Labor Proxy Construction (Containers) — Full Methods & Validity

Terminal×Month methodology + algebraic backfill for 2021–22 (HCT & Bayport)

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0) Why this addendum exists

- In the published **Service KPI: Containers** reports we scraped, **TEU/hour (תפוקה ממוצעת לשעת עבודה)** is available for legacy terminals (Ashdod-Legacy, Haifa-Legacy) for 2014–2024, and for the **new terminals** (Ashdod-HCT, Haifa-Bayport) only **from 2023 onward**.
- We **couldn't find** 2021–2022 TEU/hour for HCT or Bayport in any public source (ports' KPI booklets, IAA/MTT presentations, CBS statistical yearbooks, operator releases).
- To keep the panel complete and avoid discarding the most policy-relevant commissioning months, we fill **only the missing** $\Pi_{i,y}$ for $i \in \{\mathrm{HCT}, \mathrm{Bayport}\}$ and $y \in \{2021, 2022\}$ **algebraically**, without extracting or digitizing additional charts.

This addendum integrates with the main "Methods & Validity" note and is part of the single, citable construction protocol for **L** (labor-hours proxy).

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1) Core construction (recap, unchanged)

Let i be a terminal, $p(i)$ its port, m a month, $q(m)$ the calendar quarter, $y(m)$ the year.

Inputs

- **Monthly port TEU** $TEU_{p,m}$ (observed).
- **Quarterly terminal TEU** $TEU_{i,q}$ (observed).
- **Annual TEU/hour** $\Pi_{i,y}$ (observed when published).

Steps

1. **Terminal shares (observed):**

$$s_{i,p,q} = \frac{TEU_{i,q}}{\sum_{j \in \mathcal{I}(p)} TEU_{j,q}}$$

   Structural zeros before opening: if $TEU_{i,q} = 0 \Rightarrow s_{i,p,q} = 0$.
2. **Terminal-monthly TEU (allocation, not interpolation):**

$$\widehat{TEU}_{i,m} = s_{i,p(i),q(m)} \times TEU_{p(i),m}$$

(Port seasonality preserved; within-quarter shares are constant.)

3. **Annual hours from TEU/hour (when available):**

$$TEU_{i,y} = \sum_{m \in y} \widehat{TEU}_{i,m}, \qquad H_{i,y} = \frac{TEU_{i,y}}{\Pi_{i,y}}.$$

4. **Monthly hours (identity-preserving):**

$$w_{i,m|y} = \frac{\widehat{TEU}_{i,m}}{\sum_{m' \in y} \widehat{TEU}_{i,m'}}, \qquad L_{i,m} = H_{i,y(m)} \times w_{i,m|y(m)}.$$

All QA and robustness from the main note remain (quarter and annual reconciliation, pre-opening zeros, versioning).

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2) The gap: $\Pi_{i,y}$ for new terminals in 2021–2022

- **Known:** $TEU_{i,q}$ for HCT (from 2022Q1) and Bayport (from 2021Q3), and $\Pi_{i,2023}$, $\Pi_{i,2024}$.
- **Unknown:** $\Pi_{i,2021}$ (Bayport), $\Pi_{i,2022}$ (both terminals).

Constraints we respect

- No smoothing across structural breaks (openings are real events).
- No inference from outcomes beyond proportional allocation already defined.
- Keep the **level** of each new terminal anchored to its **first published year** (2023) and let **time-variation** before that follow only **port-wide factors** that affected both terminals.

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3) Algebraic backfill (level-shift transfer from legacy)

We construct missing $\Pi_{i,y}$ for HCT/Bayport by transferring the **legacy terminal's year-to-year pattern** within the same port, scaled by a **level shifter** identified from the first available year for the new terminal.

Definition

For each port p and new terminal $i \in \{\mathrm{HCT}, \mathrm{Bayport}\}$: - Let $\ell(p)$ be the **legacy** terminal at port p (Ashdod-Legacy or Haifa-Legacy).
- Compute a **port-specific level shifter** using the first published year y_0 (2023 for both):

$$\alpha_p \equiv \frac{\Pi_{i,y_0}}{\Pi_{\ell(p),y_0}}.$$

- For any **missing** year $y < y_0$ **after opening**, set

$$\boxed{\Pi_{i,y} = \alpha_p \, \Pi_{\ell(p),y}} \quad (\text{“level-shift transfer”}).$$

Intuition and properties

- This is algebraic (no scraping) and uses **only published numbers** we already have (legacy series and the new terminal's 2023 level).
- It assumes **port-wide shocks** to labor productivity (agreements, crane availability, weather) move both terminals **proportionally over time**, while preserving each terminal's **level** difference via α_p .
- It **does not** invent within-year dynamics; it only supplies the **annual** Π needed to scale observed TEU into hours.
- **Bounds (conservative):** we enforce $\Pi_{i,y} \leq \Pi_{i,y_0}$ for the first partial year after opening (e.g., Bayport-2021), preventing pre-publication years from exceeding the terminal's first published level.

Implementation details

1. Set $y_0 = 2023$. Compute $\alpha_{Ashdod} = \Pi_{HCT,2023} / \Pi_{Ashdod\text{-}Legacy,2023}$; $\alpha_{Haifa} = \Pi_{Bayport,2023} / \Pi_{Haifa\text{-}Legacy,2023}$.
2. **Bayport-2021:** apply $\Pi_{Bayport,2021} = \min\{\alpha_{Haifa}\Pi_{Haifa\text{-}Legacy,2021}, \Pi_{Bayport,2023}\}$. Months before 2021Q3 remain structural zeros via $TEU_{i,q} = 0$.
3. **2022 (both terminals):** $\Pi_{i,2022} = \alpha_p \Pi_{\ell(p),2022}$.
4. 2023–2024 use **published** Π as-is.

Output consistency

- Annual hours: $H_{i,y} = TEU_{i,y} / \Pi_{i,y}$ are thus identified for 2021–2024 for each terminal that is open.
- Monthly hours: $L_{i,m}$ follow the **observed** monthly TEU profile; pre-opening months remain 0.

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4) What if legacy Π appears idiosyncratic?

We provide **toggleable variants** (recorded in metadata): 1. **Capped transfer (default):** $\Pi_{i,y} = \min\{\alpha_p \Pi_{\ell,y}, \Pi_{i,y_0}\}$ in the first partial year.
2. **Smooth-ratio variant:** replace $\Pi_{\ell,y}$ by a two-year average $\overline{\Pi}_{\ell,\{y,y_0\}}$ to reduce one-year spikes (reported as sensitivity only).
3. **Legacy-only bounds:** enforce $\min\{\Pi_{\ell,y}, \Pi_{i,y_0}\} \leq \Pi_{i,y} \leq \max\{\Pi_{\ell,y}, \Pi_{i,y_0}\}$.

All variants keep structural breaks intact (openings, privatization) and never smooth across them.

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5) Additional robustness paths (beyond Π backfill)

These paths **do not rely on TEU/hour** and are meant for sensitivity analysis:

R1) Staffing-intensity proxy (L_2)

- Build annual "person-teams" $PT_{i,y} = \mathrm{Calls}_{i,y} \times \mathrm{AvgTeamsPerShip}_{i,y}$ from the same KPI source **when available** (2023–2024 for new terminals).

- Convert to hours by a single **calibration constant** per port-year $\kappa_{p,y}$ such that $\sum_m L_{2,i,m} = \sum_m L_{i,m}$ (scale-comparable).
- Allocate to months by observed $\widehat{TEU}_{i,m}$ shares or, if we later obtain monthly calls, by call shares.
- Use L_2 in parallel regressions; stability vis-à-vis L_1 mitigates mechanical-correlation concerns.

R2) Interval-identified Π

- Construct **upper and lower** Π paths for 2021–2022: e.g., $0.85 \times \alpha_p \Pi_{\ell,y}$ and $1.00 \times \alpha_p \Pi_{\ell,y}$ (or port-wide min/max).
- Run the main regressions on both bounds and report the range of coefficients.

R3) Event-window trims and dummies

- Exclude the first k months after opening (ramp-up) or include a "new-terminal ramp" dummy interacted with time to absorb transients.

R4) Legacy-only baseline

- Re-estimate using **only legacy terminals** through 2024. This removes any assumption about 2021–2022 new-terminal productivity; event-study timing still exploits port-level variation.

R5) Cross-metric triangulation (future-data hook)

- If later we obtain **TEU/ship-hour at berth** or **berth time per call**, we can compute an independent hours proxy and compare to L_1 year-by-year.

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6) Diagnostics & audit trail additions

- **Backfill log:** per (p, i, y) record α_p , source year y_0 , the chosen variant, and any cap applied.
- **Quarter/annual reconciliation** remain unchanged (we still check $\sum_{m \in q} \widehat{TEU}_{i,m} \approx TEU_{i,q}$ and $\sum_{m \in y} L_{i,m} = H_{i,y}$).
- **Versioning:** we store hashes of (i) KPI table, (ii) TEU panel, and (iii) this addendum's parameters.

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7) What this buys us (and what it doesn't)

Buys: a complete 2021–2024 terminal×month **L** panel that (i) respects openings, (ii) uses only published numbers, and (iii) is transparent and reproducible.
Doesn't: claim precise 2021–2022 TEU/hour for new terminals. We treat those years as **calibrated** by port-wide patterns and report robustness that brackets plausible alternatives.

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8) One-page recipe (for the code)

1. Read KPI wide table and compute α_p per port from 2023.

2. For new terminals and years $y < 2023$ after opening: set $\Pi_{i,y} = \alpha_p \Pi_{\ell(p),y}$, with the Q3-opening cap for Bayport-2021.
3. Proceed with the standard pipeline to obtain $H_{i,y}$ and $L_{i,m}$.
4. Emit the **backfill log** and the QA tables.

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9) Summary

Our labor proxy now combines (a) **directly published** TEU/hour wherever available and (b) a **level-shift transfer** to recover **only** the missing new-terminal years (2021–2022). The approach is **minimal-assumption**, **auditable**, and shipped with robustness paths (L_2 , interval bounds, trims, legacy-only baseline). This integrated note can be cited in the thesis methods to document **how** and **why** we constructed **L** this way and **how** we guard against inference risks.