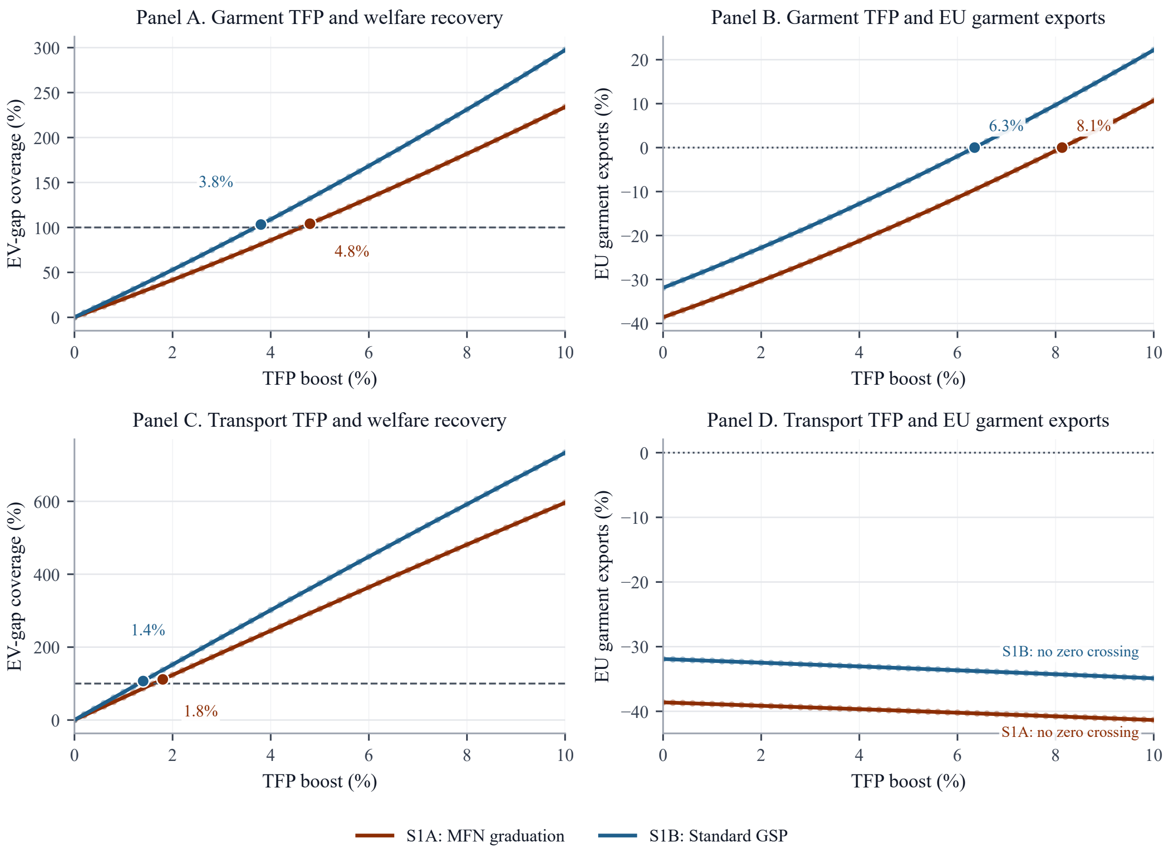
Against this background, the graduation ladder, moving from MFN to Standard GSP and then to GSP+, remains a central policy lever, but one with a practical caveat. GSP+ substantially reduces the simulated graduation shock relative to MFN treatment, yet its value depends on whether firms can satisfy the relevant rules of origin. The shift from single-transformation to double-transformation RoO poses a significant compliance challenge for the Lao apparel industry (Decreux & Spies 2020; Kharel et al. 2024). In that case, institutional eligibility for GSP+ may not translate fully into usable preference access if exporters cannot meet the stricter origin requirements. The policy value of GSP+ depends on firms' ability to document origin, organize input sourcing, and use cumulation provisions where the applicable scheme permits them (UNCTAD 2011).

5.3 Productivity Ladders: Recovery and Retention

The productivity-offset simulations estimate the efficiency gains required to offset the welfare losses from graduation. Figure 3 reports controlled Hicks-neutral productivity shifters for two policy levers: a garment-sector lever covering wearing apparel, textiles, and leather products, and a transport lever operating through transport and communication. Under the MFN fallback, the first garment-productivity increment in the simulation grid that closes the equivalent-variation loss is 4.80%, while the corresponding transport-productivity increment is 1.80%. Under Standard GSP, the corresponding grid values are 3.80% for garment productivity and 1.40% for transport productivity. Because the grid is discrete, the precise break-even point may fall between adjacent increments; in both fallback regimes, however, the transport lever reaches the EV target at a lower tested increment than the garment lever.

The policy implication is not that productivity gains automatically eliminate the graduation problem. Rather, the two levers work through different adjustment margins. Garment productivity is more directly connected to the EU-facing manufacturing corridor and speaks to sector retention. Transport productivity is less targeted to apparel exports, but it can cushion the national welfare loss by lowering broader movement and trade costs. Lao PDR's adjustment has two margins: improving efficiency in the exposed apparel-related sectors and reducing general transport costs that affect regional reallocation. The transition will depend on the sequencing of these investments and on whether productivity gains reach the activities most exposed to the post-graduation shock.

Figure 3: Productivity-Offset Curves for Welfare Recovery



Note: The figure reports EV-gap coverage from controlled Hicks-neutral productivity shifters. A value of 100 percent means that the simulated equivalent-variation loss in the relevant base scenario is closed relative to the no-productivity baseline. Garment TFP covers wearing apparel, textiles, and leather products; transport TFP applies to transport and communication. The x-axis is the imposed TFP shifter in percentage points, not a tariff or elasticity parameter. Source: Author's calculation.

6 Conclusion

Lao PDR's transition out of the LDC category creates a concentrated shock in a narrow EU-facing manufacturing corridor rather than a uniform loss of competitiveness across the economy. Regional and resource-linked activities partly buffer the broader export base, but wearing apparel and related labor-intensive activities remain exposed to the withdrawal of non-reciprocal preferences. The simulations show that the direct export loss is largest when exporters fall back to MFN treatment and much smaller when a usable GSP+ route is available. The domestic results reinforce the same message: the main adjustment is concentrated in exposed manufacturing activities, while the aggregate economy is cushioned by regional and resource-linked channels.

The analysis further indicates that regional integration through RCEP provides an adjustment margin, but not a full replacement for EU preference access. Regional market access improves total exports and creates room for reallocation toward nearby destinations. When the same regional-access gain is combined with MFN graduation, however, welfare remains negative and the EU-facing apparel corridor continues to contract. The productivity simulations reinforce this distinction. Garment productivity is the more direct lever for retaining exposed manufacturing activity, while transport productivity cushions welfare by lowering broader trade and movement costs. These levers are complements, not substitutes for usable preference access.

The policy message is conditional rather than simply preferential. GSP+ can substantially reduce the simulated shock relative to MFN treatment, but the effective gain depends on preference utilization. For apparel exporters, the shift from a single-transformation to a double-transformation RoO requirement may limit how much of the formal tariff preference can be used in practice (Decreux & Spies 2020; Kharel et al. 2024). GSP+ becomes usable market access only to the extent that firms can meet the relevant origin requirements and use the cumulation provisions available under the applicable scheme (UNCTAD 2011).

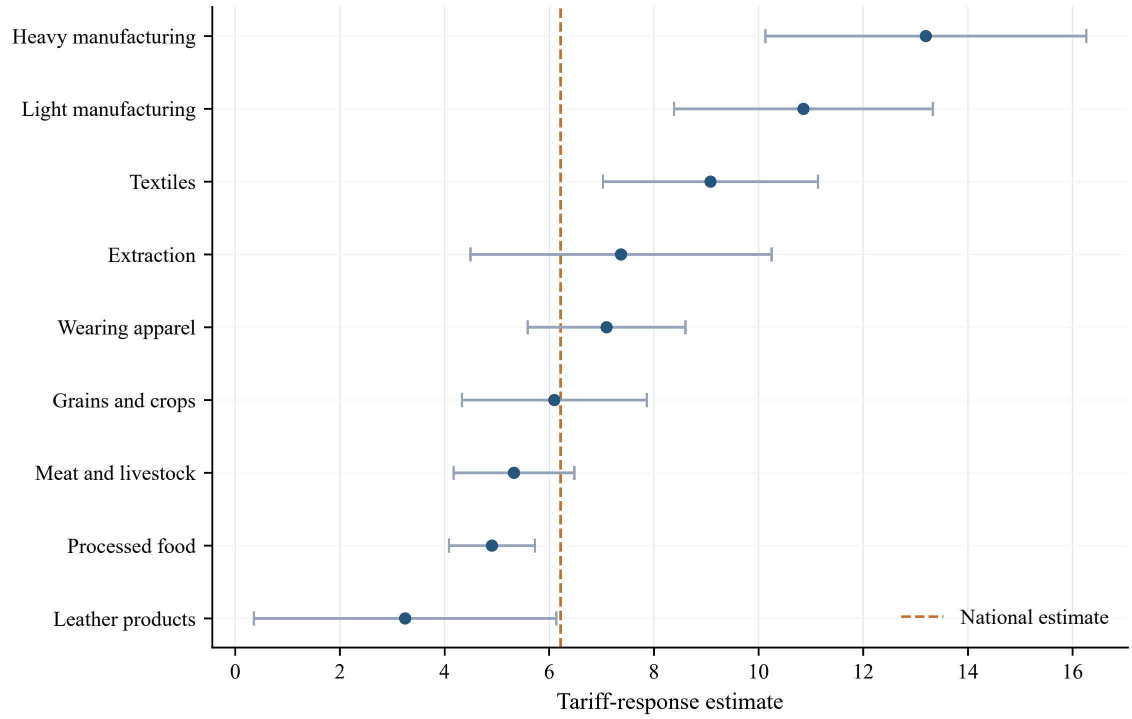
For Lao PDR, graduation is neither negligible nor equivalent to macroeconomic collapse. It is a structurally uneven transition in which regional integration can absorb part of the aggregate shock while labor-intensive, preference-dependent manufacturing remains exposed. The transition therefore requires matching macroeconomic progress with sector-level readiness. The practical agenda is to secure usable fallback preferences, strengthen origin-documentation capacity, reduce transport and logistics costs, and support productivity upgrading in the firms and activities most dependent on EU preference margins.

A Supplementary Diagnostics

This appendix reports supplementary diagnostics for the tariff-response parameter, GE-CGE export alignment, peer and third-country EU export effects, closure and labor-mobility sensitivity, and GTAP12/GTAP65 benchmark composition.

A.1 Tariff-Response Parameter Diagnostic

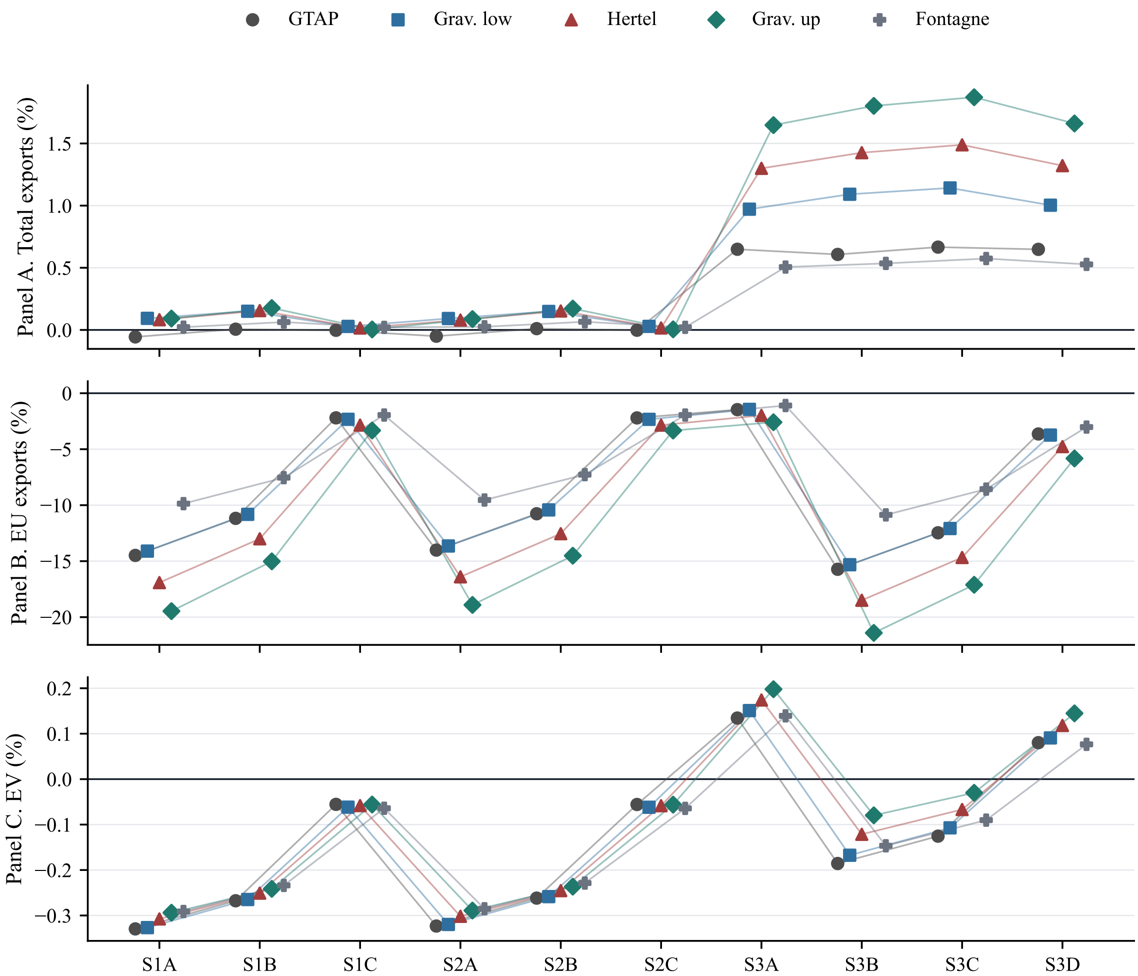
Figure 4: Tariff-Response Estimates and Sectoral Confidence Intervals



Note: The figure reports the preferred structural-gravity tariff-response parameter and sectoral confidence bounds used to motivate the calibrated trade response. The raw gravity coefficient and the GTAP-CGE substitution parameters are related but not identical: the preferred coefficient maps to the positive empirical tariff-response parameter $\theta = -\beta_1$, while the Hertel-style CGE convention maps this value to import-source and domestic-foreign substitution parameters for simulation. Source: Author's calculation.

A.2 Elasticity-Sensitivity Diagnostic

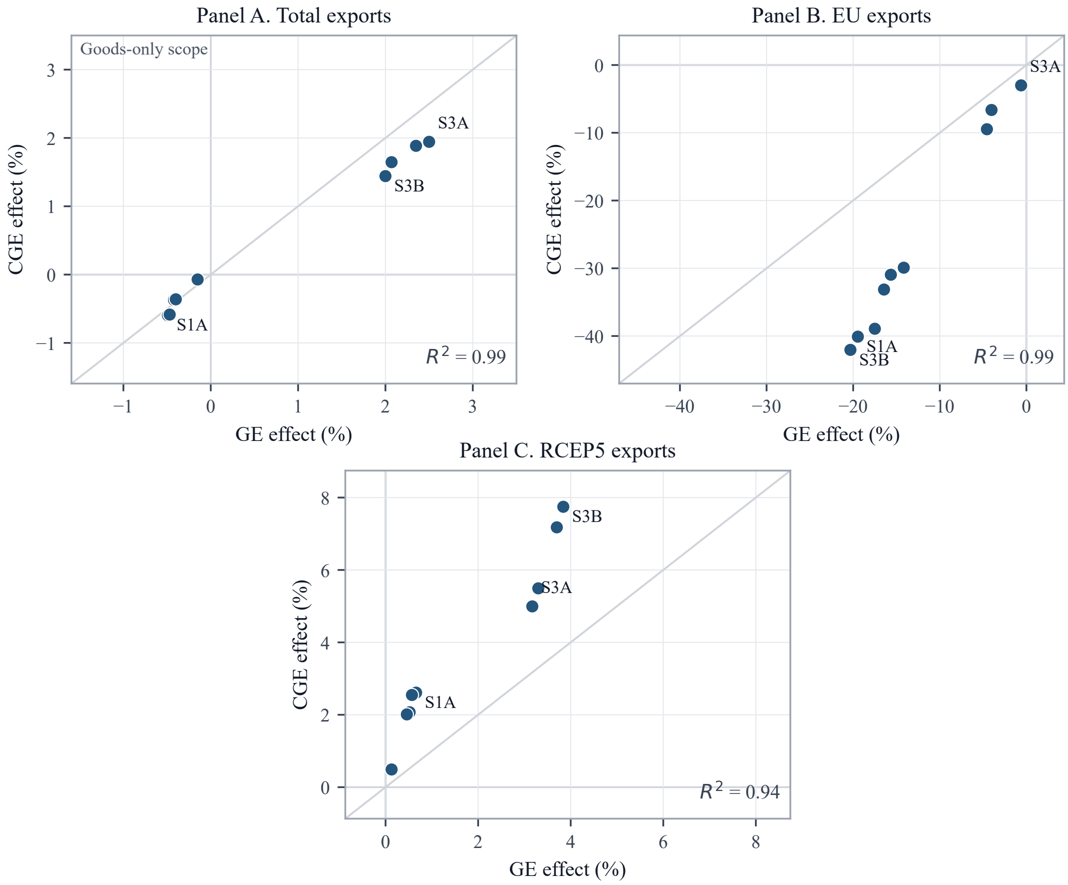
Figure 5: CGE Sensitivity to Alternative Trade-Substitution Elasticities



Note: The figure reports percentage changes from the benchmark equilibrium for total exports, EU exports, and equivalent variation under alternative Armington trade-substitution elasticities. The Hertel case is the central gravity-calibrated specification used in the headline CGE results. It maps the structural-gravity tariff-response parameter, $\theta = -\beta_1$*, into the GTAP Armington nests with* $\mathrm{ESUBM} = \theta + 1$ *for the second-level import-source nest and* $\mathrm{ESUBD} = (\theta + 1)/2$ *for the first/top domestic-import nest, preserving* $\mathrm{ESUBM} = 2\mathrm{ESUBD}$*. The gravity lower and upper cases vary the mapped Armington parameters around the estimated gravity range. The GTAP case uses the default GTAP elasticity parameterization, while the Fontagne case uses the external product-level tariff-response benchmark associated with Fontagné et al. (2022). The figure provides a deterministic parameter-sensitivity check rather than a new policy scenario or a statistical confidence interval. Source: Author's calculation.*

A.3 GE-CGE Export Bridge

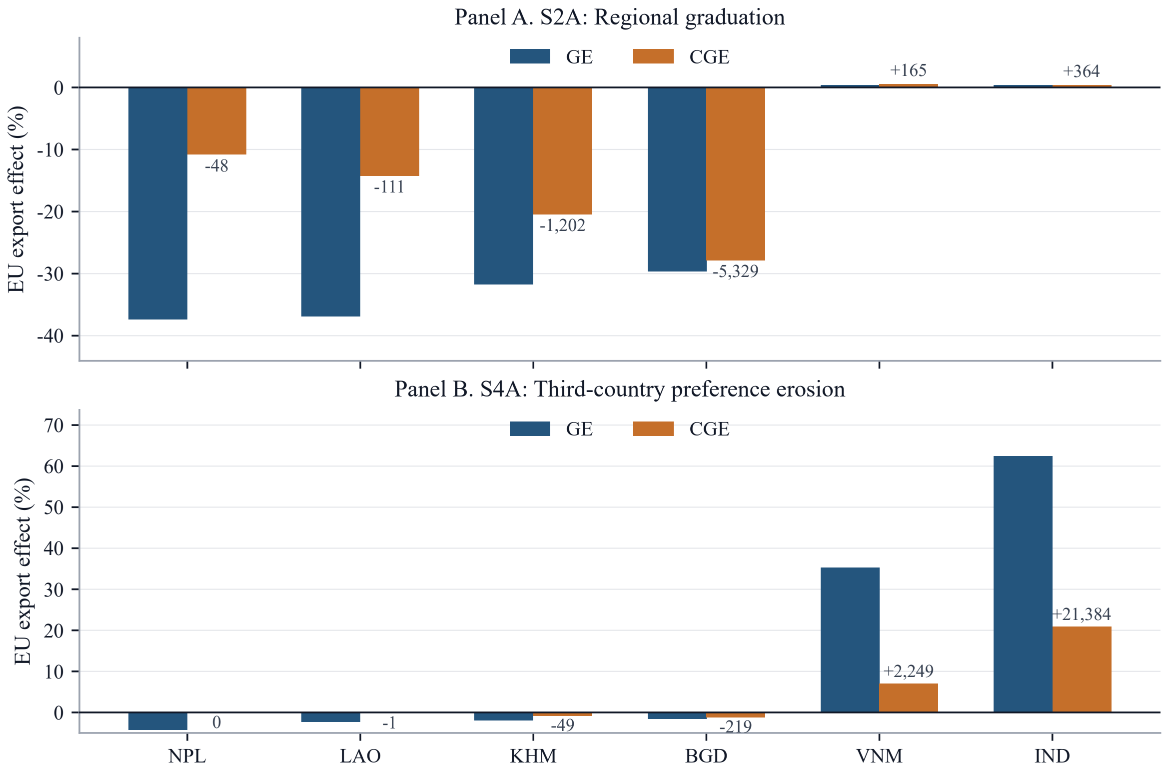
Figure 6: GE-Gravity and GTAP-CGE Export Effects after Scope Alignment



Note: The figure compares structural-gravity and GTAP-CGE export effects after aligning the export scope. Total exports are compared on a goods-only basis; EU exports and RCEP5 exports are destination-specific export effects. RCEP5 denotes China, Japan, Korea, Australia, and New Zealand. The reported fit statistics are descriptive measures of export-effect alignment across scenarios, not validation tests and not welfare, GDP, or terms-of-trade comparisons. Total exports compare GE goods-scope exports with CGE goods-only exports. Source: Author's calculation.

A.4 Peer and Third-Country EU Export Effects

Figure 7: Peer Graduation and Third-Country Market-Access Effects on EU Exports



Note: The figure reports EU export effects for peer graduation and third-country market-access scenarios. The peer panel summarizes the exposure of comparator graduating LDC exporters, while the third-country panel summarizes the relative-preference channel when other suppliers improve their own EU market access. The plotted third-country case is S4A, the 50% residual preference-wedge reduction for Viet Nam and India. The bars compare percentage export effects from the GE-gravity and GTAP-CGE result blocks; numeric labels on CGE bars report corresponding value effects in USD millions where shown. Welfare, output, and factor-market outcomes are reported separately in the CGE results. Source: Author's calculation.

A.5 CGE Sensitivity Tables

Table 7: CGE Sensitivity to the Investment-Account Closure

Code	Scenario	EV	RGDP	ToT	Total X	EU X	ASEAN X	RCEP5 X
Panel A. Short-run fixed capital-account closure								
S1A	Lao MFN	-0.308	+0.012	-0.451	+0.082	-16.916	+3.943	+3.252
S1B	Lao Std. GSP	-0.251	+0.009	-0.365	+0.155	-13.003	+3.180	+2.605
S1C	Lao GSP+	-0.058	+0.000	-0.079	+0.015	-2.845	+0.643	+0.557
S2A	Peer MFN	-0.302	+0.011	-0.443	+0.079	-16.400	+3.812	+3.156
S2B	Peer Std. GSP	-0.245	+0.009	-0.357	+0.153	-12.546	+3.064	+2.519
S2C	Peer GSP+	-0.058	+0.000	-0.079	+0.016	-2.848	+0.642	+0.558
S3A	RCEP 2027	+0.174	+0.025	+0.207	+1.300	-1.983	+0.174	+4.615
S3B	RCEP & MFN	-0.121	+0.037	-0.228	+1.426	-18.493	+3.998	+7.364
S3C	RCEP & Std. GSP	-0.067	+0.034	-0.145	+1.489	-14.673	+3.258	+6.800
S3D	RCEP & GSP+	+0.118	+0.025	+0.131	+1.322	-4.768	+0.807	+5.105
Panel B. Long-run flexible capital-account closure								
S1A	Lao MFN	-0.429	-0.008	-0.588	+1.085	-16.023	+5.124	+3.546
S1B	Lao Std. GSP	-0.349	-0.007	-0.475	+0.963	-12.232	+4.117	+2.819
S1C	Lao GSP+	-0.068	-0.001	-0.090	+0.096	-2.753	+0.733	+0.551
S2A	Peer MFN	-0.419	-0.008	-0.568	+1.048	-15.539	+4.949	+3.453
S2B	Peer Std. GSP	-0.340	-0.007	-0.458	+0.929	-11.808	+3.964	+2.735
S2C	Peer GSP+	-0.068	-0.001	-0.091	+0.098	-2.756	+0.733	+0.555
S3A	RCEP 2027	+0.227	+0.034	+0.267	+0.857	-2.492	-0.311	+4.211
S3B	RCEP & MFN	-0.191	+0.028	-0.310	+2.056	-17.972	+4.736	+7.973
S3C	RCEP & Std. GSP	-0.111	+0.028	-0.197	+1.890	-14.321	+3.722	+7.187
S3D	RCEP & GSP+	+0.169	+0.032	+0.191	+0.884	-5.252	+0.323	+4.708

Note: Entries are percentage changes relative to the benchmark equilibrium. Panel A reports the short-run fixed capital-account closure used in the main headline table. Panel B reports the long-run flexible capital-account closure used as appendix sensitivity evidence. ASEAN and RCEP5 are non-overlapping destination columns. RCEP5 denotes China, Japan, Korea, Australia, and New Zealand. S3 short-run rows use the strict RCEP 2027 tariff schedule. The S3A long-run row applies the same RCEP 2027 market-access rule as the short-run headline, with only the capital-account closure changed to capFlex. EV is equivalent variation, RGDP is real GDP, ToT is the weighted export-price terms-of-trade measure, and X denotes exports. Source: Author's calculation.

Table 8: CGE Sensitivity to Finite Labor Mobility

		EV			RGDP			Total exports			RCEP5 exports			Gross output		
Code	Scenario	Mobile	Finite	Gap	Mobile	Finite	Gap	Mobile	Finite	Gap	Mobile	Finite	Gap	Mobile	Finite	Gap
Panel A. Short-run closure																
S1A	Lao MFN	-0.308	-0.304	-0.004	+0.012	+0.009	+0.003	+0.082	+0.025	+0.057	+2.627	+2.479	+0.148	+0.183	+0.150	+0.033
S1B	Lao Std. GSP	-0.251	-0.247	-0.004	+0.009	+0.006	+0.003	+0.155	+0.100	+0.056	+2.086	+1.950	+0.136	+0.167	+0.138	+0.029
S1C	Lao GSP+	-0.058	-0.059	+0.000	+0.000	-0.000	+0.000	+0.015	-0.003	+0.018	+0.480	+0.470	+0.009	+0.027	+0.024	+0.003
S3A	RCEP 2027	+0.174	+0.175	-0.001	+0.025	+0.023	+0.002	+1.300	+1.191	+0.109	+4.615	+4.552	+0.062	+0.244	+0.215	+0.029
S3B	RCEP & MFN	-0.121	-0.118	-0.004	+0.037	+0.032	+0.005	+1.426	+1.251	+0.175	+7.364	+7.133	+0.231	+0.430	+0.368	+0.063
S3C	RCEP & Std. GSP	-0.067	-0.063	-0.004	+0.034	+0.030	+0.005	+1.489	+1.317	+0.172	+6.800	+6.582	+0.217	+0.413	+0.354	+0.059
S3D	RCEP & GSP+	+0.118	+0.119	-0.001	+0.025	+0.023	+0.002	+1.322	+1.195	+0.127	+5.105	+5.030	+0.075	+0.271	+0.239	+0.032
Panel B. Long-run closure																
S1A	Lao MFN	-0.429	-0.425	-0.004	-0.008	-0.012	+0.003	+1.085	+0.981	+0.104	+3.546	+3.351	+0.195	+0.189	+0.155	+0.034
S1B	Lao Std. GSP	-0.349	-0.344	-0.004	-0.007	-0.010	+0.003	+0.963	+0.868	+0.095	+2.819	+2.644	+0.175	+0.172	+0.142	+0.030
S1C	Lao GSP+	-0.068	-0.070	+0.002	-0.001	-0.002	+0.001	+0.096	+0.086	+0.010	+0.551	+0.549	+0.002	+0.027	+0.024	+0.003
S3A	RCEP 2027	+0.227	+0.232	-0.005	+0.034	+0.033	+0.001	+0.857	+0.741	+0.116	+4.211	+4.143	+0.067	+0.241	+0.213	+0.029
S3B	RCEP & MFN	-0.182	-0.175	-0.007	+0.027	+0.022	+0.004	+1.933	+1.711	+0.222	+7.847	+7.568	+0.279	+0.435	+0.371	+0.064
S3C	RCEP & Std. GSP	-0.105	-0.098	-0.007	+0.028	+0.024	+0.004	+1.810	+1.597	+0.213	+7.103	+6.846	+0.258	+0.416	+0.356	+0.060
S3D	RCEP & GSP+	+0.162	+0.165	-0.003	+0.033	+0.031	+0.002	+0.956	+0.830	+0.126	+4.767	+4.694	+0.073	+0.268	+0.237	+0.031

Note: Mobile is the benchmark mobile-labor allocation case. Finite mobility is the restricted labor-mobility case in which the factor-mobility parameter omegaf is set to 3 for unskilled and skilled labor only. Capital is left unrestricted in this table. For every metric, Gap equals Mobile minus Finite mobility; positive gaps therefore mean the mobile-labor benchmark reports a higher value. The real-side gaps show that labor mobility raises physical adjustment in RGDP, exports, and gross output. RCEP5 denotes China, Japan, Korea, Australia, and New Zealand. Small negative EV gaps mean the finite-mobility case can report a slightly higher EV, although the differences are near zero and mainly reflect price and terms-of-trade cushioning when export supply expands less aggressively. S3 rows use the strict RCEP 2027 market-access templates. EV is not a pure adjustment-speed metric. Source: Author's calculation.

Table 9: Lao Output and Export Composition within GTAP12 Sector Groups, 2014

Sector group	Component	Output	Total exports	EU exports	Output share	Export share
		USD millions			Within sector group (%)	
Mining and extraction	Forestry	1,591.9	867.7	2.1	49.0	61.0
Mining and extraction	Minerals nec	511.4	499.0	0.0	15.7	35.1
Mining and extraction	Oil	92.2	53.9	16.5	2.8	3.8
Mining and extraction	Coal	12.4	2.4	0.0	0.4	0.2
Mining and extraction	Others	1,042.6	0.1	0.0	32.1	0.0
Heavy manufacturing	Metals nec	640.8	632.9	0.0	44.4	58.7
Heavy manufacturing	Computer, electronic, and optical products	157.8	147.1	0.2	10.9	13.6
Heavy manufacturing	Rubber and plastic products	110.2	109.1	0.2	7.6	10.1
Heavy manufacturing	Chemical products	97.4	94.8	9.3	6.8	8.8
Heavy manufacturing	Others	436.1	93.8	19.2	30.2	8.7
Light manufacturing	Wood products	719.2	715.2	0.3	78.1	95.2
Light manufacturing	Manufactures nec	138.3	17.0	2.2	15.0	2.3
Light manufacturing	Metal products	22.5	8.5	0.0	2.4	1.1
Light manufacturing	Transport equipment nec	11.3	5.2	0.0	1.2	0.7
Light manufacturing	Others	29.0	5.5	0.2	3.2	0.7
Utilities and construction	Gas manufacture and distribution	389.6	349.2	166.9	21.3	88.9
Utilities and construction	Electricity	236.7	40.5	0.0	12.9	10.3
Utilities and construction	Water	92.1	1.5	0.5	5.0	0.4
Utilities and construction	Construction	1,112.4	1.5	0.3	60.8	0.4
Wearing apparel	Wearing apparel	386.4	274.5	164.2	100.0	100.0

Continued on next page

Table 9: Lao output and export composition within GTAP12 sector groups, 2014 (continued)

Sector group	Component	Output	Total exports	EU exports	Output share	Export share
		USD millions			Within sector group (%)	
Grains and crops	Crops nec	233.8	113.9	32.1	4.7	43.8
Grains and crops	Vegetables, fruit, and nuts	1,106.4	61.2	2.0	22.4	23.5
Grains and crops	Cereal grains nec	125.6	38.7	0.1	2.5	14.9
Grains and crops	Processed rice	1,622.4	27.1	8.7	32.9	10.4
Grains and crops	Others	1,843.9	19.3	2.8	37.4	7.4
Processed food	Beverages and tobacco products	1,307.1	70.0	7.0	40.3	47.8
Processed food	Food products nec	1,863.5	46.9	5.2	57.4	32.0
Processed food	Sugar	29.4	29.2	11.5	0.9	19.9
Processed food	Vegetable oils and fats	32.8	0.4	0.1	1.0	0.2
Processed food	Others	13.5	0.1	0.0	0.4	0.0
Leather products	Leather products	52.7	29.4	1.5	100.0	100.0
Textiles	Textiles	119.0	8.3	1.2	100.0	100.0
Livestock and meat	Meat products nec	347.5	3.8	1.2	15.4	47.4
Livestock and meat	Bovine meat products	219.4	2.4	0.8	9.7	29.5
Livestock and meat	Animal products nec	763.5	1.7	0.1	33.9	20.8
Livestock and meat	Wool and silk-worm cocoons	0.1	0.1	0.0	0.0	1.6
Livestock and meat	Others	921.3	0.1	0.0	40.9	0.7

Note: The table reports GTAP 2014 benchmark composition for Lao PDR by broad GTAP12 sector group and underlying GTAP65 component. Components are the top four GTAP65 sectors by total exports within each sector group; remaining components are aggregated as Others. Service groups are omitted so the table focuses on the tradable goods and production aggregates used to interpret the Chapter 5 sector-output results. Output is the GTAP market-value output measure. Total exports are reported at world prices. EU exports are exports to EU27. Shares are calculated within each sector group and serve as benchmark-composition diagnostics for the sector-output interpretation. Source: Author's calculation from the GTAP 10A 2014 65-sector archive; output from CM04 and exports from VXWD.

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