Econ H191 — Econometrics: Ports Reform → K/L → LP → IV-Mediation

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1 Introduction

2 Notes

Ways in which LP can increase not mediated by K/L:
- competition may cause higher utilization per worker, drive the operators to make various things for efficient etc.
- another port may improve various wait times or something

3 Econometric Notes

Setup. Two ports $p \in \{\text{Haifa}, \text{Ashdod}\}$; monthly (or quarterly) time t for 2018–2024. Mediator $M_{pt} = \ln(K/L)_{pt}$. Outcome $Y_{pt} = \ln(\text{LP})_{pt}$ (or proxies: TEUs/worker, moves/hour, $-\ln$ turnaround). Treatment clocks: competition go-live (Haifa: 2021-09; Ashdod: $\tilde{2}$022-Q4) and privatization (Haifa: 2023-01). Always include port fixed effects α_p and time fixed effects δ_t.

Step 1 — Reform → K/L (First Stage)

Dynamic event-study asking whether the reform increased capital per worker.

$$M_{pt} = \alpha_p + \delta_t + \text{event-time dummies for reform timing} + \text{controls} + \varepsilon_{pt}.$$

Target: flat pre-period dummies ≈ 0 (parallel pre-trends) and positive post dummies (reform increased K/L). Summarize a post window (e.g., 12m) as the first-stage effect on M.

Step 2 — Reform → LP (Total Effect)

Same event-study for productivity.

$$Y_{pt} = \alpha_p + \delta_t + \text{event-time dummies for reform timing} + \text{controls} + u_{pt}.$$

Total Effect (TE): average of post-reform dummies over a pre-declared window (e.g., 12–24 months). Flat pre-period implies credible parallel trends.

Step 3 — K/L → LP (Instrumental Variables for Mediator)

Because K/L is endogenous, instrument it with engineering/timing milestones Z_{pt} (crane commissioning, dredging/depth completion, automation go-live).

$$\begin{aligned} \text{First stage:} \quad & M_{pt} = \alpha_p + \delta_t + Z_{pt} + T_{pt} + \text{controls} + e_{pt}. \\ \text{Second stage:} \quad & Y_{pt} = \alpha_p + \delta_t + \widehat{M}_{pt} + T_{pt} + \text{controls} + \xi_{pt}. \end{aligned}$$

Where T_{pt} are the reform dummies (competition, privatization). the beta on M hat is the direct effect, and the coefficients on the Treatment terms are the indirect effects.

Step 4 — IV-Mediation Decomposition

Indirect effect (via K/L): (reform → K/L from Step 1) × (K/L → LP from Step 3).
Direct effect: Total Effect from Step 2 − Indirect Effect. Report confidence intervals; robustness: wild bootstrap at port level; drop 2020; truncate at 2023-Q3.

4 Econometrics

Purpose. This section lays out a clear, three–part causal design for the Israel ports reform case: (A) Reform → capital deepening (K/L), (B) Reform → labor productivity (LP), and (C) IV–mediation that decomposes the total LP effect into an indirect component via K/L and a direct component.

0) Common Setup (applies to all parts)

- **Units:** ports $p \in \{H, A\}$ (H = Haifa, A = Ashdod). **Calendar time:** months $t \in \{2018\text{-}01, \ldots, 2024\text{-}12\}$.
- **Event time (A & B only):** $\tau_{pt} := t - T_p^{\text{comp}}$, where T_p^{comp} is the deep–water competition/capacity go–live month.
- **Treatment clocks (calendar–time dummies for C):** $T_{pt}^{\text{comp}} = \nVdash\{t \geq T_p^{\text{comp}}\}, \quad T_{pt}^{\text{priv}} = \nVdash\{t \geq T_p^{\text{priv}}\}$ (Haifa: 2023–01).
- **Spillovers:** S_{pt} encodes the other port's post status; baseline binary (e.g., $S_{H,t} = T_{A,t}^{\text{comp}}$).
- **Mediator:** $M_{pt} := \ln K_{pt} - \ln L_{pt} = \ln((K/L)_{pt})$.
- **Outcome:** $Y_{pt} := \ln(LP_{pt})$; if unavailable monthly, use ln(TEUs/worker), ln(moves/hour), or $-\ln$(turnaround).
- **Controls:** X_{pt} (month–of–year, holidays, weather, average vessel size/mix, transshipment share).
- **Fixed effects:** port FE α_p and month FE δ_t.
- **Instruments (C only):** Z_{pt} are engineering/commissioning shifters (terminal commissioning, STS crane commissioning, dredging completion).
- **Design choice:** keep T^{comp} and T^{priv} separate to isolate channels in mediation.

Measurement notes. *Capital* K_{pt} is a capital–services index (weighted cranes, yard equipment, automation, deep–draft berth meters); *Labor* L_{pt} is monthly hours (preferred) or headcount for container ops; ensure consistent definitions across time and ports. Baseline uses raw monthly series; a short moving average is a robustness check only.

Part A — Reform → Capital Deepening (K/L)

Question A. Did the deep–water competition reform increase capital per worker at the treated port, relative to just before go–live, net of national shocks and the rival's status?

A1. Event–Study DiD (primary). Build simple event–time bins B_j for τ_{pt} (e.g., pre: $[-12, -1]$, go–live: $[0]$, early post: $[1, 6]$, later post: $[7, 12]$, long–run: $[\geq 13]$). Omit the last pre bin.

$$\boxed{M_{pt} = \alpha_p + \delta_t + \sum_{j \neq -1} \beta_j \nVdash\{\tau_{pt} \in B_j\} + \phi\, S_{pt} + X_{pt}'\gamma + \varepsilon_{pt}.} \tag{1}$$

Interpretation. β_j are dynamic effects of competition on M relative to just–pre; S_{pt} absorbs interference from the rival; α_p compares the port to itself over time; δ_t nets out nationwide shocks; X_{pt} handles seasonality/composition.

Identification tests. (i) **Parallel pre–trends:** all lead $\beta_j \approx 0$ (joint F–test). (ii) **No anticipation:** no jump in M for $\tau < 0$. (iii) **Spillovers handled:** include S_{pt} (binary and intensity variants).

Inference & robustness. Cluster by **time** and use wild–bootstrap p–values; add Fisher randomization inference by permuting feasible go–live months. Re–estimate excluding 2020 and truncating at 2023–Q3. As a sharp local check in ± 12 months around go–live, fit an RDiT: $M_{pt} = \alpha_p + f(\tau) + \theta_M \mathbb{1}\{\tau \geq 0\} + \lambda S_{pt} + X'\eta + u_{pt}$.

Reading the plot. Flat leads + sustained positive post bins $\Rightarrow$ "K/L increased after go–live." Convert log points: average $\hat{\beta}_j = 0.25$ over $[+6, +12] \approx 28\%$ higher K/L.

A2. Cross-port control robustness: not-yet-treated window (stacked ES). To make the "control" port explicit, restrict to months when the *other* port is not yet treated. For Haifa's effect, estimate only on $t < T_A^{\text{comp}}$ so Ashdod is a live control in every month:

$$M_{pt} = \alpha_p + \delta_t + \sum_{j \neq -1} \beta_j^H \left[\mathbb{1}\{p = H\} \cdot \mathbb{1}\{\tau_t^H \in B_j\}\right] + X'_{pt}\gamma + \varepsilon_{pt}, \quad t < T_A^{\text{comp}},$$

where $\tau_t^H = t - T_H^{\text{comp}}$. Read β_j^H as Haifa's K/L response using Ashdod (not yet treated) to purge same-month shocks via δ_t. Symmetrically, for Ashdod estimate on $t < T_H^{\text{comp}}$ with β_j^A.

A3. Cross-port difference RDiT (two-unit local). Form the cross-port difference so common-month shocks cancel mechanically. Around Haifa's go-live:

$$\Delta M_t := M_{H,t} - M_{A,t} = c + f\big(t - T_H^{\text{comp}}\big) + \theta_H \mathbb{1}\{t \geq T_H^{\text{comp}}\} + u_t,$$

estimated in a symmetric window (e.g., ± 12 months). A significant θ_H is a difference-in-discontinuities jump in K/L at Haifa's go-live, relative to Ashdod in the same months. Repeat around Ashdod's go-live with $\Delta M'_t := M_{A,t} - M_{H,t}$ to obtain θ_A. Use local linear $f(\cdot)$ (quadratic as robustness), report bandwidth and donut checks.

Part B — Reform $\to$ Labor Productivity (LP)

Question B. Did the reform raise LP at the port, all channels combined?

B1. Event–Study DiD (primary).

$$\boxed{Y_{pt} = \alpha_p + \delta_t + \sum_{j \neq -1} \theta_j \mathbb{1}\{\tau_{pt} \in B_j\} + \psi\, S_{pt} + X'_{pt}\kappa + \nu_{pt}.} \tag{2}$$

Interpretation. θ_j are dynamic *total* (reduced–form) effects on LP; S_{pt} absorbs reallocation; $\alpha_p, \delta_t, X_{pt}$ as above. Define one– and two–year post windows and report TE$= \sum w_j \hat{\theta}_j$.

Robustness & triangulation. (i) RDiT as in Part A but with Y_{pt}. (ii) Synthetic Control per port against *foreign* donors; a persistent treated–minus–synthetic gap post go–live strengthens identification. (iii) Add domestic logistics controls (DDD flavor) to soak up system–wide pulses.

Reading the plot. Flat leads + positive post bins $\Rightarrow$ "LP increased after go–live." Example: TE(1y) $= 0.18$ ($\approx 20\%$), TE(2y) $= 0.25$ ($\approx 28\%$).

B2. Cross-port control robustness: not-yet-treated window (stacked ES). Repeat the explicit cross-port design for productivity. For Haifa, restrict to $t < T_A^{\text{comp}}$:

$$Y_{pt} = \alpha_p + \delta_t + \sum_{j \neq -1} \theta_j^H \left[\mathbb{1}\{p = H\} \cdot \mathbb{1}\{\tau_t^H \in B_j\}\right] + X_{pt}'\kappa + \nu_{pt}, \quad t < T_A^{\text{comp}}.$$

Here θ_j^H compares Haifa's post bins to its last pre bin while using Ashdod (not yet treated) to absorb concurrent shocks through δ_t. Do the symmetric Ashdod window ($t < T_H^{\text{comp}}$) to obtain θ_j^A.

B3. Cross-port difference RDiT (two-unit local). Construct the cross-port difference in LP so calendar-month shocks drop out. Around Haifa's go-live:

$$\Delta Y_t := Y_{H,t} - Y_{A,t} = c + f\big(t - T_H^{\text{comp}}\big) + \vartheta_H \mathbb{1}\{t \geq T_H^{\text{comp}}\} + e_t,$$

estimated in a ± 12 month window. A positive ϑ_H indicates a sharp LP jump at Haifa's go-live relative to Ashdod. Repeat around Ashdod's go-live with $\Delta Y_t' := Y_{A,t} - Y_{H,t}$ to obtain ϑ_A. Use the same $f(\cdot)$ and bandwidth conventions as in Part A to keep designs comparable.

Part C — Mechanism via IV–Mediation (K/L → LP)

Question C. Of the total LP gain from Part B, how much is explained by the increase in K/L measured in Part A?

Why not OLS on Y vs M? Reverse causality (better LP changes K or L), omitted shocks (managerial shifts), and measurement error in K bias OLS. Solution: instrument M_{pt} with *engineering timing* that moves capital for physical reasons.

C1. Structural system (calendar–time).

$$\boxed{M_{pt} = a_0 + a_1 T_{pt}^{\text{comp}} + a_2 T_{pt}^{\text{priv}} + a_3 S_{pt} + X_{pt}'a + \alpha_p + \delta_t + u_{pt}} \tag{3}$$

$$\boxed{Y_{pt} = b_0 + b_1 T_{pt}^{\text{comp}} + b_2 T_{pt}^{\text{priv}} + b_3 M_{pt} + b_4 S_{pt} + X_{pt}'b + \alpha_p + \delta_t + v_{pt}} \tag{4}$$

Interpretation: a_1 is the effect of competition on M; b_3 is the causal elasticity of LP w.r.t. K/L (after instrumenting M); b_1, b_2 capture *direct* channels not via M.

$$\boxed{M_{pt}} = \pi_0 + \Pi' Z_{pt} + \pi_1 T_{pt}^{\text{comp}} + \pi_2 T_{pt}^{\text{priv}} + \pi_3 S_{pt} + W_{pt}'\pi + \alpha_p + \delta_t + e_{pt} \tag{5}$$

$$\boxed{Y_{pt}} = \beta_0 + \beta_1 T_{pt}^{\text{comp}} + \beta_2 T_{pt}^{\text{priv}} + \beta_3 \widehat{M}_{pt} + \beta_4 S_{pt} + W_{pt}'\beta + \alpha_p + \delta_t + \xi_{pt} \tag{6}$$

Show: (i) **Relevance** ($Z \to M$): report KP F–stat and partial R^2. (ii) **Exclusion**: in narrow windows and controlling for $T^{\text{comp}}, T^{\text{priv}}$, Z should move Y only through M; verify no contemporaneous jump in Y at Z when M cannot yet change. If $|Z| > 1$, report Hansen J and drop–one–Z stability.

C3. Effects and mediated share. From Part B, take $\text{TE} = \sum w_j \hat{\theta}_j$. Compute the *indirect effect* via K/L as $\widehat{\text{IE}}_{\text{comp}} = \hat{a}_1 \hat{b}_3$ (and $\widehat{\text{IE}}_{\text{priv}} = \hat{a}_2 \hat{b}_3$). The *direct effect* is $\widehat{\text{DE}} = \widehat{\text{TE}} - (\widehat{\text{IE}}_{\text{comp}} + \widehat{\text{IE}}_{\text{priv}})$. Obtain CIs by delta method or block bootstrap across time.

Numerical intuition. If $\hat{a}_1 = 0.30$ (K/L up 30%) and $\hat{b}_3 = 0.50$ (1% higher K/L $\Rightarrow$ 0.5% higher LP), then IE $= 0.15$ ($\approx$16%). If TE(2y) $= 0.25$ ($\approx$28%), the mediated share is about 60%, leaving DE ≈ 0.10.

Diagnostics, Inference, and Falsification (all parts)

- **Small–N inference:** cluster by time; wild–bootstrap p–values; Fisher RI by permuting feasible treatment timing.
- **Pre–trends:** joint insignificance of lead bins in Parts A
B; visual flatness.
- **Note:** use Sun–Abraham / Callaway–Sant'Anna instead of naive TWFE to get HTE-robust event-study paths for K/L and LP.
- **Spillovers:** include S_{pt} in every equation (binary and intensity variants).
- **Shock management:** drop 2020; truncate at 2023–Q3; or include explicit dummies.
- **Placebos:** unrelated domestic sectors; placebo timing shifts ($\pm$6–12 months).
- **SCM triangulation:** one SCM per port using foreign donors; compare treated gap to donor placebo distribution.
- **Falsify if:** strong lead effects; weak $Z \to M$ and no post jump in M; over–ID rejects and Y jumps at Z before M can move; results hinge on war/COVID months only.

Minimal Implementation Roadmap

1. Build monthly panel (2018–2024): $K_{pt}, L_{pt} \Rightarrow M_{pt}$; Y_{pt}; clocks $T^{\text{comp}}, T^{\text{priv}}$; spillover S_{pt}; instruments Z_{pt}.
2. **Part A:** estimate (1); plot $\hat{\beta}_j$ with 95% CIs; joint lead test; local RDiT check.
3. **Part B:** estimate (2); plot $\hat{\theta}_j$; TE(1y)/(2y); RDiT; SCM per port.
4. **Part C:** estimate first/second stages; report first–stage F and R^2; compute IE/DE with CIs.
5. Sensitivity pack: spillover intensity; windows; alternative K weights; hours vs headcount; 2020 drop; pre–war truncation; placebo timing.

Interpretation Snapshot

- **Part A** answers: did competition increase capital deepening? (post $\hat{\beta}_j > 0$ with flat leads.)
- **Part B** answers: did competition raise labor productivity in total? (post $\hat{\theta}_j > 0$ with flat leads.)
- **Part C** answers: how much of the LP gain is via K/L? (IE $= \hat{a}_1\hat{b}_3$; DE $=$ TE $-$ IE.)