

# TRB Annual Meeting

## Impacts of Ocean Carrier Alliances on the Maritime Freight Economy: Accounting for Variation in Alliance Utilization --Manuscript Draft--

<b>Full Title:</b>	Impacts of Ocean Carrier Alliances on the Maritime Freight Economy: Accounting for Variation in Alliance Utilization
<b>Abstract:</b>	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 extensive trade data at the vessel and container level to assess the impacts of ocean carrier alliances on the maritime freight economy, with an emphasis on US agricultural exporters. While alliances are global in their permitted scope, the level of actual cooperation between allies varies substantially across lanes and across time. When alliances are highly utilized, we find some small impacts on service frequency as measured by the number of vessels operating on each lane, but economically insignificant impacts of alliance utilization on other quality metrics including average vessel capacity, total lane-level capacity, and the number of ports/countries accessible from each port.
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<b>Order of Authors:</b>	Jake Wagner
	Adam Wilson

# Impacts of Ocean Carrier Alliances on the Maritime Freight Economy: Accounting for Variation in Alliance Utilization

Jake Wagner

[jake.wagner@wsu.edu](mailto:jake.wagner@wsu.edu)

Adam Wilson

[adam.wilson1@wsu.edu](mailto:adam.wilson1@wsu.edu)

Washington State University, School of Economic Sciences

## Abstract

Since the turn of the 21<sup>st</sup> 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 extensive trade data at the vessel and container level to assess the impacts of ocean carrier alliances on the maritime freight economy, with an emphasis on US agricultural exporters. While alliances are global in their permitted scope, the level of actual cooperation between allies varies substantially across lanes and across time. When alliances are highly utilized, we find some small impacts on service frequency as measured by the number of vessels operating on each lane, but economically insignificant impacts of alliance utilization on other quality metrics including average vessel capacity, total lane-level capacity, and the number of ports/countries accessible from each port.

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## Introduction

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 20<sup>th</sup> 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<sup>1</sup>. 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 19<sup>th</sup> century, cooperation among carriers fully permeated the maritime industry in the form of cooperative groups of carries called “conferences.”

A primary concern of economists and regulators has been, since at least the work of Alfred Marshall in the early 20<sup>th</sup> 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 US 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 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 some 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 20<sup>th</sup> century. The Ocean Shipping Reform Act of 1984 weakened the market power of the shipping conferences, and by 1998 the conference system was

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<sup>1</sup> So long as the political relationship between the respective countries allowed, of course.

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 techniques, quickly led to strategic alliances becoming the dominant cooperative strategy between ocean carriers (Evangelista and Morvillo 1999, Fussilo 2006, Sheppard and Seidman 2001, Panayides and Wiedmer 2011).

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. OCAs must be approved by the Federal Maritime Commission (FMC) and are highly similar to the vessel sharing agreements that carriers have been commonly utilizing both before and after the fall of the conference system; however, vessel sharing agreements 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, which is typically less than a dozen. OCAs, by contrast, are global agreements that allow for the use of hundreds of vessels (in other words, up to the majority of the alliance members' combined fleets). 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). One needs not be a transport economist to recognize the global reach of such an agreement. OCAs also require standing committees and/or coordination centers to be jointly operated by the members in order to execute the alliance's joint operations.

This kind of operational cooperation was common under the conference system. However, unlike conferences, OCAs 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).

OCA members are required by their alliance agreements to negotiate slot sharing prices—the price that the member charges for carrying an ally's container on vessels operated by the member—along with the specific number of slots on their ships that each member will allow their ally to utilize on that lane. This slot allocation and pricing is known to all members of the alliance, but it is not filed with the FMC nor made available to the public. Importantly, as of the time of this writing, all 3 active OCA agreements stipulate, either directly or indirectly, “the principle that the Parties' basic slot allocation will be equivalent to contribution” to the alliance (OCEAN Alliance Agreement, 2024). We discuss this allocation extensively below.

OCAs have been the subject of much review by economists, which we discuss in more detail in the next section, and have been viewed by many as allowing 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 all concerns that the maritime freight economy under the alliance system is sufficiently competitive. Taken together, carriers in OCAs represent roughly 90% of global capacity, raising concerns that alliances may exercise market power in various ways (Evangelista and Morvillo 1999) (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).

This paper provides empirical research into the impacts of OCAs, arguing that viewing the members of an OCA as a single collective entity, and especially viewing all services provided by all members on all lanes as related to the OCA, is a flawed approach. Rather, it is vital to account for the fact that, while global in their *permitted* scope, in practice OCAs are highly utilized on some lanes and minimally utilized, if at all, on other lanes. The same is true across time, as we will see below in our analysis of the PIERs Bill of Lading database, which includes carrier, commodity, vessel, and various other data on every container imported or exported from US maritime ports since 2006. We investigate whether OCAs improve capacity utilization and quality of service, as well as to what extent OCAs facilitate anti-competitive behavior among carriers.

This section introduced Ocean Carrier Alliances and provided the basic historical and regulatory context for our analysis, and the next section reviews the relevant economics literature. We then discuss our research methodology, followed by a discussion of the data sets utilized in our analysis. The Results section presents the empirical findings, and we conclude with a discussion of OCA impacts and recommendations for future research.

## **Literature Review**

As mentioned above, Alfred Marshal 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. Marshal's warnings did not go unnoticed, but for the majority of the 20<sup>th</sup> 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 US 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 economic models applied to the maritime freight economy throughout 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.

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. (Crujssn, Dullaert and Fleuren 2007, Fussilo 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 has 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 analyst 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.

## Data

The primary database 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)<sup>2</sup> level from US Customs and Border Protection, US Census data, UN port information, as well as data manually collected by PIERS staff. The data include the quantities and types of each commodity being shipped, the carriers, vessel identification codes, 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 shipments, these data allow us to inspect many aspects of the maritime freight economy.

To the PIERS data we add vessel specifications such as total capacity along with port entry and exit dates for each vessel from the US Army Corp of Engineers Foreign Traffic Vessel Entrances and Clearances database. Due to the private nature of contract pricing discussed above, we do not have price information for each BOL in the PIERS database.

Almost all data columns 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 vessel<sup>3</sup>. Where possible, we use the port entry dates from the Corp of Engineers database to resolve discrepancies, and otherwise cluster nearby dates into a single arrival or departure date using a machine learning algorithm. Second, in order to analyze the dynamics of cargo slot sharing between carriers, we infer the vessel's primary carrier (i.e., the carrier operating that vessel at any given time, whether by owning the vessel, chartering it, or any of the other various means by which carriers control vessels) from the carrier and vessel on each BOL in the PIERS data. The carrier representing the plurality of containers carried on a given vessel during a given month is taken to be that vessel's primary carrier. Containers carried on that vessel from carriers other than the primary carrier are thus deemed shared cargo.

To measure the impacts of alliances, we identify several port and lane-quality metrics that are relevant to export shippers' quality of service. These metrics are identified for each month for each lane/port and include:

- The number of vessels operating on each lane
- The average capacity of vessels operating on each lane
- The total capacity of all vessels operating on each lane

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<sup>2</sup> 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.

<sup>3</sup> E.g., Even though container vessels rarely spend more than a few hours in port, one bill may be dated as arriving January 3<sup>rd</sup> and another, from the same vessel and port, may be dated January 5<sup>th</sup>. 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.

- The number of foreign ports accessible from each U.S. port
- The number of foreign countries accessible from each U.S. port
- The number of foreign regions accessible from each U.S. port

Ocean carrier alliances are hypothesized to impact port and lane-quality metrics through the market power that alliances may exert, under non-competitive market conditions. We measure market concentration on each lane, using the Herfindahl-Hirschman Index (HHI), which is the sum of squared volume shares on a given market, across alliances. On lanes with sufficient market concentration, carriers may be able to exert market power, to the detriment of export shippers, as measured by the port and lane-quality metrics. Importantly market concentration does not necessarily give rise to non-competitive markets.

Analysis is restricted to exports on each of the top 500 lanes by total volume and over time in months; summaries of the aggregated data used for analysis are shown in Table 1.

	count	mean	std	min	50%	max
<b>Alliance HHI</b>	38046	1946.00073	3213.526	0.000012	286.217703	10000
<b>TEUs</b>	38046	2152.3505	2931.474	0.15	1465.965201	48794.37
<b># vessels</b>	38046	17.372759	10.3044	1	17	72
<b>Avg. capacity</b>	35737	2563.95498	1502.253	0	2460.661765	8555.588
<b>Total capacity</b>	38046	58005.8151	77169.94	0	15846.91177	648601
<b># ports</b>	38046	33.878673	24.8659	1	32	92
<b># countries</b>	38046	11.790201	6.739478	1	12	25
<b># regions</b>	38046	4.386112	3.217102	1	3	10



## Methodology and Results

To measure the impact of market concentration on port and lane-quality metrics, a panel fixed effects model is specified:

$$Y_{ijt} = \alpha C_{ijt} + \gamma V_{ijt} + \beta_{ij} + \delta_{it} + \delta_{jt} + \epsilon_{ijt} \quad (1)$$

where  $Y_{ijt}$  is the lane-level quality metric of interest on lane  $ij$  in time  $t$ ,  $C_{ijt}$  is the market concentration (HHI) on lane  $ij$  in time  $t$ ,  $V_{ijt}$  is the volume of exports on lane  $ij$  in time  $t$ ,  $\beta_{ij}$  is a lane-level fixed effect,  $\delta_{it}$  is a U.S. origin port-time fixed effect,  $\delta_{jt}$  destination foreign port-time fixed effect, and  $\epsilon_{ijt}$  is a normally distributed error. 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-level time variant unobservables, and foreign port-level time variant unobservables.

Results from Equation (1) are presented in Table 2.

	# vessels	Avg. capacity	Total capacity	# ports	# countries	# regions
$C_{ijt}$	<b>-0.00028</b>	<b>-0.022</b>	-0.066	<b>-0.000084</b>	-0.00000062	0.00000022
$V_{ijt}$	<b>0.0011</b>	0.008202	<b>-0.48</b>	<b>0.00055</b>	<b>0.000059</b>	<b>0.0000024</b>
$\beta_{ij}$	yes	yes	yes	yes	yes	yes
$\delta_{it}$	yes	yes	yes	yes	yes	yes
$\delta_{jt}$	yes	yes	yes	yes	yes	yes

Alliance concentration is a statistically significant predictor of the # of vessels on each lane, the average capacity of vessels on each lane, and the number of ports accessible from each U.S. port.

To understand the relevant impact of increased concentration based on the results in Table 2, we consider a 5,000-point increase in HHI, representative of non-concentrated lane becoming very concentrated (a single alliance is responsible for upwards of 70% of lane-level volumes). Table 3 shows the unit change and percentage change at the mean from a 5,000-point increase in HHI.

# vessels	Avg. capacity	Total capacity	# ports	# countries	# regions
-1.4	-110	-330	-0.42	-0.0031	0.0011
-8%	-4%	-2%	-1%	0%	0%

These results show that while market concentration is a statistically significant predictor of lane-level quality attributes, these impacts are in most cases economically insignificant.

One exception is the number of vessels, where a large increase in market concentration is estimated to reduce the number of vessels operating the lane by 8%.

## **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 shippers. We also, however, find little evidence as carriers would suggest that alliance utilization improves service quality.

Importantly, this work so far does not evaluate the impacts of alliances on container freight rates, perhaps the most important quality attribute from the shipper's perspective. The evaluation of the impacts of ocean carrier alliance on container freight rates remains as future work.

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