Ports of Power

Katerina Nikalexi*

London Business School

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Abstract

This paper studies how foreign ownership of maritime infrastructure reshapes inland trade networks. I combine hand-collected data on Chinese state-backed acquisitions of European ports with 1.5 million truck-level shipments linking 368 NUTS2 European regions between 2011 and 2022. Using a continuous-treatment event study that leverages the policy-driven and externally timed rollout of China's Maritime Silk Road, I estimate heterogeneous effects across European regions based on their baseline port reliance. Regions more exposed to Chinese port acquisitions experience relatively larger contractions in trade along both the intensive and extensive margins. The results reveal a reconfiguration of trade corridors, consistent with a shift toward containerized transport within existing industrial structures. From a policy perspective, the results speak directly to Europe's strategic concerns in the governance of critical trade infrastructure.

Keywords: International macroeconomics; Empirical trade; Regional economic activity; Geoeconomics.

JEL Classification: E37; F14; F52; R12; L92.

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1 Introduction

Ports are the architecture of trade. Nearly ninety percent of world commerce moves by sea, and around three-quarters of Europe's external trade by value passes through its seaports. At the heart of this network lie a few deep-water container terminals that link global shipping lanes to Europe's inland markets. By shaping the cost and reliability of access to international markets, ports influence where goods are produced, which regions connect to global value chains, and how transport networks evolve [Redding and Venables, 2004, Coşar and Demir, 2016, Faber, 2014]. Because such infrastructures are costly to build and slow to relocate, their ownership and governance can have lasting effects on the geography of trade [Kalouptsidi, 2014, Hale, Caballero, and Candelaria, 2014, Pandalai-Nayar, 2014].

This paper studies how the acquisition of European port terminals by Chinese state-backed firms—part of the broader Maritime Silk Road—has reshaped the continent's inland trade network. Using Europe-wide microdata on 1.5 million road-freight shipments linking 368 regions between 2011 and 2022, I trace how governance shocks at coastal gateways diffuse inland, affecting the organisation of trade within Europe's internal market. In this sense, ports act as both economic bottlenecks and strategic interfaces: whoever governs them can shape the flow of interdependence.

Ownership of infrastructure matters because it governs the incentives that determine how existing capacity is used. In integrated logistics networks, such control may improve efficiency through coordination, but it can also redirect flows and increase concentration risks. Understanding these reallocations is essential for assessing how control of transport nodes influences regional exposure to global shocks and the resilience of supply chains. Yet systematic evidence on the economic consequences of ownership—distinct from physical capacity or connectivity—remains limited, largely because such changes are rare and often endogenous.

The recent sequence of port acquisitions by Chinese state-backed firms provides a unique opportunity to study these mechanisms. Over the past two decades, Chinese investors have acquired equity and long-term operational rights in major European terminals—Piraeus, Rotterdam, Valencia, Genoa, Hamburg, and others. Although some early transactions predated 2013, most were subsequently integrated into the Maritime Silk Road—the maritime arm of China's Belt and Road Initiative (BRI), which connects Asia to Europe through a network of ports and logistics investments. These transactions unfolded through national privatization programs and EU-level regulatory reviews, creating staggered and plausibly exogenous timing relative to short-run freight dynamics. The European port system thus offers a natural setting to study how governance shocks at the coast propagate through inland trade networks.

The rise of what scholars term geoeconomics—the use of economic and financial instruments to pursue strategic objectives—has made control over economic networks newly salient (Blackwill and Harris, 2016; Farrell and Newman, 2019). Recent surveys emphasize that contemporary geoeconomic power increasingly operates not through tariffs or trade barriers, but through influence over key nodes in global networks, including finance, logistics, and infrastructure (Trebesch and Mohr, 2024). In this view, ownership and governance of critical assets function as durable sources of leverage that can reweight patterns of interdependence without overt policy intervention.

Recent work formalizes this logic by highlighting how states deploy control over networked infrastructures—such as payment systems, shipping routes, and data flows—as tools of economic statecraft (Clayton, Maggiori, and Schreger, 2024). Policy developments underscore its relevance: in 2025, for instance, the United States introduced port-entry levies on China-linked vessels, and China imposed reciprocal fees on U.S.-linked ships, illustrating how access to maritime gateways has become a strategic instrument. Complementing this perspective, emerging evidence shows that control of transshipment hubs can redirect global trade flows even in the absence of tariffs or demand shifts (Do, Ganapati, Wong, and Ziv, 2025).

This paper situates Europe's experience squarely within this geoeconomic framework. It provides micro-level evidence on how foreign ownership of maritime infrastructure—an archetypal network chokepoint—reshapes inland trade patterns, demonstrating how governance of physical nodes translates into changes in economic interdependence across regions.

1.1 Results preview

Using a continuous-treatment event-study framework à la De Chaisemartin and D'Haultfœuille [2024], I estimate the impact of Chinese port acquisitions on regional trade outcomes across 368 NUTS2 regions between 2011 and 2022. Regions more exposed to Chinese port acquisitions experience relatively larger contractions in trade along both the intensive and extensive margins: a 20–30 percent decline in road-freight volumes and a 4–5 percent increase in trade-partner concentration relative to less-exposed regions. These effects point to a reconfiguration of trade corridors rather than an aggregate contraction—flows weaken along established Western routes and strengthen modestly along Southern and Eastern axes linked to the Maritime Silk Road. Taken together, the results reveal an adjustment in the organization of trade rather than its scale, highlighting infrastructure ownership as a structural channel through which global investment reshapes regional connectivity.

1.2 Related Literature

This paper builds on and connects four strands of research.

Transport infrastructure and spatial frictions. A large literature shows that transport networks shape the geography of economic activity. In models of market access, reductions in trade costs expand local demand and shift production toward newly connected regions [Redding and Venables, 2004]. Empirical work on railways, highways, and roads—ranging from colonial India [Donaldson, 2018] to China [Faber, 2014] and Africa [Gollin and Rogerson, 2021]—demonstrates that connectivity shocks generate large spatial reallocations. Within this field, recent work highlights the maritime sector as a critical interface between global and inland trade: Coşar and Demir [2016] link containerization to trade expansion, while Kalouptsidi [2014] and Hale, Caballero, and Candelaria [2014] show how port dynamics and shipping networks propagate shocks across space. This paper extends that literature by focusing not on the construction or capacity of infrastructure, but on its ownership and governance as determinants of spatial reallocation.

China and global adjustment. The analysis complements the China shock literature [Autor, Dorn, and Hanson, 2013, Pierce and Schott, 2016, Colantone and Stanig, 2018, Dippel, Gold, and Heblich, 2019] by identifying an analogous adjustment operating through the infrastructure of trade rather than through goods markets. While earlier studies show how import competition from China reshaped production and employment, this paper examines how Chinese investment in Europe's ports has reorganized how goods move across regions, providing a new lens on China's integration into global and European value chains.

Networks and propagation. In parallel, a growing literature conceptualizes economies as networks of input–output and trade linkages [Allen and Arkolakis, 2014, Chaney, 2014, Baqaee and Farhi, 2019, Pandalai-Nayar, 2014, Allen and Atkin, 2023, Juhász, Lane, and Pál, 2023]. In these frameworks, shocks to one node can reweight flows across the entire system. This paper provides empirical evidence of such a nodal mechanism in a continental setting, where governance changes at a few maritime gateways diffuse inland through Europe's transport network.

Geoeconomics and state-led investment. Finally, the paper relates to research on global intermediation and state-capitalist investment [Maggiori, Neiman, and Schreger, 2020, Evenett, 2020, Garcia-Herrero and Xu, 2023, Clayton, Maggiori, and Schreger, 2024], which studies how states project influence through cross-border capital allocation and ownership. Recent syntheses of geoeconomic policy emphasize that such influence increasingly operates through instruments that exploit network position and asset control—alongside, and sometimes instead of, tariffs and sanctions [Trebesch and Mohr, 2024]. This paper provides micro-level evidence on one such channel: state-linked acquisitions of logistics infrastructure can shift the structure of trade interdependence by reweighting connectivity between regions.

Together, these literatures underscore a broader insight: the geography of trade depends not only on where infrastructure is built, but also on who owns and governs it.

1.3 Contribution

This paper contributes new evidence, methods, and concepts to debates on trade, infrastructure, and geoeconomics.

Empirically, it provides the first systematic quantification of how foreign ownership of Europe's maritime gateways reshapes inland trade. Using microdata on 1.5 million shipments across 368 regions, the analysis traces how governance shocks at coastal nodes diffuse through inland transport networks. The results reveal a reweighting rather than a contraction of connectivity: regions more exposed to Chinese-acquired ports experience 20–30 percent declines in road-freight volumes and fewer active trading links, while southern and eastern corridors linked to the Maritime Silk Road gain relative importance. This evidence establishes infrastructure ownership as a structural determinant of regional trade geography.

Methodologically, the paper develops a network-based research design that embeds a continuous-treatment event-study framework à la De Chaisemartin and D'Haultfœuille [2024] within a shift–share exposure structure [Borusyak, Hull, and Jaravel, 2022]. By exploiting the staggered timing of multiple port-level ownership shocks and fixed pre-treatment trade linkages, the approach identifies dynamic and heterogeneous responses to governance changes as they diffuse through interconnected regional trade networks. The design provides a general template for analysing spatial spillovers from sequential infrastructure or investment shocks.

Conceptually, the paper frames infrastructure ownership as a governance shock that operates through control of network nodes rather than through changes in prices, productivity, or physical capacity. By altering the incentives and constraints that shape how existing infrastructure is used, ownership changes could generate spatial reallocation within trade networks even in the absence of new investment. In this sense, the paper bridges the literature on trade and infrastructure, which emphasizes market access and transport frictions [Redding and Venables, 2004, Faber, 2014, Donaldson, 2018], with work on network adjustment and propagation, where shocks to central nodes reweight flows across the system [Allen and Arkolakis, 2014, Chaney, 2014, Baqaee and Farhi, 2019, Allen and Atkin, 2023], and with research on state-capitalist investment that highlights ownership and control as channels of economic influence [Clayton, Maggiori, and Schreger, 2024, Maggiori, Neiman, and Schreger, 2020, Garcia-Herrero and Xu, 2023].

Conceptually, the paper reframes infrastructure ownership as a governance shock: a channel of spatial reallocation driven by institutional and strategic incentives rather than by prices or productivity. In doing so, it bridges the literatures on trade and infrastructure [Redding and Venables, 2004, Faber, 2014, Donaldson, 2018], on network adjustment [Chaney, 2014, Baqaee and Farhi, 2019, Allen and Atkin, 2023], and on state-capitalist investment [Clayton, Maggiori, and Schreger, 2024, Maggiori, Neiman, and Schreger, 2020, Garcia-Herrero and Xu, 2023].

Taken together, these contributions show that the geography of trade depends not only on where infrastructure is built, but also on who owns and governs it. By identifying how foreign investment in strategic transport nodes reorganises Europe's internal trade network, the paper opens a new empirical window on the intersection of global investment, regional trade, and economic statecraft.

1.4 Policy Relevance

From a policy perspective, the findings speak directly to Europe's strategic concerns over autonomy and resilience. They show that the ownership and governance of critical transport infrastructure can reweight the continent's trade network, altering the routes and linkages through which goods move. Understanding how governance at key transport nodes shapes inland trade is therefore essential not only for assessing Europe's external dependencies, but also for evaluating the adequacy of the frameworks—privatisation, concession, and investment-screening regimes—that regulate such assets and safeguard connectivity. Recognising ownership as a structural determinant of trade flows is central to designing policies that balance openness with resilience and strategic autonomy. Europe's challenge is not to retreat from foreign capital, but to govern interdependence effectively.

Roadmap. The remainder of the paper proceeds as follows. Section 2.1 introduces China's Belt and Road Initiative and situates the European port acquisitions within its maritime component. Section 2.2 describes Europe's deep-water container hubs and explains how their ownership links to inland transport. Section 3 details the Eurostat European Road Freight Transport microdata and the hand-collected investment dataset that underpin the analysis. Section 4 documents new stylized facts on the evolution of Europe's inland trade network. Section 5 presents the identification strategy and econometric framework, while Section 6 reports the main results on freight volumes, partner concentration, and corridor heterogeneity. Section 7 discusses mechanisms and interpretation, and Section 8 concludes with broader policy implications.

2 Background

The next section provide institutional and empirical context. Section 2.1 introduces China's *Belt and Road Initiative* and its maritime component, situating European port acquisitions within the broader policy framework of state-led connectivity. Section 2.2 describes Europe's deep-water container ports and their centrality in continental trade.

2.1 The Belt and Road Initiative (BRI)

Launched in 2013 through major speeches by Xi Jinping—first in Astana on 7 September, then in Jakarta on 3 October—the initiative combines two components: (i) the *Silk Road Economic Belt*, and (ii) the *21st-Century Maritime Silk Road*.

Since 2013, more than 140 countries have signed cooperation agreements under its banner. According to the American Enterprise Institute's *China Global Investment Tracker*, Chinese overseas investment and construction combined reached approximately USD 2.5 trillion between 2005 and 2024.[1] Within that total, the *Belt and Road Initiative* accounts for about USD 640 billion in construction and USD 430 billion in investment since its launch in 2013—together exceeding USD 1 trillion in BRI-linked activity. Energy projects represented roughly 46 percent of Chinese overseas construction, followed by transport infrastructure—including railways, roads, and ports—at about 28 percent.[2]

Figure 1 illustrates the two routes of the Belt and Road Initiative, showing how the overland Economic Belt and the Maritime Route connect Asia to Europe through a network of inland and coastal corridors. The strategic weight of the BRI thus materialises most clearly at its maritime gateways. By 2024, Chinese entities had stakes in 129 overseas port projects worldwide—spanning every continent except Antarctica—illustrating the maritime reach of the Belt and Road Initiative.[3]

Across Europe, Chinese participation in port infrastructure—through acquisitions, concessions, and joint ventures—represents the tangible frontier of the Initiative's expansion and provides the setting for the analysis that follows. The initiative is implemented through a decentralised architecture of state-owned enterprises, development banks, and provincial consortia. Key executing agents include *China COSCO Shipping Corporation*, *China Merchants Group*, and the *China Communications Construction Company*, financed by institutions such as the *China Development Bank*, the *Export–Import Bank of China*, and the *Silk Road Fund*. Concession and regulatory calendars—host-country tenders, merger-control procedures, and investment-screening reviews—determine when assets change hands. This institutional sequencing is central to the empirical design: the timing of port acquisitions followed legal and financial calendars—privatisation tenders, regulatory reviews, and concession renewals.

[1] American Enterprise Institute (2025), "$2.5 Trillion: 20 Years of China's Global Investment and Construction," *China Global Investment Tracker*, January 2025, available at: https://www.aei.org/research-products/report/2-5-trillion-20-years-of-chinas-global-investment-and-construction/

[2] American Enterprise Institute (2025), Table 2, p. 8, ibid.

[3] Council on Foreign Relations, "Tracking China's Overseas Ports," 2024, available at: https://www.cfr.org/tracker/china-overseas-ports

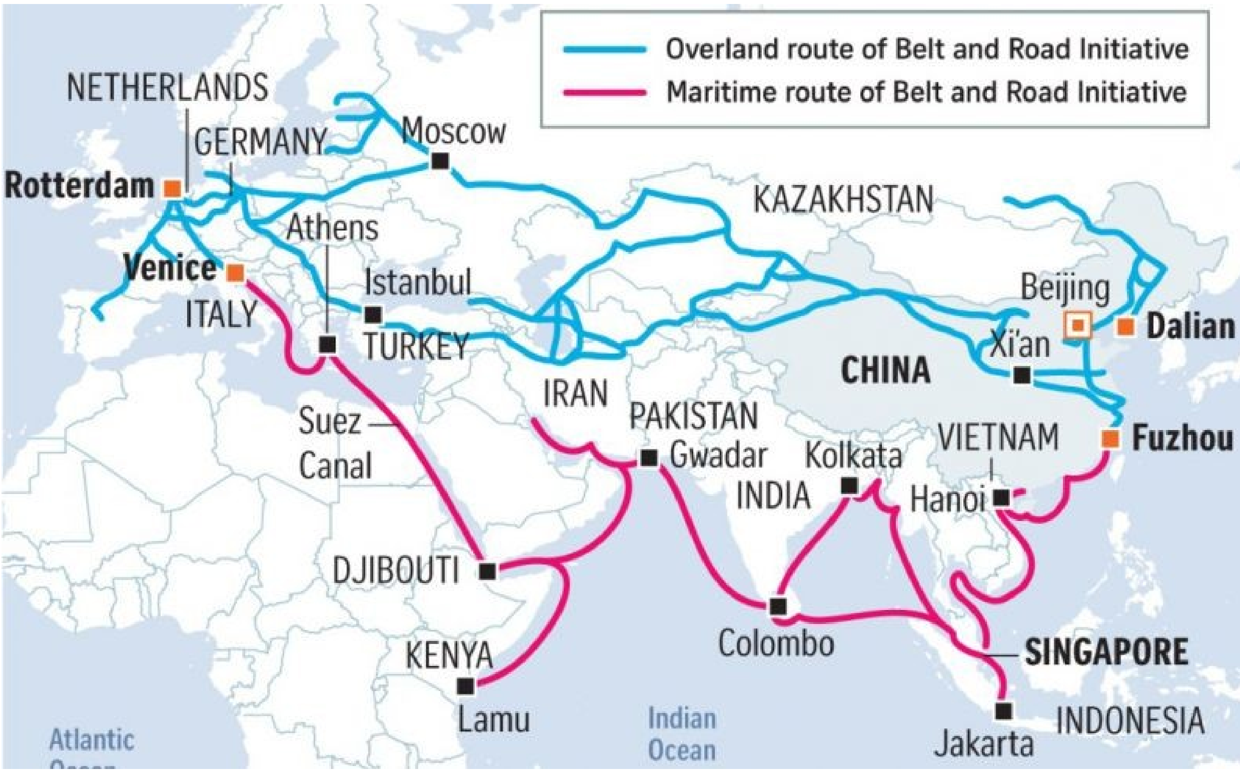


Figure 1: Routes of China's Belt and Road Initiative. The *Silk Road Economic Belt* (overland) links China with Central Asia and Europe, while the *21st Century Maritime Silk Road* connects China's coastal ports with Southeast Asia, South Asia, the Indian Ocean, and the Mediterranean toward Europe and Africa.

2.2 Deep-Water and Container Ports in Europe

Within Europe, this institutional architecture has materialised through targeted acquisitions in the continent's most strategic maritime gateways. Rather than dispersed investments, these deals concentrate in a small number of deep-water container hubs that anchor Europe's external trade and internal connectivity.

Such ports can handle ultra-large vessels (with drafts exceeding 14 meters) and thus function as the gateways through which the bulk of Europe's external trade enters and leaves the continent. According to UNCTAD, over 90 percent of world merchandise trade by volume travels by sea, and roughly two-thirds of that moves in containers. In the European context, maritime gateways mediate about 75 percent of the value of extra-EU trade.[4]

[4]Eurostat, "Maritime transport of goods," 2024 edition.

These hubs operate within a hierarchical structure: a limited number of deep-water terminals act as *network anchors*, while hundreds of smaller feeder ports and inland terminals depend on their scheduling, capacity, and ownership decisions. Changes at the top of this hierarchy propagate through the hinterland, shaping access, routing costs, and the spatial distribution of trade across Europe's internal market. A small set of terminals—the *Northern Range* (Rotterdam, Antwerp–Bruges, Hamburg, Bremerhaven) and the *Mediterranean Rim* (Piraeus, Valencia, Genoa)—anchors this system. These nodes form the endpoints of the EU's *Trans-European Transport Network* (TEN–T) corridors.

Container ports therefore provide the physical interface between global and regional economies: they connect seaborne trade to inland markets via road, rail, and logistics networks. The analysis in this paper focuses precisely on this interface—how shifts in the ownership and governance of major container terminals affect the pattern of inland trade across Europe's internal market.

2.3 Chinese-Linked Port Investments in Europe

Since the mid-2000s, Chinese state-backed enterprises have been the leading investors in European maritime infrastructure. Two state-controlled firms account for most of this activity: *COSCO Shipping Ports* and *China Merchants Port*. An EU Parliament study identifies Chinese SOEs with a presence in 15 EU ports, while the only non-SOE Chinese cases it notes are two terminals operated by Hutchison Ports (Poland and Sweden). Taken together, this implies that roughly 88% of observed Chinese port stakes in the EU are held by state-controlled companies. In throughput terms, China controls about 10% of European container handling.[5] As the majority of acquisitions involve COSCO, I refer to COSCO throughout for expositional simplicity.

These transactions began before the formal launch of the *Belt and Road Initiative* (BRI) in 2013, with early entries in Rotterdam and Piraeus, which accelerated thereafter under the

[5] European Parliament, Policy Department for Structural and Cohesion Policies (TRAN), *Chinese Investments in European Maritime Infrastructures* (2023), pp. 15–16.

Initiative's maritime component. They span both the Northern Range (Zeebrugge, Antwerp, Hamburg) and the Mediterranean corridor (Piraeus, Valencia, Bilbao, Vado Ligure), extending to joint ventures in France (Marseille–Fos, Le Havre, Dunkirk) and exploratory cooperation agreements in several Atlantic and Adriatic ports, without equity transfer so far and thus outside the scope of analysis.

Across countries, the form of participation varies from majority control of port authorities (as in Piraeus) to partial terminal ownership (e.g. Valencia, Zeebrugge, Hamburg) and joint ventures with European logistics firms (e.g. Terminal Link in France). The *timing* of these acquisitions is staggered across national jurisdictions, reflecting domestic privatisation schedules, EU merger-control reviews, and sectoral regulatory processes rather than local trade conditions. This institutional sequencing generates the plausibly exogenous temporal variation that underpins the empirical design of this paper.

3 Data

3.1 From Ports to Regions

Before introducing the road-freight microdata, it is useful to pause on the geography depicted in Figure 17. The figure illustrates the analytical shift from viewing ports as isolated gateways to conceiving of *ports and regions* as an integrated spatial system. It maps the 368 NUTS-2 regions of Europe and highlights, in red, those hosting ports in which COSCO holds equity. This treatment layer visualises the spatial distribution of Chinese participation across Europe's maritime gateways and provides the regional frame for the analysis that follows.

Because NUTS2 regions capture both the port cities and their inland hinterlands, this spatial frame enables analysis of how ownership shocks at coastal nodes diffuse into the continental economy. By showing ports within their hinterlands, the figure underscores that ownership changes at a few coastal gateways can reverberate inland—altering trade volumes, partner concentration, and corridor orientation across Europe's network.

Conceptually, this move from ports to regions shifts the unit of analysis from physical assets to the spatial networks they organise. Ports handle roughly three-quarters of the EU's external trade by value and feed those flows into the inland system, where road freight alone accounts for nearly half of intra-EU trade by value and more than 70 percent by weight. Together, these channels link Europe's maritime gateways to its interior economy: the regions behind them—industrial centres, logistics hubs, and distribution corridors—are where the economic effects of ownership ultimately materialise.

This regional framing provides the analytical bridge to the microdata used in this paper. The next subsection introduces the uniquely detailed *European Road Freight Transport (ERFT)* dataset, which traces how port-level ownership shocks propagate through freight flows across Europe's 368 NUTS-2 regions between 2011 and 2022.

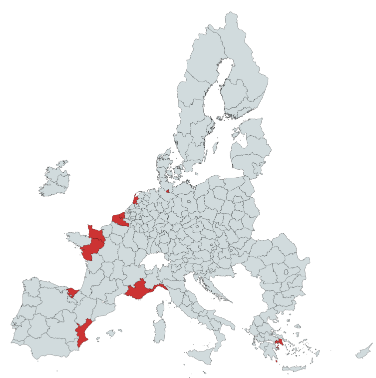


Figure 2: NUTS2 regions and treated ports across Europe.

3.2 Road Freight Microdata (ERFT/RC)

The core data source for this analysis is the anonymised *European Road Freight Transport* (ERFT/RC) microdata compiled by Eurostat. Collected by national statistical authorities under Regulation (EC) No. 70/2012 and harmonised by Eurostat [Eurostat, 2020], these files provide the most detailed evidence available on how goods move within Europe. For the first time, they offer a consistent and comprehensive *subnational measure of trade flows* across

Table 1: Chinese-linked port investments and concessions in Europe

Country	Port / Terminal	Investor / vehicle	Year(s)	Stake / Type
Greece	Piraeus (PPA; PCT concession)	COSCO Shipping Ports	2008; 2016	PCT 35-yr concession (2008); PPA **67%** equity (2016)
Netherlands	Rotterdam (Euromax)	COSCO Shipping Ports	2008; 2021	**35%** (2008) → **17.85%** (post-2021)
Belgium	Zeebrugge (CSP Zeebrugge)	COSCO Shipping Ports	**2017**	**100%** terminal owner
Belgium	Antwerp (Antwerp Gateway)	COSCO Shipping Ports	2017–2018	**20%** terminal JV stake
Spain	Valencia (Noatum/CSP Spain)	COSCO Shipping Ports	**2017**	**51%** controlling stake
Spain	Bilbao (Noatum/CSP Spain)	COSCO Shipping Ports	**2017**	∼**39.5%** terminal stake
Germany	Hamburg (CTT, HHLA)	COSCO Shipping Ports	2022; **2023**	**24.9%** minority, govt-approved (Oct 2022), finalised (Jun 2023)
Italy	Vado Ligure (Vado Gateway)	COSCO Shipping Ports	**2019**	**40%** (APM 50.1%, COSCO 40%, Qingdao 9.9%)
France	Le Havre (GMP Terminals)	Terminal Link[a]	2013–2014	**JV exposure** via 49% CMPort in Terminal Link
France	Dunkirk (Terminal des Flandres)	Terminal Link[a]	2013–2014	**JV exposure** via 49% CMPort in Terminal Link
France	Marseille–Fos (selected)	Terminal Link[a]	2013–2014	**JV exposure** via 49% CMPort in Terminal Link
France	Rouen (container terminal)	Terminal Link[a]	2013–2014	**JV exposure** via 49% CMPort in Terminal Link

Notes: "CSP Spain" refers to the Valencia/Bilbao assets acquired with Noatum in 2017; Terminal Link is a CMA CGM subsidiary, 49% owned by China Merchants Port since 2013/14. Rotterdam Euromax: initial 35% (2008) later reduced to 17.85% after a 2021 transaction. Sources: see text for citations to corporate filings, public databases and investigative articles.

the continent—an essential foundation for tracing how infrastructure ownership shapes the geography of movement.

Access and sourcing. Access to the ERFT microdata is restricted to recognised research institutions and granted exclusively for scientific purposes through Eurostat's *Microdata Access Portal*.[6] Obtaining access requires (i) institutional accreditation as a research entity, (ii) submission and approval of a project proposal, and (iii) consultation with the relevant national statistical authorities. Approved projects are granted secure access to the anonymised scientific-use files via Eurostat's S-CIRCABC platform or accredited remote terminals. Access is time-limited and governed by strict confidentiality, output vetting, and data-destruction rules upon project completion.

Structure and coverage. The ERFT/RC micro-data comprise three linked modules: **A1 (Vehicle)**, **A2 (Journey)** and **A3 (Goods)**, connected through the unique identifiers `QuestN` (vehicle), `JournN` (journey) and `GoodsN` (goods operation). Each record describes a specific movement of goods by road, reporting the origin and destination regions (NUTS codes), tonnage, distance and goods-type (NST 2007 classification). Data are col-

[6] See Eurostat (2025), "How to Apply for Microdata Access?" Directorate A – Methodology: Innovation in Official Statistics.

lected quarterly for vehicles registered in each reporting country and cover both domestic and international journeys. To protect confidentiality, detailed NUTS3 locations are converted to NUTS2 codes and very rare origin–destination pairs (code `SUPP`) are suppressed or masked. The vehicle–journey–goods linkage and the comprehensive regional coverage offer harmonised, high-frequency insight into road-freight movements across Europe.

Analytical construction. I aggregate the goods records (A3) to construct a balanced panel of bilateral freight flows between 368 NUTS2 regions over 2011–2022, disaggregated by NST 2007 industry and by direction (inbound/outbound). The ERFT design records all types of journeys—hire-for-reward, own-account, distribution rounds, and transshipments—allowing the construction of a complete regional trade matrix. A distinctive advantage of the dataset is that it includes the diagonal entries of this matrix ($i = j$), representing within-region distribution journeys. These internal shipments are crucial for capturing the full spatial adjustment of trade, as they reflect local reallocation of freight flows following changes in port access or routing priorities.

A subnational measure of trade. Unlike customs or balance-of-payments data, which record international transactions at the country level, the ERFT microdata capture the actual movement of goods across European regions. This makes it possible to trace *re-routings and corridor shifts* that are invisible in macro data. For example, a container re-routed from Antwerp to Piraeus and then distributed northward through the Balkans and Central Europe leaves no footprint in customs data but appears clearly as a change in the pattern of inland freight flows. This capacity to observe the geography of trade at the operational level—who trades with whom, through which port, and by which corridor—enables the first systematic quantification of how infrastructure ownership shocks propagate through Europe's internal market.

Prior use. Because of strict confidentiality and the dataset's complexity, the ERFT microdata have rarely been used in academic research. To my knowledge, only Santamaría, Ventura, and Yeşilbayraktar [2023] employ aggregated flows, estimating intra-EU trade elasticities without reconstructing the underlying network. This paper is the first to map Europe's regional trade network directly from the microdata and to connect its evolution to foreign-ownership shocks at maritime gateways. In doing so, it introduces a new empirical dimension to the study of global infrastructure investment: while earlier work in economics has examined the effects of Chinese trade or FDI shocks on firms and industries, no prior study has traced how Chinese port acquisitions reshape Europe's internal trade network or regional economies.[7] The ERFT/RC microdata thus bridge macro trade statistics and spatial-network analysis, providing the resolution needed to link port governance to continental trade flows.

Data preparation. The empirical workflow proceeds in four steps:

1. **Linking and extraction:** connect the A1–A3 modules through unique identifiers and retain complete vehicle–journey–goods chains within each quarter.

2. **Geocoding and harmonisation:** convert regional identifiers to NUTS2 and reconcile administrative changes (Ireland, Lithuania, Hungary, Poland, United Kingdom).

3. **Aggregation:** compute total tonnage and partner concentration (HHI) for each region–industry–year cell, along additional variables outlined in Section 5.1.

NST 2007 classification. The ERFT microdata include information on the type of goods transported, classified according to the European standard *NST 2007* (Nomenclature for Transport Statistics). This breakdown enables analysis of cargo composition and logistics

[7] The closest related literatures are the "China shock" studies on manufacturing employment [Autor, Dorn, and Hanson, 2013, Colantone and Stanig, 2018] and recent work on geoeconomic investment and connectivity [Clayton, Maggiori, and Schreger, 2024, Garcia-Herrero and Xu, 2023], but none address subnational trade networks or transport infrastructure ownership.

Table 2: NST 2007 goods categories (1-digit level)

Code	Title
01	Products of agriculture, hunting, forestry and fishing
02	Coal and lignite; crude petroleum and natural gas
03	Metal ores and other mining and quarrying products
04	Food products, beverages and tobacco
05	Textiles and textile products; leather and leather products
06	Wood and products of wood and cork; pulp, paper and paper products; printed matter
07	Coke and refined petroleum products
08	Chemicals, chemical products, and man-made fibres; rubber and plastic products
09	Other non-metallic mineral products
10	Basic metals; fabricated metal products, except machinery and equipment
11	Machinery and equipment n.e.c.; office machinery and computers; electrical machinery; radio, television and communication equipment
12	Transport equipment
13	Furniture; other manufactured goods n.e.c.
14	Secondary raw materials; municipal wastes and other wastes
15	Mail, parcels
16	Equipment and material used in the transport of goods
17	Goods moved in the course of household and office removals; baggage and personal effects; motor vehicles being moved for repair; other non-market goods n.e.c.
18	Grouped goods: a mixture of types of goods transported together
19	Unidentifiable goods: goods that cannot be identified for transport statistics purposes
20	Other goods not elsewhere classified

Source: Eurostat, *NST 2007—Statistical classification of goods transported* (Eurostat Statistics Explained, 2018). Categories 18–20 generally include containerised or consolidated cargo and serve as a proxy for logistics-intensive shipments (see Section 4).

patterns across 20 one-digit categories listed in Table 2. The final three categories (18–20) correspond to grouped, unidentifiable, and "other" goods—shipments that typically move in containers or as consolidated cargo. I interpret shifts toward these categories as changes in logistics composition rather than transformations in production structure.

3.3 Investment Linkages

To measure regional exposure to foreign port ownership, I compile an original dataset of Chinese-linked port investments in Europe that consolidates information from multiple primary and secondary sources. Existing databases—such as UNCTAD's *FDI/TNC* statistics and the American Enterprise Institute's *China Global Investment Tracker* (CGIT)—provide partial coverage but are incomplete for port terminals and omit information crucial to my identification strategy. I assemble a hand-collected chronology of port-related transactions between 2011 and 2022, representing roughly ten percent of European container-handling capacity, drawing from a combination of corporate, institutional, and regulatory sources.

The starting point of this analysis is the China Global Investment Tracker. The China Global Investment Tracker is a public database that records large Chinese overseas investment and construction projects. It reports the country, sector, investor, and announced value and year of each project. While it identifies projects and timing, it does not provide information on equity shares acquired, terminal throughput (TEUs), or other details necessary to evaluate investment intensity, operational control, and network significance. Accordingly, I use the CGIT to locate and time potential investments and then complement it with legal tenders, national privatisation documents, port-authority filings, and corporate annual reports that specify the exact ownership share and operational scope.[8]

Sources and collection. The dataset consolidates publicly accessible information from four families of sources:

1. **Corporate filings:** annual reports and investor presentations of China COSCO Shipping Ports Ltd., China Merchants Port Holdings, and other global terminal operators, cross-verified with port-authority disclosures and national corporate registries.

2. **European institutional documentation:** European Commission DG COMP merger-control filings, national privatisation tenders, concession announcements, and the 2023 EU *Economic Security Strategy*.

3. **Press:** Reuters, Lloyd's List, the Financial Times, and specialist maritime outlets (e.g., PortEconomics, Drewry Maritime Research) reporting transaction timing, ownership

[8] Comparable terminal-level data on ownership shares and capacities are available from proprietary sources such as Drewry Maritime Research's *Global Container Terminal Operators* reports. However, access to these databases requires costly subscriptions, making them impractical for independent academic research.

shares, and concession durations.[9]

4. **Local and academic sources:** port-authority annual reports, regional and national parliamentary audits, and independent investigative projects such as *Investigate Europe* and the *China–Global South Port Database*.

Each investment record identifies the port, host country, year of transaction or concession start, ownership stake, terminal capacity (TEUs), operating partner, and relevant TEN–T transport corridor. For acquisitions occurring in stages (e.g., Piraeus 2009 and 2016; Zeebrugge 2017–2018), both dates are recorded, distinguishing between equity closing and effective control transfer. Monetary amounts are expressed in nominal euros, and TEU capacities are sourced from operator and port-authority disclosures.

Validation and harmonisation. Because disclosure practices differ across ports and countries, each record is triangulated using at least two independent sources. When discrepancies arise—for instance between corporate filings and media reports—official filings and European regulatory documents are treated as primary. For each transaction, I record the year, equity share, and, where applicable, concession terms that define the investor's stake in port operations. The dataset captures both majority and minority equity participations as well as joint-venture or concession-based arrangements, provided that the investment involves a quantifiable ownership share.

Novel contribution. The hand-collected investment dataset bridges the gap between qualitative port-level case studies and aggregate FDI statistics. It provides, for the first time, a harmonised chronology of Chinese equity participations and concession agreements in European maritime infrastructure, matched to economic-geography identifiers such as eq-

[9] No proprietary or subscription-only datasets were used. All records were collected from publicly available documents and cross-verified across at least two independent sources. Comparable terminal-level data on ownership shares and capacities are available in Drewry Maritime Research's *Global Container Terminal Operators* reports, but access to these proprietary files is commercially priced and impractical for open academic research.

uity share, terminal capacity (TEUs), TEN–T corridor affiliation, and NUTS2 hinterland correspondence. This granularity moves beyond headline announcements to document the timing, scale, and geography of Chinese involvement at coastal nodes and the institutional sequencing of Europe's port-privatisation process. Combined with the ERFT microdata, it establishes the empirical foundation for linking ownership changes at maritime gateways to measurable shifts in inland freight patterns. In doing so, it creates the first Europe-wide dataset that connects foreign infrastructure investment to the structure of regional trade networks—a level of integration not previously achieved in the literature.

Forms of participation and scope of analysis. Port-level transactions fall into three broad categories. First, *port-authority control*, where Chinese operators hold majority ownership or long-term concessions granting direct governance rights over port operations (e.g. Piraeus). Second, *terminal-level equity stakes*, where Chinese firms hold participations in the operating company of a specific container terminal, typically with management or scheduling rights but without authority-wide control (e.g. Valencia, Zeebrugge, Hamburg, Vado Ligure, and the French Terminal Link network). Third, a broader set of *non-equity engagements*, including memoranda of understanding, construction contracts, or prospective concessions (e.g. Rijeka, Sines, Koper, Klaipėda). The analysis focuses on the first two categories—port-authority control and terminal-level equity stakes—because they represent observable *ownership shocks* likely to influence routing and service organisation. In contrast, non-equity agreements lack operational involvement and therefore do not alter the economic structure of Europe's trade network.

Institutional sequencing of major acquisitions. Across countries, the timing and form of these ownership changes followed national privatisation and regulatory calendars rather than commercial conditions. Early concessions, such as COSCO's 2008 terminal lease in Piraeus, emerged from state-led privatisation frameworks; later transactions were shaped by merger-control and foreign-investment reviews within the EU single market. For instance, Spain's 2017 Noatum acquisition required CNMC and European Commission clearance; Belgium's Zeebrugge takeover (2017–18) followed regional government approval; and Germany's Hamburg transaction (2021–23) was capped at a minority share after federal screening. These sequences illustrate that the institutional process governing port acquisitions was staggered and externally constrained, producing the quasi-exogenous variation in timing used for identification. Detailed documentation for each case—including legal tenders, regulatory filings, and ownership structures—is provided in Appendix A.

4 Stylized Facts

This section documents the key empirical patterns that motivate the identification strategy. It traces how Europe's inland trade network evolved between 2011 and 2022, zooms in on the case of Piraeus as a micro-level example of reorientation, and then generalises across industries to show that the transformation originates in the logistics and infrastructure layer rather than in production.

4.1 Spatial structure of Europe's trade network

Figure 3 provides a first visualisation of Europe's regional trade network, mapping the top decile of bilateral freight connections in 2011 and 2022, aggregated across all industries. Each node represents a NUTS2 region, with size proportional to total freight volume and colour denoting national clusters; links indicate the strongest flows between origins and destinations in the ERFT data. Node positions reflect actual geographic coordinates, so the network is geographically anchored rather than schematic.

The 2011 snapshot reveals a network concentrated along the *Northern Range–Rhine axis*. The densest connections run between the Netherlands, Belgium, and western Germany, anchored by the ports of Rotterdam and Antwerp and extending into the Rhine–Ruhr industrial belt. In 2011, Rotterdam, Antwerp, and Hamburg jointly handled over two-fifths of all EU

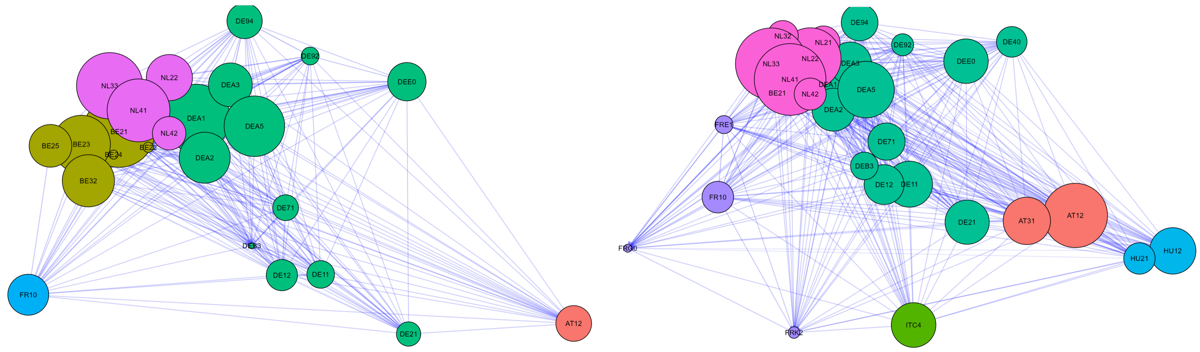


Figure 3: Top-decile freight connections in the European road-freight network, 2011 and 2022. Nodes represent NUTS2 regions; size indicates total freight volume and colour denotes national clusters. The maps show the network's concentration along the Northern Range–Rhine axis in 2011 and its subsequent extension toward the Mediterranean and Central–Eastern corridors by 2022.

container traffic, underscoring how heavily Europe's inland network depended on its northwestern gateways.[10] Outside this core, France, southern Europe, and the eastern periphery remain only weakly connected—reproducing Europe's pre-BRI geography of trade, centred on a compact, high-volume corridor.

By 2022, the network retains this Northern core but exhibits a broader and more diversified reach. High-volume connections increasingly extend along the Mediterranean and Central–Eastern axes—most visibly through northern Italy (ITC4), Austria (AT31–AT12), and Hungary (HU21–HU12)—forming a secondary east–west spine that links the Adriatic and Mediterranean basins to Central Europe. This evolution aligns with recent analyses of Europe's transport geography, which highlight a gradual extension of dense freight corridors beyond the traditional Northern Range toward Mediterranean and Central–Eastern gateways.[11]

When extending the analysis to the top quintile of flows, these trends become clearer:

[10] Eurostat, Maritime Transport of Goods (2011); Notteboom and Parola (2012).

[11] European Commission, *Trans-European Transport Network (TEN–T) Core Corridors Overview* (2023); Eurostat, *Maritime Transport of Goods* (2024); Notteboom and Rodrigue (2013).

the southern and eastern corridors gain further prominence, revealing a denser inland web that integrates Mediterranean ports and Central–Eastern regions into Europe's main transport backbone. A similar reorientation is visible across industries, with the broad pattern of diversification largely maintained. Some nuances: the shift is most pronounced in containerised and multimodal freight—an aspect examined in detail in Section 4.3. These visual regularities indicate that the south–eastern extension of Europe's trade network reflects a broad, systemwide shift rather than a statistical artefact of aggregation.

Overall, the maps provide an intuitive view of Europe's inland trade geography and its evolution over the past decade. They show that the ERFT microdata capture a dense, regional transport network whose structure—initially concentrated in northwestern Europe—has progressively extended toward the Mediterranean and Central–Eastern regions. Although these shifts may also reflect broader structural developments—EU cohesion funding, infrastructure investment, and the eastward extension of logistics corridors—they are presented here simply as descriptive evidence of how Europe's inland connectivity has evolved.[12]

4.2 Example: Piraeus as a gateway

Among Europe's maritime gateways, the Port of Piraeus (region EL30) provides the clearest micro-level view of how ownership changes can alter inland connectivity. Following COSCO's 2008 terminal concession and its 2016 majority acquisition of the Piraeus Port Authority, the port expanded from a marginal Mediterranean stop into one of Europe's busiest container hubs. Although the ERFT microdata capture only *intra-EU* road-freight movements, any shipment unloaded at Piraeus and then transported by truck within the same NUTS2 region appears as a *Piraeus→Piraeus* (EL30→EL30) flow. Such diagonal entries trace the port's role as an entry and consolidation node—the point where goods first touch EU soil and

[12] Empirical work has documented how these mechanisms—rising cross-border integration, EU structural funds, and the eastward extension of logistics corridors—have progressively rebalanced activity within Europe. See Crescenzi, Di Cataldo, and Rodríguez-Pose [2016]; European Commission [2023]; Dijkstra, Garcilazo, and McCann [2015]; Brakman, Garretsen, and van Marrewijk [2019]; and Iammarino, McCann, and Ortega-Argilés [2019].

enter the continental transport system. Road freight forms the physical interface between Europe's maritime gateways and its internal market, carrying over 70 percent of intra-EU trade by weight and acting as the primary channel through which seaborne imports diffuse inland.[13] Ownership shocks at the coast reshape the geography of trade not by altering what is produced, but by changing how goods move through this maritime–inland linkage.

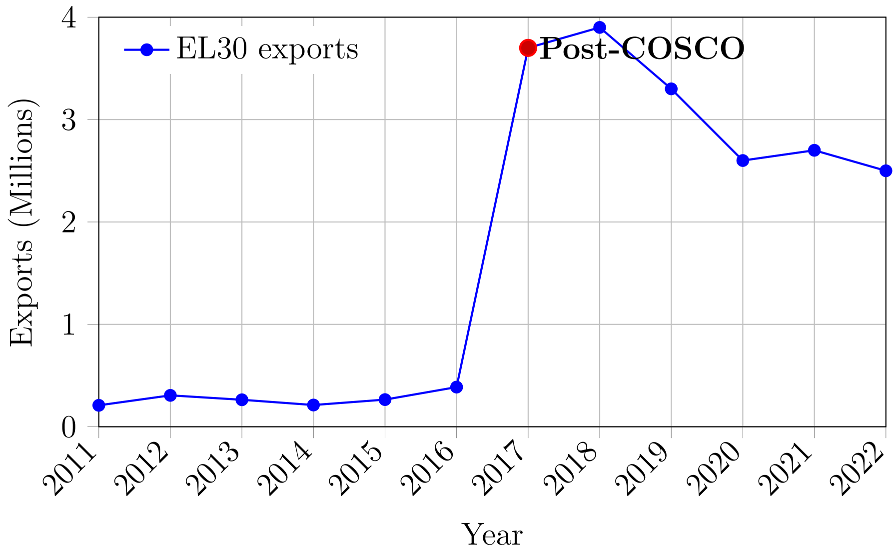


Figure 4: EL30 exports, 2011–2022

Notes: The figure shows total trade flows through the Port of Piraeus (EL30), including inbound, outbound, and bilateral trade. Diagonal flows refer to intra-regional exchanges. EL30 corresponds to the Attica region, which hosts the Port of Piraeus within the Athens metropolitan area. Units are in multiples of 100kg.

Figure 4 visualises the evolution of trade originating from Piraeus. Following COSCO's 2016 acquisition of the Piraeus Port Authority, EL30's exports rose from a few tens of thousands of tonnes per year to several hundred thousand, surging from roughly 0.3 million to 3.7 million tonnes between 2016 and 2017 —an increase of around twelvefold—before stabilising at a higher plateau. This surge marks the moment when Piraeus shifted from a marginal Mediterranean port to a major origin point within the EU's inland transport network. Closer inspection reveals, however, that virtually the entire increase arises from the *diagonal* EL30→EL30 cell—shipments whose recorded origin and destination are both

[13] Eurostat, Road Freight Transport Methodology: Reference Manual (2016); OECD/ITF, Port–Hinterland Connectivity and Regional Development (2019); Notteboom and Rodrigue (2013), "The Geography of Containerization: Ports, Terminals, and the Global Supply Chain."

within Attica. When decomposed by journey type and goods category, these flows are concentrated in *containerised journeys* and in the *unidentifiable goods* segment of the NST 2007 classification—precisely the categories associated with consolidated and transshipped cargo entering the EU by sea and dispatched inland by truck.

Macro consistency. The sharp rise in recorded shipments is broadly consistent with Piraeus's transformation into a major maritime gateway. Aggregate trade data show a parallel increase in China–EU trade and in China's exports to Greece over this period: EU imports from China nearly doubled between 2015 and 2021, while Greek imports from China rose from under $3 billion to almost $8 billion (Figure 5, RHS axis).[14] These patterns are therefore compatible with a genuine expansion in containerised traffic. However, the *timing* and *order of magnitude* of the EL30 surge are less clear-cut: the spike does not align perfectly with the 2016 COSCO acquisition, and its aftermath remains puzzling. The goods recorded as originating from Piraeus in the 2017 quarters cannot be fully traced in later years to neighbouring regions or downstream destinations within the road-freight network. Some flows may have been absorbed locally or shifted into rail and maritime transport, but the absence of consistent follow-on road linkages suggests that part of this jump reflects transient or misclassified shipments rather than a stable post-acquisition expansion in inland freight.

Microdata and corruption detection. The pattern and timing of these anomalies mirror the irregularities later scrutinised in the *Operation Calypso* investigation, where the European Public Prosecutor's Office (EPPO) uncovered a large-scale VAT fraud and undervaluation scheme centred on goods routed through the Piraeus logistics zone.[15] Such shipments—coded as intra-regional and often classified as unidentified or unidentifiable goods—inflate local freight statistics but appear only partially, if at all, in macro trade data,

[14] UN Comtrade, *China–EU and China–Greece Bilateral Trade Statistics*.

[15] See Financial Times, "EU Investigates Piraeus Trade Fraud Scheme," October 2025; EPPO Press Release, "Operation Calypso: Pan-European VAT Fraud Network Dismantled," June 2025; European Anti-Fraud Office (OLAF), Annual Report (2025).

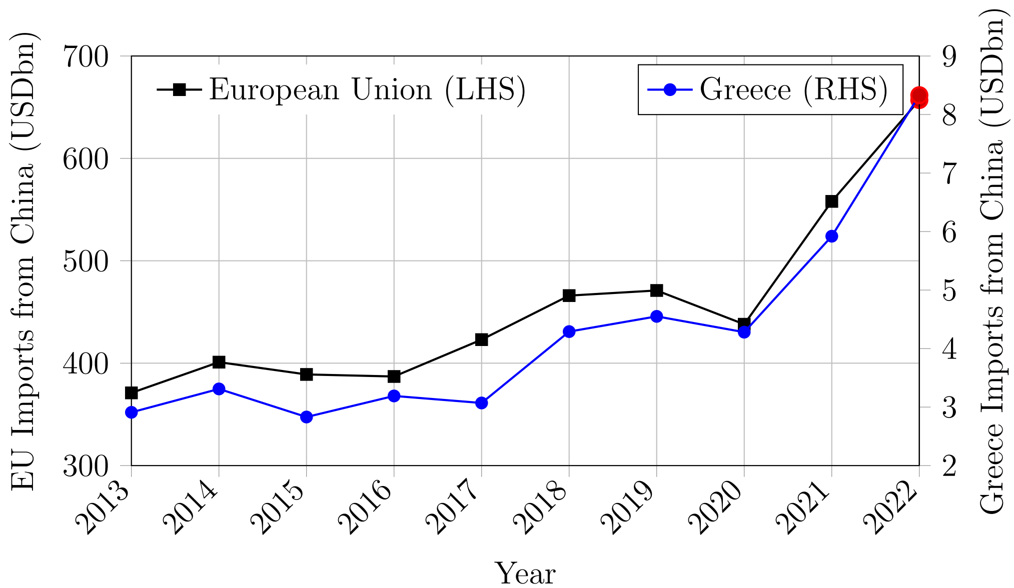


Figure 5: Imports from China to the EU (LHS) and Greece (RHS), 2013–2022

Notes: Imports from China for Greece (right axis) and the European Union (left axis) are reported in billions of USD. The right-hand scale highlights Greece's strong post-2018 increase.
Source: UN Comtrade.

which record declared customs transactions rather than the physical circulation of goods.[16] This discrepancy underscores both the limits of conventional trade measurement and the potential of logistics microdata for regulatory oversight—highlighting how shipment-level evidence can help detect misclassification and customs fraud schemes such as Calypso.

From a data perspective, the case illustrates a distinctive strength of the ERFT microdata: it records the movement of goods rather than their declared trade value. By tracking origins, destinations, and goods codes, the dataset reveals rerouting, consolidation, and manipulation patterns that aggregate statistics obscure. In this sense, the ERFT microdata provide a unique lens on the behavioural and logistical dynamics of trade, exposing how ownership and governance interact at the interface between global shipping and the European single market.

These shipments—recorded as intra-regional and often coded as generic or unidenti-

[16] Aggregate Eurostat trade series understate the effective inflow through Piraeus, even as throughput data show container volumes rising from 880,000 TEU in 2010 to over 5.6 million TEU in 2019 and about 4.6 million TEU in 2023. Sources: Piraeus Port Authority, Annual Reports (2010–2023); COSCO Shipping Ports, Investor Presentation (2024).

fied—inflate local freight statistics but only partially appear in macro trade data, since customs declarations obscure their true origin. The residual difference between Piraeus's physical throughput—which rose from 880,000 TEU in 2010 to over 5.6 million TEU in 2019—and reported trade values underscores this discrepancy: part of the surge in the microdata reflects real expansion in logistics activity, but part likely captures misreported or misclassified flows consistent with the fraud patterns identified by European authorities.[17]

From anomaly to mechanism. The broader patterns that emerge from the microdata point to a structural rather than an isolated phenomenon. The spike in EL30-to-EL30 "diagonal" flows is exactly what we would expect if containerised cargo were unloaded at Piraeus and then entered the road network as domestic dispatches. Containers are a maritime technology, hence so growth concentrated in container-compatible categories is a natural fingerprint of sea-borne entry followed by inland trucking.[18]

Together, the aggregate network maps and the Piraeus case motivate motivate a sectoral decomposition: if the mechanism operates through logistics and entry, the effects should be concentrated in industries that depend on containerised and multimodal cargo, and should appear disproportionately in intra-regional ("diagonal") EL30↔EL30 exchanges.

4.3 Sectoral patterns of inland trade reorientation

The case of Piraeus illustrates how changes in port ownership and governance can reshape the organisation of inland trade—not by altering what Europe produces, but by changing how goods enter and circulate within the single market. The sharp rise in containerised and "unidentifiable" cargo moving within EL30 suggests that what appears as local trade often reflects re-routing and consolidation of external shipments. To assess whether similar patterns hold across Europe's network, I disaggregate the inland trade matrix by industry to

[17] Piraeus Port Authority, *Annual Reports* (2010–2023); COSCO Shipping Ports, *Investor Presentation* (2024).

[18] UNCTAD, *Review of Maritime Transport* (2023).

identify which sectors drive the observed south–eastern expansion of dense freight corridors.

The industry-level evidence shows that Europe's inland trade reorientation is broad-based but not uniform. The clearest south–eastern expansion between 2011 and 2022 occurs in sectors that largely rely on containerised, multimodal, and long-haul freight—chemicals and plastics (NST 08), basic metals (NST 10), transport equipment (NST 12), and grouped or unidentifiable goods (NST 18–19). These industries exhibit the same polycentric pattern observed in the aggregate network, with new high-density corridors linking Italy, Austria, and Central–Eastern Europe to the traditional Northern Range. By contrast, sectors dominated by local production or short-distance transport—such as household goods, mail, or waste—show little structural change. Overall, the diversification of Europe's inland freight geography reflects not a shift in *what* is produced but in *how* goods move: the transformation has occurred within the logistics and infrastructure layer of integration. Representative sectoral maps for these industries are provided in Appendix B (Figures 12–16), showing how container-compatible sectors drive the south–eastern extension of high-volume corridors across the continent. On top of these visualisations, Table 3 summarises qualitatively which industries align most closely with the aggregate reorientation and which remain largely unchanged, highlighting the heterogeneity of Europe's inland adjustment. Across sectors and regions, periods of rising exposure coincide with higher NST 18–20 shares, underscoring that the reconfiguration originates within the logistics and infrastructure layer rather than in production itself. These descriptive facts thus suggest a reallocation within the *logistics layer*—how goods move—rather than broad changes in *what* is produced.

The evolution of Europe's network structure is equally revealing. Figure 6 plots average network-centrality indices between 2011 and 2022. In this setting, *out-degree centrality* measures the number of distinct regional trade partners to which a region exports by road in a given year, capturing the breadth of its direct trade connections within the network. Similarly for in-degree. *Eigenvector centrality*, by contrast, assigns greater weight to connections with already well-connected partners: a region linked to central or high-volume hubs attains higher eigenvector centrality even if its number of partners is limited. In economic terms, out-degree reflects the *extent* of a region's trade links, while eigenvector centrality reflects the *influence* or *embeddedness* of those links within the wider continental network.

The results are striking: while the average degree of connectivity (plotted on the LHS axis) declines modestly, eigenvector centrality (plotted on the RHS axis) rises sharply after 2017. This pattern provides further descriptive evidence that Europe's trade network has become more hierarchical and hub-oriented—fewer active links overall, but a greater concentration of flows through a smaller set of highly connected nodes. Looking closely, what we see here is a quantitative fingerprint compatible with the reconfiguration shown in the spatial maps: inland connectivity tightening around key southern and eastern gateways such as Piraeus, Valencia, and Genoa. These trends are consistent with a shift toward a continental hub-and-spoke structure and provide a compelling bridge to the econometric analysis that follows.

However, while these regularities align closely with the geography of COSCO's port acquisitions and the timeline of the Maritime Silk Road, they do not by themselves establish that ownership changes *caused* this reorientation. To test whether foreign control of ports systematically reweighted inland trade, the next section formalises this relationship within a continuous-treatment event-study framework that exploits the staggered timing of port acquisitions across Europe.

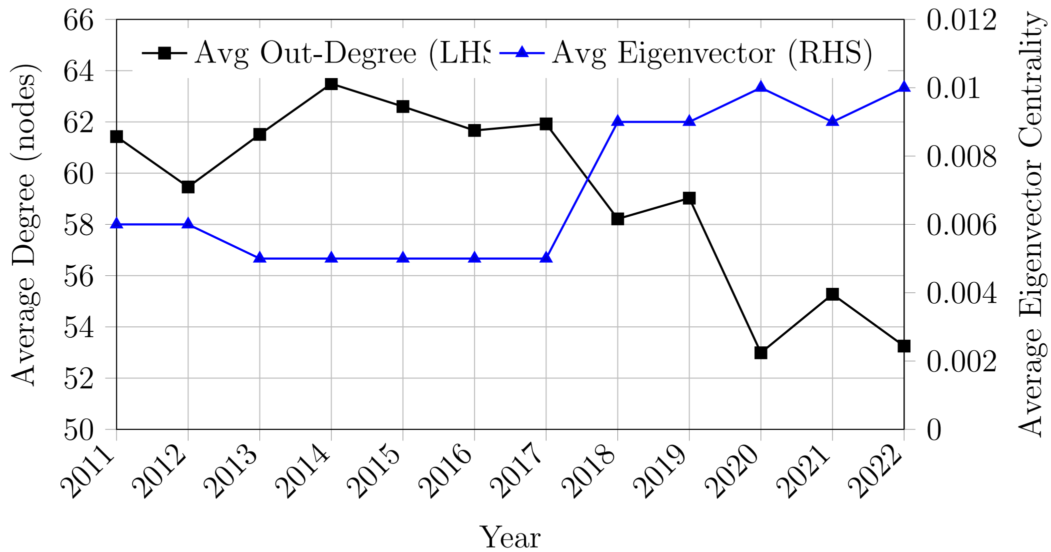


Figure 6: EU network metrics: degree (LHS) and eigenvector centrality (RHS), 2011–2022

Notes: Yearly averages over the EU trade network. Left axis shows average in- and out-degree per node; right axis shows average eigenvector centrality. Markers denote annual observations.
Source: Author calculations on EU trade network (constructed from UN Comtrade).

Table 3: Evolution of Europe's inland trade network by NST industry, 2011–2022

NST	Sector (short title)	2011 pattern	2022 pattern	Alignment with aggregate shift	Likely mechanism
01	Agriculture & fishing	NW core, limited E reach	Adds SE links (AT, HU, IT)	Moderate	Food logistics integration
02	Coal, oil & gas	Sparse NW flows	Expands E–W corridors	Strong	Energy diversification and corridor investment
03	Metal ores & mining	Northern import focus	Adds IT, AT, PL	Strong	Industrial inputs via Mediterranean ports
04	Food & beverages	Western core	Expands to Med & CEE	Moderate–strong	Agri-food logistics and supply chains
05	Textiles & leather	W Europe	SE corridor integration	Strong	Relocation of light industry and just-in-time flows
06	Wood, paper, print	NW dominance	Adds IT–AT–DE linkages	Strong	Intermediate supply chains
07	Refined petroleum	Northern ports	Wider E–W & S–N coverage	Strong	Energy corridor diversification
08	Chemicals & plastics	Rhine–Ruhr core	SE expansion (AT–IT–HU)	Very strong	Containerised intermediates
09	Non-metallic minerals	Industrial NW	Adds modest SE reach	Moderate	Construction and regional demand
10	Basic metals	NW focus	Clear SE corridor growth	Strong	Industrial integration and manufacturing linkages
11	Machinery & equipment	Germany-centric	Extends toward Med/CEE	Moderate	Manufacturing integration
12	Transport equipment	Central cluster	Adds AT–HU–IT linkages	Strong	Automotive supply chains
13	Furniture & other manufactures	Fragmented	Denser continental reach	Moderate–strong	Finished goods logistics
14	Waste & recyclables	NW focus	Spreads E–W, especially PL	Moderate	Cross-border recycling trade
15	Mail & parcels	Scattered W flows	Denser N–S integration	Limited	Domestic and parcel services
16	Transport materials	NW–Rhine corridor	SE expansion	Moderate–strong	Industrial logistics and input flows
17	Household goods	Domestic clusters	Largely unchanged	Weak	Local service flows
18	Grouped goods	Northern core	SE expansion (IT–AT–HU)	Very strong	Containerised and multimodal logistics
19	Unidentifiable goods	NW dominance	SE diversification	Strong	Hub-and-spoke transshipment
20	Other goods n.e.c.	Broad but stable	Slight SE reach	Partial	Mixed freight and residual cargo

5 Identification Strategy

The descriptive evidence above suggests a clear but complex pattern: Europe's inland trade network has become more hierarchical and spatially reoriented, with activity concentrating around a smaller set of highly connected southern and eastern gateways. This transformation appears most pronounced in containerized and multimodal sectors and is consistent with a logistics-layer reconfiguration rather than an industrial shift.

In this section, I formalise the investigation by asking whether the timing and geography of Chinese port acquisitions can *causally* account for the observed inland reallocation of trade. Specifically, I test whether regions more exposed to acquired ports experienced differential changes in freight volumes and partner concentration relative to less-exposed regions, once the institutional timing of ownership transfers is taken into account.

From descriptive patterns to causal effects. Simple correlations between port acquisitions and regional trade outcomes may reflect underlying differences rather than true ownership effects. Ports acquired by foreign operators tend to be larger, more connected, or already expanding faster than non-acquired ports, and inland regions that depend on them may have distinct economic structures or integration trajectories. A before–after comparison would therefore conflate ownership effects with concurrent trends in global shipping demand, industry composition, or infrastructure investment cycles. To isolate the causal impact of ownership itself, I exploit the fact that each port's acquisition followed its own regulatory and institutional calendar—externally determined by privatisation tenders, merger-control reviews, and concession laws—and that regional exposure to these events is fixed by historical port-reliance patterns. This staggered, continuous-treatment design allows estimation of causal responses of regional trade along two margins: (i) the *intensive margin*—changes in the volume of inbound and outbound freight—and (ii) the *extensive margin*—changes in the concentration of partner links, measured by the Herfindahl–Hirschman Index (HHI).

Why naïve TWFE is problematic under staggered, heterogeneous treatment. A conventional two–way fixed effects (TWFE) regression that interacts treatment with time in a single coefficient would be inappropriate here. When treatment adoption is staggered and effects vary across cohorts or over time, TWFE estimates can be severely biased, as treated units serve as invalid controls for later-treated ones, generating negative or inconsistent weights [Goodman-Bacon, 2021]. These issues are particularly acute in this setting, where (i) treatment intensity is *continuous* (based on baseline port reliance), (ii) adoption is *staggered* across multiple ports, and (iii) dynamic responses are expected as logistics networks adjust gradually. Recent econometric advances provide solutions specifically designed for such environments [De Chaisemartin and D'Haultfœuille, 2024, Sun and Abraham, 2021, Callaway and Sant'Anna, 2021]. Building on this literature, I implement a framework that accounts for heterogeneous, continuous, and time-staggered exposure.

Estimator: cohort–time ATTs with not-yet-treated controls (DCDH). The estimator developed by De Chaisemartin and D'Haultfœuille [2024] constructs *cohort-by-time* average treatment effects using only not-yet-treated units as controls in each period, thereby eliminating negative-weight pathologies. Two features make this approach particularly suited to my setting. First, it accommodates *continuous* treatment intensity by scaling each unit's response with its baseline port-reliance share, capturing graded exposure rather than binary treatment. Second, it allows estimation of dynamic effects over event time, which is essential when adjustments—such as contract renegotiation, routing changes, or corridor realignment—unfold gradually rather than immediately. [19]

Specifically, the design couples the DCDH estimator with a *shift–share exposure structure*, in which shocks originate at the port level while exposure weights are determined by pre-treatment regional–industrial trade linkages. Because each acquisition followed a

[19] This approach has become standard in modern applications of difference-in-differences with staggered and heterogeneous treatments and has been successfully applied in spatial and transport economics, including studies of highways, railways, and industrial-policy rollouts [e.g., Donaldson, 2018, Faber, 2014, Juhász, Lane, and Pál, 2023]. Building on this literature, I extend the framework to a setting characterised by continuous, network-based exposure and a sequence of staggered shocks.

distinct legal and institutional calendar, the identification exploits a *series of discrete, staggered shocks*—Piraeus in 2016, Valencia and Bilbao in 2017, Zeebrugge in 2018, Hamburg in 2022—rather than a single global event. This dual layering of variation—across both exposure intensity and the institutional timing of ownership changes—permits identification of dynamic responses that combine the strengths of continuous-treatment and multi-shock difference-in-differences designs.

By adapting DCDH to a shift–share setting and applying it to a network of sequential infrastructure shocks, this paper contributes methodologically by extending the framework to *continuous, multi-shock, network-based exposures.* This hybrid approach links recent econometric advances on staggered treatment heterogeneity with the spatial-network logic of shift–share designs [e.g., Borusyak, Hull, and Jaravel, 2022, Autor, Dorn, and Hanson, 2013], providing a novel empirical lens for quantifying how geographically distributed ownership shocks diffuse through interconnected regional economies.

Dynamic difference-in-differences event study. To examine how port-ownership changes affect inland trade, I estimate a dynamic, continuous-treatment difference-in-differences model following De Chaisemartin and D'Haultfœuille [2024]. The specification relates regional trade outcomes to time-varying exposure to Chinese-acquired ports as follows:

$$y^m_{ijt} = \sum_{k=-K_0}^{K_1} \beta^m_k \, \text{Exposure}_{ijt} \cdot \mathbf{1}\{t - g_{ij} = k\} + \alpha_{ij} + \gamma_t + \varepsilon^m_{ijt}, \tag{1}$$

where y^m_{ijt} denotes the outcome of interest (e.g., log freight volume or partner concentration) for region i, industry j, and year t. Exposure$_{ijt}$ measures the baseline-share-weighted reliance of region–industry cells on ports that later come under Chinese ownership. $\mathbf{1}\{t - g_{ij} = k\}$ is an *event-time indicator* that equals 1 when year t is exactly k years before or after the ownership change and 0 otherwise. Here g_{ij} is the first year when region i in industry j becomes affected by a port-ownership change. These indicators divide the timeline into years relative to the event: $k = -1$ is the year before, $k = 0$ is the year of the change,

$k = +1$ one year after, and so on. Interacting them with the exposure measure allows the coefficients β_k^m to trace how outcomes evolve around the timing of port acquisitions for regions with different baseline exposure levels.

The specification includes region–industry fixed effects (α_{ij}) to absorb time-invariant heterogeneity in trade patterns and year fixed effects (γ_t) to capture common shocks. The coefficients β_k^m trace dynamic responses to port-ownership shocks over event time, with $k < 0$ representing pre-trend placebos and $k > 0$ post-treatment effects. Standard errors are two-way clustered by region and year.

Identification relies on (i) parallel trends across regions with different baseline port reliance and (ii) the institutional exogeneity of ownership timing discussed below. Because the exposure weights are fixed in the pre-treatment period (2011–2012), they are unaffected by contemporaneous flows, preventing mechanical endogeneity and ensuring that estimated coefficients capture genuine adjustments in trade connectivity.

5.1 Outcome Variables and Empirical Construction

I estimate four main outcomes that capture both the *scale* and the *structure* of trade for each region–industry cell: the logarithm of inbound and outbound freight volumes, and the logarithm of the Herfindahl–Hirschman Index (HHI) of partner concentration for inbound and outbound flows.

Inbound and outbound freight volumes. Let w_{rijt} denote the tonnage of goods in industry j shipped *from* origin region r *to* destination region i in year t, and w_{idjt} the tonnage shipped *from* region i *to* destination region d. The ERFT/RC microdata report these directed origin–destination shipments. For each region–industry–year cell, I aggregate across all partners to obtain total inbound and outbound volumes:

$$W_{ijt}^{\text{in}} = \sum_r w_{rijt} \qquad \text{(aggregate across all origins for inbound trade)}, \tag{2}$$

$$W_{ijt}^{\text{out}} = \sum_d w_{idjt} \qquad \text{(aggregate across all destinations for outbound trade)}. \tag{3}$$

These outcomes capture the percentage change in inbound and outbound tonnage of industry j in region i relative to baseline values.

Partner concentration (HHI). To examine how network structure evolves, I compute the Herfindahl–Hirschman Index (HHI) of partner concentration separately for inbound and outbound trade. Define the partner shares as

$$s_{rijt}^{\text{in}} = \frac{w_{rijt}}{W_{ijt}^{\text{in}}}, \qquad s_{idjt}^{\text{out}} = \frac{w_{idjt}}{W_{ijt}^{\text{out}}}, \tag{4}$$

and compute

$$HHI_{ijt}^{\text{in}} = \sum_r \left(s_{rijt}^{\text{in}}\right)^2, \qquad HHI_{ijt}^{\text{out}} = \sum_d \left(s_{idjt}^{\text{out}}\right)^2. \tag{5}$$

Each index lies in $[0,1]$, where higher values denote greater concentration (fewer effective partners).

Outcomes and aggregation conventions. The outcomes used in the event study aggregate *across destinations* (for outbound) and *across origins* (for inbound), holding the industry dimension j:

$$\log W_{ijt}^{\text{out}} \equiv \log\Big(\sum_{r\in\mathcal{D}_i} W_{ijrt}^{\text{out}}\Big), \qquad \log W_{ijt}^{\text{in}} \equiv \log\Big(\sum_{r\in\mathcal{D}_i} W_{ijrt}^{\text{in}}\Big).$$

Partner concentration (HHI) is computed on the corresponding destination/origin shares within (i, j, t):

$$HHI_{ijt}^{\text{out}} = \sum_{r \in \mathcal{D}_i} \left(\frac{W_{ijrt}^{\text{out}}}{\sum_{r' \in \mathcal{D}_i} W_{ijr't}^{\text{out}}} \right)^2, \qquad HHI_{ijt}^{\text{in}} = \sum_{r \in \mathcal{D}_i} \left(\frac{W_{ijrt}^{\text{in}}}{\sum_{r' \in \mathcal{D}_i} W_{ijr't}^{\text{in}}} \right)^2.$$

5.2 Constructing exposure

Indices and sets. Let $i \in \mathcal{R}$ index origin regions (NUTS2), $r \in \mathcal{R}$ index destination regions, $j \in \mathcal{J}$ index industries (NST 2007), $p \in \mathcal{P}$ index *ports/terminals*, and $t \in \mathcal{T}$ index years. For each origin i, let $\mathcal{D}_i \subseteq \mathcal{R} \cup \mathcal{P}$ denote the set of all observed destinations for shipments from i (including other inland regions and ports). By construction, $\mathcal{P} \subseteq \mathcal{D}_i$ for all i (ports are a subset of possible destinations).

Baseline reliance (2011–2012 mean). Over the pre-treatment window $\mathcal{T}_0 = \{2011, 2012\}$, define the average outbound trade to each destination:

$$\overline{W}_{ijr,0}^{\text{out}} = \frac{1}{2} \sum_{t \in \mathcal{T}_0} W_{ijrt}^{\text{out}}, \qquad \overline{W}_{ij\cdot,0}^{\text{out}} = \frac{1}{2} \sum_{t \in \mathcal{T}_0} W_{ij\cdot t}^{\text{out}}.$$

Baseline reliance on destination r and on port p are:

$$s_{ijr,0}^{\text{out}} = \frac{\overline{W}_{ijr,0}^{\text{out}}}{\overline{W}_{ij\cdot,0}^{\text{out}}}, \qquad s_{ijp,0}^{\text{out}} = \frac{\overline{W}_{ijp,0}^{\text{out}}}{\overline{W}_{ij\cdot,0}^{\text{out}}}.$$

Because ports are only a subset of all destinations, their total share is bounded by unity:

$$\sum_{p \in \mathcal{P}} s_{ijp,0}^{\text{out}} \leq \sum_{r \in \mathcal{D}_i} s_{ijr,0}^{\text{out}} = 1,$$

with equality only if all outbound flows transit through ports. Analogous inbound reliances $s_{ijr,0}^{\text{in}}$ and $s_{ijp,0}^{\text{in}}$ are defined symmetrically.

Ownership shocks and dynamic exposure. Let $D_{pt} \in \{0, 1\}$ indicate whether port p is under Chinese state-backed ownership or concession in year t. Ports become treated at different times, so D_{pt} switches from 0 to 1 at the acquisition year and remains one thereafter. Because each D_{pt} "switches on" at its own acquisition year T_p, a region–industry's total exposure rises discretely in proportion to its baseline port reliance on that port.For each region–industry (i, j), the time-varying exposure aggregates these baseline reliance shares over treated ports. *Outbound exposure* for region–industry (i, j) at time t is the shift–share:

$$\text{Exposure}_{ijt}^{\text{out}} = \sum_{p \in \mathcal{P}} s_{ijp,0}^{\text{out}} \, D_{pt} \in [0, 1],$$

and *inbound exposure* is

$$\text{Exposure}_{ijt}^{\text{in}} = \sum_{p \in \mathcal{P}} s_{ijp,0}^{\text{in}} \, D_{pt} \in [0, 1].$$

Because the weights are *baseline* (2011–2012) shares, they are predetermined with respect to the subsequent adoption calendar; because D_{pt} varies only at the port–time level, these are classic shift–share constructions where an externally timed port-level shock is filtered through fixed geographic weights [Borusyak, Hull, and Jaravel, 2022].

Intuitively, Exposure_{ijt} increases whenever a port on which (i, j) previously relied becomes treated. Because the $s_{ijp,0}$ weights are predetermined and satisfy $\sum_{p \in \mathcal{P}} s_{ijp,0} \leq 1$, exposure is continuous on $[0, 1]$ and evolves only through the institutional timing of port acquisitions. In the limit, a value of $\text{Exposure}_{ijt} = 1$ would correspond to a region–industry whose entire baseline maritime trade relied on ports now under state-backed ownership.

To illustrate how exposure evolves mechanically, consider Frankfurt's manufacturing base. Before 2016, its shipments were routed mainly through Piraeus, Valencia, and Bilbao. When Piraeus transferred to Chinese control in August 2016, Frankfurt's exposure rose by the share of its baseline reliance on that port. It increased again in 2017 with COSCO's acquisition of Noatum Ports (Valencia and Bilbao), and later marginally in 2022 following the Hamburg transaction. Each discrete jump reflects the industry-specific share of Frankfurt's trade routed through the newly acquired ports, producing a stepwise increase in treatment intensity over time. Analogous adjustments occur across other regions according to their baseline port-reliance structure.

Embedding this structure within the dynamic difference-in-differences estimator yields a causal interpretation for the event-time coefficients $\widehat{\beta}_k^m$, which measure how outcomes change as a progressively larger share of a region's baseline maritime interface becomes treated.

Series of shift–share shocks. In essence, this design embeds not a single shift–share shock, but a *series of port-specific shift–share treatments*. Each port p generates its own time-varying indicator D_{pt}, and each region–industry cell carries a distinct vector of exposure weights $(s_{ijp,0})_{p\in\mathcal{P}}$. The cumulative treatment intensity for (i, j) at time t is therefore the weighted sum of all ports that have transitioned into Chinese state-backed ownership by that date. This differs from canonical shift–share settings—which aggregate one global shock through spatial exposure weights—by allowing multiple, independently timed shocks that interact with highly granular trade-relations data. Because the ERFT/RC microdata record flows at the *region–industry–destination–year* level, it is possible to track how each acquisition (Piraeus in 2016, Valencia/Bilbao in 2017, Zeebrugge in 2018, Hamburg in 2022, etc.) sequentially alters the exposure profiles of inland regions. The resulting treatment variation exploits both the spatial network structure of European freight and the staggered institutional sequencing of ownership events, yielding a richer identification design than a single aggregated shock.

Connection to shift–share literature. This multi-shock construction retains the logic of shift–share instruments [Autor, Dorn, and Hanson, 2013, Borusyak, Hull, and Jaravel, 2022]: external shocks (D_{pt}) are filtered through predetermined geographic weights ($s_{ijp,0}$). However, rather than a single global "China shock" at one point in time, this paper leverages a series of discrete, legally dated ownership shocks at multiple ports and exploits the fact that regional exposure evolves as those ports transition into treatment. In combination with the high-frequency, subnational freight data, this approach allows me to estimate not only cross-sectional differences in exposure but also dynamic adjustments within regions as their port connections become progressively treated.

Formally, the design can be written as a sum of P port-specific shift–shares:

$$\text{Exposure}_{ijt} = \sum_{p=1}^{P} s_{ijp,0} \, D_{pt},$$

so that each $\{D_{pt}\}$ acts as an independent shock transmitted through fixed, predetermined weights $s_{ijp,0}$. The identifying variation therefore arises from differences in baseline port reliance *and* from the staggered timing of ownership across ports, providing $P \times T$ potential treatment cells rather than a single global shift–share.

Interpretation. Following De Chaisemartin and D'Haultfœuille [2024], each coefficient $\widehat{\beta}_k^m$ measures the average change in outcome y_{ijt}^m k years after an increase in exposure, relative to the year before an ownership event. Because treatment intensity is continuous, the coefficients scale linearly: a 0.1 increase in exposure (meaning that ten percent of a region–industry's baseline port reliance shifts to ports under state-backed ownership) corresponds to a $0.1 \times \widehat{\beta}_k^m$ change in the dependent variable at event time k. Under the maintained assumptions of parallel trends and no anticipation, these $\widehat{\beta}_k^m$ trace causal, dynamic treatment effects of foreign port ownership on inland trade outcomes. Reading across $m \in \{\log W^{\text{in}}, \log W^{\text{out}}, \log HHI^{\text{in}}, \log HHI^{\text{out}}\}$ provides a coherent picture of adjustments along both the intensive margin (volumes) and the extensive margin (partner concentration).

5.3 Why timing is plausibly exogenous

My identification hinges on the *timing* of COSCO's acquisitions being plausibly exogenous to short–run local trade conditions. I argue this is reasonable for three reasons:

1. **Externally constrained sequencing.** The Belt & Road Initiative (BRI) was announced in 2013 as a long–horizon state strategy. As Xi Jinping later reflected:

> "[I] proposed the building of the Silk Road Economic Belt and the 21st Century Maritime Silk Road . . . which I call the Belt and Road Initiative. As the Chinese saying goes, 'Peaches and plums do not speak, but they are so attractive that a path is formed below the trees."'

(*Retrospective line from Xi Jinping describing the 2013 launch in Kazakhstan and Indonesia*).

For context, Xi's original speeches and official accounts emphasize the strategic linkage between Asia and Europe, and the parallel creation of a maritime route:

- **Astana, September 2013 (Silk Road Economic Belt):** "His journeys opened the door to friendly contacts between China and Central Asian countries as well as the Silk Road linking east and west, Asia and Europe." china.usc.edu, Xi Jinping speech in Astana (Sept 2013).
- **Jakarta, October 2013 (Maritime Silk Road):** "Southeast Asia has since ancient times been an important hub along the Maritime Silk Road . . . China will work together to build the 21st-Century Maritime Silk Road." Official English summary of Xi's speech, Jakarta (Oct 2013).
- **Belt and Road Forum, 2017 (linking East and West by sea):** "Our ancestors, navigating rough seas, created sea routes linking the East with the West, namely, the maritime Silk Road." Ministry of Foreign Affairs of China, BRI Forum Keynote.

The connection between maritime routes and Europe is formalized later in the official 2015 BRI policy document, which explicitly links China's coastal ports to Europe by sea:

> *"The key directions of the 21st-Century Maritime Silk Road are: from China's coastal ports, passing across the South China Sea to the Indian Ocean, ex-*

> *tending to Europe; and from China's coastal ports, passing across the South China Sea to the South Pacific."*

(National Development and Reform Commission, Ministry of Foreign Affairs, and Ministry of Commerce, "Vision and Actions," 2015).

Similarly, Xi Jinping has repeatedly described ports as the structural anchors of the Maritime Silk Road:

> *"Ports are the starting points and pivots of the maritime Silk Road. Over 2,000 years ago, our predecessors set sail, braving the seas, and opened a maritime Silk Road connecting East and West."*

(People's Daily Xi Jinping Speeches Database, 2017).

2. **Port-specific institutional timing.** Port acquisitions in Europe followed nationally regulated privatization schedules, public tenders, and multi-level regulatory reviews. These processes imposed fixed legal milestones largely detached from short-term trade fluctuations.

   For example, Greece's HRADF launched the international tender for a 67% stake in Piraeus Port Authority in March 2014. A binding offer was accepted in January 2016, and the initial 51% stake was transferred in August 2016, with a contractual step–up to 67% conditional on specific milestones. Such legally mandated timelines reflect formal privatization calendars rather than responses to transitory trade shocks.

   Similarly, COSCO's minority acquisition in Hamburg's Tollerort terminal (2021–2023) unfolded under intense domestic scrutiny and overlapping institutional reviews. The process included federal reclassification of the terminal as critical infrastructure, inter-ministerial negotiations, and a final Federal Cabinet decision capping COSCO's stake at 24.9% (excluding veto rights and board seats). Hamburg's lease framework, federal screening mechanisms, and public opposition jointly determined both the timing and structure of the transaction.

Parallel institutional constraints shaped other cases. In Zeebrugge, COSCO Shipping Ports' full takeover in 2018 followed the 2016 COSCO corporate merger, European Commission merger control clearance, and subsequent approvals from the port authority and Flemish government. In Spain, COSCO's 2017 purchase of a 51% stake in Noatum Ports (Valencia, Bilbao) required CNMC authorization, Council of Ministers approval, and concession transfers under the Port Reform Law, while aligning with JP Morgan Infrastructure Fund's divestment schedule.

Taken together, these cases illustrate that the sequencing of acquisitions was determined by national regulatory and ownership frameworks—fixed institutional calendars rather than contemporaneous local trade conditions. Additional details on the institutional setting and legal frameworks governing each transaction are provided in *Appendix A*.

3. **Long lead times and phased control.** Major port transactions involve multi-year negotiations, due diligence, regulatory clearances, and financing arrangements. Even after signing, share transfers and operational integration occur in phases, often conditional on performance or regulatory milestones. These long lags between investment intent and effective control leave little scope for timing that reacts to short-term trade fluctuations.

4. **Regional context not coincident with surges.** Independent reporting notes a broader wave of China–linked projects across the Balkans and Southeastern Europe over the decade after BRI's launch (well over a hundred projects and tens of billions of euros). This scale and pace reflect geopolitical capital flows rather than fine–tuned responses to any one region's trade uptick.

Identification and institutional sequencing. These institutional, contractual, and geopolitical features underpin the assumption that COSCO's port acquisitions were not timed in response to short-run regional trade dynamics. National tender schedules, multi-year negotiation processes, and the broader Belt and Road investment wave introduced external sequencing largely orthogonal to local economic fluctuations. The resulting variation is staggered across independent legal jurisdictions, each governed by its own privatization frameworks, concession laws, and regulatory calendars. This structure limits coordinated anticipation or endogenous selection while providing quasi-experimental timing across Europe's port network.

Moreover, treatment exposure propagates through pre-existing port–region trade linkages, whose intensity is determined by geography and infrastructure rather than contemporaneous performance. Hence, shifts in regional trade following acquisitions are more plausibly interpreted as responses to exogenous changes in ownership and operational control.

Anticipation and validation. One potential concern is that firms or logistics operators could adjust in advance of announced tenders. In practice, this is unlikely for two reasons. First, the outcomes and timing of tenders are highly uncertain, subject to lengthy legal and regulatory procedures. Second, operational control typically transfers years after announcements, following audits and concession approvals.

6 Results

This section presents the main empirical results. Estimates capture *relative* effects—differences in trade outcomes between regions more and less exposed to Chinese-acquired ports, conditional on region, industry, and year fixed effects. Coefficients are interpreted as dynamic semi-elasticities of trade outcomes with respect to exposure intensity. A coefficient β_k^m thus measures the semi-elasticity of outcome m (e.g., freight volume or partner concentration) with respect to a one-unit change in exposure k years after an ownership event. The results below begin with baseline dynamics in freight volumes and then trace corresponding adjustments in partner concentration, followed by a section on trade corridor heterogeneity.

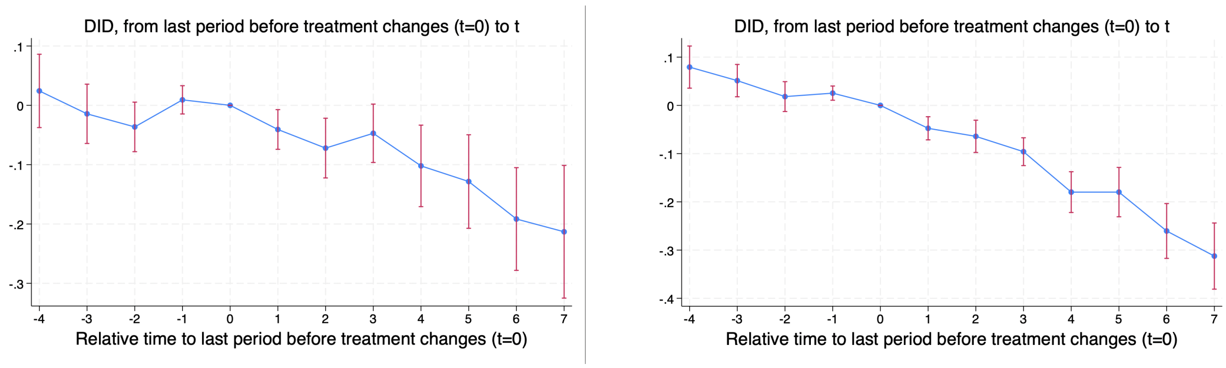
6.1 Baseline Dynamics: Freight Volumes

The first set of results examines the *intensive margin* of trade—that is, how much total freight regions move. Figure 7 (LHS) plots the event-time coefficients for log outbound freight volumes. Pre-treatment coefficients are statistically indistinguishable from zero, indicating parallel trends. Post-acquisition coefficients turn negative and gradually diverge. The magnitude of the response is economically meaningful. A one-unit increase in exposure—that is, shifting an entire region's baseline reliance from non-treated to treated ports—reduces outbound volumes by about 20 percent relative to less-exposed regions.

For inbound trade, pre-trends are slightly noisier, with small deviations at certain horizons, but the post-treatment dynamics mirror those of outbound volumes. In this case, a one-unit increase in exposure—that is, shifting an entire region's baseline reliance from non-treated to treated ports—reduces inbound volumes by about 30 percent relative to less-exposed regions.

These are *relative* effects: highly exposed regions contract compared with otherwise similar regions connected mainly to untreated ports, not an aggregate fall in European freight. The dynamic pattern—flat before treatment and gradual after—is consistent with delayed logistical and contractual adjustments rather than abrupt shocks. Comparable magnitudes are found in infrastructure- and market-access literatures where large-scale transport shocks alter the geography of trade [e.g. Donaldson, 2018, Faber, 2014, Gollin and Rogerson, 2021], suggesting that changes of a few percentage points per year in effective market access translate into material but not catastrophic reallocation of freight flows.

The larger response in inbound freight (–30%) relative to outbound (–20%) aligns with evidence that exporters have greater discretion in routing decisions, whereas importers are typically tied to fixed supply contracts and established delivery chains. Prior studies of



(a) Outbound freight volumes

(b) Inbound freight volumes

Figure 7: Event-study estimates for log inbound and outbound freight volumes

transport chokepoints similarly find that outbound adjustments occur more readily when network frictions or ownership changes alter relative costs [e.g. Faber, 2014, Coşar and Demir, 2016].

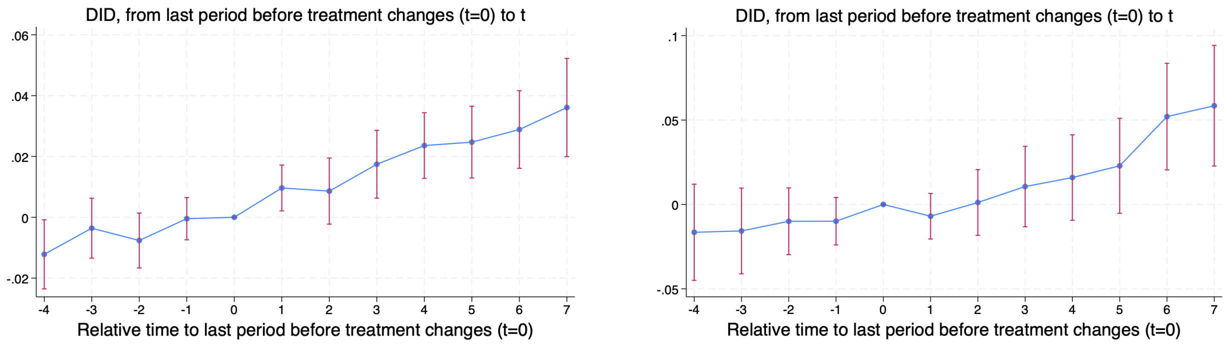
6.2 Partner Concentration and Network Tightening

The second margin of adjustment concerns the *extensive margin*—how trade relationships are distributed across partners. Figure 8 reports event-study estimates for the Herfindahl–Hirschman Index (HHI) of partner concentration, computed separately for outbound and inbound flows at the region–industry level:

$$HHI_{ijt}^{\text{out}} = \sum_{d} (s_{idjt}^{\text{out}})^2, \qquad HHI_{ijt}^{\text{in}} = \sum_{r} (s_{rijt}^{\text{in}})^2,$$

where s_{idjt}^{out} and s_{rijt}^{in} denote the shares of freight sent or received from each partner. Higher values indicate greater concentration—that is, fewer effective partners.

Pre-treatment coefficients are flat, and both series rise steadily after treatment. Regions more exposed to Chinese-acquired ports experience a 4–5% increase in HHI within five years, implying a moderate but statistically meaningful loss of partner diversity. Trade becomes more concentrated: freight is routed through fewer origins or destinations, consistent with consolidation around shared logistics corridors or vertically integrated carrier networks.



(a) Outbound partner concentration **(b)** Inbound partner concentration

Figure 8: Event-study estimates for log HHI (partner concentration)

This pattern mirrors findings from other settings where transport nodes or ownership integration reshape the *structure*—rather than the overall scale—of trade flows [e.g. Coşar and Demir, 2016, Hale, Caballero, and Candelaria, 2014, Pandalai-Nayar, 2014]. Taken together, the intensive-margin contraction in freight and the extensive-margin tightening of partner links point to a logistics-layer reorganisation rather than a collapse of economic activity.

6.3 Corridor Heterogeneity and Reorientation of Trade Flows

The preceding results show that regions more exposed to Chinese port acquisitions experience relative declines in freight volumes and rising partner concentration. Because the design identifies *relative* effects, these contractions imply reallocation rather than an overall fall in European trade. The key question is therefore: *where do these flows go*? Which corridors within Europe gain relative weight as others lose it?

A natural hypothesis is that the relative gains accrue to regions more closely integrated into China's *Belt and Road Initiative* (BRI). Beyond port ownership, the BRI encompasses a dense network of Chinese-funded infrastructure across Europe's southern and eastern periphery—rail links, logistics hubs, and energy corridors—often negotiated bilaterally outside EU coordination. Central and Southeastern European economies, including the Visegrád countries, have viewed engagement with the BRI as a potential source of geopolitical leverage and capital diversification within the EU framework [Garcia-Herrero and Xu, 2023, Clayton, Maggiori, and Schreger, 2024, Farrell and Newman, 2019]. Their openness to Chinese investment has been interpreted as both an economic opportunity and a strategic hedge against Western-dominated integration, creating a distinct political–economic alignment along Europe's Mediterranean and Eastern flanks. In this context, port acquisitions may have reinforced a broader reallocation of trade toward the BRI's European logistics arc.

Table 4: TEN–T Core Corridors and BRI Alignment

Corridor No.	**TEN–T Core Corridor**	**BRI Alignment**
1	Baltic–Adriatic Corridor	
2	North Sea–Baltic Corridor	×
3	Mediterranean Corridor	
4	Orient/East–Med Corridor	
5	Scandinavian–Mediterranean Corridor	×
6	Rhine–Alpine Corridor	×
7	Atlantic Corridor	×
8	North Sea–Mediterranean Corridor	×
9	Rhine–Danube Corridor	×

Notes: Classification based on whether corridor regions (i) signed Belt and Road cooperation agreements, (ii) host Chinese-funded infrastructure or logistics projects, or (iii) are economically integrated with BRI maritime and overland routes. Sources: European Commission (TEN–T 2023).

To examine this hypothesis, I embed the analysis in Europe's transport architecture. The *Trans-European Transport Network* (TEN–T) defines nine core multimodal corridors linking seaports, inland terminals, and industrial centres across the continent.[20]

Using official TEN–T maps, I extract the list of core logistics cities along each corridor and match them to NUTS2 regions in the dataset, yielding a one-to-many correspondence between corridors and regions. This mapping makes it possible to classify corridors as *BRI-aligned* or *non-BRI-aligned* depending on whether they predominantly include regions that

[20]The nine TEN–T corridors are: (i) Scandinavian–Mediterranean, (ii) North Sea–Baltic, (iii) North Sea–Mediterranean, (iv) Rhine–Alpine, (v) Rhine–Danube, (vi) Baltic–Adriatic, (vii) Orient/East–Mediterranean, (viii) Mediterranean, and (ix) Atlantic. See European Commission, *TEN–T Core Network Corridors Overview*, 2023.

have signed BRI cooperation agreements, received Chinese-funded infrastructure investment, or are otherwise economically integrated with China through the Belt and Road framework.

This mapping allows classification of corridors as *BRI-aligned* or *non-aligned* according to whether they include regions that (i) have signed BRI cooperation agreements, (ii) host Chinese-funded infrastructure, or (iii) are economically integrated with BRI maritime or inland routes. In practice, the Orient/East–Mediterranean and Mediterranean corridors—linking Piraeus, Valencia, Genoa, and Vado Ligure to Central and Eastern Europe—form the *BRI-aligned* group, while the Rhine–Alpine, North Sea–Mediterranean, Atlantic, and Scandinavian–Mediterranean corridors represent the legacy *non-aligned* group.

This classification captures Europe's two main logistics arcs: the traditional Northern Range–Rhine system and the emerging Southern–Eastern axis aligned with the Maritime Silk Road. By interacting exposure with corridor indicators, I estimate how treatment effects differ across these transport backbones.

Thw two panels on Figure decompose effects grouped by major TEN–T transport corridors. Negative effects are concentrated along the Rhine–Alpine and North-Sea–Mediterranean (Western) corridors, while effects are close to zero or slightly positive along the Mediterranean and Orient/East–Med corridors that align with the Belt-and-Road maritime routes. This pattern indicates a *reallocation of trade corridors*: freight intensity declines relatively in traditional Western gateways and shifts toward Southern and Eastern corridors connected to newly acquired ports. Again, these are *relative* reallocations—the network as a whole remains active but changes orientation.

In summary, corridor-level heterogeneity reveals that the effects of foreign port ownership are spatially asymmetric: Europe's logistics backbone is being reweighted south and east, with BRI-linked corridors emerging as relative gainers. This south–eastward reorientation is consistent with the descriptive network evidence from Section 4 and sets the stage for the next analysis on network centrality, which quantifies how inland connectivity has been redistributed across regions.

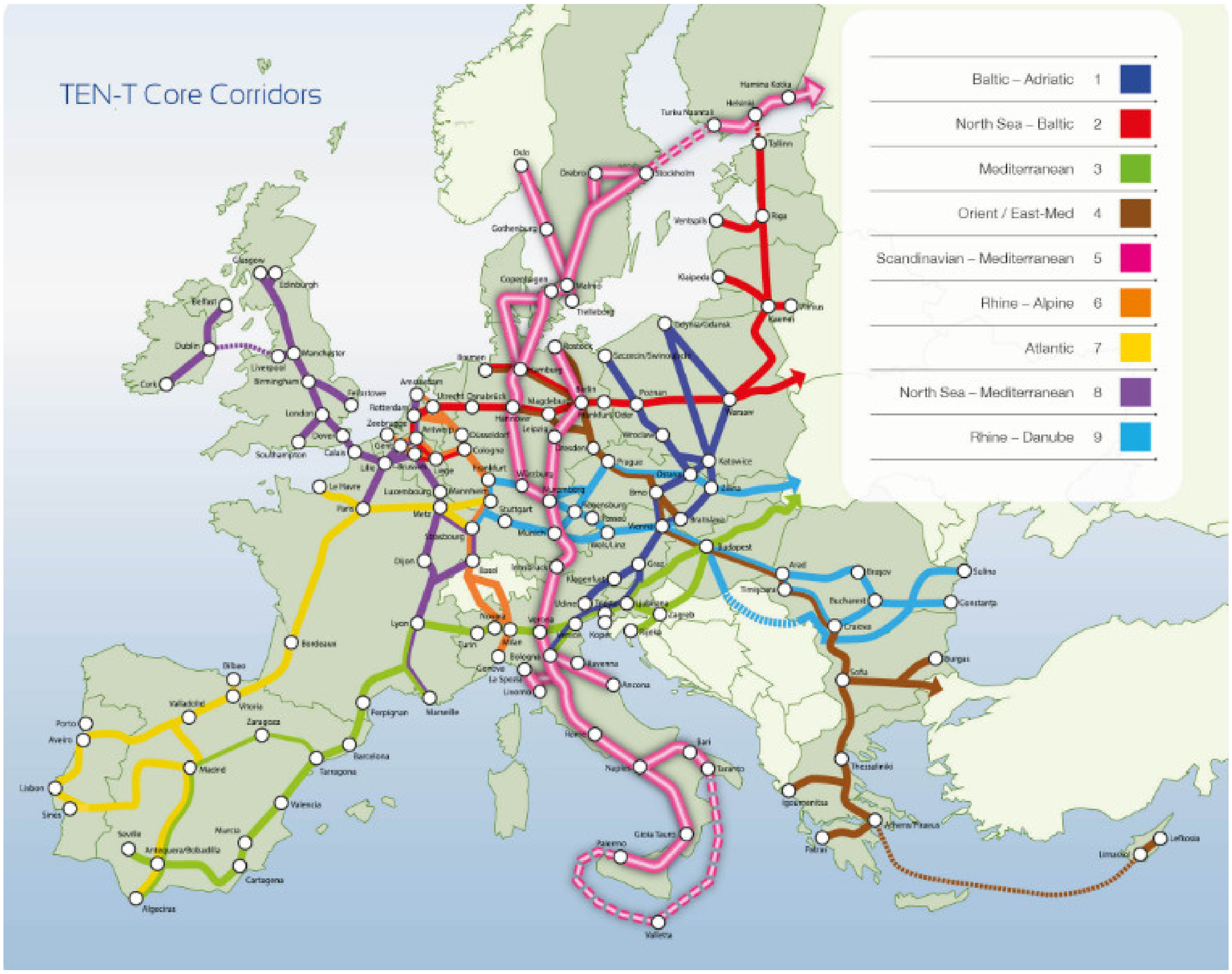
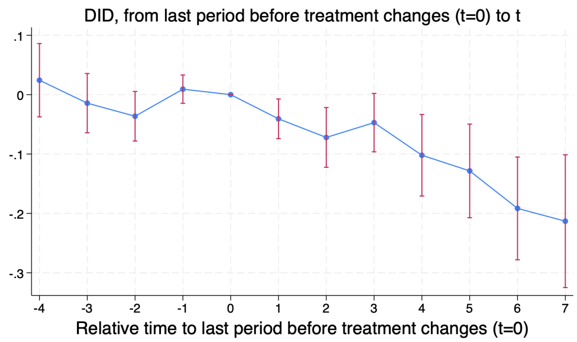


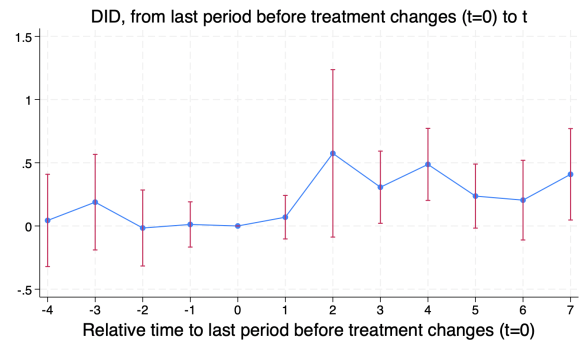
Figure 9: TEN–T Core Network Corridors across the European Union. The Mediterranean and Orient/East–Med corridors overlap with Belt and Road maritime and inland routes, forming the *BRI-aligned* group described in Table 4.

Source: European Commission, *Trans-European Transport Network (TEN–T) Core Network Corridors Overview*, DG MOVE (2023).

The pattern is mirrored in the centrality results below. This approach moves from corridor-level comparisons to a network perspective, identifying which regions have become more or less central in the pattern of intra-European trade as port ownership and corridor realignments have unfolded.



(a) Western-EU Corridors



(b) BRI-Aligned Corridors

Figure 10: Event-study estimates for outbound trade by corridor group.

6.4 Network Centrality: Winners and Losers

The network-centrality analysis provides a complementary, descriptive view of how connectivity within Europe's inland trade network has been reweighted over time. Between 2011 and 2022, the most central nodes shift from Western and Northern Europe—Rotterdam, Antwerp–Bruges, and their Dutch and Belgian hinterlands—toward Southeastern and Mediterranean regions such as Greece, Bulgaria, Croatia, and Southern Italy. Sixteen of the twenty largest "centrality winners" are located in countries integrated into the Maritime Silk Road, while only three of the top twenty "losers" are. This pattern aligns closely with the relative effects documented above: the regions that experienced the steepest relative declines in freight volumes and rising concentration are also those losing network importance, while regions along BRI-aligned corridors gain it. Although this evidence is descriptive, it fits consistently with the econometric results—supporting the interpretation that foreign port ownership has not diminished Europe's overall connectivity, but has *re-anchored it geographically.* Such relative shifts in centrality are consistent with network-theoretic models where shocks to key nodes reweight link intensities without altering the total size of the network [Chaney, 2014, Baqaee and Farhi, 2019].

Policy interpretation. The corridor heterogeneity and the centrality metrics have direct implications for Europe's infrastructure and economic-security policy. The TEN–T frame-

(a) Centrality Winners (Top 20)

Region	Name
ES64	Galicia (ES)
BG31	Severozapaden (BG)
BG42	Yugozapaden (BG)
HR02	Zagrebačka (HR)
EL42	Sterea Ellada (GR)
ITF2	Friuli–Venezia Giulia (IT)
BG41	Yugoiztochen (BG)
BG34	Severoiztochen (BG)
ITG2	Sardegna (IT)
ITC2	Nord–Ovest (IT)
RO41	Sud–Vest Oltenia (RO)
PT18	Alentejo (PT)
EL51	Makedonia–Thrace (GR)
ES43	Extremadura (ES)
ES23	Andalucía (ES)
PT15	Algarve (PT)
BG32	Severen Tsentralen (BG)
BG33	Severoiztochen (BG)
SK04	Východné Slovensko (SK)
ITG1	Sicilia (IT)

BRI partners: 16 / 20 (80 %)

(b) Centrality Losers (Top 20)

Region	Name
LI00	Liechtenstein (LI)
UKN0	Northern Ireland (UK)
EE00	Estonia (EE)
EL43	Crete (GR)
NO02	Hedmark og Oppland (NO)
NO04	Agder–Rogaland (NO)
EL61	Epirus & W. Macedonia (GR)
BE10	Brussels (BE)
UKE4	West Yorkshire (UK)
UKD3	South Yorkshire (UK)
UKC1	East Midlands (UK)
RO12	Centru (RO)
SI04	Zahodna Slovenija (SI)
NO03	Trøndelag (NO)
UKI4	West Midlands (UK)
SI03	Vzhodna Slovenija (SI)
DK02	Midtjylland (DK)
UKE1	Northumberland (UK)
UKC2	West Midlands (UK)
NO05	Vestlandet (NO)

BRI partners: 3 / 20 (15 %)

Figure 11: Top twenty "centrality winners" and "losers" in Europe's trade network, 2011–2022. Panel (a) lists regions gaining the most in degree centrality; Panel (b) lists those losing the most. Sixteen of the twenty winners lie in countries participating in the Belt and Road Initiative or 17+1 framework, whereas only three of the twenty losers do. The pattern indicates that inland connectivity has re-anchored south- and east-ward, aligning Europe's trade network more closely with BRI-linked corridors.

work was designed to unify transport infrastructure across the continent, yet the results suggest that ownership and governance—not only physical integration—determine which parts of the network expand or decline. Corridors anchored by ports under foreign control have gained logistical weight relative to those under legacy governance, implying that strategic capital allocation can tilt the spatial balance of the internal market. In policy terms, this is a form of "network power": control of nodes influences which corridors grow, potentially reorienting Europe's connectivity toward the Mediterranean and Eastern gateways aligned with the Silk Road Economic Belt.

6.5 Transshipment and Containerised Cargo

In line with the corridor and centrality patterns documented above, a complementary mechanism emerges in the composition of freight itself. The ERFT/RC microdata capture the *physical movement of goods* rather than declared trade transactions, allowing the detection of rerouting and logistical adjustments that reflect *transshipment activity*—the repackaging, consolidation, or redirection of cargo through new hubs—rather than changes in production or demand. Such adjustments are most evident in sectors reliant on containerised and multimodal transport (NST 18–20).

Large discrete shifts in freight flows occur precisely in these containerised categories and in regions aligned with the Belt and Road's maritime and inland corridors. The clearest case is Piraeus (EL30), where containerised road-freight volumes surge roughly one year after COSCO's 2016 acquisition of the port authority. This increase coincides with Piraeus's transformation into a regional transshipment hub, consistent with the inland reallocation and corridor reweighting observed elsewhere in the data. In this sense, the surge in containerised cargo around Piraeus illustrates the micro-mechanism through which ownership changes propagate inland—an early manifestation of the broader logistics-layer adjustment discussed below and consistent with the transshipment-hub dynamics identified by Do, Ganapati, Wong, and Ziv [2025].

Taken together, the rise in containerised cargo offers micro-level evidence of a logistics-layer adjustment that could be consistent with two complementary channels. First, a network channel, where foreign control of maritime nodes increases the centrality of transshipment hubs and reroutes cargo through affiliated gateways. Second, an institutional channel, where differences in concession oversight and customs enforcement shape how strongly those network incentives manifest. In settings where monitoring is weaker or fragmented—such as parts of Southeastern Europe—the same ownership change can produce larger logistical shifts than in tightly regulated systems like France or Northern Europe. Overall, these results reinforce the idea that ownership reorganises how goods move rather than what is traded, with domestic governance capacity modulating the outcome. The next section discusses these mechanisms within the broader frameworks of transport costs, vertical integration, and geoeconomic statecraft.

7 Discussion

The evidence points to a consistent pattern of *relative reallocation*: regions more exposed to Chinese-owned ports experience relative decreases along both the extensive and the intensive margin of trade.

This section unpacks these mechanisms—linking the empirical evidence to the broader literatures on transport costs, vertical integration, and geoeconomic statecraft.

Routing incentives and vertical integration. Ownership and terminal concessions confer operational control over berthing, scheduling, and storage. When terminal operators are vertically integrated with shipping lines or logistics networks, they can subtly shift cost and reliability advantages toward affiliated routes. These routing incentives can reweight inland flows, reducing effective market access for regions dependent on competing gateways. In network terms, small nodal cost shocks propagate along supply links, producing the corridor-level reallocation observed in the data [Hale, Caballero, and Candelaria, 2014, Chaney, 2014, Allen and Atkin, 2023]. The compositional shift toward containerised categories (NST 18–20) could be reinforcing this mechanism: ownership changes could accelerate containerisation and transshipment rather than altering what is produced.

Institutional and governance heterogeneity. The magnitude of these effects varies with domestic oversight and concession frameworks. In settings with weaker monitoring or more flexible concession rules—such as parts of Southern and Eastern Europe—foreign operators face fewer regulatory constraints and can coordinate terminal operations more closely with affiliated carriers. By contrast, Western landlord ports under stricter EU competition and state-aid rules exhibit smaller adjustments. These differences suggest that institutional capacity could be mediating how ownership translates into network outcomes, an insight consistent with the emerging literature on the political economy of infrastructure control [Evenett, 2020, Garcia-Herrero and Xu, 2023, Clayton, Maggiori, and Schreger, 2024].

Strategic integration and network re-anchoring. Beyond cost and governance channels lies a broader strategic logic. Ownership links European gateways more tightly to China's global logistics system, integrating Southern and Eastern corridors into the Maritime Silk Road while reducing the relative importance of the traditional Northern Range. From a European perspective, the result is not disconnection but a *re-anchoring of connectivity*: the continent's inland network pivots toward new maritime hubs. This dynamic reflects a shift from competition in goods markets to competition over *control of connectivity*, the core of what scholars term geoeconomic statecraft [Blackwill and Harris, 2016, Farrell and Newman, 2019].

Overall, these possible mechanisms point to an adjustment operating through the *logistics layer* of globalization. Ownership changes alter routing priorities and governance structures, producing geographically asymmetric but system-wide reallocations of trade flows. The European trade network remains intact, but its centre of gravity moves south and east—a reconfiguration of connectivity rather than a contraction of commerce.

8 Conclusion

Ports are the architecture of trade, and who governs them helps determine how goods move across space. This paper provides the first systematic evidence that foreign ownership of maritime infrastructure can reshape Europe's inland trade network. Using microdata on 1.5 million road-freight shipments between 2011 and 2022, and exploiting the staggered, policy-driven rollout of China's Maritime Silk Road, the analysis shows that regions more exposed to Chinese-acquired ports experienced relatively larger contractions in freight volumes and fewer active trading links. These are relative reallocations—flows that weaken along established Western corridors and strengthen along Southern and Eastern axes connected to the Belt and Road Initiative. More broadly, the findings allude that the organisation of trade—its routing, connectivity, and control—has become as central to Europe's interdependence as its overall scale.

Future research should examine how these connectivity shifts translate into regional economic outcomes and long-term resilience. Linking freight data to firm-level and regional input–output accounts would make it possible to trace how changes in routing and access affect production, employment, and value creation across European regions. Such analysis would extend the paper's focus on network reconfiguration to the real economy, quantifying how infrastructure governance mediates regional adjustment and competitiveness. Integrating road, rail, and maritime datasets would further illuminate how shocks at maritime gateways propagate through multimodal systems, revealing complementarities and bottlenecks between transport modes. These extensions would situate ownership shocks within broader questions of European industrial policy and resilience—how global logistics disruptions, foreign investment, and decarbonization pressures jointly reshape Europe's geography of production and connectivity.

From a policy perspective, the findings speak directly to Europe's debates on autonomy and resilience. They show that ownership and governance of critical transport infrastructure can reconfigure the continent's trade network, altering the corridors through which goods move. Resilience therefore depends not only on diversifying partners but also on strengthening the frameworks—privatisation, concession, and investment-screening regimes—that regulate such assets and ensure transparency and interoperability. Europe's challenge is not to retreat from foreign capital, but to govern interdependence effectively: to keep its networks open, contestable, and strategically balanced.

All things considered, the paper provides the first systematic evidence that governance changes at a handful of maritime gateways have reshaped Europe's inland trade network.

The results document relative declines in freight volumes and partner concentration, as well as the geographic reconfiguration of trade corridors. They underscore that the organisation of trade—not only its scale—has become a central dimension of Europe's economic interdependence. The challenge ahead lies not in limiting foreign capital, but in governing interdependence effectively.

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A Port Chronologies and Institutional Context

This appendix provides detailed documentation of the institutional sequencing of major port acquisitions referenced in the main text. For each case, I summarise the legal tender or concession, approval procedures, and effective transfer of ownership.

A.1 Piraeus (Greece)

As outlined, the American Enterprise Institute's *China Global Investment Tracker* provides an accessible starting point for mapping the chronology of Chinese participation in European ports, among other investment projects. I complement this with the legal tender associated with the acquisition deal, titled "Invitation to submit an expression of interest for the acquisition of a majority stake in the share capital of Piraeus Port Authority S.A." (Athens, 5 March 2014) and the corresponding press release following the Board of Directors of the Hellenic Republic Asset Development Fund declaring COSCO Group as the preferred investor for the acquisition of the shares of Piraeus Port Authority S.A., in accordance with the terms of the tender process (Athens, 17 February 2016).

On the *China Global Investment Tracker*, for example, in its country table for Greece, the earliest transport-sector record appears in November 2008, identifying "China Ocean Shipping (COSCO) – Transport – Greece – US$ 5.79 billion." This observation corresponds to the 35-year container-terminal concession granted to COSCO Pacific's subsidiary *Piraeus Container Terminal S.A.* described in the 2014 HRADF tender dossier. Later CGIT entries list additional transport investments—July 2016 (US$ 320 million) and October 2021 (US$ 110 million)—which align with the two equity transfers documented in official Greek sources: the 2016 sale of a 67 percent stake in Piraeus Port Authority S.A. Taken together, the CGIT data, the HRADF legal tender, and COSCO Shipping Ports annual reports trace a consistent sequence of port-related investments in Greece—2008 (terminal concession) $\rightarrow$ 2016 (majority control)—providing an externally verified baseline for the staggered treatment timing used in this paper's identification strategy.

Two legal-institutional steps anchor the Piraeus chronology used for identification:

(i) Container-terminal concession (COSCO–PCT). The HRADF tender dossier (Invitation to Submit an Expression of Interest, 5 March 2014) sets out the pre-existing concession relationship between PPA and the COSCO subsidiary PCT:

> "On 25 November 2008, PPA entered into a concession agreement with Piraeus Container Terminal S.A. ("PCT"), a subsidiary of Cosco Pacific Limited, ... whereby PCT was granted the right to operate the so-called 'New Container Terminal' in the Port of Piraeus for a period of thirty (30) years subject to two (2) potential five-year extensions."

This same dossier records the subsequent extension:

> "The initial duration of the [PCT] agreement was 35 years, but in 2012 it was extended until February 2052."

(quotations from HRADF tender dossier; see also the EP case study background).[21]

(ii) Share acquisition (PPA majority stake) and step-up structure. The same HRADF dossier defines the share-sale structure:

> "...the Fund's Board of Directors has decided ... to sell a majority stake corresponding to a percentage of 67% in the share capital of PPA (the 'Stake') ... through an international competitive tender process."

and explicitly ties the transaction to renegotiation of the State–PPA concession agreement.[22]

On 17 February 2016, HRADF publicly announced the outcome of the tender:

[21] HRADF, *Invitation to Submit an Expression of Interest for the Acquisition of a Majority Stake in PPA S.A.*, 5 March 2014, pp. 3–4 (company snapshot; COSCO concession and extension). See also Ghiretti et al. (2023), case study "Piraeus, Greece," p. 21: "In November 2008 ... the initial duration of the agreement was 35 years, but in 2012 it was extended until February 2052."

[22] HRADF, *Invitation*, 5 March 2014, pp. 2–3 (transaction structure; renegotiation of the HR Concession Agreement). :contentReference[oaicite:3]index=3

> "Cosco Group (Hong Kong) Limited is nominated Preferred Investor for the acquisition of the **67%** share capital of PPA S.A."

The same notice clarifies the legal sequencing: submission to the Court of Audit for pre-contractual control and completion *subject to competent authorities' approvals*.[23]

Macroeconomic and institutional context. The 2016 sale of a majority stake in the Piraeus Port Authority S.A. (PPA) was inseparable from Greece's post-crisis privatisation commitments under the country's international assistance programmes. Following the 2010 sovereign-debt crisis, Greece entered successive bailout agreements with the European Union, the European Central Bank, and the International Monetary Fund (IMF). As part of the conditionality attached to these loans, the Greek state undertook to raise funds through the divestment of state assets. As noted in contemporary analyses,

> "In 2010 the Greek government was in the midst of a financial and economic crisis, reliant on loans from the European Union and the International Monetary Fund (IMF). As part of their repayment plan, the Greek government was required to privatise some of its assets, including the Port of Piraeus (Law 4336/2015)."

(King's College London, 'What can be learnt from China's investment in Europe?', 2022).[24]
A related study explains that

> "Together with a viable repayment plan, Greece was required to privatise some of its state assets, such as the Port of Piraeus, amounting to €50 billion."

(King's College London, 'China in Focus: The Port of Piraeus', 2022).[25]
In legal terms, these commitments were codified in Law 3986/2011 establishing the Hellenic Republic Asset Development Fund (HRADF) and reinforced by Law 4336/2015, which enumerated the privatisation pipeline agreed with Greece's creditors. The inclusion of PPA

[23] HRADF press release, "Cosco Group (Hong Kong) Limited is nominated Preferred Investor for the acquisition of the 67% share capital of PPA SA.," Athens, 02/17/2016. :contentReference[oaicite:4]index=4

[24] https://www.kcl.ac.uk/what-can-be-learnt-from-chinas-investment-in-europe

[25] https://www.kcl.ac.uk/lci/assets/china-in-focus-piraeus-paper-final.pdf

in this framework meant that the 2016 COSCO acquisition was not merely a commercial transaction but part of a state-directed programme to mobilise proceeds for debt repayment and restore fiscal credibility. In this sense, the ownership transfer constitutes an externally mandated institutional shock—driven by macro-financial conditionality rather than contemporaneous cargo demand—which supports its interpretation as an exogenous timing event within the paper's identification strategy.

Treatment in this paper. I use: (a) the 2008/2012 COSCO–PCT concession as predetermined *baseline exposure* and (b) the 2016 HRADF share-transfer decision/closing window as the discrete *ownership shock* for the port authority (with the contractual step-up to **67%** forming the terminal level of control). This coding aligns the legal record (concession vs. corporate control) with our identification, which requires externally sequenced timing rather than contemporaneous cargo conditions.

A.2 Hamburg (Germany)

The European Parliament's TRAN study records both the scaling and outcome of the Hamburg transaction:

> "The Hamburg port investment was originally planned to be EUR 100 million, but has since been reduced in scale, with a decrease in the **shareholding to 24.99%**. The revised investment value is not yet known . . . "

It further summarises the deal as "a minority shareholding in a single terminal within an EU port (Port of Hamburg, Germany)."[26] Accordingly, in this dataset Hamburg enters as a *minority-terminal* shock—material for route prioritisation and liner–terminal coordination, but legally distinct from majority port-authority control.

[26] Ghiretti et al. (2023), p. 14 (note to Figure 2) and p. 16 (case-study scope).

Institutional and political context. The Hamburg transaction was negotiated within Germany's investment-screening framework and the governance structure of the Free and Hanseatic City of Hamburg, which holds roughly 69% of *Hamburger Hafen und Logistik AG* (HHLA), the parent operator of Container Terminal Tollerort (CTT). In September 2021 HHLA and COSCO Shipping Ports Limited (CSPL) announced a plan for CSPL to acquire a 35% stake in CTT. This triggered a multi-ministerial review under the *Außenwirtschaftsverordnung* (Foreign Trade and Payments Ordinance), which regulates foreign investment in critical infrastructure. After prolonged debate among the Federal Chancellery and the Ministries of Economic Affairs, Foreign Affairs, and Transport, the Federal Cabinet approved a revised version of the deal on 26 October 2022, explicitly limiting the shareholding to **24.9%** and excluding COSCO from board representation or veto rights. The Federal Ministry for Economic Affairs and Climate Action stated:

> "The Federal Government has decided to approve the acquisition of a 24.9 percent minority share by COSCO Shipping Ports Limited in the HHLA subsidiary Container Terminal Tollerort GmbH under investment control law. This approval is subject to the condition that no acquisition of further shares or influence may take place."

(Federal Ministry for Economic Affairs and Climate Action, Press Release, 26 October 2022). HHLA welcomed the modified approval, stating that:

> "We welcome the decision of the German Government. The minority shareholding now approved strengthens Hamburg's position as a logistics hub while safeguarding German investment law requirements.[27]"

The resulting transaction thus reflects a politically mediated compromise: a capped minority equity stake that preserved the City of Hamburg's controlling interest and satisfied federal security scrutiny. From an identification perspective, the 2022 approval constitutes a

[27]Source: *(HHLA Press Release, 26 October 2022).*[28]

narrowly defined *ownership event* constrained by institutional safeguards, distinct from the full-privatisation logic observed in Piraeus. Despite these institutional differences from the full-privatisation model observed in Piraeus, the episode illustrates how regulatory and political constraints shape both the size and the timing of ownership transfers—an important consideration for interpreting variation in treatment intensity across ports without threatening identification validity.

A.3 Valencia and Bilbao (Spain)

In June 2017, *COSCO Shipping Ports Ltd.* (CSPL) entered into a definitive agreement to acquire a controlling stake in the Spanish port opernot caator *Noatum Ports S.L.U.*, thereby obtaining operational control of the container terminals in Valencia and Bilbao. The agreement, announced on 12–13 June 2017, provided for the purchase of a **51 percent equity interest** from the private-equity fund *TPG Capital* for approximately **€203 million** (US$ 228 million), while TPG's investment vehicle *TPIH S.A.R.L.* retained the remaining 49 percent.[29] The transaction transferred control of Spain's largest privately operated port group—established in 2010 through the restructuring of Dragados SPL—to a state-linked Chinese operator, subject to approval by Spain's National Commission for Markets and Competition (CNMC) and notification to the European Commission under the EU Merger Regulation. COSCO's acquisition encompassed the terminals *CSP Valencia Terminal* and *CSP Bilbao Terminal*, both major container gateways within the TEN-T Mediterranean and Atlantic corridors. In the context of this paper, the 2017 closing constitutes a clearly dated *terminal-level ownership shock*, generating exposure for the Iberian hinterland regions linked to these corridors.

> "COSCO Shipping Ports will acquire 51% of Noatum Ports S.L.U., which operates container terminals in Valencia and Bilbao, subject to regulatory approvals

[29] Reuters, "China's COSCO Shipping buys $228 million stake in Spain's Noatum Port," 13 June 2017; Lloyd's List, "COSCO to buy 51 per cent stake in Noatum's Valencia and Bilbao container terminals," 12 June 2017; PortTechnology, "CMA CGM buys into Spanish terminals," 9 December 2022.

in Spain and the European Union."

(COSCO Shipping Ports Ltd., Announcement to the Hong Kong Stock Exchange, 12 June 2017).[30]

Institutional and political context. The Noatum transaction unfolded within Spain's legal framework for foreign investment and port concessions, which combines national competition oversight with EU merger control and state-port governance. Under the *Ley de Puertos del Estado y de la Marina Mercante* (Royal Legislative Decree 2/2011), all port terminals operate under concession contracts granted by the public port authorities; any change of ownership or control of concessionaires requires administrative authorisation to preserve service continuity. The sale of Noatum Ports was therefore reviewed by the *Comisión Nacional de los Mercados y la Competencia* (CNMC) and cleared under Case C/0793/17, following notification to the European Commission pursuant to Council Regulation (EC) No 139/2004 on merger control. Regulatory filings and contemporaneous press releases indicate that both Spanish and EU authorities approved the transaction in late 2017, confirming that COSCO's acquisition posed no competition or security concerns within the internal market.

At the time, Spain was still consolidating its post-crisis fiscal position under EU supervision and seeking to attract long-term infrastructure capital without direct state disinvestment. The divestment by TPG Capital was thus treated as a private commercial sale consistent with Spain's investment-promotion policy and port-sector liberalisation goals, rather than as a sovereign privatisation. The transaction was also facilitated by Spain's *Plan de Infraestructuras, Transporte y Vivienda 2012–2024* (PITVI), which emphasised the modernisation of port logistics through private participation. In this sense, the COSCO–Noatum deal exemplified how regulatory and fiscal institutions jointly determined the permissible scale and timing of foreign participation in strategic transport assets. From an identification perspective, these institutional constraints—merger reviews, concession-law approvals, and fiscal-policy sequencing—produced externally timed ownership changes that can be treated

[30] https://ports.coscoshipping.com/en/PressReleases/20170612/20170612_1.html

as plausibly exogenous to short-run regional trade dynamics.

A.4 Marseille–Fos, Le Havre, Rouen, and Dunkirk (France)

In June 2013, *China Merchants Holdings International* (now *China Merchants Port Holdings*, CMPH) signed a strategic partnership agreement with France's shipping and logistics group *CMA CGM S.A.*, acquiring a **49 percent** stake in its terminal-operating subsidiary *Terminal Link S.A.S.*. The transaction, valued at approximately US$ 540 million, was approved by France's *Autorité des marchés financiers* and the European Commission in 2013 and completed in 2014. Terminal Link holds concessions in a network of terminals across French and overseas ports, including the container facilities at **Marseille–Fos**, **Le Havre**, **Rouen**, and **Dunkirk**. According to CMA CGM's corporate filings, the partnership granted CMPH joint governance rights over Terminal Link's portfolio of fourteen terminals worldwide, four of which are in France.[31] The French terminals involved include the *Terminal de France* and *Terminal Nord* at Le Havre, the *Terminal des Flandres* at Dunkirk, the *Terminal du Grand Ouest* at Marseille–Fos, and container operations in Rouen. In the empirical dataset, the 2013–2014 closing of this transaction is coded as a joint-venture ownership event generating partial foreign exposure at the terminal level.

Institutional and political context. Foreign participation in France's maritime sector operates under a concessionary regime defined by the *Code des ports maritimes* and the 2008 reform that converted major ports into autonomous *Grandes Ports Maritimes* (GPMs). Under this framework, port-authority land and infrastructure remain state property; private operators hold time-limited concessions subject to ministerial oversight by the *Ministère de la Transition écologique et de la Cohésion des territoires*. The CMA CGM–CMPH agreement therefore did not transfer ownership of port authorities or land assets but created a

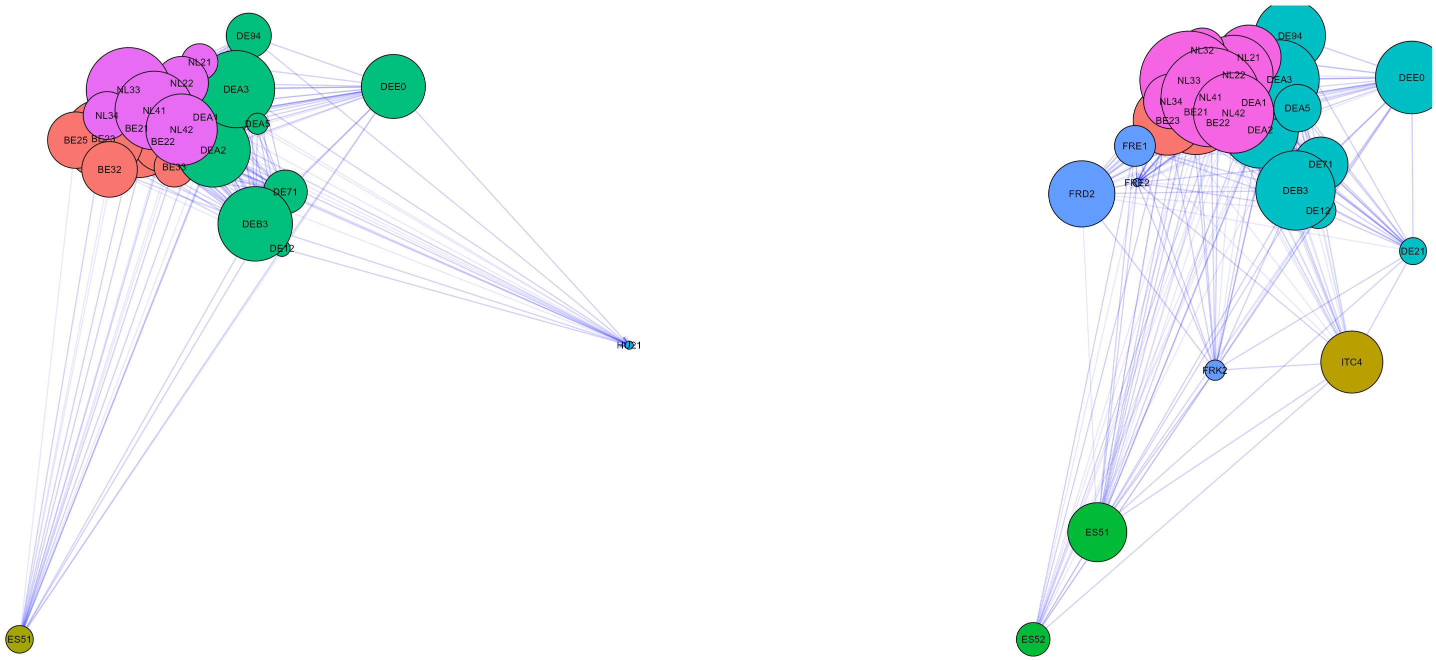
[31] CMA CGM S.A., *Press Release*, 25 June 2013: "CMA CGM and China Merchants Holdings International have completed the 49 % equity investment of Terminal Link S.A.S."; China Merchants Port Holdings, *Annual Report 2014*, p. 38.

Franco–Chinese joint venture within an existing French corporate entity (Terminal Link) already bound by concession contracts with the GPMs of Marseille–Fos, Le Havre, Rouen, and Dunkirk. The transaction was notified to and cleared by the European Commission under EU merger-control procedures and aligned with France's strategic policy of attracting capital for port-terminal modernisation without relinquishing sovereign control.

Politically, the deal occurred during the period when the French government, through Bpifrance, had become a minority shareholder in CMA CGM, ensuring continued domestic influence. It was publicly endorsed by the Ministry of the Economy as a "partnership reinforcing Marseille's and Le Havre's competitiveness in global liner networks." In this sense, the Terminal Link transaction illustrates how France channelled Chinese investment through regulated joint ventures rather than direct privatisations, constraining both the *extent* and the *timing* of foreign control. From an empirical standpoint, these institutional arrangements produce exposure at the terminal-level nodes of France's TEN–T corridors while preserving the public-ownership layer at the port-authority level—variation that informs the study's identification of heterogeneous treatment intensity across Europe's maritime network.

B Sectoral road freight networks

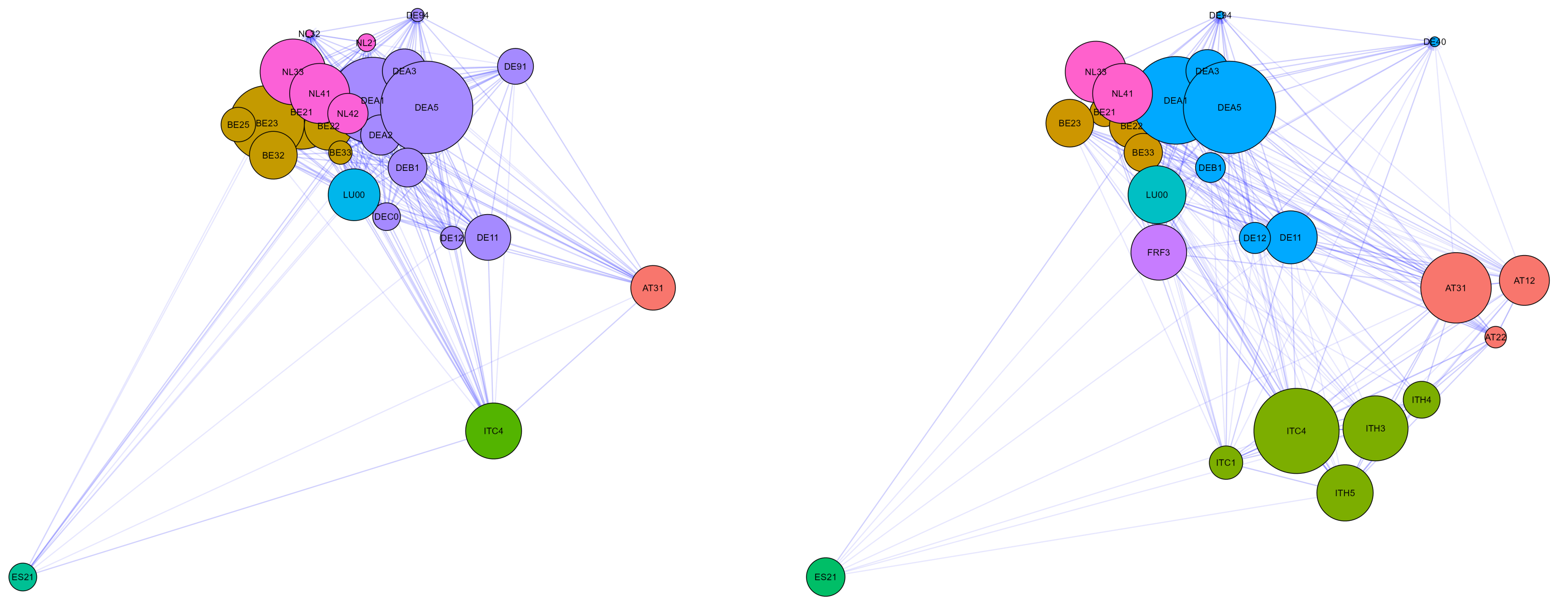
This appendix presents the full set of industry-level network graphs referenced in Section 4.3. Each figure plots the top decile of bilateral road-freight connections between NUTS2 regions in 2011 and 2022, disaggregated by NST 2007 one-digit industry. Node positions correspond to the regions' actual geographic coordinates, so that the networks are superimposed on a stylised map of Europe rather than on an abstract layout. The maps illustrate the sectoral heterogeneity underlying the continent-wide reorientation of inland trade documented in the main text: while some industries retain a compact Northern Range core, others—particularly container-compatible and multimodal sectors such as chemicals, metals, transport equipment, and grouped goods—exhibit a clear south–eastern extension of dense inland corridors linking the Mediterranean and Central–Eastern Europe to the continental core. Together, these figures complement the aggregate evidence in Section 4, showing that the observed reconfiguration of Europe's trade network originates in the logistics and infrastructure layer rather than in shifts in production.



(a) 2011 — Chemicals & plastics (NST 08)

(b) 2022 — Chemicals & plastics (NST 08)

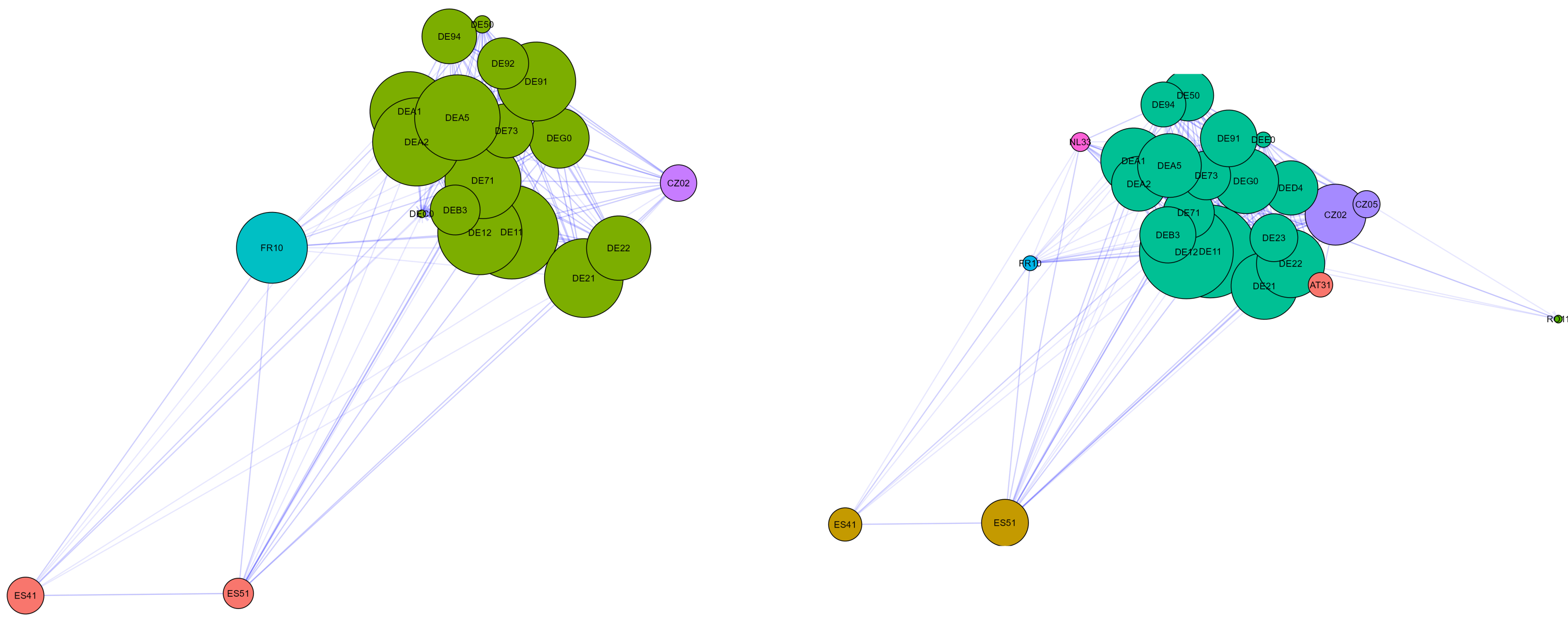
Figure 12: Chemicals & plastics (NST 08). Node positions correspond to actual regional coordinates. The network shifts from a Northern Range–Rhine concentration in 2011 to a broader polycentric structure by 2022, linking Italy, Austria, and Central–Eastern Europe to the continental core.



(a) 2011 — Basic metals (NST 10)

(b) 2022 — Basic metals (NST 10)

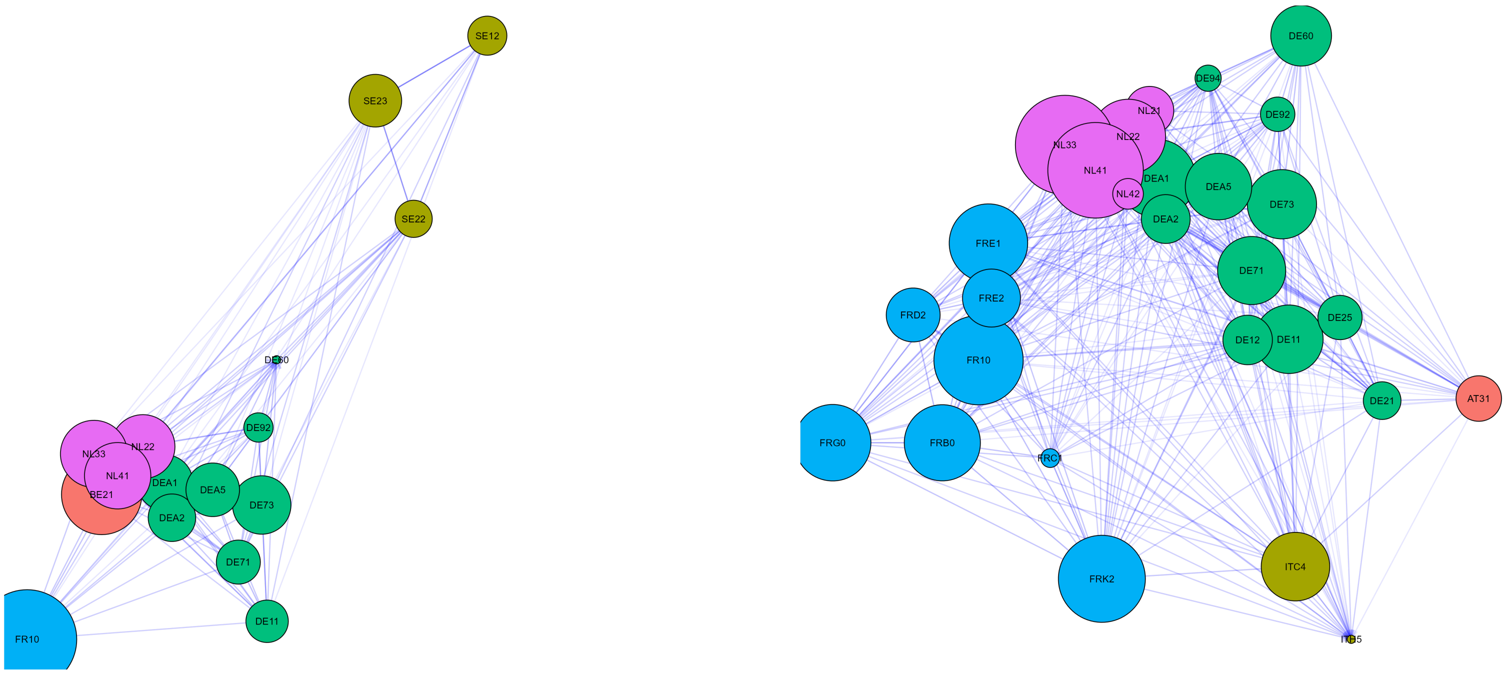
Figure 13: Basic metals (NST 10). The densest links remain in northwestern Europe but expand markedly toward Italy, Austria, and the Danube corridor by 2022, consistent with the south–eastern extension of high-volume industrial freight.



(a) 2011 — Transport equipment (NST 12)

(b) 2022 — Transport equipment (NST 12)

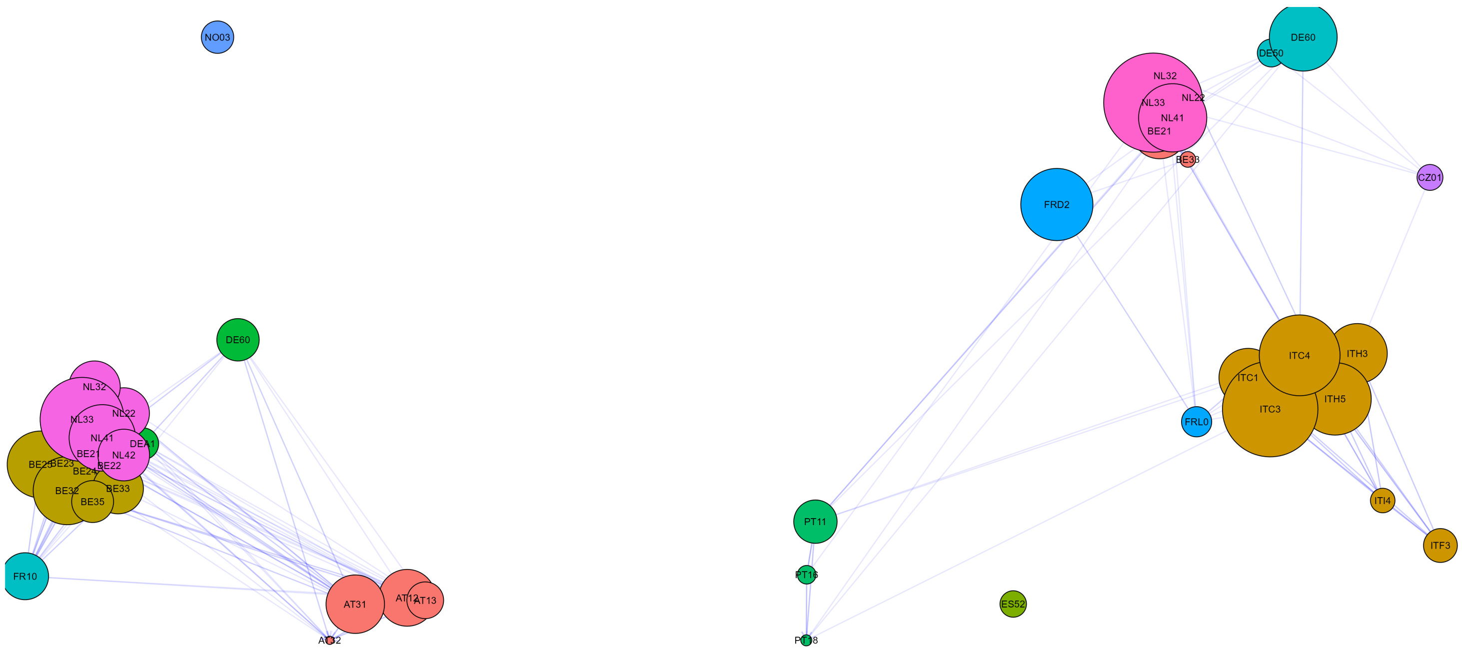
Figure 14: Transport equipment (NST 12). Between 2011 and 2022, flows extend south and east along the automotive supply chain, connecting northern Italy and Central Europe with the Rhine–Alpine corridor.



(a) 2011 — Grouped goods (NST 18)

(b) 2022 — Grouped goods (NST 18)

Figure 15: Grouped goods (NST 18). The category most closely tracks containerised and consolidated cargo. The 2022 map shows pronounced new high-volume corridors through Italy, Austria, and Hungary, signalling the reconfiguration of Europe's logistics backbone.



(a) 2011 — Unidentifiable goods (NST 19)

(b) 2022 — Unidentifiable goods (NST 19)

Figure 16: Unidentifiable goods (NST 19). A similar evolution is visible here, with south–eastern corridors strengthening after 2016, consistent with the spread of containerised and multimodal flows beyond the traditional Northern Range.

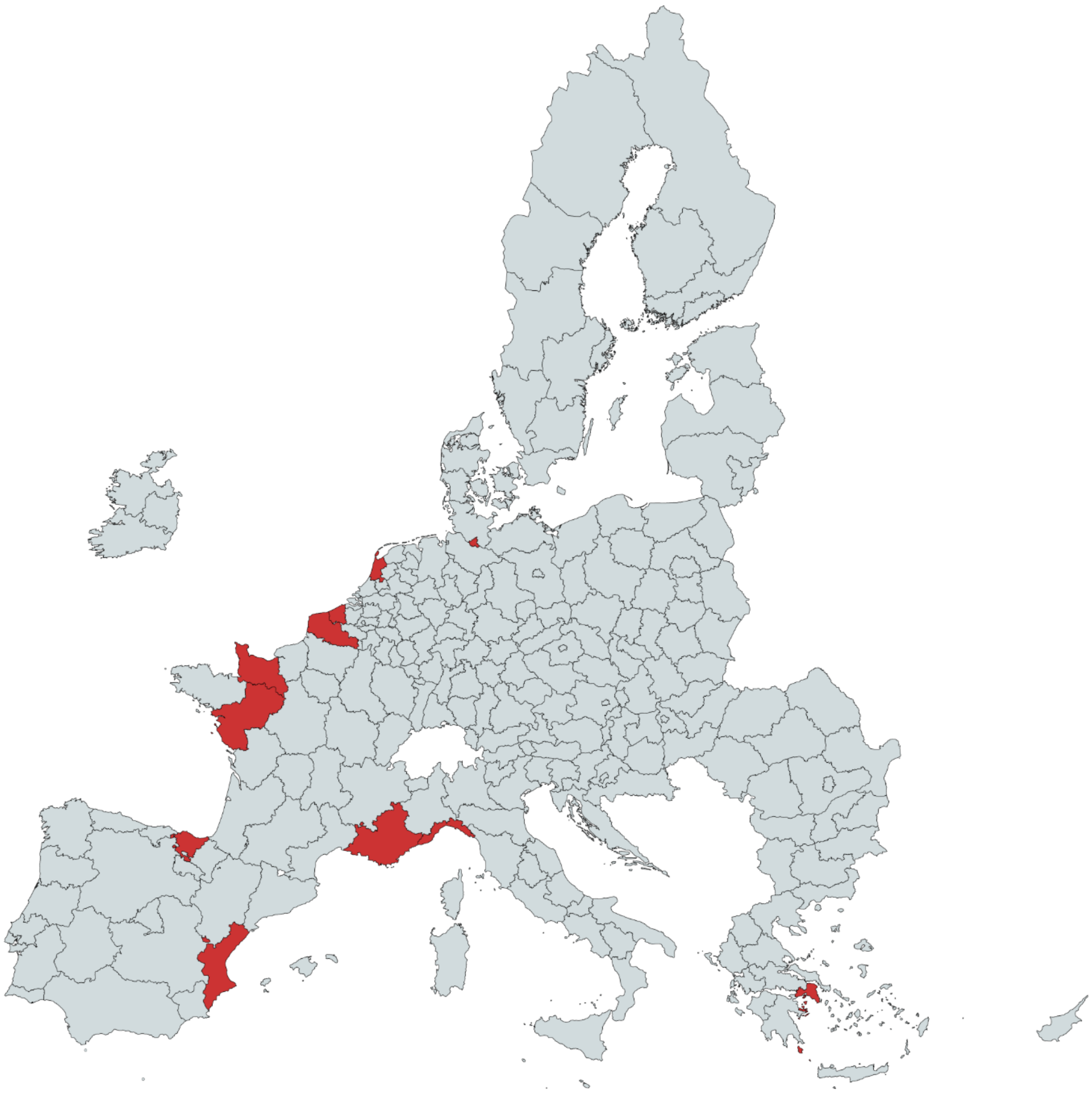


Figure 17: **NUTS-2 Regions and Treated Ports across Europe.** The map highlights in red the NUTS-2 regions hosting ports in which COSCO holds equity.