RISING TIDE OR SINKING SHIP?

EFFECTS OF OWNERSHIP ON SEAPORT PERFORMANCE

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Abstract:

This thesis examines how port ownership types (state, private, private equity) and origins (domestic versus foreign) affect performance. For this, we draw on a new self-constructed global port-company matched dataset that integrates commercial, maritime, and geospatial sources into a consistent 30-year panel. Across specifications, ownership transitions generally do not improve operational performance. Privatizations, re-nationalizations, and private transfers show no meaningful gains. Private equity ownership does not raise operational outcomes. Foreign acquisitions, with the exception of Chinese transactions, tend to reduce connectivity. Event-study and withdrawn transactions evidence reveal timing-based selection, but ownership changes still appear to add little beyond existing trends. Overall, ownership changes alone contribute marginally, if at all, to port performance. Small sample issues might limit the power of our estimators, which leaves scope for future confirmatory analyses. Furthermore, future work should deepen the analysis of selection mechanisms, incorporate cargo-adjusted competition measures, integrate financial data to assess private equity outcomes, and use more disaggregated operational performance indicators.

Keywords:

Ports, Private Equity, Infrastructure, Ownership Effects, Geopolitics

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1. Introduction

Control over global critical infrastructure has become a focal point of geopolitical competition. China's Belt and Road Initiative (BRI) has accelerated overseas port investments in recent decades (Watterson et al., 2023; Liu et al., 2020), only to meet its potential eclipse in recent Western policy decisions restricting Chinese participation in the Port of Hamburg and, most recently, the renewed scrutiny of the Panama Canal. At the same time, infrastructure development and modernization have become increasingly reliant on private capital, especially financial investors such as private equity (Gemson et al., 2012).

Ports handle more than 80% of world merchandise trade by volume, positioning their efficiency as a core determinant of economic competitiveness and national welfare (UNCTAD, 2025; Nwanosike et al., 2016; Tongzon, 2001; Baird, 2000). Yet ownership structures in the port sector have undergone a profound transformation. Historically dominated by public ownership, most ports today operate under hybrid structures, such as state land ownership coupled with concessions[1], minority private stakes, or long-term lease arrangements, while fully privately owned ports remain relatively rare (Baird, 2000; Cheon et al., 2010). Despite the prominence of these reforms, the literature provides strikingly mixed evidence: some studies document efficiency gains following port privatization (Villa, 2017; Peréz et al., 2016; Haarmeyer and Yorke, 1993), whereas others find little to no improvement (Liu, 1995; Notteboom et al., 2000; Danladi et al., 2025).

At the same time, port performance is shaped by fundamentals, such as its location, hinterland connectivity and corridor infrastructure that may overshadow ownership effects (Notteboom, 2008; Trujillo and Nombela, 1999). This complicates causal inference and has contributed to the fragmented state of existing findings. The rise of private equity (PE) as an owner of infrastructure assets further deepens this ambiguity. While PE is known to deploy active management and sophisticated financial tools (Guo et al., 2011; Kaplan and Strömberg, 2009), evidence on its role in port operations remains exceedingly limited and contested, particularly given the interplay between financial

[1] A concession is a contractual agreement in which the concessionaire pays an agreed fee to the counterparty, like in a land lease, but also assumes additional performance obligations, usually in the form of required investments to maintain or improve the asset's performance (Baird, 2000).

engineering, long-term investment horizons, and public interest obligations (Baird, 2013; Farrell, 2013).

Following the accelerated globalization and rising investment needs, foreign participation in critical infrastructure assets has become increasingly common. In particular, Chinese port investments, such as those in Piraeus or Hamburg, have sparked public concern and ultimately prompted policymakers to strengthen foreign direct investment screening frameworks or take measures to maintain, if not regain, control over these assets (Jacobs, 2023; Messingschlager, 2025; Doppen et al., 2025).

These developments raise three fundamental questions: 1) Can large-scale evidence, using robust empirical designs, provide a more definitive answer on the effects of port privatizations? 2) Can private equity sponsors meaningfully enhance efficiency in an industry characterized by high capital intensity, complex regulation and strong geographic path dependency? And 3) do foreign, and particularly Chinese, port investors generate measurable performance improvements that could justify the increased geopolitical risk?

To systematically examine this gap, we develop an entity-matching procedure that harmonizes records across various data sources that lack a common identifier. This allows us to leverage transaction information from port-related companies as a proxy for port-level ownership transitions and to construct a unique, longitudinal dataset. We then enrich this data with satellite imaging-based measures of port land reclamation. This is necessary to be able to drive any globally comparable analysis of ownership effects. Building on this, we implement an empirical approach inspired by Howell et al. (2022), who use company-level ownership data to study infrastructure governance effects for airports.

Our contribution is threefold. First, we provide a genuinely global perspective, free from the geographic or income-group restrictions that characterize much of the existing port-privatization literature (Villa, 2017; Peréz et al., 2016; Danladi et al., 2025). Second, we develop a granular, company-level panel of ownership transitions spanning more than three decades, allowing for a detailed analysis of how changes in control unfold over time. Third, we move beyond the conventional public-private dichotomy (Danladi et al., 2025; Tongzon and Heng, 2005; Baird, 2000) by classifying owners in substantially greater detail, enabling us to isolate the effects of specific investor types – most notably PE sponsors and foreign, particularly Chinese state-linked, investors – thereby contributing to the emerging literature at the intersection of PE and infrastructure ownership (Howell et al., 2022; Baird, 2013; Farrell, 2013; Gemson et al., 2012; Page et al., 2008).

Our findings challenge several prevailing assumptions in the literature. First, we do not identify consistent positive effects of privatization or ownership change on port performance, irrespective of investor type. Second, we find no evidence that PE ownership systematically improves port performance in a sustained way, although our conclusions here are limited in that we cannot infer anything about the sponsor returns on the investment. Third, we find that, in general, foreign acquisitions are associated with negative performance effects, contrary to the conventional expectation of foreign-expertise spillovers (Howell et al., 2022). Chinese acquisitions, by contrast, are associated with measurably higher connectivity. Rather than indicating a narrow ownership effect, this likely reflects the broader strategic context of China's BRI. Ports acquired by Chinese firms tend to be integrated into BRI-aligned logistics networks, where cargo flows, inland transport links and shipping services are coordinated across multiple nodes. As a result, these ports are connected to established trade corridors and benefit from the high route density and more frequent vessel calls due to Chinese trade dominance (Liu et al., 2020).

Some of our estimators might suffer from small sample issues. Nonetheless, these results underscore that simple ownership classifications alone are not suitable predictors of improved operational outcomes in the port sector. While expanding classifications into geographical dimensions (foreign and Chinese investors) leads to improved insights, effects still seem very limited. For policymakers, this suggests that regulatory design, competitive environment, and underlying physical and geographic characteristics might play a far more central role in shaping port performance than the identity of the owner.

The structure of this thesis is as follows. Chapter 2 reviews the relevant literature on port privatization, port economics, and determinants of port attractiveness for PE investors, supplemented by a case study of Associated British Ports and a discussion of recent geopolitical developments. Chapter 3 introduces the data sources, explains the refinement and construction of the dataset, and then sets out the empirical strategy along with the descriptive statistics. Chapter 4 reports the results of the empirical analyses. Chapter 5 situates these findings within the broader literature and concludes by comparing our research design with that of Howell et al. (2022), offering a side-by-side assessment of ownership transition effects in airports and ports as well as the limitations of our study.

2. Institutional Context

2.1. Privatization of Ports

Privatization is commonly understood as the transfer of ownership of publicly held assets into private hands (Cullinane and Song, 2002). A broad empirical literature documents that privatization can improve allocation of economic resources, reduce direct government intervention, and enhance operating efficiency through exposure to market competition (Henry, 2006). These benefits frequently materialize in elevated profitability driven by improved operational practices and strengthened managerial incentives (Megginson et al., 1994; Henry, 2006). In light of these, many privatization programs ultimately reflect political considerations alongside economic motives (Cullinane and Song, 2002; Kelly, 1996).

These political motivations can be broadly grouped into endogenous drivers, relating to country-specific political or economic considerations, and exogenous forces, arising from external pressures on the country's government, often linked to international lending arrangements (Henry, 2006). Starting in the 1980s, a global wave of privatizations unfolded across developed, developing, and transitional economies. The underlying reasons were plentiful, but in developed countries, such as the United Kingdom (UK) or Germany, privatizations were typically justified by endogenous or pragmatic motivations, most notably the pursuit of efficiency gains and relief of public budgets strained by the underperforming assets during the global recession (Cowan, 1987; Henry, 2006). While these considerations were also present in developing countries, privatization was more often a response to external pressure to reduce the sovereign debt burdens by selling state-owned assets. In transitional economies, particularly many former members of the Soviet Union, privatization primarily reflected an ideological shift from central planning to market-based institutions (Henry, 2006).

The literature offers mixed evidence regarding the net societal benefits of port privatization. Many studies argue that private ownership leads to improved port efficiency (Villa, 2017; Peréz et al., 2016; Haarmeyer and Yorke, 1993) and stimulates investment (Nwanosike et al., 2016). Tongzon and Heng (2005) even view privatization as a means of sustaining competitiveness in an increasingly globalized maritime trade sector. Other scholars contend this view and find no significant performance improvements following privatization (Liu, 1995; Notteboom et al., 2000; Danladi et al., 2025). However, there is a broad consensus that a privatization event only yields net societal benefits when accompanied by a robust regulatory framework to prevent the firms with naturally high market power from disproportionally extracting private gains at the expense of users and broader welfare (Jones et al., 1990; Beesley, 1997; Cullinane and Song, 2002; Baird, 2013). This concern is mitigated when the privatized company operates within a competitive market environment, characterized by limited economies of scale and scope as well as low barriers to entry, constraining the ability to exercise this potential inherent monopoly power (Cullinane and Song, 2002; Haarmeyer and Yorke, 1993; Villa, 2017). Hence, efficiency gains arise not from private ownership per se but from its interaction with competition (Cullinane and Song, 2002).

Among the assets targeted for privatization were many transport entities, including port infrastructure, motivated by the prospect of relieving governments from substantial capital commitments for this highly capital-intensive industry and by expectations of operational efficiency gains (Cullinane and Song, 2002). Over time, such efficiency improvements became increasingly important for maintaining integration within rapidly expanding global supply chains driven by rising international trade (Danladi et al., 2025; Tongzon, 2001). The growing prevalence of offshored manufacturing to lower-cost jurisdictions exposed global supply networks to higher transport and coordination costs, prompting firms to continuously reassess shipping routes and production footprints. Such adjustments are evident today in the partial relocation of production capacities from China to other developing economies following the intensified trade conflict with the United States (Danladi et al., 2025; Cullinane and Song, 2002; Smit, 2025). The high capital requirements for port expansion prompted adjacent industries, such as cargo owners or shipping companies, to assume an increasingly active role in port development (Cullinane and Song, 2002; Heaver, 1995; Cheon et al., 2010; Trujillo and Nombela, 1999). Today, most ports are either managed or owned by a private party (Cullinane and Song, 2002; Cheon et al., 2010).

However, port privatization also introduces significant potential drawbacks. The new private operator may, intentionally or not, fail to uphold the port's broader economic and social functions, and misalignment between public objectives and private incentives can, in fact, undermine the very efficiency gains privatization is meant to achieve. Especially in markets with limited competition, privatization may effectively create private monopolies, enabling operators to prioritize investor-aligned clients, restrict access, or distort service provision in ways to reduce overall welfare, all of which are fundamentally at odds with the desired objectives (De Monie, 1996; Cullinane and Song, 2002).

Against this backdrop, transport infrastructure, including port operations, became a prominent target for privatization. Governments sought to both alleviate the high associated capital requirements and to realize efficiency gains in sectors essential to international trade and national economic growth (Cullinane and Song, 2002).

2.2. Port Economics

Ports have historically served as critical nodes connecting maritime trade routes to inland markets. Although the composition of cargo and technological requirements have evolved, the core economic function of ports, facilitating the efficient transfer of goods between maritime hubs and their respective hinterland, has remained largely unchanged for centuries (Talley, 2006; Doppen et al., 2025). To scale revenue, ports typically seek to maximize their annual cargo throughput subject to a profitability constraint. An exception to this applies to ports under government ownership or control, where profit maximization may be a secondary or even negligible objective due to the availability of public subsidies and the potential for bailouts (Talley, 2006; Haarmeyer and Yorke, 1993).

The performance of a port is substantially conditioned by its geographical location, which determines both its strategic relevance and the breadth, restrained by the connectivity of its natural hinterland markets (Robinson, 2002; Goss, 1999). This advantage is often reinforced both by government licensing regimes and the high capital intensity of port infrastructure, in that it limits competitive market entry possibilities for competitors, which can ultimately lead to regional or even national monopolies. Beyond that, the demand for port services is shaped by the port's pricing policies and the services offered as well as the reliability and efficiency to which they can be performed (Talley, 2006). Hence, in their simplest form, ports provide a relatively commoditized service: vessel handling. Differentiation comes primarily through operational performance, which affects the direct and implicit costs borne by shipping lines (Goss, 1999; Tongzon and Heng, 2005).

Handling speed, channel and berth accessibility, and congestion management are examples of such operational differentiators that can materially impact shipping operators' operating and opportunity costs. When the implicit savings generated by these exceed the fee differentials, shipping lines may redirect cargo flows and adjust shipping routes in the medium to long term (Robinson, 2002; Farrell, 2013; Haarmeyer and Yorke, 1993). Notteboom et al. (2000) illustrate this mechanism by showing that higher efficiency in Northern European port terminals motivated shipping companies to prefer importing large shares of their goods destined for the Southern European market through these ports, despite significantly higher inland transport distances. While some of these operational options are within the administration's control, such as employing more staff to reduce unloading times, others are geographical predispositions, such as port channel accessibility. Yet, economic fundamentals, such as GDP growth and the degree of international trade, continue to be crucial drivers of port performance (Sorgenfrei, 2018; Nwanosike et al., 2016).

In addition to providing and improving these traditional services, port operators have increasingly pursued vertical and horizontal integration strategies. Many have expanded into repair services or logistics zones to secure higher margins, value-added activities, and offer means of additional differentiation in a competitive environment (The World Bank, 2024, Trujillo and Nombela, 1999; Tongzon and Heng, 2005). Client- or freight-specific modifications to port infrastructure are often paired with large, long-term contractual agreements, thereby securing existing cargo volumes and attracting new business with a greater revenue stability (Baird, 2013). These developments may, in turn, generate synergistic effects with the core business by enhancing the port's attractiveness to shipping operators and thereby prompting adjustments in shipping routes to capture these benefits (The World Bank, 2024; Farrell, 2013; Tongzon and Heng, 2005). Recent examples include the rapid construction of LNG import capacity following the Russia-Ukraine conflict, as ports sought to establish themselves as a regional entry point to non-Russian gas (LNG Terminal Wilhelmshaven GmbH, n.d.; RWE, 2024).

Although site-specific attributes continue to shape port competitiveness, a central contribution to port attractiveness for its stakeholders remains the connectivity to the hinterland and the related ability to serve inland markets which is an inherently complex task given the multitude of local and international actors with whom operators must coordinate (Notteboom, 2008; Nwanosike et al., 2016; Villa, 2017; Trujillo and Nombela, 1999).

Port ownership models generally fall into three categories: full state ownership, state-controlled concessional or landlord models, and fully private ports. While the early 1990s saw predominantly state ownership of major container ports, a steady trend towards private involvement has emerged. Many regulators have favored concession models, which maintain public control over the land while leveraging the efficiency and investment capacity of private operators (Cheon et al., 2010; Haarmeyer and Yorke, 1993). In such models, states usually retain responsibility for overarching functions via public port authorities (Baird, 2000). The private participation can then be organized either via management contracts, effectively land leases, or concessions, leases with the obligation to make necessary or pre-agreed investments. The general commercialization of the whole port into different operating units enables governments to reap specialization and competition benefits. Fully privatized ports remain rare, partly because long asset lives and high capital intensity may slow investment cycles under purely private control and states have an interest to retain control over critical underlying land (Baird, 2000).

The academic literature finds that ownership type alone is not the strongest contributor to port performance (Cullinane and Song, 2002; Tongzon, 1995, Cheon et al., 2010). However, private owners often possess better access to capital markets as a result of the ability to pledge the assets as collateral (Cullinane and Song, 2002), which can significantly expand investment capabilities. These conditions naturally motivate the growing involvement of an emerging, prominent class of financial investors in infrastructure markets: private equity.

2.3. Infrastructure and Port Attractiveness for Private Equity

Private equity refers to equity investments made into privately held, non-listed companies. Historically, PE activity concentrated on corporate buyouts, such as the infamous acquisition of RJR Nabisco in the late 1980s (Kaplan and Strömberg, 2009). Over the past decades, however, PE funds have widened their investment scope to encompass a broader range of asset classes, including real assets such as real estate or infrastructure. In part, this shift is a response to declining relative public-sector investment as well as increased demand for private capital and the operational expertise often associated with PE ownership (Gemson et al., 2012; Page et al., 2008).

PE investors are generally viewed as active owners capable of applying sophisticated strategic and operational frameworks, ranging from organic to inorganic growth measures, to under-managed assets (Guo et al., 2011; Kaplan and Strömberg, 2009). Consistent with this characterization, they tend to favor infrastructure projects located in developed economies, at later stages of maturity and with multiple sponsors to facilitate risk-sharing (Gemson et al., 2012). While project finance structures optimize the capital structure and limit recourse to the sponsor, they place PE investors at the bottom of the cash waterfall (Chemmanur and John, 1996). Therefore, financial returns often hinge on multiple expansion, typically achieved through bearing constructing risk and exiting in more favorable market conditions, thereby realizing capital gains at exit, amplified by financial leverage (Gemson et al., 2012). Thus, a substantial portion of PE returns does not stem from asset-specific operational improvements but from broader market dynamics affecting debt-equity mispricing and valuation multiples (Guo et al., 2011; Kaplan and Strömberg, 2009).

Ports have increasingly attracted the attention of infrastructure-focused PE firms due to their distinctive investment characteristics. Typically, they constitute critical nodes in global trade, are often supported by long-term contractual arrangements that secure stable cash flows and, on the back of geographic scarcity and regulatory frameworks, frequently enjoy a degree of local monopoly power (Baird, 2013; Farrell, 2013). In parallel, many ports still offer substantial operational improvement potential, particularly where legacy public management has inhibited efficiency upgrades. Moreover, macroeconomic factors such as a regional capacity shortage can create ample opportunities for a promising investment (Farrell, 2013).

Empirical evidence from the UK, where private port ownership is largely organized under the full private ownership model, suggests that PE-backed ports exhibit more elevated and resilient EBITDA margins (Baird, 2013). Yet the distributional consequences of these gains remain debated. Baird (2013) argues that PE owners extract significant economic rents from their assets during the holding period, often at the expense of their stakeholders, such as shipping companies and service providers (Goss, 1999). The elevated EBITDA margins are a prerequisite to service the costs associated with the substantial debt burden weighing on the company that arose from the leveraged acquisition. In short, this leverage often purely constitutes financial engineering, rather than funding for growth-oriented investments. While such debt is often structured above the operating company level, it can indirectly constrain operational investment through pressures for dividends or shareholder-loan repayments – resources that might be invested in port expansion (Baird, 2013; Farrell, 2013). Management fees charged to the portfolio company by the sponsor to essentially create an additional source of return and potentially lower direct management fees charged to the limited partners might reinforce this pressure (Kaplan and Strömberg, 2009). Beyond enhancing sponsor returns, the high leverage can also strengthen port-level performance, as the heightened default risk probes higher management discipline and curbs free cash flow inefficiencies (Kaplan and Strömberg, 2009).

While several case studies show limited reinvestment activity from PE-backed ports in expansion, Farrell (2013) contends that this outcome is more attributable to regulatory frictions, such as lengthy public inquiry approval processes, for instance, for capacity expansions, than to a lack of investment appetite. Nevertheless, she acknowledges that the broader society's benefit is reduced given the prevalence of tax-efficient offshore holding structures that shift taxable income outside the domestic economy.

In short, while PE involvement in port infrastructure may yield short-term operational gains, its longer-term implications for competitiveness and social welfare remain contested. These tensions highlight the importance of robust governance frameworks in shaping the outcomes of privatized ports.

2.4. Case Study of Port Ownership: Associated British Ports

The historic British Transport Docks Board, which comprised 19 UK ports and handled about 25% of the UK's maritime trade, was privatized in connection to public sector reforms in the 1980s under the Thatcher administration (The National Archives, n.d.; The Margaret Thatcher Foundation, n.d.). Subsequently, the company was listed on the London Stock Exchange under the new name Associated British Ports Holding Ltd. (ABP) (Baird, 2013).

Following exponential and sustained growth in global trade, combined with the strategic importance of port assets, ABP soon got into the crosshairs of multiple financial and long-term investors. In early 2006, the "Admiral Acquisitions" consortium, illustrated in Figure A1, led by Goldman Sachs's infrastructure investment division, approached ABP's board with a take-private proposal on the back of stable, contracted revenues (Baird, 2013). After a brief competitive bidding process against a Macquarie-led consortium, including financial investor 3i Group and the Canada Pension Plan Investment Board (CPPIB), the Admiral consortium emerged as the higher-bidding party. Shareholders accepted the take-private offer of GBP 0.910 per share, which implies a total GBP 2.8 billion equity value. The acquisition was financed with a significant debt package of over GBP 2.0 billion, collateralized by the extensive real asset base. Regulatory approvals were obtained relatively smoothly, despite simultaneous emerging higher scrutiny over foreign direct investments following Dubai Ports World's acquisition of US port assets, and ABP was successfully delisted (The Economist Times, 2006; Röhling et al., 2022; Meikle, 2006).

The listed ABP put a large emphasis on taking ownership stakes in port service providers that were already contracted at its ports, such as Tilbury Container Services in 1992, to profit from vertical integration benefits (Baird, 2013). Under sponsor ownership, a range of additional operational and financial value creation measures were implemented. Among those was a general capacity expansion, such as the development of a deep-water container berth to accommodate mega-ships in Southampton (Associated British Ports, n.d.; Farell, 2013) or the upgrade to a centralized surveillance and security system to reduce labor demand (Security Today, 2010). There was also a diversification and stabilization of the product portfolio through initiatives such as a new fuel terminal in Immingham to handle biomass cargo (Biomass Magazine, 2015; Farell, 2013). Another key strategic pillar was locking in long-term, profitable contracts with key customers by investing in client-specific infrastructure, such as a wind turbine plant at the Port of Hull or a roll-on/roll-off terminal for Volkswagen vehicle transports in Grimsby (Baird, 2013). During this holding period, revenue stayed mostly flat while asset base expanded and EBITDA margin increased to over 60% in 2011 (Farrell, 2013). However, this performance was strained by the substantial debt burden of approximately GBP 4.0 billion outstanding in 2011. The debt was largely held at the acquisition vehicle level and partially pushed down through shareholder loans (see Figure A1), resulting in operational port surpluses being used to service and repay this debt rather than being distributed as dividends to the ultimate shareholders (Baird, 2013; Farrell, 2013).

In 2015, Goldman Sachs and Infracapital, both fund life-restricted sponsors, initiated the exit process of the consortium structure after successfully de-risking the asset, rendering it suitable for longer-term investors and capturing the associated premium. Ultimately, the already-interested CPPIB, together with Hermes Infrastructure, both large pension funds, acquired the one-third[2] stake through the set-up Anchorage Ports LLP for a reported GBP 1.6 billion, implying a total equity value of above GBP 5.0 billion (Reuters, 2015; Aglionby, 2015). Depending on the extent of deleveraging and interim distributions versus additional equity injections to fund capital expenditures during the nine-year holding period, this equates to a minimum 2.0x money multiple for the outgoing consortium. It is worth noting that returns could even be scaled through the use of additional back-leverage at the level of the individual investment vehicles.

In parallel, GIC sold a 10% stake to the Kuwait Investment Authority, the sovereign wealth fund of Kuwait, to crystallize some of the value appreciation since the initial transaction (Insider Media, 2015). These developments effectively restructured ABP's ownership into three core shareholders – OMERS, GIC, and Anchorage Ports LLP – and KIA as a more passive minority shareholder, all characterized by extended investment horizons typical for their nature as either pension or sovereign wealth fund.

This new shareholder consortium continued to pursue a hands-on ownership strategy and invests significantly in the competitiveness of the ABP network going forward. Illustrative instances include a large-scale capital expenditures program to further expand capacity, such as the container terminal expansion in the Port of Hull (Associated British Ports, 2019), as well as centralized digital efficiency measures (Associated British Ports, 2023b; Wärtsilä Corporation, 2022). In addition, the group has accelerated efforts to further decarbonize and "sustainabilize" the traditionally very pollution-heavy industry (The Maritime Executive, 2023; Associated British Ports, 2023a). To date, despite some volatility around the ownership transition and the Covid-19 pandemic, ABP has been able to continue the financial trajectory from the first sponsor ownership phase. Recent market commentary suggested a potential stake tendering by CPPIB in 2023 (Reuters, 2023).

[2] At signing, the new investors were guaranteed a 30.0% stake, while the remaining 3.33% from the Goldman Sachs and Infracapital aggregated participation were subject to pre-emption rights exercisable by the continuing investors, GIC and Borealis.

In total, this case of ABP exemplifies how private influence and concentrated ownership can exert a transformative influence on the operations and profitability of ports, despite their significant exposure to external macroeconomic and regulatory factors.

2.5. Geopolitical Considerations for Port Ownership

Foreign direct investments are recognized as a driver for economic growth and often, at least in the short term, as a mechanism for balancing global wealth disparities. Usually, they also come with significant business from the respective investor country (Doppen et al., 2025). However, international investment, particularly entailing control over strategic assets, can also come with significant risks for national interests. This is especially salient in the current context of deglobalization and renewed political and military tensions between the Western and Eastern hemispheres, which have been unfolding over the past decades (Lake et al., 2021; Doppen et al., 2025).

Given the critical role of ports for the national economy, security, and military sovereignty, many Western states have adopted a more restrictive stance to foreign direct investments originating from the Eastern world, especially investments made by Chinese state-controlled companies (Doppen et al., 2025). An instance is the controversial investment by the China Ocean Shipping Company (COSCO) in the Tollerort container terminal of the Port of Hamburg in 2022-23. Following extensive public debate and union opposition, the transaction was ultimately limited to a non-controlling 24.9% stake to preserve economic and governance independence (Messingschlager, 2025; Ghiretti et al., 2023). This reduction in the permitted Chinese ownership share required intervention by the national government, overriding the otherwise high degree of decision-making autonomy exercised by the Hanseatic port. While the prohibition entailed a significant risk that China could redirect its maritime traffic toward other European ports, thereby shifting the localised benefits from Chinese trade, Germany nevertheless chose to restrict the investment from a strategic to a purely financial one (Doppen et al., 2025; Röhling et al., 2022; Ghiretti et al., 2023).

Within the realm of foreign investment in port infrastructure, the US has set an early precedent with the Dubai Ports World (DPW) controversy in 2006. The Committee on Foreign Investment in the United States (CFIUS), a federal body responsible for selectively scrutinizing foreign acquisition requests for US entities, initially approved DPW's proposed acquisition of Peninsular and Oriental Steam Navigation Company (P&O), which included the operation of six US ports. However, intense public opposition, amplified by congressional debates and concerns over the historic ties between DPW's state owner, the United Arab Emirates, and the Taliban regime, forced a change of course (Jacobsen, 2007). DPW ultimately proceeded with the acquisition of P&O but carved out and sold the US assets to an American buyer. Although the underlying national security concerns and emotional sensitivities were grounded in the broader US security context of the time, the episode set a powerful precedent that caused many foreign investors to reconsider the US as a destination for large-scale and strategically sensitive investment (Jacobsen, 2007).

Nevertheless, China has already established its maritime footprint through various investments in port ownership globally, with a multitude of different financial instruments. Beginning around 2008, this expansion accelerated as a combination of increased national interest in port ownership connected to the BRI and declining returns of US securities as a result of the quantitative easing policy scheme connected to the global financial crisis. These factors granted state-controlled shipping companies, most notably China Merchants and COSCO, access to cheap, state-backed BRI financing and fiscal stimuli, which were partially curtailed by capital controls in 2017. China's port investment has accumulated to an estimated USD 136 billion across 88 states by 2021 (Watterson et al., 2023; Liu et al., 2020).

One of the most prominent instances was COSCO's acquisition of a controlling ownership stake in the Piraeus Port Authority. Originating during the Greek sovereign debt crisis in the early 2010s, European institutions exerted pressure on Greece to privatize public assets to service its debt, constituting an exogenous pressure for the Greek government to advance privatizations (Henry, 2006). These circumstances enabled COSCO to top up its majority participation in two of the three terminals in Piraeus to a controlling interest in the whole port authority as part of a staggered process starting in 2016 (Jacobs, 2023). China effectively positioned itself as a buyer of Greek treasury bills, whose proceeds were required to meet Greece's outstanding debt service obligations, when the European Central Bank refused to do so. In exchange for this quasi-bailout from the Chinese state, COSCO was implicitly permitted to increase its ownership stake in the vital European Port of Piraeus. While the Chinese government ultimately never purchased the full amount of treasury bills promised, largely due to German government intervention, the transaction was still approved by the Greek authorities, setting a noteworthy precedent for the erosion of European infrastructure sovereignty (Mathews, 2017).

Another pillar of China's maritime BRI is COSCO's ownership in the Port of Zeebrugge, which originated with the acquisition of a 24% stake in the container terminal in 2014 and was completed in 2017. The asset is particularly noteworthy as it constitutes a key maritime transport hub in the North Sea with the physical capacity to accommodate the largest vessels. Its strategic location enables it to serve continental European markets through a dense inland transport network and to help revive trade links with the UK, which have declined since Brexit (European Network of Corporate Observatories, 2020). Within two years, COSCO was able to increase cargo traffic by 50% before the Covid-19 pandemic broke out. Significant follow-on investments are planned by several Chinese state-controlled entities and major corporations. The port constitutes the Western European pillar of the Chinese BRI framework. The management bodies of Zeebrugge and Antwerp port, of which China Merchants Port Holdings holds a minority stake in the latter, merged in 2022. Hutchison Port Holdings operates the corresponding inland terminal[3] (Jacobs, 2023), exposing the critical transport node to significant direct and indirect Chinese influence. Considering the strategic importance as a starting point of Europe's largest petro-chemical cluster, essential for LNG supply and future green hydrogen hub, this development naturally raises concerns within EU regulators and NATO officials (Doppen et al., 2025).

Foreign influence can come with significant benefits for the asset performance and the host country. Going back to the Port of Piraeus, this is greatly evidenced as the Chinese-operated terminals have been substantially outperforming the Greek-managed counterpart. Through the operations by such an experienced and large-scale company, there is great potential for true technological and know-how spillover to the local operators (Meunier, 2015). Further, COSCO has invested significant amounts in the modernization of its terminals and the connection to the hinterland through the rail

[3] Ownership of the inland terminal would be transferred to a new Blackrock-led ownership consortium following its buyout of Hutchison Port Holdings from CK Hutchisons Holding in early 2025.

network. In connection with this, COSCO secured a strong long-term revenue base through contracts with key global companies that now rely on Piraeus as their entry point to the European market. The port also serves as a major gateway for Chinese imports into the European Union (EU) and North Africa, with an estimated 10% of total Chinese shipments only to the EU passing through it (Meunier, 2015; Ghiretti et al., 2023).

Besides the general benefits of foreign involvement, foreign ownership through direct investment also entails several risks for host nations, as highlighted in recent analyses by Ghiretti et al. (2023) and Watterson et al. (2023). First, state-backed capital can result in port overcapacity and market distortion. Second, the host state might grow a heavy economic dependence on the investor country, exposing them to coercive leverage and strategic vulnerabilities as a result of the economic chokehold, similar to the EU's dependence on Russian gas at the start of attacks on Ukraine. Third, the state might become subject to commercial and military espionage such as illustrated by COSCO's proposed implementation of the Hellenic Port Community System in Piraeus, which would have granted the Chinese operator an economic competitive advantage through access to comprehensive logistics data, including pricing and freight information. This is particularly relevant in the case of Piraeus, where Chinese-controlled port infrastructure directly borders Greek and, by extension, NATO military infrastructure. Fourth, and potentially most critically, in the event of a military conflict involving the investing nation, dual-use infrastructure might be repurposed to a naval base or supply facility. Research shows that a substantial share of ports with Chinese state-linked investment possess characteristics consistent with potential military usage. In addition, recent requirements that newly built civilian vessels be easily convertible for military deployment have raised concerns that the expansion of dual-use infrastructure worldwide may be intended to enhance China's naval capabilities (Watterson et al., 2023).

Recently heightened systemic tensions between the United States and China, combined with the reelection of Donald J. Trump as President of the United States, have reignited debates over national security and economic sovereignty. Shortly after his reelection, Trump pressured Hong Kong-based CK Hutchison Holdings (CKHH), alleged to be vulnerable to Chinese state influence, to relinquish control of the Panama Ports Company (Berg et al., 2025). Effectively, this led to the divestment of CKHH's majority ownership share in Hutchison Port Holdings, which holds its stakes in non-Chinese port terminals, including the Port of Balboa and Cristóbal at the Panama Canal, to a consortium led by US investment firm BlackRock, Inc., for a deal valued at USD 22.8 billion (Berg et al., 2025; Doppen et al., 2025; Lloyd's List, 2025). While this deal (Figure A2) constitutes a political and symbolic victory for the new administration[4], the financial premium paid was substantial as the assets were valued at USD 13.0 billion prior to the transaction. In addition, it remains uncertain whether a mere ownership change is sufficient to fully reverse the entrenched Chinese influence in these ports, such as the participation in the security design, without broader structural and personnel replacements (Berg et al., 2025).

Collectively, these developments demonstrate that, although China has already accumulated substantial influence in the global port landscape, Western governments have become increasingly cautious about foreign ownership in critical infrastructure. They are now actively developing, albeit still uncoordinated, strategies such as the EU-level Investment Screening Mechanisms to curtail or even reverse Chinese control over strategic maritime assets (Doppen et al., 2025).

3. Data, Methodology and Descriptive Statistics

3.1. Data Sources

Matching dataset. The raw data is sourced from three main databases: (1) Standard and Poor's Capital IQ Pro (S&P CIQ) for port transactions since 1973 (though we reduce to 1990 later because of reliability concerns), (2) United Nations Conference on Trade and Development (UNCTAD) for the time-series Port Liner Shipping Container Index (PLSCI)[5] that aggregates port connectivity and operational port performance data into one index (see Appendix A3), and (3) the World Port Index (PUB 150) from November 2025 (below WPI) that provides a snapshot on more granular operational port data. All of the above are further detailed in the Appendix A2.

Logically, the first, extensive step is to map identifiers of the differing data sources. In order to be able to merge the data from different sources and run the analyses, we

[4] At the time of writing, the transaction had been announced but not yet closed, pending regulatory approvals, particularly from the Chinese authorities (Alim et al., 2025).

[5] At times, we refer to increases in the PLSCI as increases in connectivity, using the term synonymously for illustrative purposes, although higher PLSCI may also reflect improvements in operational performance.

therefore first map S&P CIQ company identifiers (*port_ids*) to the UN location codes used in trade and transport (*locodes*), which are present in both the UNCTAD and WPI datasets. This could not simply be done via matching the canonicalized port names, which exist in all sets, as the overlap was minimal, i.e., only 2 exact matches from 2,095 *port_ids*, which gave rise to our token-based matching mechanism. This essentially is a multi-step matching process with decreasing match priority and quality controls along the way. The token matching works as follows: first, so-called tokens (i.e. single words or longer strings) are created from available and port-specific data columns per port for the S&P CIQ dataset and aliases for the *locode*-merged UNCTAD/WPI dataset. Hence, the tokens point to a specific *port_id* and the aliases to a specific *locode*. The goal is to match one *port_id* to one *locode*, but to clarify, while one *port_id* can only be mapped to one *locode* (actual port), one *locode* can be mapped to multiple *port_ids*.

In brief, all tokens per *port_id* are compared to their matching aliases and assigned a score based on an inverse-frequency mechanism, which penalizes aliases that occur frequently in the whole dataset and favors those that are rare with a respective rating value. Then this score is summed up per *locode,* and the highest matching *locode* is matched to the *port_id*, subject to exceeding an empirically calibrated minimum threshold of 0.4 to balance false positives and negatives. This discrimination mechanism is based on the self-selected function $f(x) = 2^{\frac{1}{x}} - 1$ that ensures that all individual token values are within the range of [0; 1] and that significantly reduces the value for repeating words.

This token matching logic is then used in several steps to granularize the matched file we obtain. We first start with tokens generated purely from the names, which yield 570 matches. Then, we turn to match the cities from both datasets, as often cities contain only a very limited set of ports. If the *locode* dataset contains only a single port for that city, we assign a direct match, otherwise we reapply token-based procedure. This same logic is then in turn applied to the country level. This yields another 730 matched ports. As a last step, the business description in the *port_id* dataset is tokenized, and the token-based matching is run again to cache out these matches. We end with a set of 1,484 *port_ids*.

The procedure yields a harmonized dataset linking each *port_id* to a corresponding *locode*, with unmatched cases flagged accordingly. We also retain information on the matching stage to assess the reliability of each link.

Ownership panel. Essential to our analysis is the ownership and transaction data, which is the underlying reason for using the S&P CIQ data and motivates the requirement to match the *port_id* on the operational data. However, a key challenge is that, to our knowledge, neither S&P CIQ nor any other data provider offers comprehensive longitudinal or historic port ownership data. To obtain such data, we therefore construct a longitudinal panel that assigns each port an annual ownership class for the period 1973-2025. The objective is to derive a consistent, year-by-year ownership classification despite heterogeneous data sources and incomplete historical coverage. We therefore chose to implement a backward propagation algorithm that reconstructs ownership types by combining (i) current baseline ownership observations and (ii) transaction-level information that traces changes in control.

The baseline ownership dataset provides a current snapshot of ownership for a subset of ports, identifying the port company owned and attributing its owner a corporate role in the specified year. The transaction dataset documents majority ownership-related transactions involving each port company, such as acquisition activity, and records the involved parties (buyers and sellers), their corporate types, and the year of the transaction. We define the universe of ports as the union of all *port_ids* appearing in either dataset. For each port, we then reconstruct the continuous annual ownership series for 1973-2024 by iteratively propagating observed ownership types backward and forward around recorded transactions. Although the periods differ after the last transaction, between transactions, and before the first transaction, the logic for attributing ownership is unified and follows a consistent three-stage hierarchy.

If an ultimate parent entity exists, and its company type is known, ownership is classified using this very type (*STATE*, *STRAT*, *PE*). If unknown, the same will be tested for the direct parent level, before the algorithm turns on the company type of the entity directly involved in the transaction (buyer or seller) or from the baseline owner. If all three levels fail to yield a company type, the ownership for that period is marked as *UNMAPPED*.

Since often ports are split into different operating units (Baird, 2000), such as terminals in the Port of Piraeus, which are typically co-owned by multiple entities, we must apply a class priority rule to determine the dominant ownership type. For this, we argue that the influence of certain ownership types, even when held as a minority stake within a consortium, will dominate the influence of others. Practically, we assume that state ownership takes precedence. However, because our data does not allow us to distinguish between active state involvement and more passive landlord functions arising from concession or leasing agreements (Baird, 2000), our coding reflects only the presence of recorded, assumed as active, state ownership rather than its operational intensity. This is followed by PE ownership, as even with minority participation, the underlying profit-maximizing rationale of financial sponsors persists, which motivates them to implement their value-accretive measures despite being in a minority position (Kaplan and Strömberg, 2009). Strategic, private investors is the “catch-all” for the residuals.

Although the identification logic outlined above is identical, its reference point differs across the three intervals. After the last recorded transaction K (t(K)+1 to 2024), we rely on the buyer of the last transaction as the controlling owner past the transaction period but fall back to the baseline ownership observations if no buyer class can be identified. Between two transactions (t(k)+1 to t(k+1)), the ownership is attributed to the buyer in transaction k, and as a consistency check, the resulting class must match the class inferred from the sellers in the following transaction k+1. Ultimately, before the first transaction (1973 to t(k=1)), ownership is inferred from the sellers in the first transaction.

Geomapping Dataset. To approximate port-level land expansion over time, we construct annual satellite-based indicators of terrestrial surface area within a standardized radius around each port (see Figure A3). For every port-year observation with a recorded ownership transaction, we retrieve cloud-filtered Sentinel-2 imagery from Google Earth Engine (see Appendix: Data Sources), prioritizing the more stable summer months. If insufficient observations are available, we fall back on Landsat data to ensure full temporal coverage. For these images, we derive a water-land classification using the Modified Normalized Difference Water Index (MNDWI), which distinguishes built or reclaimed land from surrounding water. Due to image quality, we compute the total land area contained within the port’s predefined area-of-interest only from 2008 onwards. The approach enforces a consistent sensor choice within each port-level time series to avoid artificial jumps caused by differences in satellite imagery characteristics. Importantly, we impose only minimal spatial smoothing and avoid over-aggressive filtering to preserve genuine construction patterns. The resulting panel provides a harmonized measure of annual land area that is comparably defined across ports, years, and regions. These remotely sensed indicators enable us to trace both the timing and magnitude of physical expansion around each port, independent of self-reported or administratively compiled infrastructure data. The differences across years are then smoothed with a 3-year rolling median combined with an upper-envelope selection mechanism to reduce the noise from measurement inaccuracies.

Withdrawn Transactions Dataset. The dataset used for our counterfactual is sourced from S&P CIQ, identical to the base layer for the completed transactions, with the modification that the transaction was not completed and hence did not cause any ownership changes.

Final Dataset. The dataset that is being used as a basis for further analysis is, in essence, a product of the other created datasets (see Table A1). For this, the *port_id* to *locode*-matched dataset is fundamental as these unique identifiers can then be used to retrieve supplementary port-level information from the different sources. Notably, the matching metadata is still maintained to sensitize on the matching quality later in the process.

3.2. Methodological Approach

Our empirical strategy combines several complementary approaches to measure how different ownership structures, and especially their transitions, affect port performance (see Appendix A4 for greater detail). Following Howell et al. (2022), we begin by constructing a harmonized global panel that records ownership type, transition, and port performance outcomes for more than three decades. We use ownership information of port-related companies as a proxy for port-level control and standardize ownership into three mutually exclusive categories (*STATE*, *STRAT*, *PE*), augmented with indicators for foreign (*is_FOR*) and Chinese involvement (*is_CHIN*). All subsequent empirical designs are implemented on this unified panel, ensuring that different results can be interpreted as alternative views on the same underlying data-generating process.

We proceed in two steps. First, we characterize long-run differences across ownership types using owner-type-based level differences regressions with port and year fixed effects. These models establish whether ports under different ownership arrangements systematically differ in connectivity, revenue, or physical expansion. While not causal, they provide an important benchmark and point of reference for interpreting the following event-based designs.

Second, we study changes in ownership using event-time windows. Transitions are grouped into interpretable families, such as privatization, PE entry, foreign/Chinese entry, or re-nationalization, and each port is assigned an event year for the first occurrence of each relevant transition (see Table A7). Around these events, we construct consistent event windows that capture short- and medium-term adjustments.

To estimate causal effects, we rely on two model specifications. Static difference-in-differences (DiD) compares the change in performance of transitioning ports with that of ports that remain in the same ownership category throughout the event window. This provides an average treatment effect for each transition type. We then extend this design to dynamic event studies to trace year-by-year performance around the transaction.

Finally, to address the remaining selection, in that buyers select ports based on unobservable future prospects, we exploit withdrawn transactions as a quasi-experimental counterfactual following Seru (2014) and Bach et al. (2025). These ports were sufficiently similar to treated ports to enter negotiations, and hence incur significant transaction-related costs, but ultimately did not change ownership. Comparing completed deals to such withdrawn deals, which were only sparsely available, allows us to isolate the effect of executing a transaction from the underlying intent to transact.

3.3. Descriptive Statistics

This procedure yields a final dataset of approximately 2,095 unique port-related firms, of which 1,484 can be matched to a specific port. As noted earlier, multiple firms may correspond to the same port. After excluding ports for which ownership information and/or dependent-variable data are unavailable, the resulting analytical sample comprises 1,138 ports. As mentioned, we classify ownership into four categories: *STATE*, *STRAT*, *PE*, and a residual *UNMAPPED* group. Table A8 shows that in the most recent time period strategic investors constitute the largest owner class with 735 ports, while the remaining observations are distributed relatively evenly across *STATE* (120), *PE* (138), and *UNMAPPED* (142). The mean and median dependent variable values by ownership group in selected years are shown in Table A2.

In the same spirit, Table A7 shows that most identified ownership transitions (65.1%) take place between private strategic owners. The next largest category consists of primary buyouts (11.2%), followed by trade sales and inter- and intra-state transactions, with both 6.0% respectively.

The annual number of transactions shows no clear temporal trend (Figure A7). Some years display noticeable spikes, for instance, in completed transactions in 2007, in PE buyer activity in 2021 and 2023, and in withdrawals in 2018. These fluctuations may relate to broader macroeconomic conditions, such as the Covid-19 shock or periods of exceptionally low interest rates that make such capital-intensive infrastructure acquisitions more attractive. Nevertheless, these associations remain descriptive and should not be interpreted causally.

Comparing port characteristics across owner types reveals systematic differences. Roughly 45% of strategically and PE-owned ports are classified as "large" in the WPI dataset, whereas state-owned ports tend to be even larger on average, with 50% falling into the large-port category (Table A8). Table A9 further indicates that state-owned ports exhibit substantially greater competitive density, with an average nearest-port distance of 248.1 km and an average of 1.2 ports within a 100 km radius. In contrast, PE-owned ports face markedly less competition, averaging only 0.5 neighboring ports, suggesting that PE sponsors may deliberately target assets with weaker competitive pressures, consistent with ambitioned higher returns to operational value-creation and the potential of extracting higher monopoly rents. Strategically owned ports display the lowest average nearest-port distance (201.4 km). These observations may reflect governments' and strategic investors' greater tolerance for local market concentration, given their ability to shape competitive conditions through regulatory oversight and trade policies.

A country-level breakdown in Table A10 shows that most observations originate from major maritime economies, including the United States, Brazil, Russia, Spain, and China. Ownership patterns vary meaningfully across regions: state ownership remains particularly prevalent in Asian economies such as Hong Kong (31%) and China (37%). Ex ante, we expected the share of state-owned Chinese ports to be even higher. This discrepancy might stem from forms of indirect or "shadow" ownership through strategic companies, which we partially try to capture with a pre-defined, non-exhaustive list of Chinese state-controlled companies (see Table A6). In contrast, PE involvement is disproportionately high in India (21%) and Canada (22%). Reasons for the high financial sponsor ownership in Canada might be the large-scale investment activity of institutional investors, such as the aforementioned CPPIB, that often cooperate with buyout firms on these investments, such as in the ABP case. These patterns are corroborated by the global spatial distribution of ownership (Figure A4 Panel A and B), which highlights that PE activity is concentrated in developed economies and advanced Asian emerging markets, with substantial growth from 2000 to 2024. The zoomed-in European map in the same figure (Figure A4 Panel C) likewise suggests dense PE presence around major strategic corridors, such as the English Channel or the Suez Canal.

Figure A5 Panel A shows that foreign ownership has expanded worldwide, particularly in the United States, Europe, South America, and Australia, consistent with increasing dependence on and integration into globalized supply chains. Relative to China's 54 ports in the sample, however, external ownership remains low. Chinese involvement is concentrated in mainland China but extends to key strategic assets abroad, including the Ports of Zeebrugge and Piraeus, which are critical nodes in the maritime section of the BRI (European Network of Corporate Observatories, 2020), and into the Pacific region (Figure A5 Panel B). The absence of observable Chinese stakes in other international ports, specifically across Africa, likely reflects incomplete ownership data rather than a lack of economic activity (Watterson et al., 2023).

Table A11 shows that state-owned ports are, on average, located closest to major urban centers, followed by PE and then strategically owned ports. The relatively greater urban proximity of PE-owned ports compared to strategic owners is consistent with a preference for revenue stability through improved hinterland connectivity and access to consumer markets, in line with Notteboom (2008) and Trujillo and Nombela (1999). For state-owned ports, closer proximity to cities may additionally reflect employment, regional development, or public service considerations. As PE sponsors exert limited influence over port-level demand relative to state or strategic owners, such proximity may also serve as a form of downside protection. We find no substantial ownership-related differences in terminal specialization, such as oil or LNG facilities (Table A12).

A time-series analysis of PE and state ownership shares in Figure A6 reveals a slight increase in financial-sponsor participation over the sample period. While part of this rise likely reflects the broader reallocation of global capital toward private markets and thus the pressure on financial sponsors to enter new verticals, it nonetheless points to a growing interest in port assets among PE investors. The PLSCI-weighted trend analysis, however, shows that the total share of connectivity owned by PE increased only from just under 10% to approximately 14%, making it unclear whether this increase reflects operational value creation, the acquisition of better-connected ports, or simply general increases in PLSCI values over time. State-owned PLSCI share remains rather stable at around 17%.

Holding-period statistics further reinforce expected patterns. Table A13 shows that PE ownership[6] exhibit the shortest median holding period of 13.0 years, broadly aligning with traditional fund-life cycles and in line with Kaplan and Strömberg's (2009) finding that median company ownership through PE owners is 9.0 years. However, the substantial dispersion, exhibited through the standard deviation of 13.9 years, reflects the coexistence of multiple investment strategies ranging from risk-averse core approaches to more opportunistic ones. This variation can be illustrated by the contrast between the 25-year fund horizon of Swiss Energy Infrastructure Partners (Energy Infrastructure Partners, 2025) and the considerably shorter timeline in the ABP case, where Goldman Sachs initiated an exit after just over ten years to return capital to its limited partners. Caution is warranted when interpreting *STATE* holding periods, as our data only captures ownership from 1990 onward, thereby truncating the true duration of many state tenures.

The average PLSCI level in the three years preceding a transaction (Table A14 Panel A) suggests potential selection dynamics: the best-connected ports tend to remain under state ownership, ports acquired by strategic investors are, on average, better connected than those acquired by PE. However, this pattern reverses when examining median values. The median PLSCI of PE-acquired ports of 184 exceeds the 86 of strategic acquisitions and the 125 for ports that were never privatized. This discrepancy implies that PE investors follow a more systematic acquisition strategy, whereas strategic investors occasionally acquire very large or exceptionally well-connected ports that raise the mean but not the median, resulting in a markedly high standard deviation in excess of 400. A similar comparison for the three years following a transaction (Table A14 Panel B) shows that the median PLSCI increases to 97 for strategically acquired ports, whereas

[6] The median is calculated based on the total duration of PE ownership across successive PE sponsors, meaning that the 13.00 years may reflect multiple PE owners rather than a single investor's holding period.

it declines to 95 for those acquired by PE. This pattern suggests that PE owners might place less emphasis on, or may be less well-positioned for, connectivity-enhancing measures during their ownership.

4. Results

4.1. Cross-sectional Differences in Port Performance by Ownership Type

To assess the effects of ownership on port performance, we conduct multiple estimations that progress from descriptive correlations toward specifications suitable for causal inference. We begin by estimating cross-sectional level differences between ownership types, including port and year fixed effects (see Table 1) for nested results on fixed effects for Specification C). We estimate three nested model specifications, starting with a baseline ownership categorization (A) and successively introducing binary indicators for foreign (B) and Chinese ownership (C). Across specifications, we observe limited systematic variation in port performance by ownership. With one exception, none of the estimated coefficients are statistically significant, suggesting that, once port and year fixed effects are included, baseline operating conditions do not meaningfully differ across state, strategic, and PE as well as foreign or Chinese ownership. Even so, several patterns emerge.

First, consistent with Section 3.3, ports under strategic or PE ownership tend to exhibit lower connectivity than those under state ownership. However, this difference loses statistical significance once fixed effects are introduced, and the PE coefficient even changes sign when foreign ownership is additionally controlled for (see Table 1). These patterns point toward underlying selection dynamics rather than genuine ownership-driven performance differences.

Second, examining baseline differences in revenues reveals that Chinese-owned ports tend to be substantially larger. This pattern emerges only once country or port fixed effects are included (see Table 2). When further controlling for ownership type and foreign ownership status, port-affiliated companies with any Chinese ownership involvement are, on average, nearly 8 times larger[7] than those without such involvement. While this might partly reflect high-profile Chinese acquisitions of large port authorities, such as Piraeus and Zeebrugge, it may also allude to stronger revenue growth under Chinese ownership.

Third, ports owned by strategic investors or PE sponsors tend to be associated with slightly higher levels of land reclamation activity compared with state-owned ports. This tendency is persistent across all three model specifications, though the differences never reach conventional levels of statistical significance.

Overall, the static level comparisons indicate that ex-ante differences across ownership types are limited and seem to be superseded by selection effects. While long-run level differences are informative, policymakers are typically more concerned with the consequences of ownership transitions. In the next chapter, we therefore focus on the years surrounding ownership changes and their effects on port performance.

4.2. Static DiD Estimates for Ownership Transition Effects

To identify changes resulting from ownership transitions, we first estimate a standard static DiD model.

For port connectivity (Table 3), we find no statistically significant effects of either privatizations or re-nationalizations. Neither type of transition generates measurable changes in port connectivity within the event window. This pattern might point to selection dynamics in which governments re-acquire strategically important ports for political or geopolitical reasons, without the intention, or fiscal capacity, to improve operational performance. Transitions to and from financial sponsors likewise show no discernible effects. By contrast, international transactions yield significant and negative coefficients. Acquisitions by foreign owners are associated with a low, double-digit negative effect on port connectivity, while Chinese acquisitions exhibit increases of a similar magnitude. The negative effects for the former may reflect specialization in bilateral trade corridors (Doppen et al., 2025) or limited expertise in managing complex hinterland logistics networks. The latter might allude to integration into BRI-aligned logistics corridors (Liu et al., 2020), which might account for the observed divergence

[7] As this coefficient is large, we cannot work with the approximation for the natural logarithm log(1+x) ≈ x anymore and rather need to rely on the exact formula for estimated effects: $100 \times (e^{\hat{\beta} \times 1} - 1)$.

relative to the broader group of foreign acquisitions. In Table A2, we show the current and past distribution of PLSCI means and medians across ownership types, with values spanning from around 100 to 400. Low double-digit changes, as we find to be associated with foreign and Chinese ownership involvement, thus constitute only moderate changes.

For revenue (Table 4), we only observe significant coefficients for exits by financial sponsors. Transitions from PE to non-PE ownership are associated with a sharp 72%[8] decline in revenue when comparing the 5 years after the transactions to the 2 years before it. This suggests that non-financial owners may struggle to maintain the elevated revenue levels achieved under PE ownership, potentially reflecting revenue-maximizing strategies prior to divestment. The absence of significant effects for PE acquisitions indicates that these revenue patterns are built gradually, beyond the five-year event window. Alternatively, this could also reflect opportunistically timed exits by the financial sponsor ahead of anticipated downturns or concentration on extracting rents in the period immediately preceding divestment. Regarding Chinese involvement, our dataset at this stage is too limited to estimate the revenue effects suggested by our results in Section 4.1.

Finally, for land reclamation (Table 5), we detect no coefficients that are significantly different from zero. With around 1 to 13 hectar in land reclamation, these coefficients would also suggest relatively low magnitudes of change, well within the general level of noise in our geo-imaging process. Although Chinese acquisitions appear to differ from other foreign transactions, the effective sample size of 12 ports and 18 post-treated observations renders these estimates insufficiently reliable for interpretation.

Taken together, these results suggest that ownership transitions may be associated with some changes in port infrastructure. However, the presence of anticipation effects and potentially pre-trends, along with selection dynamics cannot be fully addressed within this empirical design. Over the next two chapters, therefore, we introduce additional empirical approaches aimed at assessing and, where possible, accounting for these underlying dynamics.

We also report the nested results for each dependent variable, namely PLSCI, revenue, and land reclamation, in Table A3, Table A4, and Table A5, respectively. However, they do not yield any additional insights beyond those discussed above.

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[8] As this coefficient is large, we cannot work with the approximation for the natural logarithm log(1+x) ≈ x anymore and rather need to rely on the exact formula for estimated effects: $100 \times (e^{\hat{\beta} \times 1} - 1)$.

4.3. Dynamic Effects and Pre-trends

To obtain an initial view on potential pre-trends and to assess dynamic effects around the ownership transition (event) year, we implement a dynamic event-study design and estimate coefficients for the two years preceding and five years following each transaction.

For port connectivity (Table 6), we again find no significant effects for privatizations. In the case of re-nationalizations, however, the estimators for relative years -2 through 2 are significantly positive. This pattern is in line with our earlier intuition that states tend to re-acquire ports whose connectivity is already improving, reflecting strategic selection rather than post-transition operational change. A similar dynamic emerges for acquisitions by financial sponsors from non-financial owners. These primary buyouts display positive pre-event PLSCI patterns. This pattern is consistent with the idea that PE investors may select comparatively higher-performing assets, potentially reflecting more detailed diligence processes. Post-event PLSCI trajectories remain insignificant, in line with static results. Conversely, secondary buyouts exhibit declines in PLSCI over the post-event period, indicating a deterioration in connectivity across successive PE ownership cycles. Acquisitions of ports by foreign buyers display no clear anticipation effect in terms of PLSCI but show increasingly negative post-event coefficients, confirming the effects observed in the static DiD estimates.

For revenue (Table 7), data limitations substantially restrict our analysis. Only two transition types, trade sales and transactions from domestic to foreign owners, have sufficient observations for reliable estimation. For PE exits, we find no significant pre-event trends, while post-event coefficients become increasingly negative, supporting our earlier hypothesis that revenue levels achieved under PE ownership are difficult for subsequent non-financial owners to sustain. Domestic-to-foreign transactions also show no significant pre-trends.

For land reclamation (Table 8), we observe no significant effects for either privatization or re-nationalization. Some pre-event movements appear around exits of financial sponsors, though evidence is inconclusive. Foreign buyers tend to acquire ports with higher levels of land reclamation in the pre-event period, indicating that foreign buyers may prefer or actively target ports undergoing construction. As before, the coefficient for Chinese involvement cannot be meaningfully interpreted due to the limited sample size.

Overall, the dynamic estimates reveal clear temporal profiles for certain transition types (e.g. connectivity around domestic-to-foreign transactions) while hinting to selection dynamics in others (e.g. PE acquisitions). One way to address such selection in transaction-based research designs is to use withdrawn or failed deals as a counterfactual. The next chapter therefore exploits withdrawn prospective acquisitions of port-related companies to account more directly for these biases.

4.4. Addressing Selection: Withdrawn Transactions as a Counterfactual

To address the systematic selection patterns observed for some ownership transition types, we employ withdrawn transactions as a counterfactual, inspired by Seru (2014) and Bach et al. (2025). These cases serve as a benchmark in which negotiations were initiated but ultimately did not conclude and hence did not trigger a change in ownership, thereby approximating treated ports that received the "intention-to-transact" effect without the ownership transition itself. Data on such withdrawn deals, however, is relatively rare and often poorly documented. Across our data from S&P CIQ, we identify only 153 withdrawn transactions. After matching on our dependent variables and applying data availability constraints, at most 27 ports remain usable as counterfactuals. Filtering by specific transition categories would leave too few observations for any meaningful inference, so we estimate pooled effects across all withdrawn cases.

In the static "any transaction" specification from the Section 4.2 model, coefficients for all three dependent variables are positive, though statistically insignificant. Using the quasi-experimental design in this chapter, we derive a negative, but insignificant, coefficient for port connectivity and a positive one for land reclamation, while revenue estimates are unreliable due to only three usable observations (see Table 9). None of these coefficients reaches statistical significance. In aggregate, withdrawn transactions do not reveal any systematic average effect on port operations. Whether this reflects heterogeneous effects cancelling out or genuinely negligible impacts is unclear. Future access to more comprehensive data on withdrawn port transactions would allow for a more granular assessment. For now, the evidence suggests that the average operational effect of prospective transactions is likely very limited.

5. Discussion

5.1. Economic Magnitude and Interpretation

The empirical results observed across ownership transitions can be interpreted through two central economic mechanisms: systematic selection into ports with particular performance trajectories and differences in owners' incentives and capabilities to deploy capital and operate effectively within complex port-hinterland logistics systems.

Our results point to some degree of selection across ownership transitions. Re-nationalizations, for example, exhibit pronounced positive pre-event trends, indicating that states tend to re-acquire ports precisely when their connectivity is already improving. This suggests strategic timing rather than an investment-driven motive. States also disproportionately own larger ports (see Table A8), which benefit from economies of scale, operate closer to the technological frontier and thus may naturally score higher on connectivity (Notteboom et al., 2000). Primary buyouts likewise display positive pre-event dynamics, consistent with intensive screening and selection into well-performing assets (Kaplan and Strömberg, 2009). PE exits to non-PE investors show the opposite pattern: revenues decline after transfer to non-PE owners, mirroring the fading of PE-driven revenue enhancements and the timing of divestment. For non-Chinese foreign buyers, positive pre-trends in land reclamation suggest a preference for ports already undergoing expansion, often divested by the developer near the completion of the project, such as a new terminal. Chinese buyers concentrate on large, globally connected hubs, with greater size and higher throughput that drives baseline revenues. These port investments are part of the broader, globally oriented BRI and appear to benefit from this integration, reflected in their connectivity (Liu et al., 2020).

Beyond selection, our analysis also gives indicative evidence of modest ownership effects. A port's operational performance depends critically on its owners' ability to marshal capital, manage regulatory processes, and coordinate complex hinterland logistics networks. Our defined ownership groups differ systematically along these dimensions, and these differences help to explain the small but detectable treatment effects observed for certain transition types.

Connectivity-enhancing investments typically require long payback periods, substantial capital, and coordination with regulators. Following privatization, increased regulatory scrutiny may lengthen approval processes and slow port expansion projects (Farrell, 2013), while private owners might not prioritize long-horizon capacity building. It is therefore not unexpected that we observe no significant changes within our five-year event window. In our analysis, re-nationalizations often coincide with relative declines in land reclamation, possibly explained by state re-acquisitions of assets for strategic purposes rather than expansionary motives.

We do not find evidence that PE value creation strategies translate into improvements in port connectivity. This may reflect the limited relevance of connectivity and operational efficiency for PE returns, which predominantly arise from revenue growth, financial engineering, and multiple expansion (Kaplan and Strömberg, 2009; Guo et al., 2011; Baird, 2000). Notteboom et al. (2000) emphasizes that maintaining spare capacity is a key prerequisite for attracting new shipping lines and thereby increasing the PSLCI, yet such capacity-building can conflict with the corporate-level efficiency-oriented objectives of financial sponsors. Furthermore, PE owners tend to reduce the amount of capital expenditures and any innovation gains documented in corporate buyouts (Kaplan and Strömberg, 2009) may not readily translate to ports, given the sectors capital intensive nature (Baird, 2000). This is echoed in the muted effect of PE ownership on land reclamation. Secondary buyouts face even tighter constraints due to 20 to 30 percent higher leverage on the back of elevated purchase prices and decreased information asymmetries with lenders (Achleitner and Figge, 2012). Such debt burdens might further limit the scope for operational investments. Combined with weaker operational embeddedness and local logistics integration, these constraints may help explain the negative dynamic PLSCI trajectories seen in successive PE ownership cycles.

Non-Chinese foreign owners may pursue investments geared toward bilateral trade corridors rather than broad network connectivity. With weaker local embeddedness, reflected in fewer established relationships with inland transport operators, local logistics firms, and regulatory bodies, such owners may temporarily disrupt port performance and, in the medium-term, prompt shipping line adjustments (Notteboom, 2008; Trujillo and Nombela, 1999). This may help to explain the post-transaction PLSCI decline. While some foreign buyers undertake targeted land reclamation, potentially consistent with

Doppen et al. (2025), who argue that such foreign investors may channel new business from their home countries, these expansions do not necessarily translate into gains in global connectivity. Chinese acquisitions differ from other foreign transactions because they can be integrated into coordinated BRI logistics corridors (Liu et al., 2020). This provides predictable cargo flows, complementary inland infrastructure investments, and a high degree of strategic interaction, which ultimately reduces the reliance on local integration alone and might explain why Chinese ownership tends to maintain or improve connectivity despite the very same ownership disruption.

Taken together, our results suggest that the country of origin may matter more than the mere owner type. Performance effects appear to arise not from ownership class per se but from the alignment of capital availability, investment incentives, and local operational capacity. These factors differ both across owner types and between domestic and foreign buyers and vary with whether acquirers pursue geopolitical, strategic, or commercial objectives.

5.2. Ownership Effect Comparison to Howell et al. (2022)

Howell et al. (2022) show that airport privatization, on average, does not improve operational or financial performance unless the asset is acquired by a PE investor. They attribute this PE-specific effect to high-powered incentives and superior access to capital, which in turn support physical capacity expansion, optimized fee structures that encourage the use of larger aircraft, and increased integration of commercial activities such as retail concessions. Their findings underscore that ownership type, particularly PE versus non-PE, drives materially different post-transaction outcomes.

In contrast, our results suggest that neither privatization nor PE ownership generates systematic and sustained performance gains in the port sector. Our inference is necessarily limited to the outcomes that we can measure with precision, namely connectivity, proxied by the PLSCI, revenue, and physical port expansion derived from satellite-based geomapping. The absence of sustained PE-specific effects might be explained by key structural differences between airports and ports. Ports are substantially more capital-intensive, face more rigid constraints on physical expansion, and operate in environments where user elasticity is shaped by location-specific advantages and specialized infrastructure. Moreover, unlike airports, ports have limited scope for low-capital-intensity revenue diversification, such as retail commercialization, which may constrain the channels through which PE owners can apply their typical operational value creation strategies.

Where Howell et al. (2022) document foreign ownership effects, while noting that these estimates are susceptible to selection, our results do not point to a consistent foreign-expertise premium in ports. This divergence may reflect the central role of hinterland connectivity, which requires deep integration with domestic logistics networks and makes foreign entrants less able to generate measurable improvements. It may also reflect limitations to our outcome variables, which do not capture changes in cost structures or other internal operational adjustments following a transaction. However, we do observe distinct effects associated with Chinese ownership, plausibly due to the broader integration of these assets within the BRI and China's central position in global maritime trade.

Sample differences also shape comparative findings. Howell et al. (2022) analyze 359 airports in their main sample, inevitably a smaller universe than ports, and are therefore able to hand-collect detailed financial and operational data, such as the measures for geographic expansion and terminal counts. Our setting covers more than 1,000 ports, three times as many assets, rendering manual data collection infeasible with our means. To generate the data, we rely on various techniques such as our token-based matching algorithm, ownership backwards propagation, and a geomapping procedure to construct a consistent global panel. While usable at scale, these data handling methods are not perfectly accurate and introduce noise.

Finally, Howell et al. (2022) rely on auction data to mitigate selection concerns, exploiting the variation in which investors bid for particular airports. Such information is not available for ports in our dataset. Instead, we employ withdrawn transactions as a quasi-experimental counterfactual, allowing us to compare assets that advanced sufficiently far into negotiations to attract serious buyer interest but ultimately did not transact (Seru, 2014; Bach et al., 2025). While this approach captures a similar underlying logic, conditioning on the intent to transact, it is less informative about whether strategic and financial bidders systematically target the same assets, limiting the extent to which it can mirror the auction-based design. Furthermore, it is limited by our scarce data on withdrawn transactions. We do not only have few transactions overall, we also cannot verify how far the transaction process went, how close these transactions were to being completed, and why they were discontinued. Conceptually, however, this approach may offer a cleaner estimate of transaction effects, as it abstracts from completed transactions when constructing the counterfactual and instead uses a set of counterfactuals that do not culminate in a change of ownership, rather than a different potential ownership type.

5.3. Limitations and External Validity

Our analysis is subject to several limitations that may affect interpretation. First and foremost, our study is constrained by data availability. Information on predominantly privately held ports as well as their ownership and operations is dispersed across heterogeneous sources, necessitating substantial data assembly and harmonization. Because ports are frequently organized into multiple operating entities, often under concession or licensing structures, the ownership of port-related companies serves only as an approximation of actual port-level control. In some cases, these companies derive only a fraction of their revenues from the focal port, creating the possibility that observed post-transaction financial changes reflect developments elsewhere in the firm rather than port-specific performance. Also, satellite-based geomapping introduces measurement noise in regions due to environmental conditions and limited historical imagery, although large-scale physical changes remain detectable.

Second, the mapping and data-processing procedures introduce additional uncertainty. Our matching algorithm, which relies mainly on company names, cities and business descriptions, performs well in most cases but cannot fully rule out occasional mismatches. Moreover, our restriction of assigning each port identifier to a single *locode* does not always reflect reality. For instance, a firm might operate multiple ports but is described only at the group level, as is the case for ABP, which is matched to London due to its ambiguous company name and headquarters.

Third, the backward propagation of ownership histories depends on the completeness of S&P CIQ's transaction data. Because the available information does not allow us to fully reconstruct complex ownership structures, we classify each port according to a single dominant ownership type. In line with that, our longitudinal ownership paths rely solely on majority transactions in equity stakes and assets. Because such transactions are not observed in our data, changes in minority stakes that materially alter ownership structures, as well as any unrecorded transactions, may lead to significant misclassifications in our reconstructed ownership trajectories. In contrast, while our ownership transition classification relies on majority transactions, we acknowledge that many ownership stakes, particularly those held by states or PE sponsors, are in fact minority positions. Kaplan and Strömberg (2009) reason that the expertise of a financial sponsor may be sufficient to create value even without majority control over the target. Such "strategic" minority positions can therefore generate meaningful and in some cases even amplified ownership effects (Battistin et al., 2016). However, the de facto degree of influence varies with consortium governance and the contractual provisions specified in shareholder agreements. These institutional details remain unobserved in our dataset and, analogously, affect the construction and validity of foreign-ownership indicators.

Fourth, the WPI dataset used to enrich the static operational attributes of ports lacks longitudinal observations. While adequate for stable characteristics such as location coordinates, it may distort inferences about buyer motivations or post-transaction investment strategies. Infrastructure that is visible today, such as LNG terminals built rapidly during the 2022 European energy crisis, may not have existed at the time of acquisition, limiting our ability to draw conclusions about value creation initiatives undertaken by new owners. That is why we only use this information for descriptive statistics and do not include it in our models.

Finally, port-level results aggregate the net effect of all terminal-level developments within a port. Improvements in one terminal may be offset by declines in another, also commonly referred to as cannibalization effects, particularly where competition exists within the same port complex, potentially masking important heterogeneity.

Altogether, our dataset is comparatively large. However, as it is sparsely populated in some areas (revenue) and noisy in others (land reclamation), its explanatory power is limited. Many of our estimations suffer from small sample issues, which might contribute to the limited power of our estimators.

External validity may be limited by the geographical and temporal constraints in our data. As shown in Figure A4 Panel A and B, our data is heavily skewed toward Europe and North America, which restricts the generalizability of our results to ports in developing economies. Temporal coverage also varies across dependent variables. PLSCI Data is only available from 2006 onward, our land reclamation measure is limited to 2008 onward due to the reliability of satellite images. Though sparse, revenue data exists from 1990 in our dataset. These varying time frames may further constrain the external validity of our results.

6. Conclusion

This thesis sets out to examine whether changes in ownership can meaningfully improve the performance of ports, an industry defined by its intense competition, high capital requirements, and geopolitical scrutiny. Motivated by the mixed evidence in port privatization studies, the expanding role of PE in infrastructure, the rise of foreign and state-linked investors, and increasingly pointed policy debates about who should control maritime assets. Against this backdrop, we asked three questions: Can large-sample evidence clarify the effects of ownership change on operational performance? Do financial investors deliver efficiency gains in a setting defined by long-lived physical assets? And do foreign, especially Chinese, buyers improve the performance of the ports they acquire, and if so, does this justify the elevated risk to national sovereignty?

Our findings provide a cautious but clear answer. Across a global sample and a granular classification of ownership types, we find no systematic positive effects of ownership type change on port performance. Both static and dynamic specifications show that most transitions, regardless of their direction or ownership type, do not have statistically meaningful or sustained effects on port connectivity, revenues, or physical expansions. While PE acquisitions might generate temporary improvements in operating performance, these gains seem to dissipate after exit. Some of our estimators' insignificance might be driven by small sample issues. However, on balance, owner type exhibits little explanatory power. Owner origin, by contrast, does appear to matter: non-Chinese foreign investors tend to be associated with declines in connectivity, whereas acquisitions by Chinese investors show higher connectivity. We interpret the latter as the integration of acquired gateways into BRI-aligned trade corridors rather than an ownership effect in the narrow sense. Aggregated, these results indicate that ownership alone is a weak predictor of how well a port performs. Regulatory conditions, competitive pressures, and physical and geographic characteristics seem to matter far more than who holds the equity. This perspective also helps to explain why the existing literature, often focused on a single region or a narrow subset of ports, has produced inconsistent results.

Several questions remain open. First, while event study patterns suggest sizable selection effects in some transitions, most notably re-nationalizations and primary buyouts, the limited number of withdrawn transactions prevents us from systematically testing these mechanisms across all ownership transition types. Second, whether ownership matters more in competitive versus quasi-monopolistic settings is an open issue, and future work could incorporate interaction terms between ownership type and more refined competition measures, such as port density within cargo segments. Third, our analysis of PE ownership is necessarily incomplete without access to deal-level and financial statement information, since we cannot evaluate ultimate sponsor returns and set these in relation to operational performance. Finally, PLSCI, while widely used, is a composite index and, as such, fails to capture more heterogeneous effects of ownership transitions that currently remain hidden in this aggregated measure. Addressing these gaps would sharpen our understanding of how ownership interacts with institutional and economic conditions and would support more informed policy debates on the governance of critical port infrastructure.

References

Achleitner, A.-K., & Figge, C. (2012). Private Equity Lemons? Evidence on Value Creation in Secondary Buyouts. *European Financial Management*, *20*(2), 406–433. https://doi.org/10.1111/j.1468-036x.2012.00644.x

Aglionby, J. (2015, March 31). *Goldman and Infracapital sell stake in busiest UK ports*. https://www.ft.com/content/83cecaee-d777-11e4-94b1-00144feab7de

Alim, A. N., Leng, C., & Ho-him, C. (2025, August 14). *Panama ports deal will not close this year, warns CK Hutchison*. Financial Times. https://www.ft.com/content/8d5badf4-7b54-4094-8c26-ace5e9aca8f2

Associated British Ports. (n.d.). *Associated British Ports | Southampton*. Retrieved November 15, 2025, from https://www.abports.co.uk/locations/southampton/

Associated British Ports. (2019, January 9). *Associated British Ports | ABP Announces New 10 Year Contract with Thor Shipping following £6 Million Investment in Hull*. https://www.abports.co.uk/news-and-media/latest-news/2019/abp-announces-new-10-year-contract-with-thor-shipping-following-6-million-investment-in-hull/

Associated British Ports. (2023a). *ABP Sustainability Strategy First Edition*. https://www.abports.co.uk/media/fo2ii2cv/abp-ready-for-tomorrow.pdf

Associated British Ports. (2023b, June 5). *Associated British Ports | ABP invests in digital asset management solution to deliver Ports of the Future*. https://www.abports.co.uk/news-and-media/latest-news/2023/abp-invests-in-digital-asset-management-solution-to-deliver-ports-of-the-future/

Bach, L., Baghai, R. P., Bos, M., & Silva, R. C. (2025). How Do Mergers Affect the Mental Health of Employees? *Management Science*. https://doi.org/10.1287/mnsc.2023.04277

Baird, A. J. (2000). Port Privatisation: Objectives, Extent, Process, and the UK Experience. *International Journal of Maritime Economics*, *2*(3), 177–194. https://doi.org/10.1057/ijme.2000.16

Baird, A. J. (2013). Acquisition of UK ports by private equity funds. *Research in Transportation Business & Management*, *8*, 158–165. https://doi.org/10.1016/j.rtbm.2013.07.004

Battistin, E., Bortoluzzi, P., Buttignon, F., & Vedovato, M. (2016). Minority and majority private equity investments: firm performance and governance. *Journal of Management & Governance*, *21*(3), 659–684. https://doi.org/10.1007/s10997-016-9364-2

Beesley, M. E. (1997). Privatization: rejections on U.K. experience. In *Privatization, regulation and deregulation*. Taylor & Francis.

Berg, R. C., Hernandez-Roy, C., Rubio, J., Ziemer, H., & Bledsoe, R. (2025). *Chinese Ports in Panama Come Under New Management*. https://www.csis.org/analysis/chinese-ports-panama-come-under-new-management

Biomass Magazine. (2015, July 15). *World's largest biomass shipment discharged at Port of Immingham | Biomass Magazine*. Biomassmagazine.com. https://biomassmagazine.com/articles/worlds-largest-biomass-shipment-discharged-at-port-of-immingham-12168

Chemmanur, T. J., & John, K. (1996). Optimal Incorporation, Structure of Debt Contracts, and Limited-Recourse Project Financing. *Journal of Financial Intermediation*, *5*(4), 372–408. https://doi.org/10.1006/jfin.1996.0021

Cheon, S., Dowall, D. E., & Song, D.-W. (2010). Evaluating impacts of institutional reforms on port efficiency changes: Ownership, corporate structure, and total factor productivity changes of world container ports. *Transportation Research Part E: Logistics and Transportation Review*, *46*(4), 546–561. https://doi.org/10.1016/j.tre.2009.04.001

CK Hutchison Holdings Limited. (2023). *CK Hutchison Holdings Limited - Our Businesses > Ports and Related Services*. Ckh.com.hk. https://www.ckh.com.hk/en/businesses/port.php

Cowan, L. G. (1987). The promise of privatization. In *Privatization & Development*. San Francisco, Calif. : ICS Press, Institute for Contemporary Studies.

Cullinane, K., & Song, D.-W. (2002). Port privatization policy and practice. *Transport Reviews*, *22*(1), 55–75. https://doi.org/10.1080/01441640110042138

Danladi, C., Tuck, S., Panagiotis Tziogkidis, Tang, L., & Okorie, C. (2025). The impact of port sector reforms on the productivity and efficiency of container ports in lower-middle-income countries: a Malmquist productivity index approach. *Journal of Shipping and Trade*, *10*(1). https://doi.org/10.1186/s41072-025-00208-0

De Monie, G. (1996). Privatization of Port Structures. In *Ports for Europe: Europes's Maritime Future in a Changing Environment*. European Interuniversity Press. https://trid.trb.org/View/570338

Doppen, F., Notteboom, T., & De Bièvre, D. (2025). In the eye of a geopolitical storm: responses of port management bodies to investment screening in the EU. *Journal of Shipping and Trade*, *10*(1). https://doi.org/10.1186/s41072-025-00213-3

Energy Infrastructure Partners. (2025, April 27). *Products - EIP*. Energy Infrastructure Partners. https://energy-infrastructure-partners.com/products/

European Network of Corporate Observatories. (2020). *COSCO in the port of Zeebrugge The Corporate Silk Road A new era of (e-)infrastructure in Europe?*

Farrell, S. (2013). Private equity in UK ports: An alternative view. *Research in Transportation Business & Management*, *8*, 166–169. https://doi.org/10.1016/j.rtbm.2013.08.001

Gemson, J., Gautami, K. V., & Thillai Rajan, A. (2012). Impact of private equity investments in infrastructure projects. *Utilities Policy*, *21*, 59–65. https://doi.org/10.1016/j.jup.2011.12.001

Ghiretti, F., Gökten, M., Gunter, J., Pindyuk, O., Sebastian, G., Tonchev, P., & Zavarská, Z. (2023). *Chinese Investments in European Maritime Infrastructure Policy Department for Structural and Cohesion Policies Directorate-General for Internal Policies PE*.

Goss, R. J. (1999). On the Distribution of Economic Rent in Seaports. *International Journal of Maritime Economics*, *1*(1), 1–9. https://doi.org/10.1057/ijme.1999.2

Guo, S., Hotchkiss, E. S., & Song, W. (2011). Do Buyouts (Still) Create Value? *The Journal of Finance*, *66*(2), 479–517. https://doi.org/10.1111/j.1540-6261.2010.01640.x

Haarmeyer, D., & Yorke, P. (1993). *Port Privatization: An International Perspective*. Trb.org. https://trid.trb.org/View/374374

Heaver, T. D. (1995). The implications of increased competition among ports for port policy and management. *Maritime Policy & Management*, *22*(2), 125–133. https://doi.org/10.1080/03088839500000045

Henry, J.-A. M. (2006). The Wave of Privatization in the 1980s and 1990s. Was it Inevitable? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1293910

Howell, S. T., Jang, Y., Kim, H., & Weisbach, M. S. (2022, October 1). *All Clear for Takeoff: Evidence from Airports on the Effects of Infrastructure Privatization*. National Bureau of Economic Research. https://www.nber.org/papers/w30544

Insider Media Ltd. (2015, July 8). *New shareholders moor at ports giant*. https://www.insidermedia.com/news/national/143050-new-shareholders-dock-green-port-hull-partner

Jacobs, K. S. (2023). *At a Glance: Chinese Strategic Interests in European Ports*. European Parliamentary Research Service. https://www.europarl.europa.eu/RegData/etudes/ATAG/2023/739367/EPRS_ATA(2023)739367_EN.pdf

Jacobsen, M. (2007, June 5). *Middle Eastern Investment in the United States: Avoiding Another Dubai Ports World Controversy*. The Washington Institute.

https://www.washingtoninstitute.org/policy-analysis/middle-eastern-investment-united-states-avoiding-another-dubai-ports-world

Jones, L. P., Tanddon, P., & Vogelsang, I. (1990). *Selling public enterprises: A cost-benefit methodology*. MIT Press.

Kaplan, S. N., & Strömberg, P. (2009). Leveraged Buyouts and Private Equity. *Journal of Economic Perspectives*, *23*(1), 121–146. https://doi.org/10.1257/jep.23.1.121

Kelly, J. (1996). One piece of a larger puzzle: The privatization of VIASA. In R. Ramamurti (Ed.), *Privatizing Monopolies: Lessons from the Telecommunication and Transport Sectors in Latin America*. Johns Hopkins University Press.

Lake, D. A., Martin, L. L., & Risse, T. (2021). Challenges to the liberal order: Reflections on international organization. *International Organization*, *75*(2), 1–33.

Liu, Z. (1995). The Comparative Performance of Public and Private Enterprises: The Case of British Ports. *Journal of Transport Economics and Policy*, *29*(3), 263–274. JSTOR. https://doi.org/10.2307/20053084

Liu, Z., Schindler, S., & Liu, W. (2020). Demystifying Chinese overseas investment in infrastructure: Port development, the Belt and Road Initiative and regional development. *Journal of Transport Geography*, *87*, 102812. https://doi.org/10.1016/j.jtrangeo.2020.102812

Lloyd's List. (2025, March 5). *CK Hutchison agrees $22.8bn deal to sell off Hutchison Ports stake*. Kuehne-Nagel.com. https://mykn.kuehne-nagel.com/news/article/ck-hutchison-offloads-panama-ports-05-Mar-2025

LNG Terminal Wilhelmshaven GmbH. (n.d.). *The Wilhelmshaven LNG terminal*. Retrieved November 23, 2025, from https://www.wilhelmshaven-lng.de/en/faq

Mathews, J. A. (2017). China's Takeover of the Port of Piraeus in Greece: Blowback for Europe. *Asia-Pacific Journal*, *15*(17). https://doi.org/10.1017/s1557466017013675

Megginson, W. L., Nash, R. C., & Van Randenborgh, M. (1994). The Financial and Operating Performance of Newly Privatized Firms: An International Empirical Analysis. *The Journal of Finance*, *49*(2), 403–452. https://doi.org/10.1111/j.1540-6261.1994.tb05147.x

Meikle, B. (2006, July 6). *Goldman tops Macquarie's bid for AB Ports*. Buyouts. https://www.buyoutsinsider.com/goldman-tops-macquaries-bid-for-ab-ports/

Messingschlager, S. (2025, September 22). *What Cosco's Hamburg deal can tell us about Europe's "rules-first" approach to China*. London School of Economics. https://blogs.lse.ac.uk/europpblog/2025/09/22/cosco-hamburg-port-chinese-investment-eu-rules-china-trade/

Meunier, S. (2015). *A Tale of Two Ports: The Epic Story of Chinese Direct Investment in the Greek Port of Piraeus*. Council for European Studies. https://smeunier.scholar.princeton.edu/sites/g/files/toruqf4691/files/2015_meunierataleoftwoports_critcom.pdf

Notteboom, T. (2008). The relationship between seaports and the intermodal hinterland in light of global supply chains. *Port Competition and Hinterland Connections*, 25–75. https://doi.org/10.1787/9789282102251-3-en

Notteboom, T., Coeck, C., & Van Den Broeck, J. (2000). Measuring and Explaining the Relative Efficiency of Container Terminals by Means of Bayesian Stochastic Frontier Models. *International Journal of Maritime Economics*, *2*(2), 83–106. https://doi.org/10.1057/ijme.2000.9

Nwanosike, F. O., Tipi, N. S., & Warnock-Smith, D. (2016). Productivity change in Nigerian seaports after reform: a Malmquist productivity index decomposition approach. *Maritime Policy & Management*, *43*(7), 798–811. https://doi.org/10.1080/03088839.2016.1183827

Page, S. N., Ankner, Dr. W., Jones, C., & Fetterman, R. (2008). The Risks and Rewards of Private Equity in Infrastructure. *Public Works Management & Policy*, *13*(2), 100–113. https://doi.org/10.1177/1087724x08326311

Pérez, I., Trujillo, L., & González, M. M. (2016). Efficiency determinants of container terminals in Latin American and the Caribbean. *Utilities Policy*, *41*, 1–14. https://doi.org/10.1016/j.jup.2015.12.001

Reuters. (2015, March 31). Hermes Infrastructure, Canadian fund to buy stake in Associated British Ports. *Reuters*. https://www.reuters.com/article/business/hermes-infrastructure-canadian-fund-to-buy-stake-in-associated-british-ports-idUSKBN0MR0WF/

Reuters. (2023, February 22). ADIA weighs bid for 2 bln stg stake in UK's Associated British Ports - Bloomberg News. *Reuters*. https://www.reuters.com/markets/deals/adia-weighs-bid-2-bln-stg-stake-uks-associated-british-ports-bloomberg-news-2023-02-21/

Robinson, R. (2002). Ports as elements in value-driven chain systems: the new paradigm. *Maritime Policy & Management*, *29*(3), 241–255. https://doi.org/10.1080/03088830210132623

Röhling, F., Steinbach, L., & Salaschek, U. (2022, November 3). *German approval of Chinese stake in Hamburg container terminal – a veto in disguise?* Freshfields. https://riskandcompliance.freshfields.com/post/102i0m9/german-approval-of-chinese-stake-in-hamburg-container-terminal-a-veto-in-disgui

RWE. (2024, January 11). *Floating LNG terminal arrives at Brunsbüttel and increases German liquid gas import capacity*. Rwe.com. https://www.rwe.com/en/press/rwe-ag/2023-01-20-floating-lng-terminal-arrives-at-brunsbuettel/

Security Today. (2010, June 2). *UK Port Operator Deploys Avigilon Surveillance System -- Security Today*. https://securitytoday.com/articles/2010/06/02/uk-port-operator-aviglion-system.aspx?admgarea=ht.networkcentric

Seru, A. (2014). Firm boundaries matter: Evidence from conglomerates and R&D activity. *Journal of Financial Economics*, *111*(2), 381–405. https://doi.org/10.1016/j.jfineco.2013.11.001

Smit, S. (2025, March 28). *Economic conditions outlook, March 2025*. McKinsey & Company. https://www.mckinsey.com/capabilities/strategy-and-corporate-finance/our-insights/economic-conditions-outlook

Sorgenfrei, J. (2018). *Port Business*. DEG Press.

Talley, W. K. (2006). An Economic Theory of the Port. *Research in Transportation Economics*, *16*, 43–65. https://doi.org/10.1016/s0739-8859(06)16003-5

The Economist Times. (2006, June 23). *Goldman outbids Macquarie Bank in AB Ports deal*. https://economictimes.indiatimes.com/news/international/goldman-outbids-macquarie-bank-in-ab-ports-deal/articleshow/1675159.cms

The Margaret Thatcher Foundation. (n.d.). *PREM19-0170*. Retrieved November 15, 2025, from https://archive.margaretthatcher.org/PREM19/PREM19-0170.pdf

The Maritime Executive. (2023, March 3). *UK Ports Group ABP Commits $2.4B for Net Zero Transition*. https://maritime-executive.com/article/uk-ports-group-abp-commits-2-4b-for-net-zero-transition

The National Archives. (n.d.). *Records of the British Transport Docks Board*. Retrieved November 15, 2025, from https://discovery.nationalarchives.gov.uk/details/r/C36

The World Bank. (2024). *Alternative Port Management Structures and Ownership Models: World Bank Reform Tool Kit*. https://mcstrmi.org/wp-content/uploads/2024/09/World-Bank-alternative-port-mgmt-structures-copy.pdf?

Tongzon, J. (2001). Efficiency measurement of selected Australian and other international ports using data envelopment analysis. *Transportation Research Part A: Policy and Practice*, *35*(2), 107–122. https://doi.org/10.1016/s0965-8564(99)00049-x

Tongzon, J. L. (1995). Determinants of port performance and efficiency. *Transportation Research Part A: Policy and Practice*, *29*(3), 245–252. https://doi.org/10.1016/0965-8564(94)00032-6

Tongzon, J., & Heng, W. (2005). Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals). *Transportation Research Part A: Policy and Practice*, *39*(5), 405–424. https://doi.org/10.1016/j.tra.2005.02.001

Trujillo, L., & Nombela, G. (1999). *Privatization and Regulation of the Seaport Industry* (Vol. 2181). World Bank Publications.

UNCTAD. (2025, April 23). *Shipping data: UNCTAD releases new seaborne trade statistics*. UN Trade and Development (UNCTAD). https://unctad.org/news/shipping-data-unctad-releases-new-seaborne-trade-statistics

Villa, J. C. (2017). Port reform in Mexico: 1993–2015. *Research in Transportation Business & Management*, *22*, 232–238. https://doi.org/10.1016/j.rtbm.2016.11.003

Wärtsilä Corporation. (2022, August 23). *Wärtsilä to digitalise Associated British Ports' maritime operations*. Wartsila.com. https://www.wartsila.com/media/news/23-08-2022-wartsila-to-digitalise-associated-british-ports-maritime-operations-3144537

Watterson, C. J., de Saint Rapt, J.-A., & Yun, E. (2023). China's state-led international port development: Challenges for port states. *Marine Policy*, *155*, 105697. https://doi.org/10.1016/j.marpol.2023.105697

World Maritime News. (2025, July 29). *China Merchants, Sinotrans & CSC Wrap Up Merger | E-PORTS*. E-Ports.com. https://www.e-ports.com/en/shipping/news/58edd9e183b89a0800bf5191

Table 1: Level Differences: Nested Owner Specifications (A/B/C)

This table reports OLS estimates of how different ownership types are associated with three port-level outcome variables. The estimates are from level regressions on the port-year panel, where the dependent variables are, in turn, the PLSCI, the log of port revenues, and our land-reclamation measure. Columns (A) to (C) correspond to increasingly rich specifications: column (A) includes only ownership-type indicators, column (B) additionally includes a foreign-ownership dummy, and column (C) adds a Chinese-ownership dummy. Government ownership serves as the omitted baseline. 1(PE) is one if the port is owned by a financial sponsor and zero otherwise; 1(STRAT) is one for strategic private ownership; 1(is_FOR) is one for any foreign control; and 1(is_CHIN) is one for Chinese control. All regressions include port and year fixed effects, and standard errors are clustered at the port level.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients.

Owner type	**(A)**	**(B)**	**(C)**
		PLSCI	
PE	-0.09	3.33	2.27
	(14.52)	(13.96)	(14.09)
STRAT	-2.10	-0.72	-1.88
	(13.41)	(13.28)	(13.44)
is_FOR		11.63	11.81
		(8.71)	(8.79)
is_CHIN			-27.28
			(36.04)
includes FOR	No	Yes	Yes
includes CHIN	No	No	Yes
R^2	0.975	0.974	0.974
No. ports	1290	1290	1290
		log(revenues)	
PE	1.21	1.02	1.37
	(1.29)	(1.13)	(1.18)
STRAT	0.27	0.26	0.72
	(1.27)	(1.22)	(1.21)
is_FOR		0.41	0.44
		(0.47)	(0.49)
is_CHIN			2.17***
			(0.74)
includes FOR	No	Yes	Yes
includes CHIN	No	No	Yes
R^2	0.786	0.799	0.802
No. ports	249	249	249

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Owner type	(A)	(B)	(C)
	land reclamation		
PE	1.63	1.49	1.48
	(3.13)	(3.23)	(3.23)
STRAT	3.22	3.32	3.32
	(2.56)	(2.53)	(2.55)
is_FOR		1.62	1.63
		(2.20)	(2.22)
is_CHIN			-0.18
			(2.55)
includes FOR	No	Yes	Yes
includes CHIN	No	No	Yes
R^2	0.113	0.117	0.117
No. ports	1520	1520	1520

Table 2: Level Differences: Nested Fixed Effects (spec C)

This table reports OLS estimates from level regressions using the full ownership specification from column (C) of Table 1 and varying fixed-effects structures. For each dependent variable, we report four specifications: year fixed effects only, country fixed effects only, port fixed effects only, and port- plus year fixed effects (our main specification). The independent variables are the same ownership dummies as in column (C) of Table 1, with state ownership as the baseline. The rows "includes FOR" and "includes CHIN" indicate that foreign and Chinese ownership are explicitly controlled for in all estimations, and the table reports R-squared and the number of ports used in each specification. Standard errors are clustered at the port level in all specifications.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients.

Owner type	**year**	**country**	**port**	**year_port**
		PLSCI		
PE	-5.87	-18.76	3.57	2.27
	(46.89)	(35.07)	(14.17)	(14.09)
STRAT	-28.42	-17.34	-1.88	-1.88
	(36.75)	(32.08)	(13.44)	(13.44)
is_FOR	0.50	-10.58	12.51	11.81
	(21.90)	(16.60)	(8.87)	(8.79)
is_CHIN	336.82***	65.94	-25.70	-27.28
	(64.47)	(64.88)	(36.13)	(36.04)
includes FOR	Yes	Yes	Yes	Yes
includes CHIN	Yes	Yes	Yes	Yes
R^2	0.084	0.504	0.974	0.974
No. ports	1290	1290	1290	1290
		(log) revenues		
PE	0.24	0.14	1.17	1.37
	(0.47)	(0.44)	(1.25)	(1.18)
STRAT	-0.62*	-0.52*	0.58	0.72
	(0.34)	(0.27)	(1.14)	(1.21)
is_FOR	-0.24	0.02	0.42	0.44
	(0.32)	(0.25)	(0.51)	(0.49)
is_CHIN	2.81***	2.31***	2.23***	2.17***
	(0.38)	(0.81)	(0.66)	(0.74)
includes FOR	Yes	Yes	Yes	Yes
includes CHIN	Yes	Yes	Yes	Yes
R^2	0.195	0.378	0.797	0.802
No. ports	249	249	249	249

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Owner type	year	country	port	year_port
		land reclamation		
PE	2.11*	1.34	0.15	1.48
	(1.18)	(1.49)	(3.40)	(3.23)
STRAT	3.24***	2.58***	3.09	3.32
	(0.78)	(0.97)	(2.63)	(2.55)
is_FOR	-1.59**	-2.25***	0.34	1.63
	(0.70)	(0.76)	(2.23)	(2.22)
is_CHIN	5.26***	4.29***	-3.33	-0.18
	(1.60)	(1.35)	(2.39)	(2.55)
includes FOR	Yes	Yes	Yes	Yes
includes CHIN	Yes	Yes	Yes	Yes
R^2	0.025	0.027	0.098	0.117
No. ports	1520	1520	1520	1520

Table 3: Static DiD: Effects on PLSCI

This table reports difference-in-differences estimates of how ownership transitions affect port connectivity. The estimates are from static DiD regressions on an event window from 2 years before to 5 years after the first completed transaction in each family. The dependent variable is the port connectivity index PLSCI. The independent variables are indicators for different transition families, with no transaction in the window and continuous ownership of the selling owner type (e.g. STATE in STATE_TO_PRIV) as the baseline. Each coefficient measures the average post-transaction change relative to pre-transaction outcomes for the treated ports compared with the matched controls. All regressions include port plus year fixed effects; standard errors are clustered at the port level. The table reports R-squared, the number of treated and control ports, and the number of post-treatment and total observations.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

			n			
Transaction family	**PLSCI coefficient (SE)**	**R^2**	**treated ports**	**control ports**	**post-treated obs.**	**total obs.**
State Interaction						
STATE_TO_PRIV	6.62 (18.32)	0.970	64	273	260	2553
PRIV_TO_STATE	16.61 (12.77)	0.975	57	1645	228	14012
Financial Sponsors						
PE_TO_NONPE	9.92 (14.74)	0.971	87	298	290	2515
NONPE_TO_PE	11.47 (9.71)	0.975	159	1697	464	14287
PE_TO_PE	-31.85 (22.26)	0.971	24	293	87	2206
Foreign Involvement						
DOM_TO_FOR	-15.14** (5.99)	0.974	102	1020	364	7772
DOM_TO_PRIV_FOR	-11.74** (5.89)	0.974	86	1029	284	7727
NONCHIN_TO_CHIN	12.17** (5.57)	0.977	12	1437	41	11659

Table 4: Static DiD: Effects on log(revenue)

This table reports static DiD estimates of how ownership transitions affect ports' log revenues. The specification mirrors Table 3, except that the dependent variable is log revenue. The same set of transition indicators and control logic is used. Coefficients capture average changes in log revenue after each type of transaction relative to pre-transaction outcomes and to ports in the matched control set. All regressions use port plus year fixed effects, and standard errors are clustered at the port level.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

Transaction family	log(rev) coefficient (SE)	R^2	n: treated ports	n: control ports	n: post-treated obs.	n: total obs.
State Interaction						
STATE_TO_PRIV	NA	NA	NA	NA	NA	NA
PRIV_TO_STATE	0.63	0.792	57	1645	34	2416
	(0.41)					
Financial Sponsors						
PE_TO_NONPE	-1.26**	0.728	87	298	53	677
	(0.63)					
NONPE_TO_PE	0.05†	0.824	159	1697	29	2446
	(0.41)					
PE_TO_PE	-31.85	0.971	24	293	87	2206
	(22.26)					
Foreign Involvement						
DOM_TO_FOR	0.09	0.884	102	1020	40	1409
	(0.35)					
DOM_TO_PRIV_FOR	-0.26	0.883	86	1029	33	1401
	(0.22)					
NONCHIN_TO_CHIN	NA	NA	NA	NA	NA	NA

Table 5: Static DiD: Effects on land reclamation

This table reports static DiD estimates of how ownership transitions affect land reclamation around ports. The specification mirrors Table 3 and 4, except that the dependent variable is our satellite imaging-based land reclamation measure. The same set of transition indicators and control logic is used. Coefficients capture average changes in the amount of annually reclaimed land after each type of transaction relative to pre-transaction outcomes and to ports in the matched control set. All regressions use port plus year fixed effects, and standard errors are clustered at the port level.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

Transaction family	land recl. coefficient (SE)	R^2	n: treated ports	n: control ports	n: post-treated obs.	n: total obs.
State Interaction						
STATE_TO_PRIV	1.16	0.162	64	273	154	1420
	(2.19)					
PRIV_TO_STATE	3.90	0.129	57	1645	104	8947
	(3.77)					
Financial Sponsors						
PE_TO_NONPE	-7.82	0.164	87	298	168	1462
	(8.50)					
NONPE_TO_PE	-0.36	0.132	159	1697	284	9125
	(1.69)					
PE_TO_PE	12.30	0.179	24	293	48	1265
	(7.92)					
Foreign Involvement						
DOM_TO_FOR	1.76	0.136	102	1020	167	4937
	(2.42)					
DOM_TO_PRIV_FOR	2.92	0.136	86	1029	135	4923
	(2.81)					
NONCHIN_TO_CHIN	-5.36***†	0.129	12	1437	18	7532
	(1.50)					

Table 6: Event Study DiD: Effects on PLSCI

This table reports event-study estimates of how ownership transitions affect port connectivity (i.e. the PLSCI) over time, based on dynamic DiD-style event study regressions on the port-year panel. For each transition type, we estimate event-time coefficients for relative years −2 through +5, with year 0 denoting the ownership change. Coefficients, therefore, trace connectivity dynamics before and after the transition relative to dynamic control groups. All specifications include port and year fixed effects, with standard errors clustered at the port level. The table reports R-squared, the number of treated and control ports total number of observations.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Event-study tables report year-by-year effects relative to the transition, using the same control design and event window as described in the text.

	PLSCI coefficient for year t+									n	
Transaction family	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**R^2**	**treated ports**	**control ports**
State Interaction											
STATE_TO_PRIV	14.06	17.64	16.31	16.36	16.74	10.54	5.80	12.88	0.970	49	158
	(15.04)	(17.63)	(19.08)	(20.80)	(25.19)	(26.89)	(29.70)	(33.63)			
PRIV_TO_STATE	27.51**	22.73*	23.55*	24.86	28.34*	27.27	24.91	26.53	0.975	42	1081
	(11.34)	(12.73)	(13.09)	(15.34)	(16.80)	(17.05)	(18.29)	(19.72)			
Financial Sponsors											
PE_TO_NONPE	9.01	18.17	20.35	21.30	13.03	13.96	9.99	13.48	0.971	54	151
	(9.97)	(12.08)	(14.64)	(17.12)	(17.97)	(20.26)	(21.72)	(23.87)			
NONPE_TO_PE	16.79**	16.68*	16.11	14.66	17.87	18.60	19.58	19.43	0.975	99	1059
	(8.20)	(8.98)	(10.29)	(10.41)	(11.75)	(13.13)	(15.00)	(16.25)			
PE_TO_PE	-29.74	-32.89	-37.98	-42.85	-43.18	-48.34	-54.03*	-51.72	0.971	16	174
	(22.76)	(24.10)	(27.69)	(29.95)	(32.30)	(33.99)	(32.64)	(40.56)			

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Transaction family	-2	-1	0	1	2	3	4	5	R^2	treated ports	control ports
Foreign Involvement											
DOM_TO_FOR	-57.06	-61.29	-63.38	-70.39*	-71.31*	-73.07*	-76.53*	-77.60*	0.974	72	640
	(42.12)	(42.49)	(42.52)	(42.60)	(42.89)	(42.53)	(42.76)	(43.50)			
DOM_TO_PRIV_FOR	-75.79	-81.93*	-80.65*	-88.48*	-86.13*	-86.70*	-89.28*	-89.20*	0.974	58	651
	(47.24)	(47.36)	(47.67)	(47.80)	(48.07)	(48.06)	(48.44)	(48.69)			
NONCHIN_TO_CHIN	34.33***†	24.51***†	24.06***†	21.40**†	37.81***†	36.69***†	33.95***†	50.67***†	0.977	8	957
	(9.41)	(5.93)	(4.06)	(9.54)	(6.23)	(6.88)	(7.62)	(18.60)			

Table 7: Event Study DiD: Effects on log(revenue)

This table presents event-study estimates of how ownership transitions affect port revenues. The estimates are from dynamic DiD regressions that mirror the specification in Table 6, except that the dependent variable is log revenue. Coefficients trace the evolution of revenues both prior to and following ownership changes, relative to dynamic control groups. All specifications include port and year fixed effects, with standard errors clustered at the port level. The table reports R-squared, the number of treated and control ports total number of observations.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Event-study tables report year-by-year effects relative to the transition, using the same control design and event window as described in the text.

	log(revenue) coefficient for year t+									n	
Transaction family	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**R^2**	**treated ports**	**control ports**
State Interaction											
STATE_TO_PRIV	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRIV_TO_STATE	0.10†	0.44†	0.36†	0.59*†	0.44†	0.59†	1.19†	1.00†	0.792	7	190
	(0.24)	(0.30)	(0.32)	(0.34)	(0.35)	(0.46)	(0.77)	(0.79)			
Financial Sponsors											
PE_TO_NONPE	-0.01	-0.80	-0.86*	-0.73*	-1.63**	-1.63**	-2.00*	-2.04*	0.735	11	35
	(0.46)	(0.51)	(0.52)	(0.41)	(0.72)	(0.80)	(1.04)	(1.10)			
NONPE_TO_PE	-0.84**†	-0.69*†	-0.33†	-0.15†	0.12†	0.03†	-0.55*†	-0.66†	0.824	9	200
	(0.41)	(0.37)	(0.42)	(0.44)	(0.35)	(0.31)	(0.30)	(0.46)			
PE_TO_PE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Foreign Involvement											
DOM_TO_FOR	0.32	1.38	0.39	1.66	0.74	0.60	0.21	0.13	0.887	10	122
	(1.05)	(0.93)	(1.07)	(1.22)	(0.91)	(0.93)	(0.80)	(0.81)			
DOM_TO_PRIV_FOR	-0.79†	0.55†	-0.76†	0.89†	-0.35†	-0.54**†	-0.72***†	-0.80**†	0.886	8	123
	(0.83)	(0.60)	(0.84)	(1.11)	(0.25)	(0.21)	(0.24)	(0.36)			
NONCHIN_TO_CHIN	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 8: Event Study DiD: Effects on land reclamation

This table presents event-study estimates of how ownership transitions affect land reclamation. The estimates are from dynamic DiD regressions that mirror the specification in Tables 6 and 7, except that the dependent variable is our satellite imaging-based land reclamation measure. Coefficients trace the evolution of annual land reclamation around a port both prior to and following ownership changes, relative to dynamic control groups. All specifications include port and year fixed effects, with standard errors clustered at the port level. The table reports R-squared, the number of treated and control ports total number of observations.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Event-study tables report year-by-year effects relative to the transition, using the same control design and event window as described in the text.

	land reclamation coefficient for year t+									n	
Transaction family	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**R^2**	**treated ports**	**control ports**
State Interaction											
STATE_TO_PRIV	1.29	-2.04	-2.25	-2.47	4.02	2.89	-3.22	12.16	0.169	38	157
	(2.41)	(2.25)	(2.15)	(2.56)	(4.47)	(4.44)	(2.88)	(7.39)			
PRIV_TO_STATE	1.72	7.96	26.98	7.51	-4.79	3.28	2.73	-4.74	0.130	36	1151
	(8.83)	(7.70)	(28.09)	(9.84)	(4.80)	(7.01)	(6.88)	(4.48)			
Financial Sponsors											
PE_TO_NONPE	25.64	-13.54**	-7.66	-13.44*	-9.36	-14.35*	-8.16	23.84	0.189	61	132
	(36.40)	(6.49)	(4.99)	(7.42)	(7.73)	(7.93)	(9.23)	(21.40)			
NONPE_TO_PE	-0.32	-0.88	-2.25	-4.18	3.65	8.06	-7.33**	-0.52	0.133	122	1126
	(2.86)	(3.31)	(5.35)	(4.21)	(5.69)	(10.97)	(3.54)	(5.45)			
PE_TO_PE	0.21	2.27	43.22	0.98	6.63	-4.31	29.80	2.29	0.189	16	157
	(8.25)	(7.21)	(28.13)	(9.76)	(13.41)	(10.07)	(18.68)	(8.42)			

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Transaction family	-2	-1	0	1	2	3	4	5	R^2	treated ports	control ports
Foreign Involvement											
DOM_TO_FOR	12.69***	10.37***	7.36***	2.67	10.95**	24.93	29.64	8.52*	0.139	41	709
	(3.25)	(2.95)	(2.72)	(3.02)	(4.82)	(18.69)	(18.32)	(5.08)			
DOM_TO_PRIV_FOR	13.62***	10.74***	6.42**	1.86	11.65*	31.31	35.37	10.00**	0.139	35	712
	(3.97)	(3.59)	(3.17)	(3.35)	(6.02)	(23.64)	(22.34)	(4.96)			
NONCHIN_TO_CHIN	9.02***†	8.70***†	7.87***†	3.22†	-0.58†	0.22†	-15.03†	3.35†	0.129	7	1005
	(1.81)	(1.83)	(1.79)	(2.90)	(2.86)	(1.31)	(12.28)	(12.34)			

Table 9: Static DiD with Withdrawn Transactions as Counterfactual

This Table reports DiD estimates from our quasi-experimental design, which uses withdrawn transactions as a counterfactual for completed deals. The estimates are based on the subsample of ports that either complete or withdraw at least one transaction in a given family using an event window from −2 to +5. The dependent variables are PLSCI, log revenues, and annual land reclamation. The independent variable is an indicator for any completed transactions (ANY_TX), with withdrawn transactions serving as the control group. Coefficients capture average differences in outcomes between completed and withdrawn ports in the post-event period, conditional on port plus year fixed effects. The tables report R-squared, the number of completed and withdrawn ports, the total number of ports, and the number of observations used. Standard errors are clustered at the port level. Due to limited data availability, ANY_TX is the only transition that could be estimated.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

			n			
Transaction family	**Coefficient (SE)**	**R^2**	**treated ports**	**control ports**	**post-treated obs.**	**total obs.**
		PLSCI				
ANY_TX	-2.10 (2.59)	0.994	439	27	466	2892
		log(rev)				
ANY_TX	-0.02† (0.19)	0.959	27	3	30	144
		land reclamation				
ANY_TX	3.36 (3.04)	0.197	392	18	410	1979

Appendix

Figure A1: Structure Chart of ABP Ports from 2006-2015 and 2015-2025

The figure shows the ownership and financing structure of ABP, where the operating company ("OpCo") is held through multiple holding companies ("HoldCo") in a typical acquisition structure design.

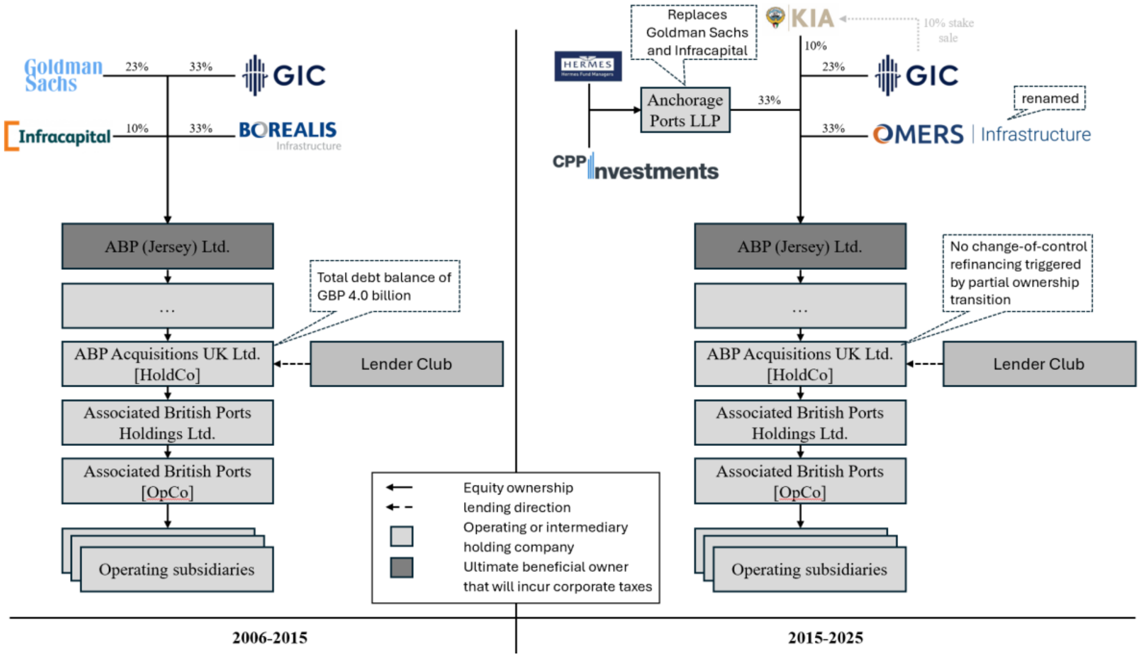


Figure A2: Structure Chart of CKHH and Transaction Perimeter for Blackrock

This figure presents a simplified corporate structure of CK Hutchison Holdings Ltd., highlighting the port segment, where assets are held in two subsidiaries, including one with the Panama Ports Company – the target in the Blackrock-led transaction in early 2025. The chart is illustrative does not represent ownership percentages (CK Hutchison Holdings Limited, 2023; Lloyd's List, 2025).

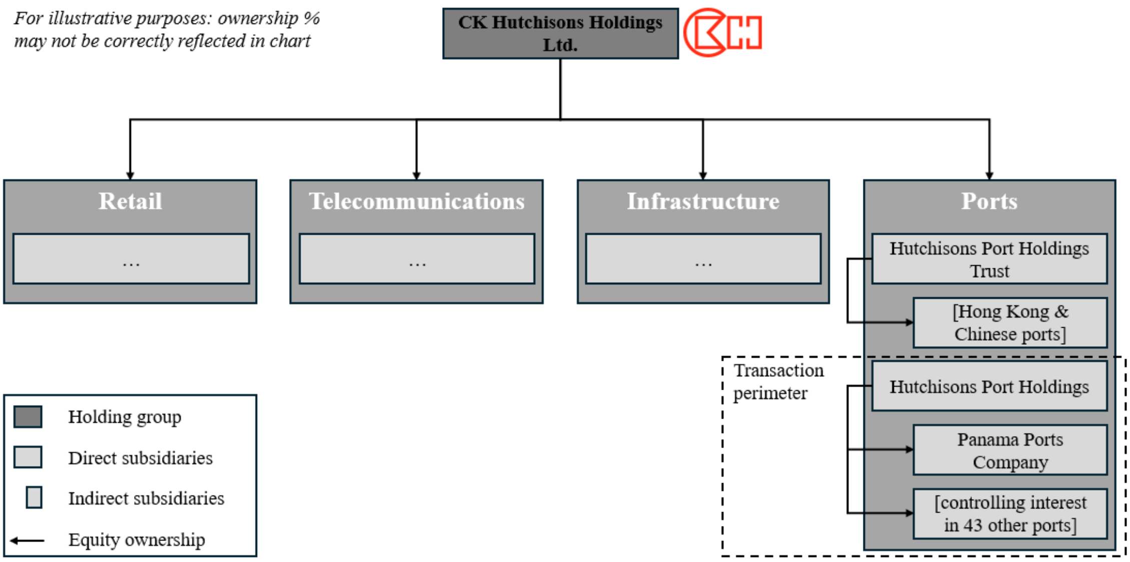
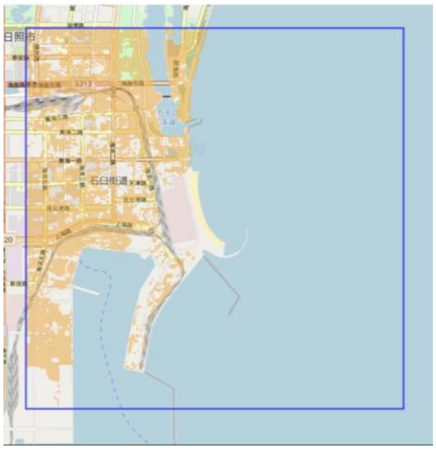


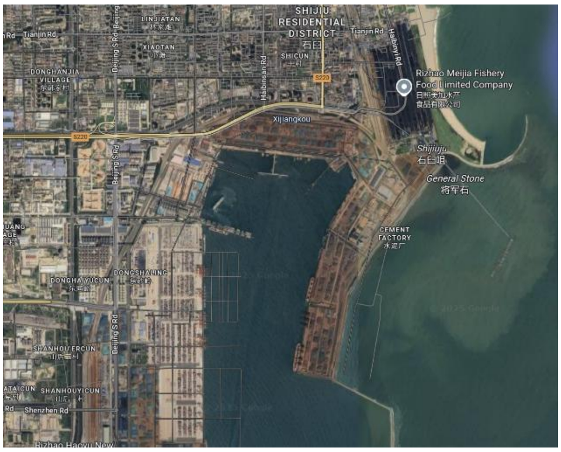
Figure A3: Geomapping Illustration for the Port of Rizhao

The figures visualize the geomapping functionality in that the algorithm can detect land reclamations and, as such, approximate physical port expansion, especially over the longer term. For this, we compute yearly port land areas using Landsat and Sentinel satellite imagery accessed through the Google Earth Engine API, and classify water vs. land using indices such as MNDWI (Modified Normalized Difference Water Index) together with sensor-specific masks and cloud filters to derive clean annual land-water boundaries. Naturally, there is some noise in these satellite images (clouds, tides, ships) and the automatic, Python-based measurement, which is nevertheless allocated randomly across all observations and is observed for via the 3-rolling median smoothing mechanism. This monotonic upper envelope ensures that the smoothed land area series can never decrease through assigning the maximum of all median-filtered values to that point, so only persistent upward shifts, consistent with true land reclamation, are recorded, while temporary drops from sensor noise are ignored. Below we added an illustration of the land area detection mechanism in 2009 (in Panel A) vs. 2021 (in Panel B) in the area of interest (box around the port coordinates whose radius was determined by the WPI size category), compared to the real and clean satellite images, which validates the basic functionality of our algorithm.

Panel A: 2009



Panel B: 2021



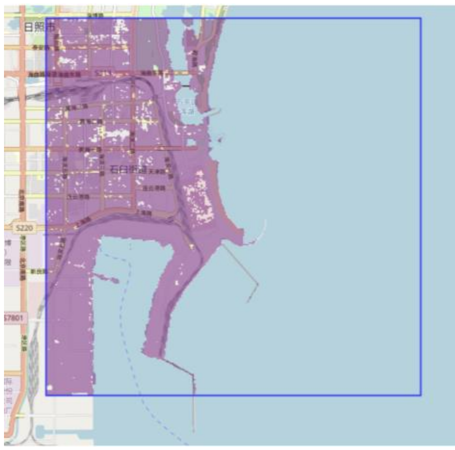
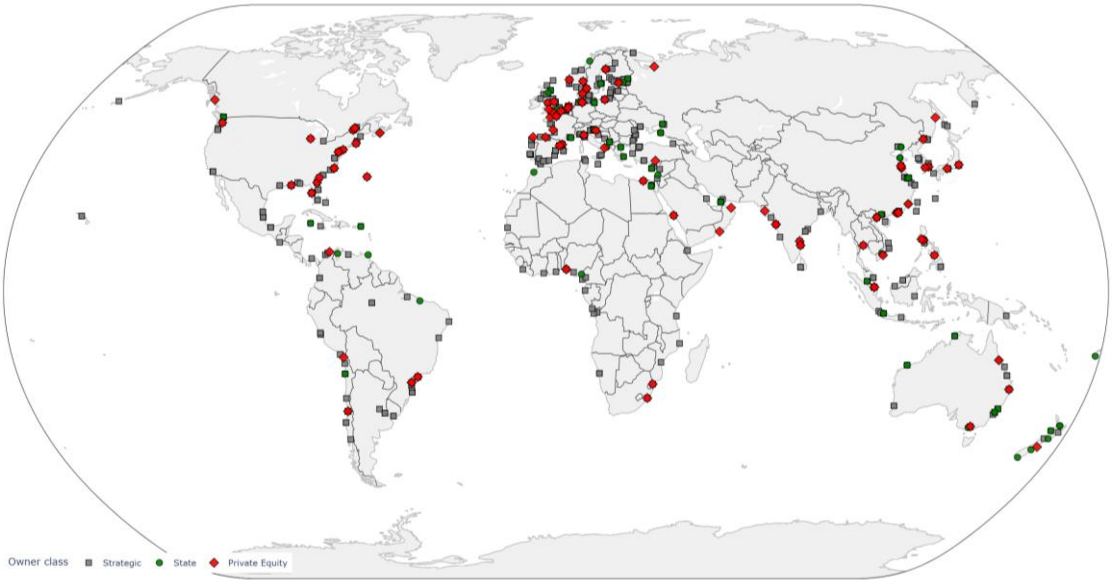


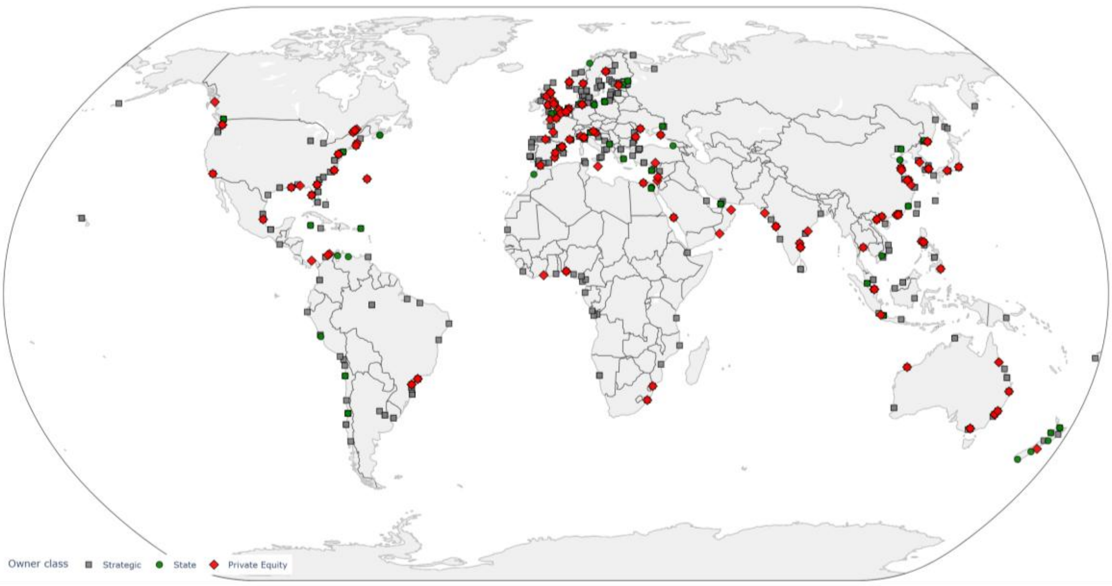
Figure A4: Global Port Ownership in 2000, 2024, and Europe

The world maps show all sample ports with valid coordinates and mapped ownership in each referenced year. Unmapped ports are excluded. The first panel displays global ownership in 2000, followed by the corresponding distribution in 2024, with an additional zoom-in on the broader European and Mediterranean region. Strategic (grey rectangles), state (green circles), and PE (red diamonds) are displayed across each.

Panel A: Global Port Ownership in 2000



Panel B: Global Port Ownership in 2024



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Panel C: European Port Ownership in 2024

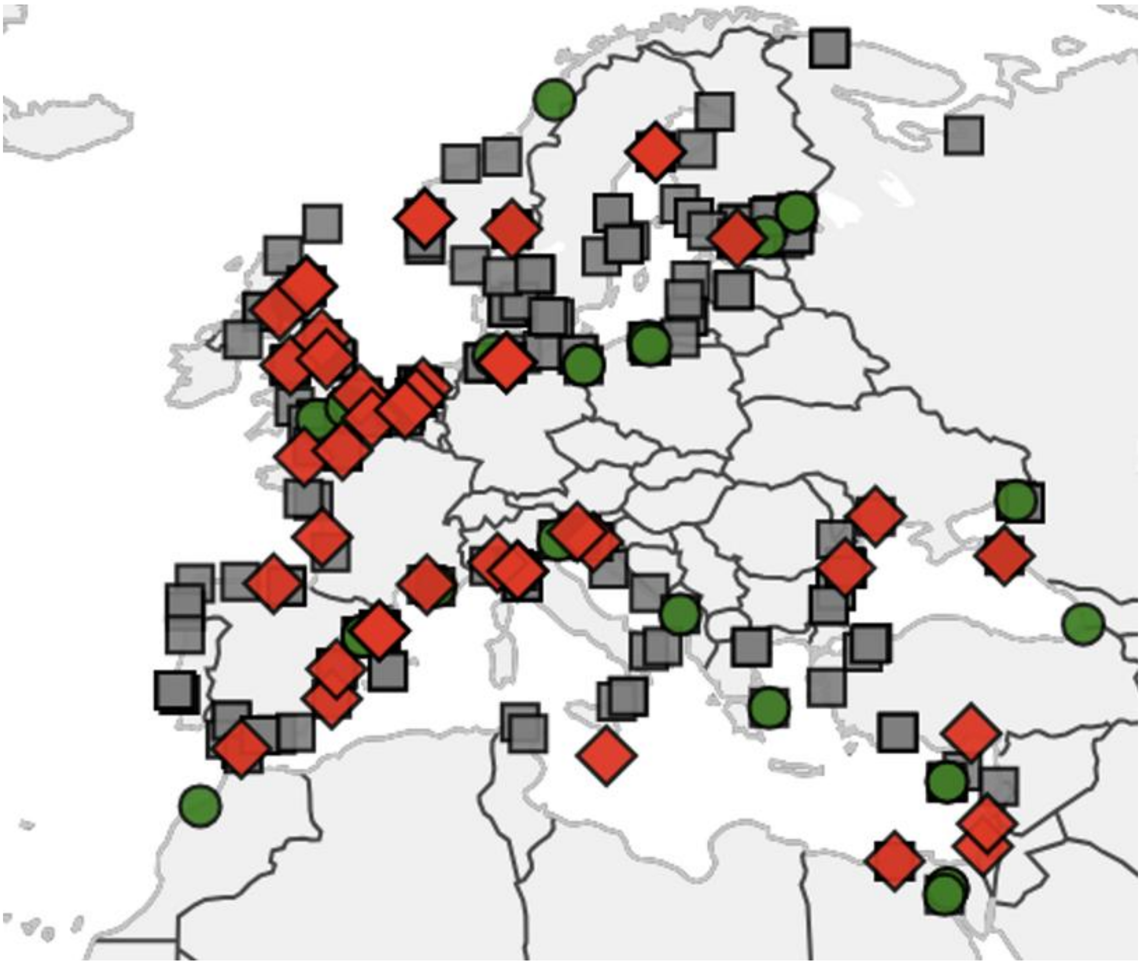
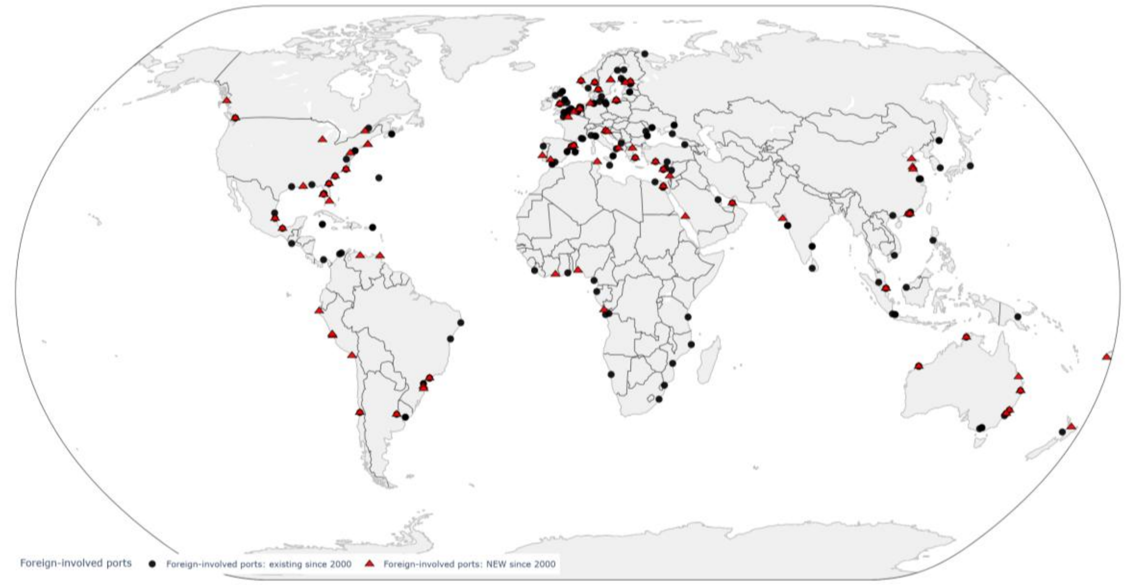


Figure A5: Map on Foreign Port Involvement

The world maps show all sample ports with valid coordinates that exhibit foreign (top) or Chinese (bottom) involvement in 2024, distinguishing ports already involved in 2000 (black circles) from newly involved since 2000 (red triangles).

Panel A: Foreign-involved ports 2000 vs. 2024



Panel B: Chinese-involved ports 2000 vs. 2024

Figure A6: State vs. PE Ownership Trend

The figure plots, for each year, the share of all sample ports owned by state or PE (left axis, based on port counts) and the corresponding share of PLSCI controlled by these owners (right axis, based on PLSCI-weighted ownership). For illustrative purposes, intra-year ownership transitions are not accounted for.

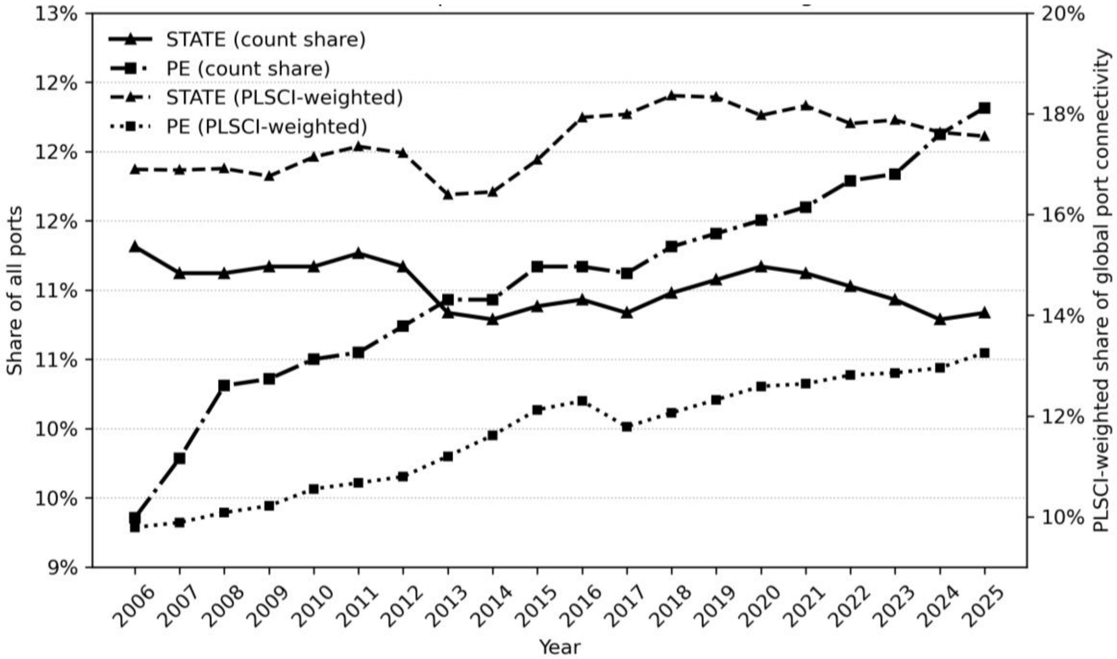


Figure A7: Annual Transaction Outcomes and Rates, 2000-2025

The figure shows, by year, the number of completed and withdrawn port transactions (bars), together with the share of completed deals acquired PE and the share of all deals that are withdrawn derived from the panel transaction data.

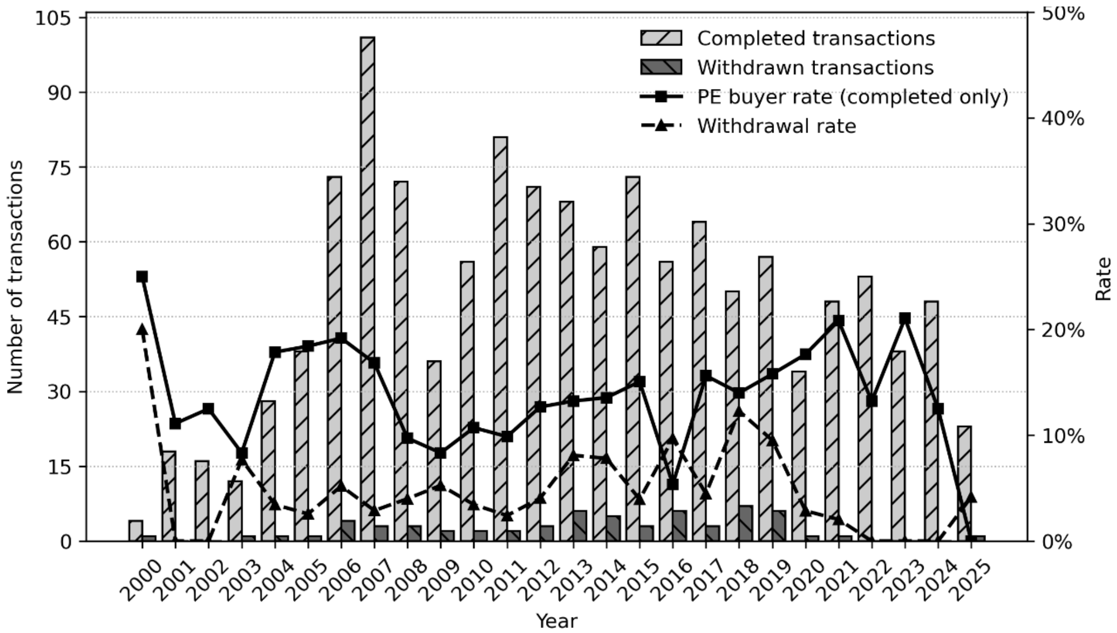


Table A1: Dataset and Variables Overview

This table summarizes the key variables in the final dataset used for the empirical analyses and indicates their respective sources. Several variables, such as the ownership and transition classification dummies, are derived from the underlying data rather than directly observed.

Variable name	**Description**	**Origin**	**Type**
Identification & classification			
port_id	Unique company identifier in CIQ	S&P CIQ	Static
locode	Unique company identifier in UNCTAD	UNCTAD	Static
year	Years from 1973 onwards	UNCTAD	Panel
owner_class	Ownership type, e.g. STATE	Ownership Prop.	Panel
event_class	Ownership transition type, e.g. STATE -> STRAT	Ownership Prop.	Panel
deal_count	=1, if a transaction was completed in this year	S&P CIQ	Panel
Completed (dummy)	=0, if this the transaction was withdrawn (*deal_count* <> 1)	S&P CIQ	Panel
is_FOR (dummy)	=1, if the owner was a foreign entity	S&P CIQ	Panel
is_CHIN (dummy)	=1, if the owner was a Chinese entity	S&P CIQ	Panel
Dependent & other descriptive variables			
revenue	Revenue for the respective year	S&P CIQ	Panel
index_year_average	Annual average of quarterly PLSCI	UNCTAD	Panel
channel depth, oil terminal depth, coordinates, etc.	Descriptive, statically observed variables, sparsely available per port	WPI	Static
harbor size	Size classification according to WPI	WPI	Static
land reclamation	Self-computed measure for land expansion for each port area with available coordinates	Geomapping	Panel
…			

Table A2: Dependent Variable Mean and Median

The tables report, for each owner class and for the years 2010, 2014, 2020, and 2024, the mean and median PLSCI, revenue and land reclamation values, calculated over all ports with non-missing ownership attribution and available respective data.

Panel A: PLSCI

	PLSCI mean				PLSCI median			
Owner	**2010**	**2014**	**2020**	**2024**	**2010**	**2014**	**2020**	**2024**
STATE	357.2	337.24	387.04	419.94	140.25	145.14	179.96	202.27
STRAT	259.44	249.27	244.68	258.27	111.33	114.65	120.05	135.38
PE	246.38	247.88	280.68	282.49	114.94	128.36	167.98	157.7
UNMAPPED	184.25	188.93	208.21	228.04	91.65	88.68	109.22	128.45

Panel B: revenue (in USD)

	revenue mean				revenue median			
Owner	**2010**	**2014**	**2020**	**2024**	**2010**	**2014**	**2020**	**2024**
STATE	37,118	137,490	1,758,868	1,501,104	33,233	63,694	219,248	107,557
STRAT	229,695	122,640	172,631	222,862	97,818	32,179	46,843	39,444
PE	73,319	321,147	301,191	469,841	50,315	112,458	139,041	164,110
UNMAPPED	73,008	104,394	216,900	162,917	26,181	22,294	30,776	28,036

Panel C: land reclamation (in hectar)

	land reclamation mean				land reclamation median			
Owner	**2010**	**2014**	**2020**	**2024**	**2010**	**2014**	**2020**	**2024**
STATE	3.21	7.73	0.16	4.87	0.00	0.00	0.00	0.00
STRAT	7.11	7.73	1.66	4.86	0.00	0.00	0.00	0.00
PE	14.64	23.48	0.85	1.58	0.00	0.00	0.00	0.00
UNMAPPED	5.02	16.39	0.99	3.45	0.00	0.00	0.00	0.00

Table A3: Static DiD: Nested Fixed Effects (FE): Effects on PLSCI

This table reports static difference-in-differences estimates of how ownership transitions affect port connectivity under alternative fixed-effects structures. The specification is identical to that used in Table 3, only that now results are not only shown for estimations using port plus year fixed effects. Each row corresponds to a transition family (and fixed effects specification), while columns report estimates from specifications that progressively add fixed effects: year fixed effects only, country fixed effects, port fixed effects, and port plus year fixed effects. In all cases, the omitted category consists of ports that do not experience a transition in the window and remain under the seller-type ownership. Coefficients measure the average post-transaction change in PLSCI relative to the pre-transaction period and relative to the relevant control group.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

Transaction family (FE)	PLSCI coefficient (SE)	year	port	country	R^2	n: treated ports	n: control ports	n: post-treated obs.	n: total obs.
Privatizations									
STATE_TO_PRIV (year)	-112.20 (70.34)	Yes	No	No	0.009	64	273	260	2553
STATE_TO_PRIV (country)	3.66 (51.53)	No	No	Yes	0.540	64	273	260	2553
STATE_TO_PRIV (port)	19.81 (15.60)	No	Yes	No	0.969	64	273	260	2553
STATE_TO_PRIV (year_port)	6.62 (18.32)	Yes	Yes	No	0.970	64	273	260	2553
PRIV_TO_STATE (year)	12.05 (51.72)	Yes	No	No	0.001	57	1645	228	14012
PRIV_TO_STATE (country)	40.75 (31.42)	No	No	Yes	0.481	57	1645	228	14012
PRIV_TO_STATE (port)	20.06 (12.56)	No	Yes	No	0.975	57	1645	228	14012
PRIV_TO_STATE (year_port)	16.61 (12.77)	Yes	Yes	No	0.975	57	1645	228	14012
Financial Sponsors									
PE_TO_NONPE (year)	-37.77 (46.82)	Yes	No	No	0.003	87	298	290	2515
PE_TO_NONPE (country)	-29.36 (28.35)	No	No	Yes	0.532	87	298	290	2515
PE_TO_NONPE (port)	19.29 (12.16)	No	Yes	No	0.971	87	298	290	2515
PE_TO_NONPE (year_port)	9.92 (14.74)	Yes	Yes	No	0.971	87	298	290	2515
NONPE_TO_PE (year)	-39.41 (40.98)	Yes	No	No	0.001	159	1697	464	14287
NONPE_TO_PE (country)	-32.71 (29.99)	No	No	Yes	0.495	159	1697	464	14287

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Transaction family (FE)	coefficient (SE)	year	port	country	R^2	treated ports	control ports	post-treated obs.	total obs.
NONPE_TO_PE (port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NONPE_TO_PE (year_port)	11.47 (9.71)	Yes	Yes	No	0.975	159	1697	464	14287
PE_TO_PE (year)	28.53 (112.82)	Yes	No	No	0.002	24	293	87	2206
PE_TO_PE (country)	5.49 (62.32)	No	No	Yes	0.524	24	293	87	2206
PE_TO_PE (port)	-22.10 (20.99)	No	Yes	No	0.970	24	293	87	2206
PE_TO_PE (year_port)	-31.85 (22.26)	Yes	Yes	No	0.971	24	293	87	2206
Foreign Involvement									
DOM_TO_FOR (year)	14.08 (52.71)	Yes	No	No	0.001	102	1020	364	7772
DOM_TO_FOR (country)	-1.70 (34.68)	No	No	Yes	0.410	102	1020	364	7772
DOM_TO_FOR (port)	-7.60 (5.26)	No	Yes	No	0.973	102	1020	364	7772
DOM_TO_FOR (year_port)	-15.14** (5.99)	Yes	Yes	No	0.974	102	1020	364	7772
DOM_TO_PRIV_FOR (year)	13.71 (58.85)	Yes	No	No	0.001	86	1029	284	7727
DOM_TO_PRIV_FOR (country)	16.34 (39.60)	No	No	Yes	0.405	86	1029	284	7727
DOM_TO_PRIV_FOR (port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
DOM_TO_PRIV_FOR (year_port)	-11.74** (5.89)	Yes	Yes	No	0.974	86	1029	284	7727
NONCHIN_TO_ CHIN (year)	78.28 (234.43)	Yes	No	No	0.003	12	1437	41	11659
NONCHIN_TO_ CHIN (country)	108.38 (211.29)	No	No	Yes	0.590	12	1437	41	11659
NONCHIN_TO_ CHIN (port)	8.75* (5.13)	No	Yes	No	0.977	12	1437	41	11659
NONCHIN_TO_ CHIN (year_port)	12.17** (5.57)	Yes	Yes	No	0.977	12	1437	41	11659

Table A4: Static DiD Nested Fixed Effects (FE): Effects on log(revenue)

This table reports static difference-in-differences estimates of how ownership transitions affect revenues under alternative fixed-effects structures. The specification is identical to that used in Table 4, only that now results are not only shown for estimations using port plus year fixed effects. Each row corresponds to a transition family (and fixed effects specification), while columns report estimates from specifications that progressively add fixed effects: year fixed effects only, country fixed effects, port fixed effects, and port plus year fixed effects. In all cases, the omitted category consists of ports that do not experience a transition in the window and remain under the seller-type ownership. Coefficients measure the average post-transaction change in log revenues relative to the pre-transaction period and relative to the relevant control group.

Significance levels: Coefficients are marked with stars according to their p-value: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

Transaction family (FE)	log(rev) coefficient (SE)	year	port	country	R^2	n: treated ports	n: control ports	n: post-treated obs.	n: total obs.
Privatizations									
STATE_TO_PRIV (year)	NA	NA	NA	NA	NA	NA	NA	NA	NA
STATE_TO_PRIV (country)	NA	NA	NA	NA	NA	NA	NA	NA	NA
STATE_TO_PRIV (port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
STATE_TO_PRIV (year_port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRIV_TO_STATE (year)	0.70 (0.57)	Yes	No	No	0.007	57	1645	34	2416
PRIV_TO_STATE (country)	1.23* (0.64)	No	No	Yes	0.269	57	1645	34	2416
PRIV_TO_STATE (port)	1.02*** (0.32)	No	Yes	No	0.780	57	1645	34	2416
PRIV_TO_STATE (year_port)	0.63 (0.41)	Yes	Yes	No	0.792	57	1645	34	2416
Financial Sponsors									
PE_TO_NONPE (year)	-1.31** (0.65)	Yes	No	No	0.103	87	298	53	677
PE_TO_NONPE (country)	-0.60 (0.77)	No	No	Yes	0.271	87	298	53	677
PE_TO_NONPE (port)	-0.48 (0.62)	No	Yes	No	0.594	87	298	53	677
PE_TO_NONPE (year_port)	-1.26** (0.63)	Yes	Yes	No	0.728	87	298	53	677
NONPE_TO_PE (year)	-1.19† (1.21)	Yes	No	No	0.017	159	1697	29	2446

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Transaction family (FE)	coefficient (SE)	year	port	country	R^2	treated ports	control ports	post-treated obs.	total obs.
NONPE_TO_PE (country)	-1.00† (1.24)	No	No	Yes	0.394	159	1697	29	2446
NONPE_TO_PE (port)	0.25† (0.43)	No	Yes	No	0.817	159	1697	29	2446
NONPE_TO_PE (year_port)	0.05† (0.41)	Yes	Yes	No	0.824	159	1697	29	2446
PE_TO_PE (year)	NA	NA	NA	NA	NA	NA	NA	NA	NA
PE_TO_PE (country)	NA	NA	NA	NA	NA	NA	NA	NA	NA
PE_TO_PE (port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
PE_TO_PE (year_port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Foreign Involvement									
DOM_TO_FOR (year)	-0.44 (0.52)	Yes	No	No	0.044	102	1020	40	1409
DOM_TO_FOR (country)	0.91** (0.43)	No	No	Yes	0.549	102	1020	40	1409
DOM_TO_FOR (port)	0.46 (0.45)	No	Yes	No	0.861	102	1020	40	1409
DOM_TO_FOR (year_port)	0.09 (0.35)	Yes	Yes	No	0.884	102	1020	40	1409
DOM_TO_PRIV_FOR (year)	-0.75 (0.47)	Yes	No	No	0.044	86	1029	33	1401
DOM_TO_PRIV_FOR (country)	0.99* (0.53)	No	No	Yes	0.543	86	1029	33	1401
DOM_TO_PRIV_FOR (port)	-0.00 (0.22)	No	Yes	No	0.859	86	1029	33	1401
DOM_TO_PRIV_FOR (year_port)	-0.26 (0.22)	Yes	Yes	No	0.883	86	1029	33	1401
NONCHIN_TO_CHIN (year)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NONCHIN_TO_CHIN (country)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NONCHIN_TO_CHIN (port)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NONCHIN_TO_CHIN (year_port)	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A5: Static DiD Nested Fixed Effects (FE): Effects on land reclamation

This table reports static difference-in-differences estimates of how ownership transitions affect annual land reclamation under alternative fixed-effects structures. The specification is identical to that used in Table 5, only that now results are not only shown for estimations using port plus year fixed effects. Each row corresponds to a transition family (and fixed effects specification), while columns report estimates from specifications that progressively add fixed effects: year fixed effects only, country fixed effects, port fixed effects, and port plus year fixed effects. In all cases, the omitted category consists of ports that do not experience a transition in the window and remain under the seller-type ownership. Coefficients measure the average post-transaction change in annual land reclamation relative to the pre-transaction period and relative to the relevant control group.

Significance levels: Coefficients are marked with stars according to their p-value: * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors are reported in parentheses below coefficients. Reliability: Coefficients marked with a cross (†) correspond to specifications that do not pass our predefined reliability checks (e.g. very small sample size, missing or unstable standard errors). These results are reported for completeness but should be interpreted with caution. Design: Static DiD tables report the coefficient on the post-treatment indicator (treated port × post-event window).

Transaction family (FE)	land recl. coefficient (SE)	year	port	country	R^2	n: treated ports	n: control ports	n: post-treated obs.	n: total obs.
Privatizations									
STATE_TO_PRIV (year)	1.38 (2.51)	Yes	No	No	0.027	64	273	154	1420
STATE_TO_PRIV (country)	2.19 (2.89)	No	No	Yes	0.031	64	273	154	1420
STATE_TO_PRIV (port)	0.49 (1.90)	No	Yes	No	0.139	64	273	154	1420
STATE_TO_PRIV (year_port)	1.16 (2.19)	Yes	Yes	No	0.162	64	273	154	1420
PRIV_TO_STATE (year)	4.32 (4.63)	Yes	No	No	0.024	57	1645	104	8947
PRIV_TO_STATE (country)	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRIV_TO_STATE (port)	0.24 (3.91)	No	Yes	No	0.109	57	1645	104	8947
PRIV_TO_STATE (year_port)	3.90 (3.77)	Yes	Yes	No	0.129	57	1645	104	8947
Financial Sponsors									
PE_TO_NONPE (year)	3.22 (4.07)	Yes	No	No	0.041	87	298	168	1462
PE_TO_NONPE (country)	2.44 (4.53)	No	No	Yes	0.036	87	298	168	1462
PE_TO_NONPE (port)	-13.40 (8.36)	No	Yes	No	0.137	87	298	168	1462
PE_TO_NONPE (year_port)	-7.82 (8.50)	Yes	Yes	No	0.164	87	298	168	1462
NONPE_TO_PE (year)	2.35 (2.33)	Yes	No	No	0.024	159	1697	284	9125

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Transaction family (FE)	coefficient (SE)	year	port	country	R^2	treated ports	control ports	post-treated obs.	total obs.
NONPE_TO_PE (country)	NA	NA	NA	NA	NA	NA	NA	NA	NA
NONPE_TO_PE (port)	-2.35 (1.53)	No	Yes	No	0.112	159	1697	284	9125
NONPE_TO_PE (year_port)	-0.36 (1.69)	Yes	Yes	No	0.132	159	1697	284	9125
PE_TO_PE (year)	4.16 (8.25)	Yes	No	No	0.049	24	293	48	1265
PE_TO_PE (country)	11.84 (8.61)	No	No	Yes	0.054	24	293	48	1265
PE_TO_PE (port)	11.37 (7.14)	No	Yes	No	0.140	24	293	48	1265
PE_TO_PE (year_port)	12.30 (7.92)	Yes	Yes	No	0.179	24	293	48	1265
Foreign Involvement									
DOM_TO_FOR (year)	3.43 (3.97)	Yes	No	No	0.022	102	1020	167	4937
DOM_TO_FOR (country)	4.57 (3.88)	No	No	Yes	0.025	102	1020	167	4937
DOM_TO_FOR (port)	1.69 (2.22)	No	Yes	No	0.119	102	1020	167	4937
DOM_TO_FOR (year_port)	1.76 (2.42)	Yes	Yes	No	0.136	102	1020	167	4937
DOM_TO_PRIV_FOR (year)	5.60 (4.77)	Yes	No	No	0.022	86	1029	135	4923
DOM_TO_PRIV_FOR (country)	5.78 (4.61)	No	No	Yes	0.025	86	1029	135	4923
DOM_TO_PRIV_FOR (port)	1.73 (2.75)	No	Yes	No	0.119	86	1029	135	4923
DOM_TO_PRIV_FOR (year_port)	2.92 (2.81)	Yes	Yes	No	0.136	86	1029	135	4923
NONCHIN_TO_CHIN (year)	-1.53† (5.06)	Yes	No	No	0.022	12	1437	18	7532
NONCHIN_TO_CHIN (country)	3.15† (4.57)	No	No	Yes	0.024	12	1437	18	7532
NONCHIN_TO_CHIN (port)	0.00† (0.00)	No	Yes	No	0.110	12	1437	18	7532
NONCHIN_TO_CHIN (year_port)	-5.36***† (1.50)	Yes	Yes	No	0.129	12	1437	18	7532

Table A6: List of State-controlled Chinese Shipping Companies

Self-compiled list based on various sources, namely Jacobs (2023) Doppen et al. (2025), Ghiretti et al. (2023) and European Network of Corporate Observatories (2020). Sinotrans Limited became a subsidiary of China Merchants Group in 2015 (World Maritime News, 2025).

Company	**Country**
COSCO SHIPPING Lines Co., Ltd.	China
China Merchants Group (shipping units)	China
Sinotrans Limited	China
COSCO Tankers (COSCO Shipping Energy Transportation)	China
China Merchants Port (CMP)	China

Table A7: Ownership Transition Matrix

The table reports, for all observed ownership change events, the number of transitions from each initial owner type (rows) to each subsequent owner type (columns), with each cell showing the respective count and the corresponding share of all transactions. Beyond that, the table also gives an overview of the different terminologies used across the thesis for certain transitions.

From \\ To	**STATE**	**STRAT**	**PE**
STATE	80 (6.0%)	58 (4.3%)	12 (0.9%)
	Inter- / intra-state	*Privatization*	*Privatization*
STRAT	52 (3.9%)	869 (65.1%)	149 (11.2%)
	Re-nationalization	*Private transaction*	*(Primary) buyout*
PE	9 (0.7%)	80 (6.0%)	25 (1.9%)
	Re-nationalization	*Trade sale*	*Secondary buyout*

Table A8: Port Size by Ownership Type

The table cross-classifies all ports with valid size classification from WPI and ownership information into a complete owner x size grid. Counts are computed after normalizing size labels and enforcing the full category set, with missing combinations filled as zero and hence not included. Each cell reports the absolute number of ports and its share of the global port population. The bottom row shows size-category totals.

	Port size				
Owner	**Very small**	**Small**	**Medium**	**Large**	**Total**
STATE	11 (1.0%)	35 (3.1%)	14 (1.2%)	60 (5.3%)	120 (10.6%)
STRAT	93 (8.2%)	186 (16.4%)	127 (11.2%)	329 (29.0%)	735 (64.8%)
PE	17 (1.5%)	37 (3.3%)	22 (1.9%)	62 (5.5%)	138 (12.2%)
UNMAPPED	18 (1.6%)	44 (3.9%)	27 (2.4%)	53 (4.7%)	142 (12.5%)
Total	139 (12.2%)	302 (26.6%)	190 (16.7%)	504 (44.4%)	1,135 (100.0%)

Table A9: Port-level Competition by Ownership Type

The table summarizes, for each current owner class, the *locode*-unique number of ports and the distribution of great-circle distances to the nearest other port and of the count of ports within a 100km radius, computed from pairwise haversine distances between all geo-located ports.

	Nearest port in km			Number of ports within 100km		
Owner	**mean**	**median**	**std**	**mean**	**median**	**std**
STATE	248.06	90.48	438.24	1.16	1.00	1.66
STRAT	201.42	91.77	364.99	0.99	1.00	1.40
PE	257.04	143.25	275.45	0.52	0.00	0.72
UNMAPPED	202.30	120.82	260.56	0.86	0.00	1.34

Table A10: Port Ownership by Country

The table reports, for the 15 countries with the largest number of port-year observations in the sample, the number of distinct ports, total port-years, and the share of port-year observations held by state, strategic, and PE owners. This allows us to draw conclusions about the general ownership dynamics in the past decades. However, caution must be warranted as this very aggregated display might disguise or exaggerate changes in ownership patterns, such as the increased activity of PE in UK ports, for instance.

			Owner		
Country	**count**	**port x years**	**STATE**	**STRAT**	**PE**
United States	129	7314	3%	86%	11%
Brazil	67	3551	3%	86%	11%
Russia	61	3233	15%	78%	7%
Spain	60	3180	5%	85%	10%
China	54	2862	37%	48%	14%
Australia	53	2809	18%	73%	9%
Singapore	48	2544	7%	90%	4%
United Kingdom	46	2438	12%	78%	10%
India	40	2226	17%	62%	21%
Italy	35	1855	5%	88%	7%
Norway	32	1696	8%	78%	14%
Hong Kong	31	1643	31%	59%	10%
Japan	28	1484	0%	85%	15%
Netherlands	28	1484	6%	82%	11%
Canada	27	1431	19%	59%	22%

Table A11: Distance to Nearest Major City by Ownership Type

The table reports, for each owner class, the mean, median, and the standard deviation of the distance to the nearest populated city with at least 300,000 inhabitants and a Natural Earth Scalerank of less than 6, which defines "major cities". In addition, we show the cumulative share of ports located within 10km, 25km, and 50km of such a city.

	Distance in km			Cumulative Share within		
Owner	**mean**	**median**	**std**	**10km**	**25km**	**50km**
STATE	119.75	32.47	249.48	35.00	45.83	55.00
STRAT	139.39	44.41	310.95	29.76	41.58	50.41
PE	131.24	40.24	263.98	35.00	46.43	51.43
UNMAPPED	167.46	60.10	301.83	25.35	37.32	43.66

Table A12: Port-level Infrastructure Availability by Ownership Type

The table reports, for each owner class, the share of ports that have a cargo pier, oil terminal or LNG terminal, defined as strictly positive reported depth in the respective WPI fields. If the *port_id* could not be mapped to the WPI dataset, this is accounted for as "NaN" and hence does not influence results below.

Owner	Cargo availability	Oil availability	LNG availability
STATE	52.0%	44.5%	0.0%
STRAT	53.9%	45.2%	0.2%
PE	54.3%	45.0%	0.4%
UNMAPPED	53.8%	47.3%	0.8%

Table A13: Holding Period by Ownership Type

The table reports, for each owner class, the number of ownership spells and the mean, median, and standard deviation of spell duration in years, where a spell is a contiguous period with the same owner from 1990 onward. Given the average low amount of ownership transitions in our observed time period, we include censored spells at the sample boundaries to give a meaningful intuition about holding period differences.

		Holding period in years		
Owner	**count spells**	**mean**	**median**	**std**
STATE	398	21.29	25.50	15.07
STRAT	2214	22.87	36.00	15.64
PE	472	16.42	13.00	13.87
UNMAPPED	302	31.44	36.00	11.38

Table A14: Pre- and Post-Ownership Differences in PLSCI by Privatization Type

The table report the number of observations, mean, median, and standard deviation of the PLSCI in the three years before to a port's privatization event (t-3 to t-1), grouped by whether the port later transitions to strategic ownership ("To SRAT"), PE ownership ("TO PE"), or never privatizes. For the last category, statistics are computed over all available PLSCI observations. Accordingly, Panel B reports the post-privatization observation values (t+1 to t+3) that are identically calculated to those in Panel A.

Panel A: pre-ownership differences

		PLSCI		
Privatization	**count**	**mean**	**Median**	**std**
To STRAT	93	268.63	85.76	453.14
To PE	22	154.62	183.66	100.25
Never	5257	289.58	124.50	400.72

Panel B: post-ownership differences

		PLSCI		
Privatization	**count**	**mean**	**median**	**std**
To STRAT	103	302.95	97.23	502.85
To PE	25	133.32	94.87	98.79
Never	5257	289.58	124.50	400.72

A1: AI Disclosure

Usage of AI tools. In this thesis, we relied on several AI tools to support different paths of the research and data handling process. ChatGPT was used for coding assistance and text reformulation, and we also made use of its DeepResearch functionality for the ABP case study to efficiently verify whether additional sources beyond our own research existed, that could have provided insights into the topic. In parallel, we utilized Research Rabbit to identify academic literature, particularly for side-topic discussions in Chapter 2 relating to institutional context, such as academic work on privatization.

Contribution of AI. AI tools contributed to the overall quality of the thesis in several ways. First, they significantly reduced the time spent on tasks such as identifying academic resources, which otherwise would have required extensive trial-and-error searches on platforms like Google Scholar. This allowed us to allocate more time to refining our analysis and the corresponding code. Second, we would argue that AI has also contributed to improving the clarity and flow of our written English, as neither of us is a native English speaker. While these are more time-saving and hygienic factors, arguably the most significant was that AI enabled us to overcome limitations in our Python syntax linked to our non-technical backgrounds. The AI, predominantly ChatGPT, helped us to translate our conceptual ideas into functioning code, such as the expansion analysis based on satellite data.

Identified Risks. Throughout the process, we also encountered several risks associated with using AI. At times, the tools produced incorrect or faulty outputs that required careful validation from our side. One time, an AI-generated code block, for example, tried matching using a common identifier. However, it once canonicalized it to a string and once to an integer. Because this error did not show immediately, we spent several days searching before resolving it. Secondly, AI sometimes returned oversimplified solutions despite being provided with detailed instructions, for instance, by generating a simplified code that did not reflect our desired outcome. The most critical part about this was that these were not even labelled as reduced or simplified versions, which has underscored our already-perceived importance of not relying blindly on AI outputs.

Insights into Using AI. We learned that AI requires very detailed and explicit instructions to produce satisfactory results. This became clear in tasks like the ownership backwards propagation, where ChatGPT did not automatically infer the seemingly obvious assumption that the seller in a transaction must be the previous owner. Moreover, we found that AI excels at translating human-language descriptions into code but performs poorly when expected to make content-specific decisions on its own. Hence, we transitioned to the process of clearly clarifying the process and understanding with the tool before proceeding with code output. In addition, especially when writing code together with AI, it helped us a lot to first only align on the process and logic conceptually before requesting the code, as then one can ensure that the understanding is correct, and integrating many diagnostic intermediary outputs supports flaw detention.

A2: Data Sources

S&P CIQ. We obtain revenue figures, current ownership information, and transaction data from S&P Capital IQ. The initial universe of firms and corresponding transaction records was extracted via the platform's web interface. To identify relevant entities, we filtered for companies whose Primary Industry classification in either S&P Market Intelligence or S&P Capital IQ/GICS is "Marine Ports and Services," or whose NAICS code corresponds to "48831 – Port and Harbor Operations." Subsequently, we enriched the dataset using the S&P Capital IQ Excel add-in, which enabled the retrieval of additional variables such as revenue, buyer and seller identities, and other transaction-level attributes.

PLSCI. We downloaded PLSCI data as of August 2025 from:

https://unctadstat.unctad.org/datacentre/reportInfo/US.PLSCI

WPI. We downloaded WPI data as of November 2025 from:

https://msi.nga.mil/Publications/WPI?utm.com

Geomapping. We used the "ee" and "geemap" API in Python with an academic subscription to Google Earth Engine:

https://earthengine.google.com/noncommercial/

A3: PLSCI Constitution

The index is generated by UNCTAD as follows: For each component, we divide the port's value by the average value for the component in the respective and then calculate the average of the six components for the port. The average across components for a given country and quarter is then multiplied by 100. The result is an average PLSCI of 100 in the respective quarter. All other indices are in relation to this value.

#	**Component**
1	Number of scheduled ship calls per week in the port
2	Deployed annual capacity in Twenty-Foot-equivalent Units : total deployed capacity offered at the port
3	Number of regular liner shipping services from and to the port
4	Number of liner shipping companies that provide services from and to the port
5	Size in TEU of the largest ship deployed on services from and to the port
6	Number of other ports that are connected to the port through direct liner shipping services (may include other stops)

A4: In-depth Discussion of Methodology

A4.1: Global Model Components and Specifications

(i) Ownership Types and Transition

Ownership classification. We classify the ultimate controlling owner for each port–year observation into mutually exclusive categories: STATE, PE, and STRAT. These categories are the basic treatment dimensions both in the static models and in the event-based designs. On top of the ownership classification, we construct two orthogonal dimensions. Foreign vs. domestic (is_FOR) and Chinese involvement (is_CHIN). These dimensions jointly allow us to distinguish, for example, a domestically owned strategic operator from a foreign state-owned owner, or a Chinese state-owned entity from a non-Chinese financial sponsor.

Transition families. Ownership changes are not treated as a monolith. We assign completed transactions into Transition families, each corresponding to a specific pattern in their ownership classification and/or foreign or Chinese involvement. These families can be sorted into the following 4 interpretable categories:

- Private equity entry: STATE to PE, STRAT to PE, and NONPE to PE (composite: PE entry from any non-PE background)
- Privatization and reallocation: STATE to STRAT, STATE to PRIV (all privatizations, combining PE and STRAT), PE to STRAT, PE to NONPE, PE to PE, PRIV to STATE (re-nationalization)

- Foreign and Chinese involvement: DOM to FOR, DOM to STATE_FOR, DOM to PRIV_FOR (domestic to foreign transitions by owner type), NONCHIN to CHIN (entry of Chinese capital)
- Catch-all: ANY_TX (any ownership turnover event, used as a benchmark family).

For each port and transition family, we identify the first completed transition that matches the pattern and define an event year and event window around it. The same event-time variables are used across static DiD, DiD-style event studies, as well as our quasi experimental analysis with withdrawn transactions.

(ii) Event windows

To capture both immediate disruption and medium-term restructuring, we define a finite set of event windows in relative time. These windows are used consistently across all event-based designs (static DiD, event studies, and withdrawn).

For every classification, we estimate the following windows:

- **Short-term**: ([-1,+1]) and ([-1,+2]), capturing the immediate shock around the completion year and the first 1–2 post years.
- **Medium-term**: ([-1,+3]), ([-1,+4]), and ([-1,+5]), capturing the implementation of new strategies, renegotiation of contracts, and subsequent operational changes.
- **Early-pre-trend windows**: For some analyses we extend the window to start at (-2) (e.g. ([-2,+5])), allowing us to test for pre-trends further back and to inspect whether performance starts to diverge already before the transaction is completed.

For the purpose of presenting results in this thesis, we focus on the largest and most meaningful window [-2, +5].

(iii) Port Performance Indicators (Dependent Variables)

We study three complementary performance dimensions:

- UNCTAD PLSCI (Index_Year_Average): The annual average of the quarterly PLSCI Index
- Log Revenue (log_revenue): A scale-adjusted measure of commercial performance capturing both traffic volume and pricing power. Revenues are harmonized from multiple sources and then log-transformed to reduce the influence of outliers and to permit percentage-interpretations of coefficients.

- Land Reclamation Area (land reclamation): ha as determined through geomapping

Not all designs are equally feasible for all dependent variables, particularly for revenue where coverage is more limited. Feasibility constraints are handled systematically through consistent filtering of classifications.

<u>(iv) Control Group Design</u>

A central challenge in causal inference with observational data is selecting a control group that approximates the unobserved counterfactual path of treated ports. We operationalize this via a cohort-based control engine: For each treated port, transition family, and event window, we identify the treated port's event year and construct the corresponding calendar-year window around it. We then determine the set of eligible control ports for that port-window pair and assemble a stacked cohort sample consisting of all treated observations in the window together with all eligible control observations in the same calendar years. This dynamic, event-time specific construction is crucial for handling staggered treatment timing: a port that is treated later can serve as a valid control for earlier cohorts.

For the dynamic DiD style event studies, we allow ports to enter the control group if a) they share the same pre-transaction owner type as the treated port (e.g. STATE for a STATE to PE transition), for the entire event window and b) do not have any completed transaction of any family inside the event window of the treated port.

For the quasi-experimental study, the control group consists of ports whose transactions were withdrawn. Unfortunately, withdrawn transaction data is sparse. We therefore exclude all ports that ever have withdrawn transactions from the treatment group in order to maximize our control group. Apart from this, ports are allowed to be in the control group if they a) have a withdrawn transaction of the tested type / family and b) have no completed transaction within the even window around their withdrawn transaction.

A4.2: Ownership-Type Level Differences

As a first step, we characterize long-run differences in performance associated with different ownership types, independent of any specific transition event. These steady-state ownership regressions provide an associative benchmark: they indicate whether PE-owned or strategically owned ports systematically look "better" or "worse" than state-owned ports in the cross-section and over time. As a first step, we characterize long-run differences in performance associated with different ownership types, independent of any specific transition event. These steady-state ownership regressions provide an associative benchmark: they indicate whether PE-owned or strategically owned ports systematically look "better" or "worse" than state-owned ports in the cross-section and over time. We present the results of these estimations in Section 4.1.

<u>(i) Model Specification and Variants</u>

We estimate a two-way fixed-effects (TWFE) model of the form:

$$Y_{i,t} = \sum_{k} \alpha_k \, D_{i,t}^{(k)} + \gamma_{FOR} \, FOR_{i,t} + \gamma_{CHIN} \, CHIN_{i,t} + \delta_i + \theta_t + \varepsilon_{i,t}$$

here:

- $D_{i,t}^{(k)}$ are owner-class dummies for PE and STRAT, omitting STATE,
- δ_i are port fixed effects, capturing time-invariant characteristics such as geography, natural depth, historical specialization, and legacy infrastructure;
- θ_t are year fixed effects, capturing common shocks such as global recessions, shipping crises, or regulatory changes;
- owner_class is encoded as category dummies with STATE as the baseline;
- FOR and CHIN are the foreign and Chinese indicators defined above as is_FOR and is_CHIN, respectively.
- We estimate three nested specifications A–C:
- Spec A (ownership only): includes only owner-class dummies, allowing us to measure the raw premium/discount relative to STATE ownership.
- Spec B (ownership + foreign): adds FOR to separate effects of privatization from simple foreignness.
- Spec C (ownership + foreign + China): adds CHIN to isolate the incremental association of Chinese involvement, holding ownership type and foreignness constant.

All models are estimated with cluster-robust standard errors at the port level, ensuring inference is robust to serial correlation within ports.

(ii) Interpretation and Limitations

The coefficients α_{PE} and α_{STRAT} quantify the average performance gap between PE or strategic ownership and state ownership, conditional on time-invariant port characteristics and common time shocks. In log-revenue models, as these coefficients are large, we cannot work with the approximation for the natural logarithm log(1+x) ≈ x anymore and rather need to rely on the exact formula for estimated effects: $100 \times (e^{\widehat{\beta} \times 1} - 1)$; in connectivity and land-reclamation models, they represent level differences in their respective units.

However, because ownership is endogenously chosen, these regressions are not interpreted as causal. PE investors may systematically acquire better-located or higher-growth ports, or states may retain ownership of strategic but low-profit assets. Even with port fixed effects, unobserved time-varying factors (e.g. prior unobserved investments, expectations about future trade growth) may drive both ownership and performance. We therefore use steady-state regressions as associative benchmarks to be contrasted with the event-based more causal designs in the remainder of the chapter.

A4.3: Static DiD

To move from associations to causal inference, we reinterpret ownership changes as discrete treatment events and apply Difference-in-Differences (DiD) designs. For each transition family and event window, the treatment is "having completed the transition" within the window. We present the results of these estimations in Section 4.2.

For a given transition family, dependent variable, and window, the static DiD model is:

$$Y_{i,t} = \beta\left(\text{treated}_i \times \text{post}_{i,t}\right) + \delta_i + \theta_t + \varepsilon_{i,t}$$

where:

- $\text{treated}_\text{i} = 1$, if port i ever experiences this transition family
- $post_{i,t} = 1$ for the years after the treatment but within the event window
- δ_i and θ_t are port or country-ownership fixed effects and year fixed effects;
- standard errors are clustered at the port level.

The coefficient β is the average treatment effect on the treated over the chosen window: it measures the average shift in performance after the transition, relative to the pre-transition period, and relative to the contemporaneous evolution of the control group.

The dynamic cohorts described above ensure that, even under staggered adoption, each treated port is compared only to ports that are valid controls in its own calendar-time window. The static DiD compresses all post-event years into a single treatment indicator. While this improves precision, it has two limitations: Firstly, it obscures the time path of adjustment: short-term disruptions and long-term improvements are averaged into a single β. Secondly, it provides no internal test of the parallel trends assumption. If treated ports were already diverging from controls before the event, β is biased. These limitations motivate the dynamic event-study design in the next section, which explicitly traces pre-trends and post-event dynamics.

A4.4: Dynamic DiD-style Event Study

In our dynamic event study, we decompose the average effect into a series of time-specific coefficients β_s, one for each year within the event window. We present the results of these estimations in Section 4.3.

To obtain fully identified dynamic treatment effects, we extend the DiD design into an event study with controls, where $treated_i\, I(rel\_year_{i,t} = s)$ are dummies for every year in the event window that equals 1 for all treated port x "year in the event window" combinations:

$$Y_{i,t} = \sum_{s=w_{min}}^{w_{max}} \beta_s \; treated_i \, I(rel\_year_{i,t} = s) + \delta_i + \theta_t + \varepsilon_{i,t}$$

Event studies are demanding in terms of data: splitting the sample into many relative years requires sufficient treated and control observations in each year's bucket. For rare transition families or wide windows, some bins may contain very few treated observations, leading to instability or non-convergence (e.g. singular design matrices, SVD failures, or exploded standard errors). This limits the number of estimations we can conduct.

A4.5: Withdrawn Transactions

Even with careful control design, DiD cannot fully guard against time-varying selection: the decision to privatize or to sell to PE may be driven by unobserved expectations about the port's future. To mitigate this concern, we exploit withdrawn transactions as a quasi-experimental counterfactual. We present the results of these estimations in Section 4.4.

For this model, we use withdrawn transactions as a counterfactual and then estimate a DiD model of the following form:

$$Y_{i,t} = \beta\left(Completed_i \cdot Post_{i,t}\right) + \delta_i + \theta_t + \varepsilon_{i,t}$$

Where $Completed_i = 1$ for ports in the completed group, and $Post_{i,t} = 1$ for the years after the treatment but within the event window. Port fixed effects, year fixed effects, and port-clustered standard errors are included as before.

Conceptually, this design compares ports that were similar enough to be serious deal candidates (and thus to pass initial screening and negotiation) but differ in whether the transfer of control actually went through. A significant β therefore isolates the effect of executing the transaction, holding the "intent to treat" approximately constant. Unfortunately, due to the low number of withdrawn transaction in our dataset, we can only conduct this estimation for any transaction (ANY_TX) and not specific transition families.