

Impacts of Ocean Carrier Alliances on U.S. Containerized Exports

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Abstract

Since the turn of the 21st century, vessel sharing via strategic alliances has become the dominant cooperative strategy among maritime freight carriers. These alliances have increasingly captured the attention of economists, industry analysts, and regulators, yet few empirical analyses have been published that measure the impact of such cooperative agreements on the maritime freight economy. This paper analyses trade data at the vessel and container level to assess the impacts of ocean carrier alliances on U.S. containerized exports. Results indicate that carrier alliances are relatively inconsequential to containerized export service levels and rates. Alliance operated vessels do not provide inferior service relative to their non-alliance operated counterparts. Carrier and alliance market concentration, within the scope of existing market structure, does not yield measurable differences in service levels. Lane-level alliance concentration does not result in reduced service or increased container rates. We also, however, find little evidence as carriers would suggest that alliance utilization improves export service quality or yields reduced rates.

Introduction

An Ocean Carrier Alliance (OCA) is a strategic alliance between two or more carriers that enable them to share space on each other's vessels, set service types and schedules, coordinate on vessel maintenance and repair, and even co-charter vessels. At their core, OCAs are designed to allow greater realization of scale efficiencies by ocean carriers associated with pooling of resources and concentrating freight on larger vessel sizes. These cooperative agreements allow ocean carriers greater cost efficiencies by consolidating freight on larger vessels with lower operating cost per unit of volume and distance (TEU-mile), increasing space utilization on these vessels, and reducing redundancy within specific lanes, thereby increasing turns per year. OCAs among ocean container shipping carriers have dominated world container trade since the mid-1990s. By the end of 2022, the prevailing three strategic alliances accounted for 80 percent of the global container shipping capacity (Ghorbani, et.al, 2022) and exerted significant influence on how products move throughout the world.

OCA agreements are intended to be operational in nature, where alliance members share operational data associated with scheduling and moving containers. The alliances are not allowed to share detailed information on prices or shipper rates, or any detailed information associated with shippers such as bids or contract agreements. This form of specific collusion is illegal. However, given that regulatory oversight in the ocean trade spans the globe, effective enforcement within any particular jurisdiction has always been suspect regarding what information is or isn't shared within ocean carrier alliances (Consortia Block Exemption Regulation (CBER) in Europe and the Federal Maritime Commission (FMC) in the U.S.). One interesting example was the proposed P3 Alliance (Maersk, MSC and CMA-CGM) in 2014 that the FMC approved but the Chinese Ministry of Commerce (not known as a strong advocate for promoting competitive markets) disallowed. Given that OCAs have shifted and changed significantly since 1995, identifying compatible partners within alliances is challenging. The initial five OCAs became three by 2020 and the largest of those alliances (2M) has recently announced the dissolution, effective January 2025.

Undoubtedly ocean carriers face tremendous risk and uncertainty when investing in new, larger vessels particularly during periods where global freight demand may be slack and utilization of vessels low, given the cyclical nature of global economic activity. OCAs allow for greater realization of profits across alliance partners during strong freight demand periods but also shared risk during slack periods. But the concentration of container freight on fewer lanes and larger vessels has also revealed tremendous risk when supply chain disruptions occur. The number and volume of shippers adversely impacted is far greater when containers are concentrated on fewer, larger and less frequent vessel sailings at fewer ports as opposed to more disaggregated distribution across more ports, more vessels (smaller) and more frequent service. One only had to witness the number of container vessels awaiting to be unloaded at the Ports of Los Angeles and Long Beach

(above 100) during the fall 2021 to appreciate this. Those impacts have reshaped global trade and likely were the largest factor contributing to the dissolution of the 2M alliance.

Few studies have sought to evaluate how the formation and proliferation of strategic OCAs have impacted trade. Our objective is to empirically evaluate the impacts of OCAs on rates and service for U.S. containerized exports.

This work does not directly measure impacts specific to agricultural trade, as most observable rates and service metrics do not vary by commodity.¹ This work is, however, particularly relevant for agricultural shippers, as waterborne containerized agricultural exports represent approximately 42% of total U.S. containerized exports by volume (TEUs) (PIERS), and containerized agricultural exports represent approximately 25 percent of total waterborne agricultural exports by volume and nearly 55 percent of total waterborne agricultural exports by value (U.S. Waterborne Containerized Agricultural Trade, USDA).

History

The transition from the sailing vessel to the steamship in the early 1800s enabled the first regularly scheduled maritime freight services, and maritime shipping has been a vital part of the global economy ever since. By the dawn of the 20th century, the maritime freight economy was well established and enabled producers, typically referred to as “shippers,” to deliver their products to any coastal market on the globe.² The firms operating the vessels that carried the cargoes between ports became known as “carriers,” and the state of competition among carriers, or lack thereof, has been the subject of many volumes.

Profit maximization for ocean carriers requires maximizing capacity utilization (minimizing empty haul), as the cost of a sailing is primarily a fixed cost (i.e., the marginal cost of adding a container to an existing sailing is near zero). In pursuit of maximal capacity utilization, ocean carriers, since the earliest days of maritime shipping, have entered cooperative agreements that provide structure for capacity sharing and improve capacity utilization (Sjostrom 2010) (Panayides and Wiedmer 2011). The exact form of this cooperation has varied over time, and by the late 19th century, cooperation among carriers fully permeated the maritime industry in the form of cooperative groups of carriers called “conferences.”

A primary concern of economists and regulators has been, since at least the work of Alfred Marshall in the early 20th century, that the economies of scale inherent in ocean shipping and the relatively small number of firms operating between port pairs enable carriers to act as monopolistic cartels (Marshall 1921). Despite these concerns, regulations in the United States have historically been favorable to cooperation between carriers, and in 1916 U.S. regulators granted antitrust immunity to shipping conferences in exchange for regulatory oversight in an attempt to mitigate the oversupply issues common at that time (Sjostrom

¹ This study does evaluate lane-level heterogeneous impacts by season and share of agricultural volumes with no indication of differential impacts.

² So long as the political relationship between the respective countries allowed, of course.

2010) (Clyde and Reitzes 1998). In practice, this allowed shippers to enter conferences on a given lane (i.e., an origin-destination port pair) that collectively set rates, subject to regulatory approval and the publishing of said rates to the public. Conference members were forced to honor the published rates for any shipper wishing to send similar cargo on that lane. The resulting economic behavior of carriers under this system has been widely viewed as the exact kind of monopolistic cartel behavior that Marshall anticipated (Stewart and Inaba 2003) (Clyde and Reitzes 1998) (Tang and Sun 2018) (Fox 1992) (Wilson and Casavant 1991) (Sjostrom 2010).

Globalization skyrocketed the maritime shipping industry to prominence. Between 1970 and 2023, shipments of goods via maritime container ship increased by more than an order of magnitude and now account for approximately 90% of international trade (UNCTAD 2023, OECD 2024). This rise brought renewed focus on maritime shipping from the public and regulators, and support for the antitrust exemptions long enjoyed by carriers began to weaken in the late 20th century. The Ocean Shipping Reform Act of 1984 weakened the market power of the shipping conferences, and by 1998 the conference system was eliminated entirely. Since that time, carriers have been required to negotiate rates and service contracts with shippers in private under typical antitrust regulations. Although strategic alliances between carriers existed during the conference era, this regulatory change, along with concurrent advancements in supply chain management, quickly led to strategic alliances becoming the dominant cooperative strategy between ocean carriers (Evangalista and Morvillo 1999, Fussilo 2006, Sheppard and Seidman 2001, Panayides and Wiedmer 2011).

OAs must be approved by the Federal Maritime Commission (FMC) and are highly similar to the vessel sharing agreements (VSAs) that carriers have been commonly utilizing both before and after the fall of the conference system; however, VSAs are typically very limited in geographic scope—applying only to a handful of lanes within a single region—and in the expected number of vessels utilized (typically less than a dozen). OAs, by contrast, are global agreements that allow for the use of hundreds of vessels (often a majority of the alliance members' combined fleets).³ OAs, unlike VSAs, also require standing committees and/or coordination centers to be jointly operated by the members in order to execute the alliance's joint operations. Unlike conferences, OAs are barred from sharing rate information between the members, jointly marketing their services, or sharing revenues. These regulations undercut carriers' ability to engage in traditional cartel price-fixing behavior (Wang 2012, Stewart, Inaba and Blatner 2003).

³ The most recent filing of the THE Alliance agreement, for instance, applies to “ports in North Asia, South Asia, Middle East (including the Arabian Gulf and Red Sea Regions), Northern Europe, Mediterranean, Adriatic, and Black Sea, Egypt, Panama, Mexico, Canada, Central America and the Caribbean on the one hand, and ports on the East, Gulf, and West Coasts of the United States, by any route including via the Panama and Suez Canals or the Cape of Good Hope, on the other, as well as ports and points served via such U.S. and foreign ports” (THE Agreement 2024).

Literature Review

Alfred Marshall laid the foundation of analyzing anti-competitive behavior in the context of high economies of scale, and ocean carriers were used as a type example in his seminal book, *Industry and Trade*, first published in 1919. Marshall's warnings did not go unnoticed, but for the majority of the 20th century, concerns about the high costs of inefficiencies in maritime shipping and the benefits offered by collaboration between carriers won out over the concerns about cartel behavior. This was not only true of U.S. regulators, as evidenced by the antitrust immunities granted to conferences that lasted from 1916 to 1998, but also of many economic analysts. We refer the reader to Sjostrom (2010) for a thorough overview of the slew of economic models used to evaluate the maritime freight economy throughout the conference era. Our discussion picks up after the fall of the conferences and the rise of OCAs as the dominant cooperative strategy among carriers at the turn of the millennium.

OCAs are sanctioned under the presumption that they allow carriers to improve capacity utilization, reduce operational costs, and increase service quality (Sheppard and Seidman 2001) (Panayides and Wiedmer 2011) (Evangelista and Morvillo 1999). However, this has not dissuaded concerns that the maritime freight economy under the alliance system is insufficiently competitive. Ocean carrier alliances represent roughly 90% of global capacity, raising concerns that alliances may exercise market power to the detriment of shippers (Ghorbani, et al. 2022) (Fusillo 2003). Despite these concerns, few empirical studies have been conducted with the goal of measuring the impacts of OCAs on the maritime freight economy (Ghorbani, et al. 2022).

Sheppard and Seidman (2001) were some of the first to address OCAs in economic journals. They provide a qualitative analysis of the benefits and potential disadvantages of alliances, arguing that cooperation via OCAs can provide carriers with the economies of scale necessary to operate efficiently without the difficulties associated with mergers and acquisitions. Subsequent works have elaborated on the benefits of OCAs, most often focusing on improved capacity utilization, e.g. (Crijssn, Dullaert and Fleuren 2007, Fusillo 2006).

OCAs are not without their challenges, however. Early work by (Midoro and Pitto 2000) highlighted the instability of OCAs due to management complexities and especially intra-alliance competition. They argue that the transaction and coordination costs inherent in managing global alliances with multiple partners hinder the ability of alliances to achieve the intended efficiency gains, a concern echoed by (Bergantino and Veenstra 2002) in their network theoretic study of OCAs. Instability and management costs have been a consistent concern since then, and analysts have investigated various approaches to achieving stability. (Ghorbani, et al. 2022) provide a thorough review of this literature.

Empirical investigations into the impacts and performance of OCAs have been sparse. (Fusillo 2003) showed that, despite the theoretical potential of OCAs to improve capacity utilization, excess capacities changed very little, if at all, in the years since the conference

era. Fusillo posits that holding excess capacity may be an intentional strategy among carriers with market power (either on their own or via their OCA) to construct barriers to entry for smaller firms. However, the data used in this analysis go only through 2001, so perhaps the instability marked by (Midoro and Pitto 2000) prevented OCAs from achieving their goals. Fusillo's 2003 analysis is also limited to industry averages, and does not differentiate capacity utilization of ships operating under an OCA from those operating independently. We will inspect this issue in our analysis below.

In 2006, Fusillo published additional research using updated data from the same PIERS database that we utilize in this study. He provides a thorough discussion of the structure of the maritime freight economy, pointing out what we mentioned above, namely that while OCAs are not allowed to fix prices, they are permitted to meet regularly to discuss a wide array of supply and demand information. Fusillo states the concern of many analysts and regulators: "Whether this leads to illicit price fixing is an open question and, because of the paucity of adequate pricing data, not easy to answer" (Fussilo 2006) pg 465. This remains true to this day, almost two decades later.

Indeed, whether the maritime freight economy enables competitive equilibria to exist in the first place has been brought into question by researchers such as Pirrong (1992), who argue that the variable demand and indivisible production costs inherent in ocean shipping result in the persistence of excess production capacities that destabilize competitive equilibria. In this condition, core theory predicts that cooperation (even so far as "cartelization") among producers may be an efficient response.

Whether or not excess production capacities in ocean shipping result in an "empty core" is somewhat controversial⁴ and beyond the scope of this study; however, the ability to reduce excess capacities has long been the primary argument for allowing cooperation among ocean carriers (Sheppard and Seidman 2001) (Sjostrom 2010) (Panayides and Wiedmer 2011). As is the case with anti-competitive behavior, though, empirical investigation into excess capacities has been scant—only one paper, (Fusillo 2003) mentioned above, is known to the authors to measure excess capacities.

Data

The primary data source used in this study is S&P Global's Port Import/Export Reporting Service (PIERS), which provides detailed data at the bill of lading (BOL)⁵ level from U.S. Customs and Border Protection and U.S. Census data. The data include the quantities and types of each commodity being shipped, the carriers, vessel identification codes,

⁴ Wang (2012) analyzed rate data from Drewry and found that the fall of the conference system in 1998 shifted the structure of the economy from cartel price-fixing to a competitive market. Notably, their analysis supported healthy competition through at least Q4 2009, well into the era of OCAs.

⁵ For every shipment, the shipper and carrier sign a "bill of lading," which serves both as the title for the goods as well as the service contract between the two parties. The bill of lading accompanies the shipment at all times while in transit.

departure and arrival ports and dates, and various other data for every shipment imported to or exported from the US via maritime ports from January 2006 through March 2024, representing more than 247 million unique shipments.

To the PIERS data we add vessel specifications such as total capacity along with port entry and exit dates for each vessel from the U.S. Army Corps of Engineers (USACE) Foreign Traffic Vessel Entrances and Clearances database. Due to the private nature of contract pricing, we do not have price information for each BOL in the PIERS database. Instead, we use average rates for each lane and month from Drewry's Container Freight Rate Insight (CFRI) reports to measure the impacts of OCA activities on container rates.⁶ Drewry CFRI reports container rates for 110 U.S. export lanes.

Almost all variables used in this study are identical to those in the original sources mentioned above, with two notable exceptions. First, arrival and departure dates in the PIERS BOL data sometimes vary from the actual arrival and departure dates of the vessel⁷. Where possible, we use the port entry dates from the USACE to resolve discrepancies. Sometimes cargo from the same vessel has different arrival and/or departure dates; in these cases, the multiple reported dates are clustered into a single arrival or departure date. Second, in order to analyze the dynamics of cargo slot sharing between carriers, we infer the vessel's owner (not reported elsewhere) as the carrier with the highest volumes on a particular voyage. Containers carried on a vessel from carriers other than the vessel's owner are deemed shared cargo.

Additional measures of carrier service levels that are important but not included in this work include: blank sailings, unreliable schedules, container availability, short receiving windows, and canceled contracts. We do not have measures for these variables and thus cannot evaluate the corresponding impacts of alliance concentration, but we do recognize these important dimensions along which service levels may be affected.

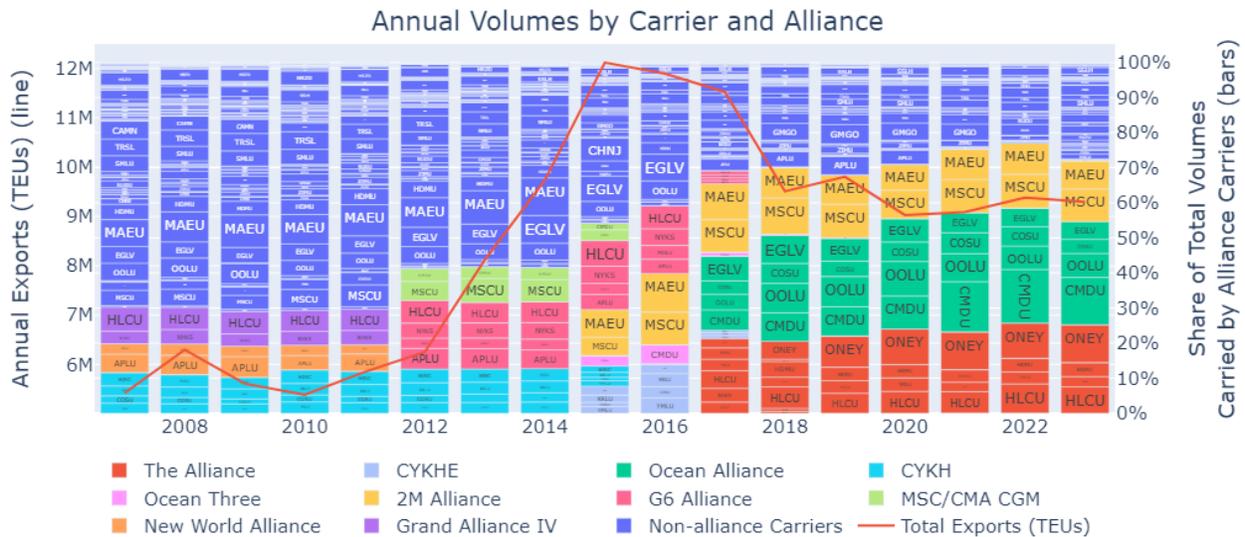
Containerized export volumes peaked in 2015, at 12 million TEUs/year, and have since fallen and plateaued at approximately 9 million TEUs/year (Figure 1, line). The share of volumes carried by alliance carriers has grown steadily since 2011, currently accounting for over 70% of containerized export volumes (Figure 1, bars). In addition to accounting for greater market share, carrier alliances have also become more concentrated. In 2015, six

⁶ Average rate data as reported by Drewry may conceal pricing power exerted by some carriers on some lanes. However, if pricing power is pervasive, we'd expect it to show up in the lane-level average rates. Drewry rates are collected from freight forwarders, not carriers, so we should be protected from misreporting to conceal illicit price fixing.

⁷ E.g., Even though container vessels rarely spend more than a few hours in port, one bill may be dated as arriving January 3rd and another, from the same vessel and port, may be dated January 5th. When a round trip between the relevant ports takes weeks, we consider those two bills to have arrived on the same date, and assume the difference in dates is due to when the bill was processed rather than when the cargo actually arrived.

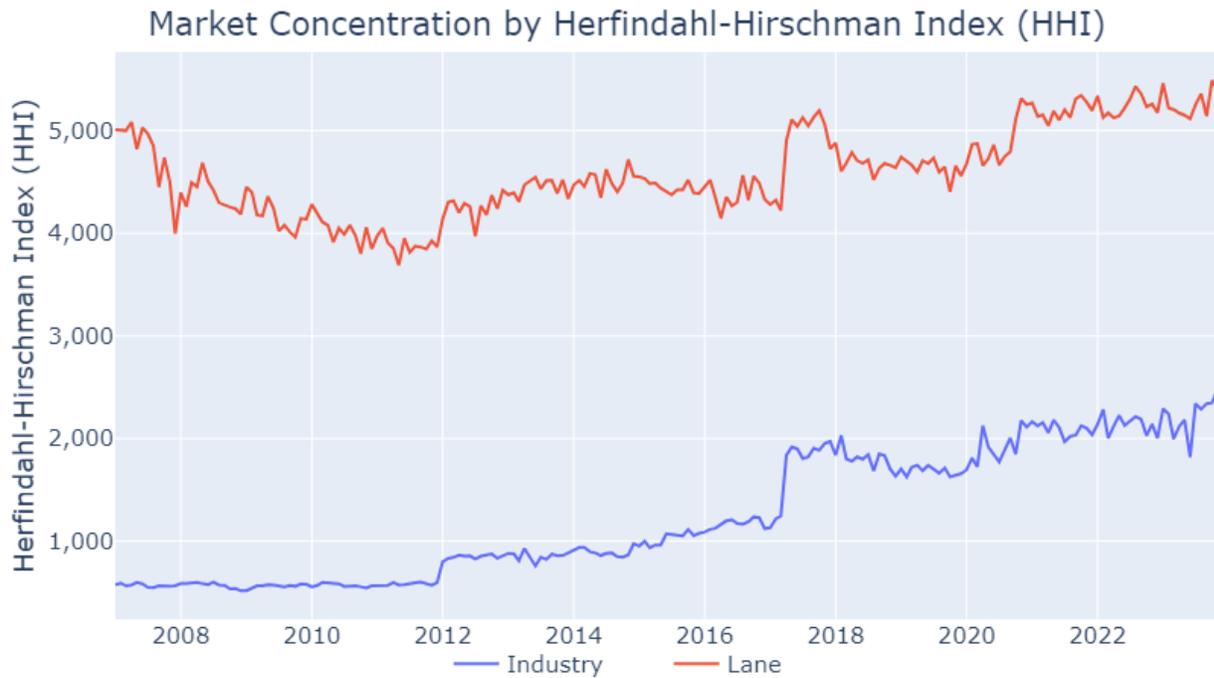
carrier alliances accounted for approximately 50% of volumes. In 2023, three carrier alliances accounted for over 70% of containerized export volumes.

Figure 1



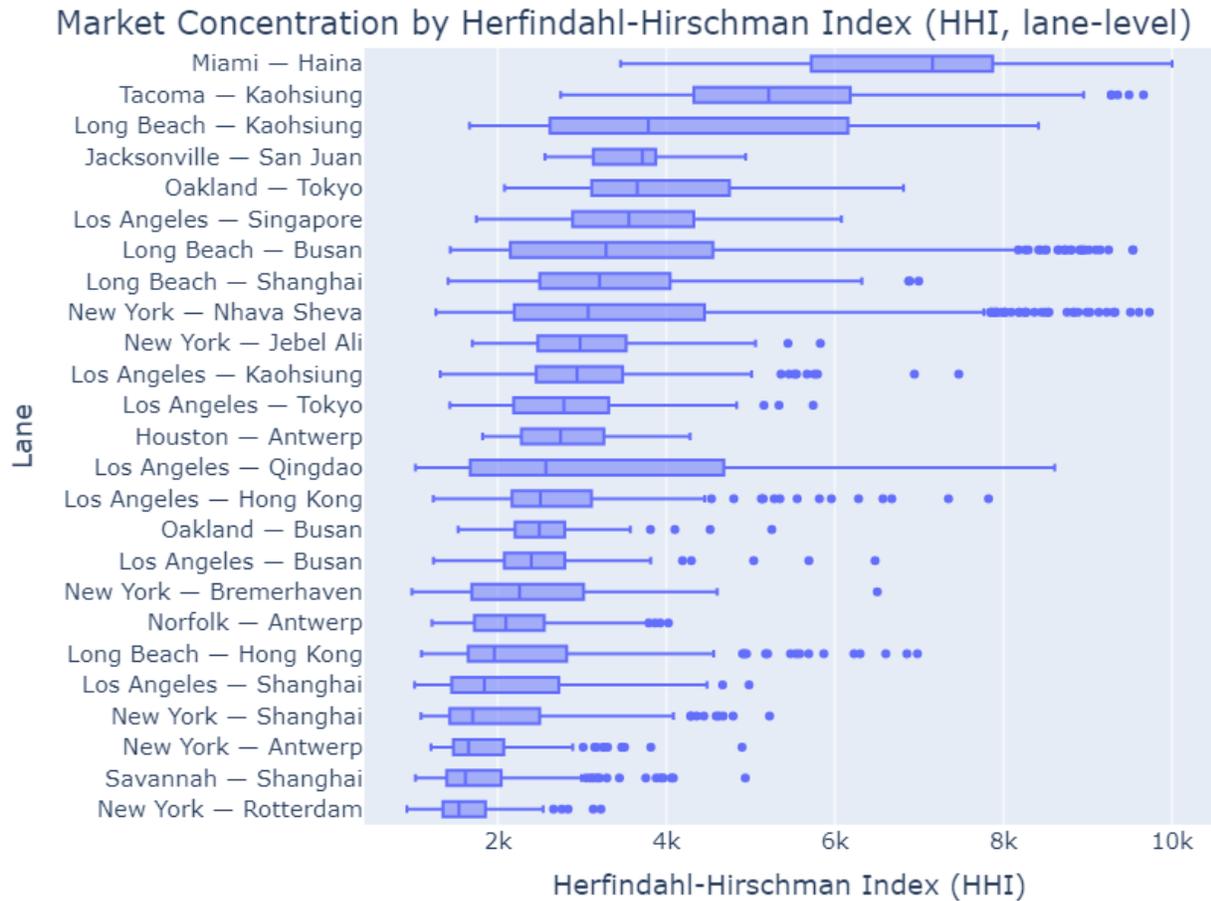
Alliance concentration is measured at the lane- and industry-levels, using the Herfindahl-Hirschman Index (HHI) (Figure 2). The Herfindahl-Hirschman Index is computed as the sum of squared volumes shares carried by each alliance, including non-alliance carriers. The HHI ranges from zero to 10,000 with higher levels representing increased concentration. A market with two carriers, each representing half of the market volumes, yields an HHI of 5,000. The industry-level HHI has grown, as the share of volumes carried by alliances has grown and alliances have become more consolidated. The median lane-level HHI has also been on the rise, from around 4,000 in 2010, to just over 5,000 today. An HHI of 5,000 is descriptive of a relatively concentrated market, representing a market with 50:50 market split, or a market with a 63:33:4 market split.

Figure 2



Alliance concentration varies by lane and through time, with the most concentrated lanes being served in some periods by only one carrier from one alliance (Figure 3). Alliance concentration is not limited to low-volume lanes – Jacksonville to San Juan, Puerto Rico, and Long Beach to Kaohsiung, Taiwan – are the two highest volume trade-lanes and have some of the highest lane-level alliance concentration.

Figure 3



Concerns over carrier alliances are caused in part by the scarcity of options induced by consolidation of carriers into a single operating entity. This concern is exacerbated by the cargo sharing behavior induced by alliance membership that yields a transition to cargo sharing that is more exclusive of non-member carriers. Figures 4 and 5 demonstrate the evolution of cargo sharing for Mediterranean Shipping Company and Evergreen Line as their alliance membership (and other carriers' alliance membership) changes.

Shared cargo accounts for approximately 30% of TEUs carried by Mediterranean Shipping Company and approximately 29% of TEUs carried by Evergreen Line. After dissolution of the MSC CMA-CGM Alliance and the formation of the 2M Alliance, Mediterranean stops carrying CMA-CGM volumes, and carries almost exclusively Maersk volumes (as a proportion of non-Mediterranean volumes). Prior to joining an alliance Evergreen Line carried cargo for a diverse set of carriers; in most months no carrier accounted for more than 25% of Evergreen's shared volumes. Leading up to joining CYKHE, Evergreen's service of non-alliance members fell as volumes carried of alliance members grew. Membership in Ocean Alliance, starkly reallocated the set of carrier volumes carried by Evergreen Line.

Figure 4

Cargo Sharing by Mediterranean Shipping Company (MSC)

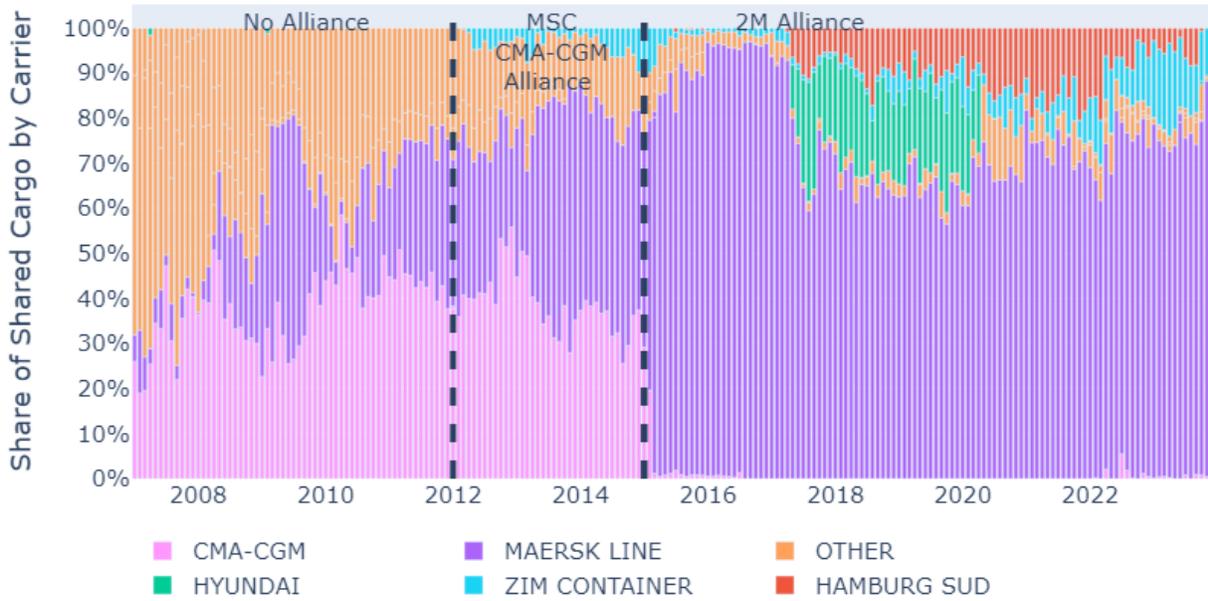
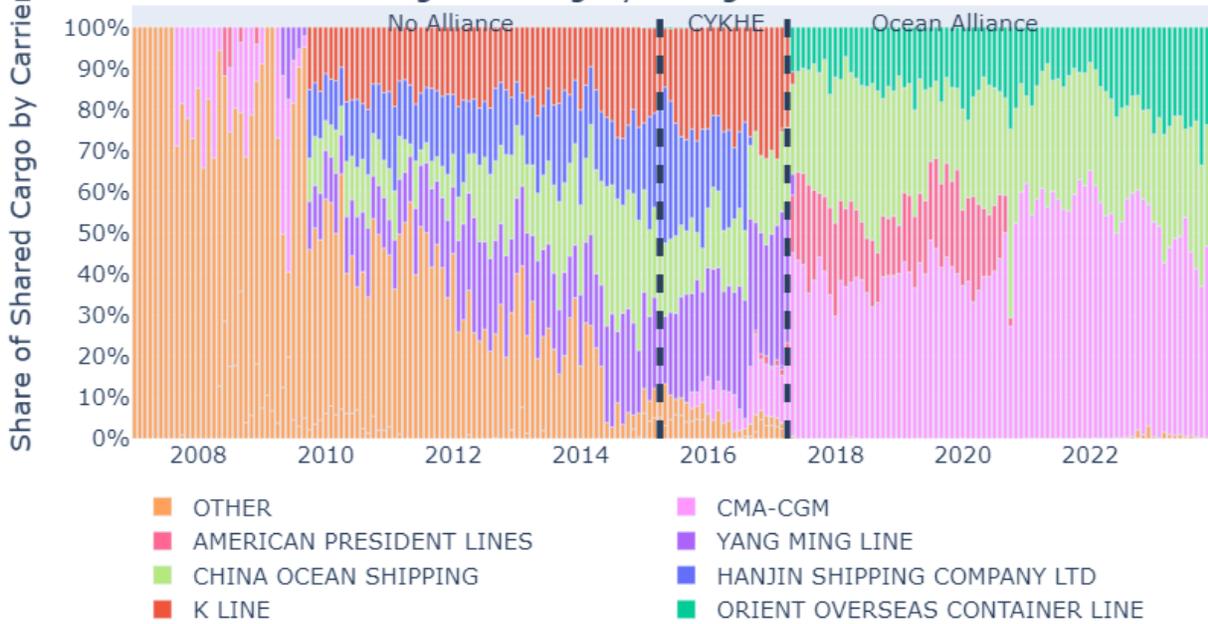


Figure 5

Cargo Sharing by Evergreen Line



The impacts of alliances are evaluated at the vessel-, carrier-, and lane-level. At the vessel-level, we evaluate operational differences in alliance-operated and non-alliance-operated vessels. Do alliance-operated vessels carry more volumes, visit more export destinations, make more turns, or provide more capacity? At the carrier-level, we evaluate the extent to which carrier market share, and alliance market share, affect carrier-level service metrics.

Do carriers with high market share operate differently than carriers without? Do member carriers of alliances with high market share operate differently than carriers whose alliances do not have high market share? At the lane-level, we evaluate the effect of lane-level market concentration on lane-level container rates and service metrics. Do concentrated, and thus potentially non-competitive lanes, exhibit higher container rates or lower levels of service? Summary statistics and descriptions for the variables of interest are presented in Tables 1-4.

A typical lane is serviced by 11 vessels each month, representing approximately 29,144 TEUs in total vessel capacity, but only 860 TEUs of shipped export volumes. Across all vessel services a typical U.S. port delivers service to approximately 38 foreign ports, 17 foreign countries and 4 foreign regions each month. The lane-level rates subset has a median rate of \$1,550/TEU and represents higher volume export lanes shipping approximately 1,214 TEUs/month. Median carrier market share is 6.5%, while median alliance market share is 25%; that is a typical alliance on a typical lane represents approximately 25% of export volumes. The majority of lanes (66%) are served by at least one alliance carrier in a given month, with approximately half (47%) of lanes served by at least one alliance carrier operating and alliance operated vessel.

Table 1: Lane Panel

	N	Mean	Median	Std
TEUs	37,368	1,596.78	861.16	2,304.99
HHI on lane ij	37,368	5,831.81	5,134.70	2,665.73
HHI at origin port i	37,368	2,939.40	2,284.69	2,034.91
HHI at destination port j	37,368	4,328.55	3,674.26	2,442.02
HHI on substitute lanes -ij	37,368	2,472.03	1,894.22	2,304.99
HHI at substitute origin ports -i	37,368	1,744.78	1,544.51	1,710.07
HHI at substitute destination ports -j	37,368	2,712.89	2,334.45	2,167.82
# Vessels	37,368	12.26	11.00	8.55
Lane Capacity	37,368	37,061.67	29,143.99	33,568.08
# Foreign Ports	37,368	31.46	38.00	13.01
# Foreign Countries	37,368	17.01	17.00	7.30
# Foreign Regions	37,368	5.24	4.00	2.94

Table 2: Lane Panel (rates subset)

	N	Mean	Median	Std
Rate	9,433	1,743.90	1,550.00	919.70

	N	Mean	Median	Std
TEUs	9,433	2,147.66	1,214.01	2,709.76
HHI on lane ij	9,433	4,880.78	4,445.03	1,984.22
HHI at origin port i	9,433	2,659.56	2,563.94	1,075.56
HHI at destination port j	9,433	3,971.82	3,602.50	1,666.99
HHI on substitute lanes -ij	5,602	3,920.43	3,859.80	2,086.49
HHI at substitute origin ports -i	5,526	2,763.17	2,103.54	2,713.51
HHI at substitute destination ports -j	7,186	3,711.95	3,560.43	2,030.53

Table 3: Carrier-Lane Panel

	N	Mean	Median	Std
Carrier market share	388,020	12.66	6.49	16.18
Alliance market share	388,020	31.21	25.00	25.51
Leaveout lane concentration	388,020	5,152.49	4,771.94	2,291.86
TEUs	388,020	205.62	69.00	443.27
# Vessels	388,020	2.27	1.00	1.79
Lane Capacity	388,020	59,821.59	52,742.50	35,481.49
# Foreign Ports	388,020	24.88	25.00	12.22
# Foreign Countries	388,020	15.96	14.00	8.86
# Foreign Regions	388,020	5.45	5.00	3.00

Table 4: Vessel-Carrier-Lane Panel

	N	Mean	Median	Std
Alliance is operating on ij in time t	1,149,384	0.66	1.00	0.47
Vessel is alliance operated on ij in time t	1,149,384	0.47	0.00	0.50
TEUs	1,149,384	64.25	22.00	137.14
# Foreign Ports	1,149,384	6.62	5.00	4.43
# Foreign Countries	1,149,384	4.53	4.00	2.68
# Foreign Regions	1,149,384	2.01	2.00	1.03
Capacity from Vessel	1,149,384	3,436.37	3,105.37	1,901.88

	N	Mean	Median	Std
Turns	1,149,384	1.09	1.00	0.33

Methodology & Results

At the lane-level, we evaluate impacts of increased alliance-level concentration, as measured by the Herfindahl-Hirschman Index (HHI) on container rates and lane- and port-level service metrics, including: the number of vessel calls, lane capacity, and the number of foreign ports, foreign countries, and foreign regions serviced by each U.S. port.

To measure the impacts of market concentration, a panel fixed effects model is specified:

$$Y_{ijt} = \alpha_1 HHI_{ijt} + \alpha_2 HHI_{it} + \alpha_3 HHI_{jt} + \alpha_4 HHI_{-ijt} + \alpha_5 HHI_{-it} + \alpha_6 HHI_{-jt} + \gamma V_{ijt} + \beta_{ij} + \delta_{it} + \delta_{jt} + \epsilon_{ijt} \quad (1)$$

where Y_{ijt} is the lane-level service metric of interest on lane ij in time t , HHI_{ijt} is market concentration on lane ij in time t , HHI_{it} is market concentration at origin port i in time t , HHI_{jt} is market concentration at destination port j in time t . Concentration on substitute lanes, origin ports, and destination ports are captured by HHI_{-ijt} , HHI_{-it} , and HHI_{-jt} .⁸ Control variables include the volume of exports on lane ij in time t , V_{ijt} , lane-level fixed effects, β_{ij} , U.S. origin port region-time fixed effects, δ_{it} , and foreign destination port region-time fixed effect, δ_{jt} . This specification allows for causal identification of the impact of market concentration on lane-level quality metrics, so long as there are not time variant lane-level unobservables correlated with market concentration and the lane-level quality metric. This specification is immune to lane-level time invariant unobservables, U.S. port region-level time variant unobservables, and foreign port region-level time variant unobservables.

The impact of alliance concentration on lane-level service metrics (Table 5) and container rates (Table 6) is nominal. While market concentration is a statistically significant predictor of lane-level service metrics and container rates, estimated impacts are in most cases economically insignificant. A one standard deviation⁹ change (+1,566 HHI) in lane-level alliance concentration from the median¹⁰ HHI of 4,565 represents significant evolution in market structure, approximately: a 50:45:5 market split evolving to a 75:25 market split; or a 50:45:5 market split evolving to a 35:30:30:5 market split, but economically insignificant changes in service metrics (+1.25 vessels/month (10%), +3,195 TEUs/month of lane capacity (7%), +0.02 foreign ports (<1%), +0.01 foreign countries (<1%), +0.003 foreign regions (<1%)) and rates (+\$21/TEU (1%)). Increased market concentration does not yield

⁸ Competitive substitute ports and lanes may mitigate the ability for alliances to exert market power. Thus, inclusion of the competitiveness of substitute ports and lanes, allows for us to isolate the impact of lane-level concentration conditioned on substitute market characteristics.

⁹ Median standard deviation of lane-level HHIs through time. Representative of the variance of within-lane concentration over time.

¹⁰ Median of lane-level median HHI through time. Representative of the typical HHI on a typical lane.

economically significant impacts to lane-level service metrics, without substantial (and atypical) change in market structure.

Though small in magnitude, the directionality of the impact of lane-level concentration on # vessels and lane capacity are suggestive of more concentrated lanes being more efficient. A one standard deviation increase in lane concentration yields a 10% reduction in # vessels, holding TEUs constant, suggesting slack capacity is better utilized. A one standard deviation increase in lane concentration yields a 7% reduction in lane capacity served, holding TEUs constant, again suggesting slack capacity is better utilized.

Table 5: Impact of Alliance Concentration on Service Levels

	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
HHI on lane ij	-0.000804***	-2.04***	1.39e-05***	-3.86e-06***	-2.17e-06***
HHI at origin port i	0.000185***	0.368***	7.51e-05***	-7.39e-05***	1.48e-05***
HHI at destination port j	-0.000344***	-0.786***	-1.15e-05***	1.64e-06	2.29e-06***
HHI on substitute lanes -ij	0.000145***	0.472***	5.1e-06	-9e-06***	1.26e-06***
HHI on substitute origin ports -i	-0.000365***	-0.923***	-1.33e-05*	-7.69e-05***	-4.69e-06**
HHI on substitute destination ports -j	0.000209***	0.564***	8.38e-06*	4.09e-06**	-1.62e-06***
TEUs	0.000713***	2.96***	3.53e-05***	-2.25e-07	-6.78e-07***
N	37,368	37,368	37,368	37,368	37,368
DF Resid	34,330	34,330	34,330	34,330	34,330
R2	0.818	0.859	0.996	0.998	1

Table 6: Impact of Alliance Concentration on Rates

	Rate	Rate	Rate
HHI on lane ij	-0.0136***	0.000634	-0.00232

	Rate	Rate	Rate
HHI at origin port i	-0.0323	-0.0445***	-
HHI at destination port j	0.0237***	-0.00506	-
HHI on substitute lanes -ij	0.0096	-	-
HHI on substitute origin ports -i	-0.488***	-	-
HHI on substitute destination ports -j	-0.00429	-	-
TEUs	0.00477	0.00867***	0.00839***
N	3,491	9,433	9,433
DF Resid	2,214	7,858	7,860
R2	0.93	0.915	0.915

Market concentration is a statistically significant predictor of lane-level quality attributes, however, these impacts are economically insignificant. Concentrated lanes remain sufficiently competitive (between alliances and/or between carriers within alliances) preventing carriers from exerting market power.

Additional lane-level models were estimated to evaluate seasonally heterogenous impacts (Table 9), heterogenous impacts by commodity type as measure by the share of agricultural shipped on each lane (Table 10), and the presence of lagged impacts (Table 11). There is evidence that impacts are heterogenous by season and commodity type, however, these impacts are not economically different from one another, and are broadly consistent with the main results (Tables 5 and 6). There is also evidence that concentration in prior periods is statistically important in determining rates and service levels in the current period for # of vessels, and lane capacity, however, these impacts are not economically different from one another, and are broadly consistent with the main results (Tables 5 and 6).

At the carrier-level, we evaluate the extent to which alliance market share impacts carrier-level service metrics. Do alliance-member carriers operate differently when their alliance has high market share? We also identify the impact of carrier market share, on carrier-level service metrics. Do carriers with high market share operate differently than those without? Impacts are measured across: the number of vessel calls, lane capacity, and the number of foreign ports, foreign countries, and foreign regions serviced by each carrier. Market share is measured at the monthly-lane-level, and impacts are estimated using a panel fixed-effect model:

$$Y_{caijt} = \alpha_1 MP_{aijt} + \alpha_2 MP_{caijt} + \alpha_3 HHI_{-aijt} + \gamma V_{caijt} + \beta_{ij} + \rho_{ca} + \delta_t + \epsilon_{caijt} \quad (2)$$

where Y_{caijt} is the lane-level service metric for carrier c in alliance a on lane ij in time period t , MP_{aijt} is alliance market share of alliance a on lane ij in period t , MP_{caijt} is carrier market share of carrier c on lane ij in time t , and HHI_{-aijt} is the lane-level market concentration calculated leaving out alliance a . Control variables include the volume of

exports by carrier c on lane ij in time t , V_{caijt} , lane-level fixed effects, β_{ij} , carrier fixed effect, ρ_{ca} , and a time fixed effect, δ_t .

The impact of alliance market share on carrier-level service metrics is nominal (Table 7). While alliance market share is a statistically significant predictor of carrier-level service metrics, estimated impacts are economically insignificant. A one standard deviation increase in carrier market share from the median market share (from 25% to 51% market share) represents a significant increase in carrier market share, but economically insignificant changes in service metrics (-0.07 vessels/month (-3%), -3,163 TEUs of monthly lane capacity (-5%), +0.19 foreign ports (+0.8%), +0.14 foreign countries (+1%), and +0.02 foreign regions (+0.5%)). Member carriers of alliances with market share do not exhibit meaningful differences in service metrics relative to carriers in alliance without market share.

The impacts of carrier market share, on carrier-level service metrics are also nominal. A one standard deviation increase in carrier market share from the mean market share (from 13% to 29% market share) represents a significant increase in carrier market share, but economically insignificant changes in service metrics (+0.6 vessels/month (24%), -1,417 TEUs of monthly lane capacity (-2%), +0.45 foreign ports (2%), +0.21 foreign countries (2%), +0.06 foreign regions (+1%)).¹¹ Carriers with market share do not exhibit meaningful differences in service metrics relative to carriers without market share.

Table 7: Impact of Carrier and Alliance Market Share on Service Levels

	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
Carrier Market Share	0.0345***	-87.6***	0.0277***	0.0129***	0.00352***
Alliance Market Share	-0.00289***	-124***	0.00727***	0.00558***	0.0009***
Leaveout Alliance	-2.3e-05***	-2.35***	9.29e-05***	4.46e-05***	1.51e-05***

¹¹ Measuring marginal effects under the ceteris paribus assumption implied by the regression is complicated as changes in carrier market share holding all other variables constant is not feasible. That is, we can't increase carrier market share while simultaneously holding carrier TEUs, alliance TEUs, and alliance market share constant. Therefore, the marginal effect reported in the regression output is only a partial effect as it is not observed in isolation. To account for this, we report marginal effects of increasing carrier market share along with the implied corresponding increase in carrier TEUs, while holding alliance market share and alliance TEUs constant. Then, one standard deviation increase in carrier market share from the mean market share and corresponding 2.27 times increase in mean carrier volumes yields: +0.77 vessels/month (34%), -650 TEUs of monthly lane capacity (-1%), +0.53 foreign ports (2%), +0.27 foreign countries (2%), and +0.08 foreign regions (+2%).

	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
Concentration (HHI)					
Carrier TEUs	0.000804***	2.92***	0.000345***	0.000255***	0.000109***
Alliance TEUs	-3.64e-05***	3.66***	-0.000123***	-8.3e-05***	-1.15e-05***
N	388,020	388,020	388,020	388,020	388,020
DF Resid	387,325	387,325	387,325	387,325	387,325
R2	0.304	0.738	0.758	0.801	0.80

At the vessel-level, we evaluate operational differences in alliance-operated and non-alliance-operated vessels. Alliance agreements do not specify which vessels are alliance-operated. We identify alliance-operated vessels based on cargo sharing behavior at the vessel-month-lane-level. A vessel is identified as alliance-operated if over 90% of cargo is attributed to a single alliance, and the vessel is carrying cargo for at least two alliance members (the vessel owner, and at least one other alliance member).

The impact of a vessel being alliance-operated is measured across lane-month-vessel service metrics, including: total volumes carried (TEUs), vessel capacity, and the number of foreign ports, foreign countries, and foreign regions serviced by the vessel. Differences in vessel service metrics between alliance- and non-alliance-operated vessels is identified using a panel fixed effect model:

$$Y_{vaijt} = \alpha_1 A_{aijt} + \alpha_2 A_{vaijt} + \theta_v + \rho_{va} + \delta_t + \epsilon_{vaijt} \quad (3)$$

where A_{aijt} is an indicator =1 if alliance a has an alliance-operated vessel active on lane ij in period t , and A_{vaijt} is an indicator =1 if vessel v is an alliance-operated vessel operating on lane ij in period t . A_{aijt} controls for alliance-lane-time-specific unobservables that may cause an alliance to operate an alliance-operated vessel on lane ij in period t . Other control variables include a vessel fixed effect, θ_v , an alliance fixed effect, ρ_{va} , and a time fixed effect, δ_t . The control group is non-alliance-operated vessels operated by an alliance member carrier from the same alliance on the same lane in the same time period. The parameter of interest is α_2 which measures the marginal effect of a vessel being alliance-operated.

Alliance activity is a significant predictor of vessel-specific service levels, however these impacts are economically insignificant accounting for only marginal impacts (Table 8). Alliance operated vessels carry approximately the same volumes (+ 0.16%), offer approximately the same capacity (-1%), and make approximately the same number of turns (-0.6%). Alliance operated vessels visit 0.67 more foreign ports (+10%), and 0.41 more countries (9%), but 0.04 fewer regions (-2%).

Table 8: Impact of Vessel Being Alliance Operated on Service Levels

	TEUs	# Foreign Ports	# Foreign Countries	# Foreign Regions	Capacity from Vessel	Turns
Alliance a is operating on lane ij in time t	8.11***	0.133***	-0.00998	-0.0399***	-30***	-0.0121***
Vessel v is alliance operated on lane ij in time t	4.89***	0.665***	0.41***	-0.0396***	-38.6***	-0.00702***
N	1,149,384	1,149,384	1,149,384	1,149,384	1,149,384	1,149,384
DF Resid	1,145,833	1,145,833	1,145,833	1,145,833	1,145,833	1,145,833
R2	0.0998	0.351	0.316	0.295	0.673	0.21

Together, results indicate that carrier alliances are relatively inconsequential to containerized export service levels and rates. Alliance operated vessels do not provide inferior service relative to their non-alliance operated counterparts. Carrier and alliance market share, within the scope of existing market structure, does not yield measurable differences in service levels. And, lane-level alliance concentration does not result in reduced service or increased container rates. That said, market structure as represented by the lane-level metrics is far more important, as measured by magnitude of impacts, than granular carrier market share or vessel operation statistics.

Discussion

While market concentration among ocean carrier alliances has been the center of much discussion and concern, we find relatively little evidence that alliance concentration is to the detriment of export shippers. We also, however, find little evidence as carriers would suggest that alliance utilization improves export service quality or yields reduced rates. Carrier alliances, by our measures, are inconsequential to containerized export service levels and rates.

The impacts of carrier alliances may vary differentially across commodities. We find no evidence of heterogenous lane-level impacts by share of agricultural volumes, though these impacts may exist at more granular commodity-type levels, or at more granular units of analysis (e.g., by carrier).

The impacts of carrier alliances may exist for containerized imports, as the export move is the "backhaul" movement and benefits from excess capacity that may yield structurally more competitive markets. Imports are typically of higher value and greater volumes, and require more capacity utilization, that may result in the exertion of carrier and alliance market power. The impacts of carrier alliances on containerized import service levels and rates warrants further study.

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Appendix

Seasonality

Do impacts of lane concentration vary seasonally? Heterogenous impacts of lane concentration are estimated for each month. There is evidence that monthly impacts are statistically different from one another for and all service quality metrics except # of Foreign Regions accessible, and rates. However, monthly impacts are not economically different from one another, and are broadly consistent with the main results (Tables 5 and 6).

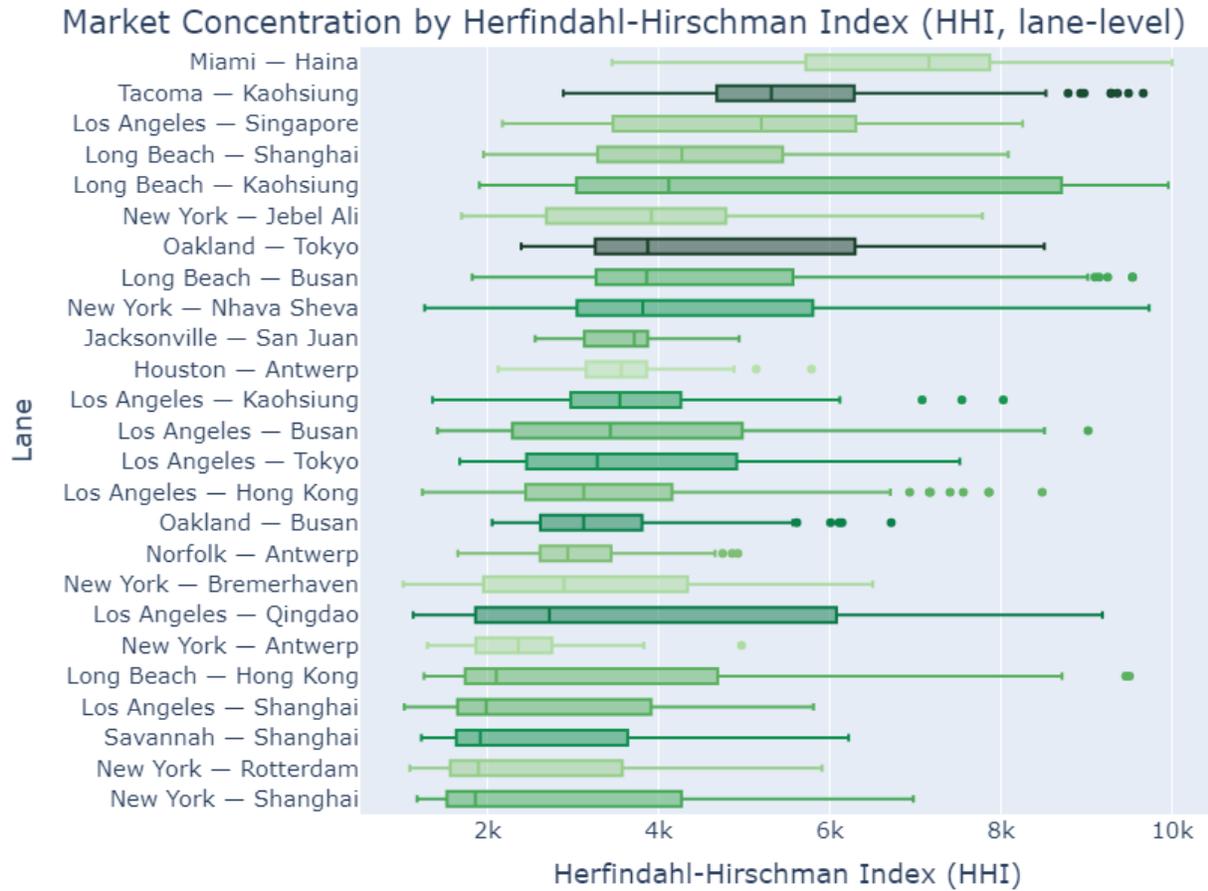
Table 9: Seasonal Impacts of Alliance Concentration on Rates and Service Levels

	Rate	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
HHI on lane ij: January	0.00222	-0.00099***	-2.23***	8.11e-06	-5.24e-06**	-1.51e-06
HHI on lane ij: February	0.00172	-0.000856***	-1.83***	4.37e-06	-8.85e-06***	-8.75e-08
HHI on lane ij: March	-0.00138	-0.001***	-2.18***	1.23e-05**	-6.3e-06***	-4.62e-07
HHI on lane ij: April	-0.0074	-0.00101***	-2.26***	4.44e-06	-1.1e-05***	-1.13e-06
HHI on lane ij: May	0.00872	-0.00109***	-2.46***	3.29e-06	-9.06e-06***	-1.20e-06
HHI on lane ij: June	-4.89e-05	-0.00102***	-2.28***	-1.26e-05***	-1.24e-05***	-1.6e-06**
HHI on lane ij: July	-0.0031	-0.00109***	-2.47***	-5.63e-06	-1.41e-05***	-2.42e-06***
HHI on lane ij: August	-0.00242	-0.00108***	-2.5***	-9.23e-06*	-1.17e-05***	-1.59e-06*
HHI on lane ij: September	-0.00892	-0.00104***	-2.41***	-9.71e-06**	-1.19e-05***	-8.43e-07
HHI on lane ij: October	-0.0178***	-0.00107***	-2.49***	-5.44e-06	-8.13e-06***	-7.51e-07
HHI on lane ij: November	-0.00564	-0.000968***	-2.23***	-9.24e-06**	-1.29e-05***	-1.11e-06
HHI on lane ij: December	0.00506	-0.000949***	-2.21***	5.23e-07	-6.07e-06***	-6.96e-07
TEUs	0.00837***	0.000925***	3.44***	3.21e-05***	3.04e-06***	-5.00e-07
N	9,433	97,065	97,065	97,065	97,065	97,065
DF Resid	7,849	93,517	93,517	93,517	93,517	93,517
R2	0.915	0.804	0.855	0.997	0.999	0.998

High Volume Agricultural Lanes

Are agriculturally concentrated lanes differentially impacted by lane concentration? Heterogenous impacts of lane concentration are estimated where each lane is segmented by the proportion of volumes that are agricultural exports (0-25%, 26-50%, 51-75%, 76-100%). Figure 6 shows lane-level market concentration, where each box is colored by the proportion of agricultural volumes for each export lane, where darker green represents a higher share of agricultural export volumes.

Figure 6



There is evidence that impacts stratified by agricultural volumes are statistically different from one another for rates and all service quality metrics. However, these impacts are not economically different from one another, and are broadly consistent with the main results (Tables 5 and 6).

Table 10: Impacts of Alliance Concentration on Rates and Service Levels by Agricultural Volumes

	Rate	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
HHI on lane ij: Low Ag Volumes	0.00295	-0.00101***	-2.43***	-4.24e-06*	-1.1e-05***	-9.36e-07**

HHI on lane ij: Med-Low Ag Volumes	-0.00097	-0.00103***	-2.29***	-4.97e-06**	-1.32e-05***	-1.3e-06***
HHI on lane ij: Med-High Ag Volumes	-0.00518*	-0.001***	-2.2***	9.07e-07	-9.31e-06***	-3.41e-06***
HHI on lane ij: High Ag Volumes	-0.00504*	-0.000979***	-2.25***	1.01e-05***	-5.63e-06***	2.96e-07
TEUs	0.00973***	0.00093***	3.53***	3.18e-05***	2.52e-06**	-6.64e-07
N	9,358	94,084	94,084	94,084	94,084	94,084
DF Resid	7,783	90,564	90,564	90,564	90,564	90,564
R2	0.916	0.801	0.854	0.997	0.999	0.998

Lagged Impacts

How does alliance concentration in prior periods affect rates and service levels in the current period? There is evidence that concentration in prior periods is statistically important in determining rates and service levels in the current period for # of vessels, and lane capacity. However, these impacts are not economically different from one another, and are broadly consistent with the main results (Tables 5 and 6).

Table 11: Lagged Impacts of Alliance Concentration on Rates and Service Levels

	Rate	# Vessels	Lane Capacity	# Foreign Ports	# Foreign Countries	# Foreign Regions
HHI on lane ij	-0.00462	-0.000646***	-1.64***	-3.21e-06	-1.49e-06	3.31e-08
HHI on lane ijt-1	0.0031	-0.000134***	-0.295***	-3.51e-06	-3.86e-06**	-3.71e-07
HHI on lane ijt-2	0.000656	-7.15e-05***	-0.101**	-1.89e-06	-1.84e-06	1.59e-07
HHI on lane ijt-3	-0.00526	-6.32e-05***	-0.0836*	-4.82e-07	-9.22e-07	-3.22e-07
HHI on lane ijt-4	0.00253	-7.36e-05***	-0.129***	2.3e-06	-1.53e-06	-4.62e-08
HHI on lane ijt-5	-0.00221	-7.96e-05***	-0.147***	2.48e-06	-1.04e-06	-1.85e-07
HHI on lane ijt-6	0.00392	-0.000135***	-0.247***	3.04e-06	-2.4e-06*	-2.89e-07
TEUs	0.00847***	0.000895***	3.39***	2.86e-05***	3.13e-06***	-2.69e-07
N	8,851	94,065	94,065	94,065	94,065	94,065
DF Resid	7,358	90,612	90,612	90,612	90,612	90,612
R2	0.915	0.809	0.857	0.998	0.999	0.998

Figures

Figure 7 shows port-level alliance concentration by origin-port. Figure 8 shows port-level alliance concentration by destination-port.

Figure 7

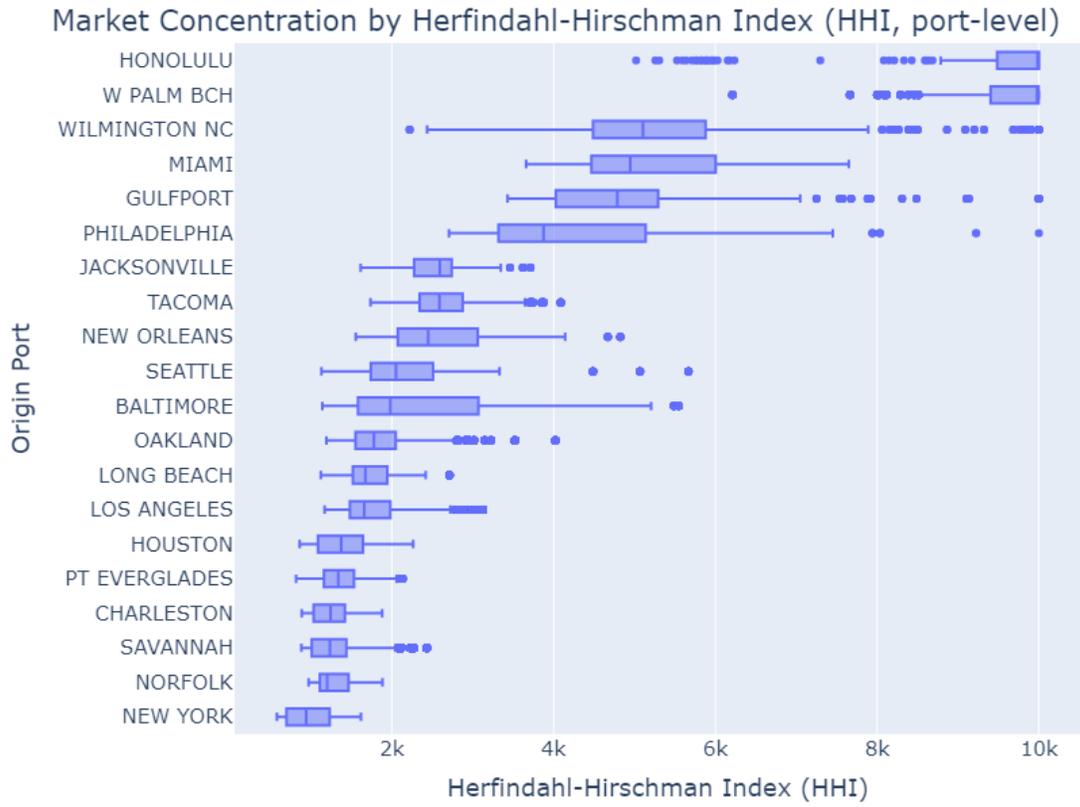


Figure 8

