Measuring the Impact of Israel's 2021-2023 Port Reforms on Labor Productivity Mediated by Capital Deepening

Abstract, Design, and Data

This paper measures the impact of Israel's recent (2021-2023) port reforms on the sector's persistently low labor productivity. The reforms were aimed at breaking monopoly conditions by introducing intra-port competition through new deep-water terminals in Haifa and Ashdod, and by privatizing Haifa's legacy operator. Beyond the overall effect of the reforms on labor productivity, the study quantifies the share of productivity gains mediated by capital deepening, a channel of special interest given the endemically notably low levels of capital per worker in Israel's non-tradable sectors. Finally, this paper contrasts the effects of privatization and intra-port competition on labor productivity.

I use an event-study DiD for staggered adoption as developed by Sun-Abraham (2021) and Callaway-Sant'Anna (2025) to evaluate the impact of each of the three reforms on K/L and on labor productivity (LP). I then use IV-mediation to distinguish gains in LP through the K/L channel as opposed to other factors by implementing a 2TSL with a yet-to-be-defined proxy to instrument K/L.

The final data I need is monthly or quarterly panel data on each port detailing output, K/L, and LP. None of these metrics are directly reported, so I will have to build proxies for each one. For output, I'll use TEU's processed, perhaps multiplied by a factor of service-time KPIs such as waiting time, dwell time, and output per ship-hour. I can access most if not all of the above metrics from Israel's Administration of Shipping & Ports report "Statistical Yearbook – Shipping & Ports 2024," which details port statistics. For related summary statistics I can use Israel's State Comptroller's 2024 report "The Ports Sector in Israel and Aspects of Operation and Service" Both are publicly available online.

For K/L, I treat K and L separately. To get K, I'll make a manual monthly capital stock proxy which combines meters of berth completed, STS and RGM cranes (multiplied by a factor of their height, outreach, and tandem lift), and perhaps software used such as OCR. I can access data on all of the above (with the possible exception of software, which I may remove from the proxy) from dated news reports and from the official websites of the Ashdod port and the Haifa Bayport Terminal. As for the legacy terminal in Haifa, I may need to send an email to someone (I have connections so I'll try and figure it out). As for Labor, pre-reform worker count is accessible through the Ministry of Finance Public Bodies Wage Report. For levels of L after the first reform in 2021, I will have to either request the data directly, or build a proxy/estimate of monthly hours worked using data that is published and available online: annual hours worked, accident rate per 100,000 hours, monthly "activity weights", and quarterly labor utilization ranges.

For LP, I'll just use my proxies for output and L to calculate LP = output / L.

Literature Review

Two literature strands motivate this study: Israel-specific diagnostics and international evidence on port reforms.

In Israel, following massive protests related to high cost of living, the Trajtenberg Committee Report (2011) points out port inefficiency driven by monopoly power as an important economy-wide cost, and recommends introducing intra-port competition by building new terminals in the Haifa and Ashdod ports. This recommendation was formally adopted by the government in late 2011. The Taub Center's analyses (Brand and Regev, 2015a; 2015b) document widening productivity gaps between Israel and the OECD and emphasize structural frictions in non-tradables, motivating attention to sectors like ports. In their study "Why Is Labor Productivity in Israel So Low?" Hazan and Tsur (2021) show that accumulated factors (including K/L) explain most of Israel's productivity gap from peer OECD economies. Joseph Zeria's 2021 book similarly diagnoses a "missing capital" gap and calculates as an example that Israeli output per worker is roughly 25% lower than the counterpart American metric purely due to capital intensity differences. These studies motivate my own paper's particular interest in productivity gains through the capital deepening channel.

When it comes to economic literature on port reforms and labor productivity more generally, a consensus seems to emerge, which is that intra-port competition (i.e. multiple terminals under different ownership) seems to be the chief engine of productivity improvement, and that capital deepening is an important effect of competition. Additionally, privatization alone does not seem to have a decisive impact on productivity gains. In a 2010 paper,Cheon, Dowall, and Song analyze port reforms globally and find that competition-inducing reforms drive up FTP growth, and emphasize that productivity gains are more likely when privatization is paired with competitive pressure and technology upgrades (likely leading to capital deepening). Additional studies show that competition is a stronger predictor of productivity gains than privatization, with ports run by multiple terminal operators outperforming private monopolies (Cullinane, Ji and Wang, 2005; Tongzon and Heng 2005). However, the channel through which efficiency is increased is not measured (e.g. capital deepening vs. higher labor utilization). Finally, the OECD Policy Roundtable *Competition in Ports and Port Services* (2011) synthesizes global experiences and concludes that introducing intra-port competition improves productivity and lowers user costs. Country-specific case studies provide confirmation for the patterns discussed above. Estache, González, and Trujillo's 2002 paper documents efficiency gains in Mexican ports following reforms, driven by "frontier shifts" (e.g. capital deepening) and "catch-up" (e.g. better utilization). No measurement is done to calculate the proportion of gains realized through each channel. Similarly, González and Trujillo's 2009 paper shows that intra-port competition yielded larger efficiency improvements in Spanish ports than privatization alone.

Overall, three gaps are evident in this literature. First, most studies either bundle competition and privatization together, or look at them over different ports. Second, while several studies mention multiple mechanisms through which reforms increased labor productivity, no study measures the productivity gains mediated by a particular channel such as labor utilization or

capital deepening. Third, the identification in these studies is too coarse, as evidence is often annual or at most quarterly, and sometimes estimated with naive two-way fixed effects, which may wrongly use post-reform (i.e. treatment) data as control in staggered rollout contexts such as Israel's, potentially biasing results. For the Israeli ports specifically, no study causally measures productivity gains due to the reform (reports and studies only point out the overall efficiency improvements over time), and no attempt is made to distinguish between gains made from different channels. These gaps are all addressed by my paper's empirical design.

Empirical Design and addressing gaps in the literature

I exploit Israel's staggered implementation of three reforms to its two primary ports as a natural experiment. My design works in two large steps: (i) staggered-adoption event-study difference-in-differences as developed by Sun and Abraham (2021) and Callaway and Sant'Anna (2023; 2025) to trace the causal effects of each reform on proxied K/L (the mediator) and proxies LP (the outcome). (ii) I use IV-Mediation (as developed by Dippel and Ferrara in their 2020 paper) to quantify the share of LP gains mediated by K/L versus other channels. Proximal monthly or panel data allows me to separate the effects of each of the three reforms: Haifa competition (September 2021), Ashdod competition (Q4 2022), and Haifa privatization (January 2023). This design addresses previous gaps in the scholarship, as I detail below.

First, the unique staggered rollout of Israel's port reforms – including the fact that competition entry and privatization reforms were implemented separately in the same port with a two year gap – combined with the relatively high-frequency (monthly or quarterly) proxies I construct, allows me to better control for identification problems which limited the robustness of previous studies. More concretely, I am able to completely separate the effects of competition-induction and privatization by having each port serve as its own before/after control, while the other port serves as a same-month control. This two-layer design (testing the treatment within the port over time and across the ports in the same period) improved the credibility and robustness of my results.

Second, I implement 2SLS IV-mediation to quantify the proportion of each reform's productivity gain mediated by capital deepening versus other channels. I do this by instrumenting K/L with various dated and manually factorized engineering milestones such as the introduction of new cranes, meters of berth completed, and so on. For the 2SLS, I first regress K/L on the proxy and on various controls (also using more advanced techniques developed by Clarke in his 2017 paper to control for spillover effects from the other port). In the second stage, I regress LP on the instrumented (K/L)_hat. Following this process I am then able to decompose total LP gains from each reform into "indirect" (i.e. via K/L, our mediator of interest) and "direct" (i.e. not via K/L) components.