Uniﬁed Merger List in the Container Shipping Industry from 1966: A Structural Estimation of the Transition of Importance of a Firm’s Age, Tonnage Capacity, and Geographical Proximity on Merger Decision

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First version: October 14, 2023

Current version: October 11, 2023

**Abstract**

We construct a novel unified merger list in the global container shipping industry between 1966 (the beginning of the industry) and 2022. Combining the list with proprietary data, we construct a structural matching model to describe the historical transition of the importance of ﬁrm’s age, size, and geographical proximity on merger decisions. We ﬁnd that, as a positive factor, a ﬁrm’s size is more important than a ﬁrm’s age by 9.974 times as a merger incentive between 1991 and 2005. However, between 2006 and 2022, as a negative factor, a ﬁrm’s size is more important than a ﬁrm’s age by 0.026–0.630 times, that is, a ﬁrm’s size works as a disincentive. We also ﬁnd that the distance between buyer and seller ﬁrms works as a disincentive for the whole period, but the importance has dwindled to economic insigniﬁcance in recent years. In counterfactual simulations, we ﬁnd that the prohibition of mergers between ﬁrms in the same country aﬀects the merger conﬁguration of not only ﬁrms involved in prohibited mergers, but also ﬁrms involved in permitted mergers.

# Introduction

Container shipping plays a pivotal role in global trade, revolutionizing the world. According to data from IHS Markit and Descartes Datamyne, it constituted 45.4% of amount-based imports to the U.S., 21.3 of amount-based exports from the United States and 10.1% of quantity-based world trade by 2021. Moreover, the container shipping industry presents an intriguing opportunity to investigate industry dynamics, including entry, exit, and investment (Otani 2023), as well as the history of mergers since its global shipping operations inception in 1966. Despite its signiﬁcance, there exists a notable absence of a consolidated dataset for container shipping mergers, particularly from 1966 to 1990, hindering quantitative research in this area. This study addresses this gap by providing a unified list of all realized mergers in the container shipping industry from 1966 to 2022.

Using our new merger list, we depict the merger waves in the global container shipping industry from 1966 to 2022 and compare them with the price and quantity transitions constructed by Otani and Matsuda (2023). The first merger wave emerged following the enactment of the 1984 Shipping Act. Subsequently, signiﬁcant merger waves occurred after 2005, aligning with the exponential growth in quantities under competitive prices. With targeted periods of the data sources, this observation leads us to categorize the industry’s history into three distinct “regimes” corresponding to the data:1966–1990, 1991–2005, and 2006–2022. Additionally, by merging our merger list with proprietary ship-level data, we delineate the merger patterns, revealing a tendency for mergers to involve relatively younger and smaller ﬁrms in more distant countries in recent years. For example, Taiwan’s Cheng Lie Navigation, which was acquired by France’s CMA-CGM in 2006, is a relatively small container-shipping company founded in 1971. Safmarine, which was acquired from Denmark’s Maersk in 1999, is a South African shipping company. The data patterns are consistent with the view that, in addition to mergers and acquisitions, the market share of independent operators in the liner shipping industry has declined in recent years (Merk and Teodoro 2022).

The merger patterns provide crucial insights into merger waves in the global container shipping industry. Multiple factors may account for this pattern. For instance, recent acquisitions may prioritize ﬁrm’s size to expand market tonnage shares, unlike the period from 1966 to 1990. Alternatively, companies may emphasize geographical proximity to establish dominance at the local level. To untangle these explanations and gain more precise insights into various channels, we employ a structural model that quantiﬁes the relative signiﬁcance of ﬁrm’s age, size, and geographical proximity using a novel approach — the matching maximum score estimator Fox (2018).

Our estimation results indicate that the assortativeness of both size and geographical proximity contribute to merger incentives or disincentives. First, the assortativeness of rm size shifts from negative (1991–2005) to positive (2006–2022). During 1991–2005, the importance of ﬁrm’s size supersedes the importance of its age by a factor of 9.974, serving as a merger incentive. Conversely, between 2006 and 2022, as a negative factor, ﬁrm’s size is more important than ﬁrm’s age by 0.026–0.630 times, that is, ﬁrm’s size works as a disincentive. In addition, we observe that geographical distance acts as a merger disincentive throughout the entire period, albeit its relative importance compared to ﬁrm’s age has dwindled to economic insigniﬁcance in recent years. This finding suggests that merger incentives are diminished to establish dominance at the local country level.

Finally, we conduct a counterfactual simulation based on the estimated parameters to examine the consequences of prohibiting mergers between ﬁrms within the same country. This type of merger restriction is highly contentious in the competitive policies of the global market, particularly in global container shipping. For instance, on June 21, 2017, South Africa’s Competition Commission issued a statement forbidding the consolidation of container businesses through three shipping lines: Nippon Yusen Kaisha (NYK), Mitsui O.S.K. Lines (MOL), and Kawasaki Kisen Kaisha (KLINE). The commission expressed concerns about market consolidation by domestic companies and cartel issues related to these ﬁrms in the car carrier business. Although the country’s competition court eventually approved the integration on January 17, 2018, its potential impact on the planned launch of the integrated container company Ocean Network Express remains noteworthy. In our counterfactual simulations, we discover that prohibiting mergers between ﬁrms in the same country aﬀects not only the merger outcomes of the involved ﬁrms but also those engaged in permitted mergers. This foretells the ripple eﬀect of local competition policies through equilibrium matchings, inﬂuencing both local markets and the global market conﬁguration.

## Related literature

This study contributes to three strands of the literature: empirical transferable utility (TU) matching, endogenous merger analysis, and recent industrial policy and antitrust studies in the shipping industry. First, it contributes to the literature on empirical TU matching. For more recent methodological developments, see Agarwal and Budish (2021). The most related econometric model is Fox (2010, 2018), whose model has been applied to other empirical topics such as banking mergers (Akkus et al. 2015, Chen and Song 2013), faculty room allocations (Baccara et al. 2012), executive and ﬁrm matching (Pan 2017), and buyer and seller relationships in the broadcast television industry (Stahl 2016). These studies applied the matching maximum score estimator proposed by Fox (2010, 2018) to two-sided many-to-many and one-to-one matching in a TU-matching environment. We apply this approach to merger waves in the global container shipping industry from its inception by dividing its history into three regimes based on institutional knowledge and data periods. To the best of our knowledge, our study is the first to illustrate the historical transitions of assortativeness of observed variables using long panel data.

Second, it contributes to the literature on endogenous merger analyses. Endogenous merger analysis in the industrial organization literature can be divided into dynamic and static matching models. In terms of dynamic matching models, they follow Gowrisankaran (1999).[[3]](#footnote-4) Conversely, using a static matching model, Uetake and Watanabe (2019) developed an empirical two-sided non-transferred utility matching model with externalities using moment inequalities and investigated the eﬀect of entry deregulation on the “with whom”-decisions of bank mergers by the Riegle-Neal Act. Akkus et al. (2015) address the same issue using a different approach. They added transfer data and constructed a one-to-one matching model with transfer utility and found that merger value increased from cost eﬃciencies in overlapping markets, relaxing regulations, and the network eﬀects exhibited by acquirer-target matching. Our study follows Akkus et al. (2015) and focuses on endogenous mergers in a single, static, large matching market for each regime, quantifying the relative importance of tonnage capacity and geographical proximity, which are the main economic forces driving firms to pursue mergers to gain cost efficiency in the shipping industry (Notteboom 2004). In addition, we compare the historical transitions in the relative importance of the variables to derive the potentially different merger incentives behind merger waves in the industry.

Third, this study contributes to the literature on recent industrial policies and antitrust in the shipping industry. In the industrial organization literature, Jeon (2022) studies the relationship between learning and investment in the container shipping industry between 2006 and 2014 and simulates social welfare in counterfactual merger scenarios in which a merger occurred between the top two ﬁrms that jointly account for over 35% of total capacity in the industry. In the maritime shipping literature, various research use the Herﬁndahl-Hirschman Index (HHI) and its modiﬁcation, although empirical studies using simple regressions of HHI are criticized (Bresnahan 1989).[[4]](#footnote-5) For example, Sys (2009) collects ﬁrm-year-level vessel volume data for the period 1999–2009 and calculates the HHI and Gini coeﬃcients to compare the degree of market concentration. The author shows that while the degree of concentration has increased in years when mergers and acquisitions have taken place, the industry is still fragmented and competitive due to small shares of ﬁrms. Merk and Teodoro (2022) use a modiﬁed Herﬁndahl–Hirschman Index (MHHI) to show that the industry concentration is higher when consortia are considered. Although these research treat speciﬁc hypothetical mergers and consortia as exogenously determined scenarios and focus on the post-merger market outcomes such as some welfare and concentration measures based on non-cooperative game theoretical models, our paper endogenizes mergers based on cooperative game-theoretical models, i.e., matching models, and focus on merger incentives. Our approach enables us to simulate hypothetical endogenous mergers based on inferred merger incentives, instead of being unable to assess welfare and concentration measures, as in the above studies.

The remainder of this paper is organized as follows: Section 2 summarizes the data and institutional background of mergers in the container-shipping industry. Section 3 constructs a structural matching model to quantify the assortativeness of the observed characteristics for each regime, and compares the levels across regimes. Section 4 presents our estimation results. Section 5 presents counterfactual simulation results. Section 6 summarizes the practical implications, discussions, and directions for future research. Finally, conclusions are presented in Section 7.

# Data and Industry Background

We provide the details of the data sources in Section 2.1. We provide the industry background in Section 2.2 and summarize the statistics for the variables in Section 2.3.

## Data source

We compiled data by merging three distinct sources. The initial source is the Containerization International Yearbook (CIY), which offers ship-level information from 1966 to 1990. The second source is the IHS Markit data (IHS), which provides ship-level information from 1991 to 2005. The third source, the Handbook of Ocean Commerce (HB), provides ship-level data from 2006 to 2022. We classify these periods in the respective data sources as “regimes,” resulting in three regimes: 1966–1990, 1991–2005, and 2006–2022. By consolidating ship-level data, we construct firm-year-level variables, including country names and tonnage capacity, measured in Twenty-foot Equivalent Units (TEU). Finally, we manually created a merger list containing the buyer and seller names along with the merger years. This list is subsequently integrated with the ﬁrm-year-level variables using institutional information. Note that MDS Transmodal data is a potential alternative for a fee, but it oﬀers a maximum of two years of panel raw data, which includes ship-year level variables used in our analysis. Therefore, we believe that our data construction method is the best and most feasible. We have some remarks because we found some inconsistencies such as a one-year lag and missing ship-level variables between the data sources and institutional facts. First, we ﬁx the inconsistencies following the observations in the newer regime data. Second, we treat firms not operating in the merged year as firms with a constant capacity level from the last active year in the merged year. Third, we treat mergers of container shipping seller ﬁrms by non-container-shipping ﬁrms outside the industry as exits from the container shipping sector, as these mergers lack information on buyer ﬁrms. Fourth, we treat consolidation-type mergers as mergers in which buyer ﬁrms have the lower bound of age and size variables at the initial merger timing. The final data on mergers are summarized in this section and used in the empirical analysis in Section 3.

Figure 1 illustrates the number of mergers between 1966 and 2022, based on a merger list. For comparison, Figure 2 illustrates the trends in route-year-level shipping prices and quantities between 1966 and 2009. Comparing these ﬁgures provides graphical intuition. First, Merger waves emerged after the enactment of the 1984 Shipping Act, signifying a shift from collusive behavior. Second, subsequent merger waves align with the exponential growth in quantities under competitive prices post-2005. As a result, we categorize the industry’s history into three distinct “regimes”: 1966–1990, 1991–2005, and 2006–2022, in accordance with the corresponding data.

Figure 1: The number of mergers between 1966 and 2022

Note: Red lines divide the regimes based on the CIY, IHS, and HB.

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* + 1. Price
    2. Quantity

Figure 2: Trends in route-year-level shipping prices and quantities.

Note: Prices are adjusted to the CPI in the U.S. in 1995. See the details in Otani and Matsuda (2023).

## Industry Background

We chronologically describe the industrial background between 1966 and 2022 by focusing on firm mergers. As mentioned earlier, we divided the entire period into three distinct regimes—1966–1990, 1991–2005, and 2006–2022—aligned with institutional background and data sources. In the subsequent merger lists, we deliberately retain the original ﬁrm names for each regime’s data, despite potential inconsistencies across these datasets.

Table 1: Merger list: CIY (1966–1990)

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Seller | Buyer | Year |
| 1 | Moore-McCormack Lines Inc | United States Lines | 1970 |
| 2 | OCL | P&O Containers | 1986 |
| 3 | Franco-Belgian Services | Maersk | 1986 |
| 4 | Y-S Line | NLS | 1988 |
| 5 | Japan Line | NLS | 1988 |
| 6 | KSC | Hanjin | 1988 |
| 7 | Finland Steamship | Finnlines | 1990 |
| 8 | Atlanttraﬁk/Barber Blue Sea | Wilhelmsen Lines A/S | 1990 |

Table 2: Merger list: IHS (1991–2005)

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Seller | Buyer | Year |
| 1 | BUSAN SHIPPING CO LTD | EUROSEAS LTD | 1994 |
| 2 | SVITZER AS | A P MOLLER | 1996 |
| 3 | APL LTD | NEPTUNE ORIENT LINES LTD (NOL) | 1997 |
| 4 | PRIMA SHIPMANAGEMENT SDN BHD | HALIM MAZMIN GROUP | 1999 |
| 5 | FARRELL LINES INC | A P MOLLER | 2000 |
| 6 | OOST ATLANTIC LIJN BV | ATLANTIC HORIZON GROUP | 2001 |
| 7 | CYPRUS MARITIME CO LTD | CYPRUS SEA LINES SA | 2002 |
| 8 | DANSK SUPERMARKED INVEST A/S | A P MOLLER | 2003 |
| 9 | THE PENINSULAR AND ORIENTAL ST | A P MOLLER | 2004 |
| 10 | EUROBULK LTD | EUROSEAS LTD | 2005 |
| 11 | CP SHIPS LTD | HAPAG-LLOYD AG | 2005 |
| 12 | DELMAS | CMA CGM HOLDING | 2005 |
| 13 | HORIZON LINES INC | MATSON NAVIGATION CO INC | 2005 |
| 14 | ROYAL P&O NEDLLOYD NV | A P MOLLER | 2005 |
| 15 | UNITED THAI SHIPPING CORP LTD | IMC SHIPPING CO PTE LTD | 2005 |

Note: We omit the mergers of Royal Nedlloyd and the Peninsular and Oriental containers (P&O Containers) in 1997, Maersk and Sea–Land in 1999, and CMA and CGM in 1999 because historical vessel data of merged firms are missing, and we could not identify these mergers from our data.

**1966**–**1990** Table 1 summarizes all mergers based on CIY between 1966 and 1990.[[5]](#footnote-6) This period involves a collusive and competitive environment with shipping conferences that are explicit and cartels globally allowed. This period has been studied in detail by Otani and Matsuda (2023) and Otani (2023). The period is divided into collusive (1966–1983) and competitive (1984–1990) periods according to the U.S. Shipping Act of　1984.[[6]](#footnote-7) In the collusive period between 1966 and 1983, a single merger occurred in 1970 (Moore-McCormack Lines, Inc. merged with United States Lines). During the competitive period between 1984 and 1990, two mergers occurred in 1986, three occurred in 1988, and two occurred in 1990.

Until the 1970s, containerization was still not adopted, and pioneering countries and ports had set containerized operations only in North America, Western Europe, and Japan (Guerrero and Rodrigue 2014), and had dominant market shares. In addition, container freight rates were high until the 1970s owing to shipping conferences, as shown in Figure 2. Thus, except for the Moore-McCormack merger, there were no significant mergers in the industry in the 1970s because collusive ﬁrms enjoyed enough proﬁts without mergers. Institutionally, Japanese shipping executives stated in newspaper interviews that liner shipping, including containers, was the most proﬁtable division in their companies at that time and supported their operations (Ishida and Sato 2006).

The 1980s was known as the expansion of containerization, which took place in North America, Western Europe, and Japan and its trading partners, such as the Caribbean, the Mediterranean, and Southeast Asian countries (Guerrero and Rodrigue 2014). During this time, these areas were integrated into global trade relations through the beginning of oﬀshoring and the emergence of new transshipment hubs such as Singapore. However, there was a signiﬁcant decline in container freight rates due to the Sea-Land’s withdrawal from shipping conferences in 1980 and the enactment of the Shipping Act of 1984 in the United States (Otani and Matsuda 2023). The falling freight rates and the depreciation of the dollar as a result of the Plaza Accord of 1985 aﬀected the proﬁtability of Japanese and European shipping companies and prompted the mergers (Duru 2018). In Japan, Yamashita Shin Nihon Kisen Kaisha (Y-S Line) and Japan Line merged to form the Nippon Liner System (NLS) in the container shipping sector. In 1988, Hanjin Shipping merged with the Korea Shipping Company (KSC), which was originally state-owned.

**1991**–**2008** Table 2 summarizes all the mergers based on the IHS between 1991 and 2005. This period includes the Ocean Shipping Reform Act (OSRA) of 1998, which divides the period into pre- and post-OSRA periods. This period has been studied in detail by Fusillo (2006, 2013) and Reitzes and Sheran (2002). We ﬁnd three mergers before 1998 and twelve mergers after the enactment of the OSRA of 1998.

Container shipping was established as one of the global standards for carrying cargo in the 1990s. Remarkably, new ports developed in East Asian countries in the 1990s. For example, Chinese port entries into global shipping networks and the emergence of post-Panamax ships have occurred (Guerrero and Rodrigue 2014). Consequently, several ports grew as new transshipment hubs, such as Salalah and Colon, to accommodate growth in emerging economies, such as Vietnam, India, and Brazil.

Global alliances for container shipping were established in the 1990s (Hirata 2017). If a shipping company decides to merge with another company when expanding its liner networks, it can have more market power, while owning or chartering a larger number of vessels, and is then exposed to huge risks of volatility in container freight or cargo volume. On the other hand, if it decides to form an alliance, it can oﬀer customers more comprehensive networks without merging with other companies, they cannot have price-setting power because members are involved in the pricing decision separately. Shipping alliances involved cooperation on a global scale, mainly on trunk routes such as the transpaciﬁc and Far East to Europe, unlike earlier shipping conferences which were limited to speciﬁc routes. In 1994, MOL formed The Global Alliance (TGA) with APL, Nedlloyd, and OOCL. The following year, NYK, Hapag-Lloyd, NOL, and P&O Containers formed the Grand Alliance (GA). The CKY Alliance was formed in 1996 by KLINE, Cosco, and Yang Ming Shipping. Hanjin Shipping entered the CKY alliance in 2001 to form the CKYH alliance. At the same time, mergers occurred, with the Royal Nedlloyd Lines merging with P&O in 1997. Both companies became P&O Nedlloyd and decided to join GA and NOL. After acquiring APL, they formed The New World Alliance (TNWA) with MOL and Hyundai Merchant Marine in 1998. Thus, ﬁrms that chose not to join alliances sought to expand through mergers, for example, CMA’s acquisition of CGM in 1999 and Maersk’s acquisition of Sea-Land and others.

In the ﬁrst half of the 2000s, merger incentives decreased because many ﬁrms achieved substantial proﬁts in the transpaciﬁc and Asia-Europe markets without resorting to mergers. This was attributed to factors such as increased exports of electrical appliances, furniture, and household goods driven by China’s rapid economic growth, a stable housing market in the U.S., and strong economic growth in Europe. In the ﬁrst half of the 2000s, cargo movements, especially on routes from China to the U.S. and Europe, experienced signiﬁcant growth. As some exceptions, mergers and acquisitions were mainly European companies seeking to increase their scale, including Maersk’s acquisition of P&O Nedlloyd, Hapag-Lloyd’s acquisition of CP Ships in 2005, and CMA-CGM’s acquisition of Delmas in 2006.

**2009–2022** Table 3 summarizes all mergers based on the IHS between 2006 and 2022. We find inconsistent merger cases between HB data and institutional background; therefore, we split the merger cases into two categories. Panel (a) summarizes the merger cases from the HB data, consistent with institutional history. In panel (b), we summarize three merger cases from the HB data that are inconsistent with the institutional history. The inconsistency comes from the fact that merged ﬁrms can keep the past operator name in the operation. We treat the three merger cases as occurring in the data, based on data records. Summarizing the two panels, we ﬁnd six mergers before 2009 and 19 mergers after the enactment of the 1998 OSRA.

A remarkable feature of this period was the oversupply of shipping services. After the U.S. housing market collapsed in 2007 with the revelation of the subprime mortgage crisis among financial institutions, transport volume growth slowed. Following the bankruptcy of Lehman Brothers in the following year, shipping demand for containerized cargo began to decline. On the other hand, with an increase in the number of vessels, the size of the vessels also increases to reduce the transportation cost per container. This encouraged the expansion of service supply and deteriorated the supply-demand balance annually. For example, Matsuda et al. (2022) showed that, compared with 1986, the volume of containerized cargo transport was 723% in 2007 and 1047% in 2016. However, the tonnage of container ships has increased from 944% in 2007 to 1784% in 2016. The oversupply of shipping services was the root cause of the market downturn in the late 2010s and was associated with falling freight rates to a competitive level.[[7]](#footnote-8) As a result, container shipping ﬁrms chose to merge in order to survive the tough shipping market.

Mergers and acquisitions have made significant progress since 2014. That year, Hapag-Lloyd’s acquisition of CSAV, Hamburg Sud’s acquisition of CCNI, and CMA-CGM’s acquisition of the German shipping line ODPR were announced. In 2015, CMA-CGM acquired the NOL and container shipping divisions of the COSCO Group and China Shipping Group. In 2016, Hapag-Lloyd’s acquisition of UASC and Maersk’s acquisition of Hamburg Sud were announced, and in Japan, NYK, MOL, and KLINE announced the integration of their liner shipping divisions in 2016. The end of August 2016 also saw the ﬁrst bankruptcy of a major shipping company (Hanjin Shipping) since the formation of alliances. Restructuring in the 2010s has been signiﬁcant in scale, with eight container shipping companies bankrupt or merged between 2015 and 2018.

Table 3: Merger list: HB (2006–2022)

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Seller | Buyer | Year |
| 1 | Cheng Lie | CMA-CGM | 2006 |
| 2 | Lloyd Triestino | Evergreen | 2006 |
| 3 | Norasia | CSAV | 2006 |
| 4 | MacAndrews | CMA-CGM | 2007 |
| 5 | Lufeng | Sinotrans | 2008 |
| 6 | IRISL | Hafez Darya Arya Shipping Lines | 2010 |
| 7 | NEW ONTO SHIPPING | CCL | 2010 |
| 8 | TSK | NYK | 2010 |
| 9 | Chongqing Marine | TAICANG CONTAINER LINES | 2011 |
| 10 | China Navigation | Swire | 2011 |
| 11 | SEACON/T.S. Lines | T.S. Lines | 2013 |
| 12 | Greater Bali-Hai | Swire | 2014 |
| 13 | CCNI | Maersk | 2015 |
| 14 | CSAV | Hapag-Lloyd | 2015 |
| 15 | China Shipping | COSCO | 2016 |
| 16 | Shanghai Puhai Shipping | COSCO | 2016 |
| 17 | UASC | Hapag-Lloyd | 2017 |
| 18 | KLINE | Ocean Network Express | 2018 |
| 19 | MOL | Ocean Network Express | 2018 |
| 20 | NYK | Ocean Network Express | 2018 |
| 21 | APL | CMA-CGM | 2017 |
| 22 | Hamburg Sud | Maersk | 2018 |

(b) HB (2006–2022): Inconsistent merger cases

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Seller | Buyer | Year | Note |
| 1 | Safmarine | Maersk | 2008 | Merger occurred in 1999 |
| 2 | Delmas | CMA-CGM | 2016 | Merger occurred in 2005 |
| 3 | ANL | CMA-CGM | 2022 | Merger occurred in 1998 |

Note: Panel (b) provides merger cases that have inconsistencies with the institutional background because ships operated by merged ﬁrms can keep the past operator name after merger years. In addition, we omitted Cosco’s OOCL merger in 2018 because the merged OOCL vessels kept OOCL as the registered operator name in the HB data until 2022; therefore, we could not identify the renewal timing of the registered operator names.

## Descriptive statistics

Table 4 presents summary statistics for ﬁrm-year-level variables of buyer and seller ﬁrms in all realized merger cases from1966 to 2022. These variables include the ﬁrm’s age in the global container shipping industry and size measured by TEU in the merger year. We normalize these values from 1e-6 (minimum age or size) to 1 (maximum age or size) within each regime for inter-regime comparison. First, we observe a decline in the mean of normalized ﬁrm ages, from 0.84 in the 1966-1990 period to 0.52 in the 2006-2022 period. This suggests that recent mergers involve relatively younger ﬁrms; that is, ﬁrms with less experience in the container shipping industry.

Second, the mean of normalized ﬁrm sizes decreases from 0.23 in the 1966-1990 period to 0.07 in the 2006-2022 period. This indicates that recent mergers involve relatively smaller ﬁrms, despite the exponential growth in ﬁrm size, particularly from 2006 to 2022. Notably, we treat new entrant ﬁrms purchasing incumbent ﬁrms as having an age and size of zero, reﬂecting the increased number of entries through mergers. Figure 3 illustrates the cumulative distributions of normalized ﬁrm size and age for each regime, reinforcing the observation that recent mergers tend to feature younger and smaller ﬁrms.

Table 4: Summary statistics of ﬁrm-year-level variables

* + 1. CIY (1966-1990)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | mean | sd | min | max |
| Age (Normalized) | 16 | 0.84 | 0.24 | 0.23 | 1.00 |
| Size TEU (Normalized) | 16 | 0.23 | 0.29 | 0.01 | 1.00 |
| (b) IHS (1991-2005) | | | | | |
|  | N | mean | sd | min | max |
| Age (Normalized) | 30 | 0.59 | 0.39 | 0.00 | 1.00 |
| Size TEU (Normalized) | 30 | 0.14 | 0.25 | 0.00 | 1.00 |
| (c) HB (2006-2022) | | | | | |
|  | N | mean | sd | min | max |
| Age (Normalized) | 50 | 0.52 | 0.28 | 0.11 | 1.00 |
| Size TEU (Normalized) | 50 | 0.07 | 0.16 | 0.00 | 1.00 |

Figure 4 depicts distributions of realized match-level distances. We observe that nearly all mergers between 1966 and 1990 involve buyer and seller ﬁrms within the same country. Although mergers within the same country account for over 30% of the entire period, the number of mergers between ﬁrms separated by distance has increased recently. This shift suggests that the reasons for mergers have transitioned from domestic to global, driven by the growth and expansion of international container transport.

These visualizations provide initial insights into the involvement of relatively younger and smaller ﬁrms in more distant countries in recent mergers. However, comprehensively assessing the relative importance of each variable with limited data requires a sophisticated structural model. In Section 3, we introduce a structural matching model to quantify the signiﬁcance of each variable and analyze the transitions across .

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Figure 3: Distributions of ﬁrm-year-level variables for each regime

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Figure 4: Distributions of match-level distances of seller and buyer ﬁrms for each regime

# Empirical analysis

Our objective is to quantify the assortativeness of observed characteristics for each regime and compare the levels across regimes. We employ a matching maximum score estimator developed by Fox (2018), which is a well-known method for measuring matching assortativeness. We model mergers in each regime as a two-sided one-to-one transferable matching game in a single market. Let and be the sets of potential ﬁnite buyers and sellers, respectively. Let be buyer ﬁrms and let be seller ﬁrms, where is cardinality. Let denote the set of ex-post matched buyers and denote that of ex-post unmatched buyers such that and . For the seller side, deﬁne and as the set of ex-post matched and unmatched such that and . Let be the sets of all ex-post matched pairs . Let denote the set of all ex-post matched pairs and unmatched pairs and s for all and , where ∅ is a null agent generating unmatched payoﬀ.

*b*

Each ﬁrm can match at most one agent on the other side; thus, . The matching joint production function is deﬁned as , where and . The net matching values for buyer and seller are deﬁned as and , where is the equilibrium merger price paid to seller ﬁrm by buyer ﬁrm and . For scale normalization, we assume and for all and . Each buyer maximizes across seller ﬁrms, whereas each seller maximizes across buyer ﬁrms.

The stability conditions for buyer ﬁrm and seller ﬁrm are as follows:

, (1)

, .

Based on Inequalities (1) and equilibrium price conditions and in Akkus et al.(2015), we construct the inequalities for matches and , as follows:

,

, (2)

*,*

*,*

where and are the unrealized equilibrium merger prices that cannot be observed in the data. The last two inequalities cannot be derived from the data because the researchers cannot observe how the total matching value, , is shared between buyer and seller .

Each buyer ﬁrm can only acquire one seller ﬁrm, which implies that the buyer ﬁrm’s choice among a set of seller ﬁrms is discrete. As a simple semiparametric technique for estimating the discrete choice, we employ maximum score estimation Manski (1975, 1985). Fox (2018) proposed a maximum score estimator using the above inequalities when we observe the transfer data or not under mild conditions. The maximum score estimator is consistent if the model satisﬁes a rank order property as in Manski (1975, 1985), i.e., the probability of observing matched pairs is larger than the probability of observing swapped matched pairs. The rank order property is equivalent to pairwise stability, which is a milder property rather than stability; therefore, the rank order property holds under the above stability conditions. See identiﬁcation details in Fox (2010) and Monte Carlo simulation results in Fox (2018), Akkus et al. (2015), and Otani (2022).

We specify , as a parametric form , where is a vector of observed characteristics of all buyers and sellers and is a vector of parameters. In the absence of transfer data, given the observed characteristics , one can estimate by maximizing the following objective function:

, (3)

where is an indicator function. The inequality is constructed by adding the ﬁrst two inequalities and

canceling out transfers and in Inequalities (2). The objective function (3) counts the number of correctly predicted pairwise stable matching under each candidate parameter .

In our empirical application, as the observed characteristics, , we use the standardized ﬁrm’s age, size measured by the total tonnage, and match-level distance calculated from the locations of the ﬂag countries at merger timing; that is, all observed variables are standardized to . Concretely, we specify the joint production function as

, (4)

where is assumed to be i.i.d. errors drawn from the zero median distribution as in Fox (2018). Note that any parameters of ﬁrm-speciﬁc characteristics cannot be identiﬁed with maximum score estimation based solely on without-transfers information. With transfer data, and , such as the payments regarding mergers from buyer ﬁrms to seller ﬁrms, the identiﬁcation is possible and the precision of the estimator improves as in Akkus et al. (2015).

# Results

Table 5 reports the estimation results of the matching maximum score estimator. As we can use only realized merger cases, we could not construct a 95% conﬁdence interval with sufficient subsampled data via bootstrap. The numbers in brackets indicate the lower and upper bounds of a set of maximizers of the objective function. If the lower and upper bounds are similar, then the parameters are point-identiﬁed.

Otherwise, the parameters are partially identiﬁed. More than 90% of correct matches were used as a measure of statistical ﬁt; thus, the estimated model predicts the actual mergers well.

First, the estimated coeﬃcient of the ﬁrm’s size shows an interesting transition. The sign changed from ambiguous between 1966 and 1990, positive between 1991 and 2005, to negative between 2006 and 2022. In particular, between 1991 and 2005, as a positive factor, ﬁrm’s size is more important than ﬁrm’s age by 9.974 times in merger decisions; that is, ﬁrm’s size works as a merger incentive. Conversely, between 2006 and 2022, as a negative factor, ﬁrm’s size is more important than ﬁrm’s age by 0.02-0.63 times; that is, ﬁrm’s size works as a merger disincentive. These results are consistent with the institutional fact that consolidation-type mergers in which buyer ﬁrms have the lower bound of age and size variables at the initial merger timing have been common rather than absorption-type mergers in recent years.

Second, the estimated coeﬃcient of the distance of seller and buyer ﬁrms shows a negative sign across all regimes but the level decreases between 2006 and 2022. This means that mergers of ﬁrms in distant countries are likely to occur; however, the importance level relative to ﬁrm’s age has decreased to economically zero recently. These results are consistent with data patterns shown in Section 2.3 and the institutional facts that shipping companies do not hesitate to merge with companies in distant regions to expand their container shipping networks.

Table 5: Matching maximum score estimation

|  |  |  |  |
| --- | --- | --- | --- |
| Regime | 1966-1990 | 1991-2005 | 2006-2022 |
| Firm age: *β*1 | 1 | 1 | 1 |
| Firm size (TEU): *β*2 | [-9.503,9.475] | [9.974,9.974] | [-0.630,-0.026] |
| Distance: *β*3 | [-9.977,-0.687] | [-1.557,-1.557] | [-0.004,-0.002] |
| % of correct matches | 1.000 | 0.905 | 0.983 |

Note: The objective function was numerically maximized using a diﬀerential evolution (DE) algorithm in BlackBoxOptim.jl package. For the DE algorithm, we require setting the domain of parameters and the number of population seeds so that we ﬁx the former to [−10, 10]. For estimation, 100 runs of 1000 seeds were performed for all speciﬁcations. The numbers in parentheses are the lower and upper bounds of the set of maximizers of the maximum rank estimator. Parameters that can take on only a ﬁnite number of values (here 1) converge at an arbitrarily fast rate, then they are super consistent. The unit of measure of all variables is normalized to [1e − 6, 1].

# Counterfactual

In the global container shipping industry, mergers between ﬁrms in the same country involve several concerns from competition policies in multiple countries. For example, on June 21, 2017, South Africa’s Competition Commission issued a statement stating that it ”forbade” the integration of the container business by the three shipping lines of NYK, MOL, and KLINE. The commission cited concerns about market consolidation by domestic companies and cartel issues involving these companies in the car carrier business. The country’s competition court ﬁnally approved the integration on January 17, 2018; however, this could impact the planned launch of the integrated container company, Ocean Network Express. In another example, Cosco and China Shipping‘s alliance decision in 2015 could face scrutiny from regulators as the market share in some east-west trades is likely to breach the 30% mark if the new entity joins the group. Above 30%, alliances must ensure their agreements comply with EU rules outlawing anti-competitive behavior.

In our counterfactual simulation, given estimated parameters, we simulate the matching outcome under the hypothetical scenario that mergers between ﬁrms in the same country are prohibited. Mechanically, ﬁrst, this scenario uses the merger cases of ﬁrms in diﬀerent countries and imposes that the joint production function (4) is changed to

Second, given counterfactual , we compute an equilibrium matching allocation. The equilibrium one-to-one matching allocation is calculated according to the following linear programming problem proposed by Shapley and Shubik (1971):

where the dual of this linear programming problem also gives equilibrium prices. In the equilibrium matching allocation, 1 if ﬁrms and s are matched and 0 otherwise. In the simulation, we ﬁx the parameters to the upper bounds of estimated parameters in Table 5, and we draw 100 i.i.d. draws of from the standard normal distribution , then solve the above linear programming problem. We conﬁrm that using the lower bounds of parameters gives the same results. We report the lower and upper bounds of percentages of the number of total matchings and the same matching conﬁgurations of the simulated 100 matching outcomes relative to the data.

Table 6 presents the counterfactual simulation results under the prohibition of mergers between ﬁrms in the same country. We compare hypothetical merger cases with actual cases and focus on the two regimes between 1991 and 2005 and between 2006 and 2022, as only one merger of ﬁrms in diﬀerent countries happened between 1966 and 1990. First, the counterfactual model predicts the number of mergers between ﬁrms in diﬀerent countries perfectly in both regimes. Second, only 0.12 to 0.44% of the counterfactual merger pairs are the same as actual pairs. This implies that the prohibition would restrict the choice set of buyer ﬁrms involved in the prohibited mergers to the set of ﬁrms in diﬀerent countries and change the matching outcome through maximization of the modiﬁed objective function (3). Therefore, we ﬁnd that the prohibition of mergers between ﬁrms in the same country aﬀects the merger conﬁguration of all ﬁrms in the industry.

Table 6: Counterfactual simulations under the prohibition of mergers of ﬁrms in the same country

|  |  |  |
| --- | --- | --- |
| Regime | 1991-2005 | 2006-2022 |
| Matching Num (data) | 15 | 25 |
| % total match (counterfactual/data) | [1.000,1.000] | [1.000,1.000] |
| % same match (counterfactual/data) | [0.120,0.440] | [0.120,0.440] |

Note: We simulate the matching outcome from the upper bounds of the estimated parameters and 100 i.i.d. draws of from the standard normal distribution . The bracket gives the lower and upper bounds of percentages of the number of total matchings and the same matching conﬁgurations of the simulated 100 matching outcomes relative to the data.

# Practical Implications, Discussion, and Future Research

## Practical Implications

Our study makes an important contribution to the development of the uniﬁed merger list of the container shipping industry and policy discussions for practitioners. The data contribution enables practitioners to obtain empirical and historical knowledge on the main container transport markets, and to develop a methodology to disentangle merger incentives. For instance, our analysis corroborates anecdotal evidence indicating that container shipping ﬁrms that abstained from joining alliances in the 1980s, and had relatively brief market tenure, primarily engaged in mergers to increase their scale in their home regions. Recently, they have tended to merge with companies in distant regions, even when there are no signiﬁcant diﬀerences in size, to expand their container shipping networks. Additionally, Jeon (2022) simulated counterfactual and exogenous merger scenarios of speciﬁc two ﬁrms between 2006 and 2014; however, she did not incorporate and explain more than ten merger cases in her model. Thus, our data contribution complements previous studies institutionally and sheds light on the data patterns and main drivers of mergers in the industry.

As a contribution to the policy discussion, our counterfactual ﬁnds that the prohibition of mergers between ﬁrms in the same country would change the merger conﬁguration signiﬁcantly. This predicts the propagated impact of the prohibition caused by the local competition policies on the local markets and on the global market conﬁguration. For example, if Japanese container shipping companies were restricted from merging their container divisions owing to a dominant market share in Japan, they might have pursued mergers with ﬁrms in other countries to enhance their shipping network and scale. Such a scenario could have altered the current structure of the container shipping market.

## Discussion

We summarize the potential concerns for the data and methodology. First, we merge three data sources that record potentially diﬀerent variables and observations for each regime. Thus, we could not check the robustness check on the choice of the regime owing to data limitation and inconsistency, although we believe that our choice of the regime is reasonable for institutional and graphical reasons. Second, we may face a small sample problem, particularly between 1966 and 1990, although the matching maximum score approach works in a small sample in Monte Carlo simulations (Akkus et al. 2015, Otani 2022). Third, we eliminate merger cases that involve ﬁrms whose variables are missing in our three data sources. This might be because unlike the MDS Transmodal data mentioned above, it does not cover all the routes and vessels in the container trade. This is because the IHS data lacks some historical information on vessel operations, and the HB data collects data on routes and vessels focusing on trunk lines and routes to/from Japan, using operator advertisements. For example, Maersk’s merger with Sea-Land and P&O Containers’ merger with Nedlloyd are not in the data and are not reﬂected in the analysis, as shown in the footnotes in the merger lists in Tables 2 and 3.

## Future Research

Here, we discuss possible extensions and some shortcomings of this study. As a methodological issue, ﬁrst, this study focuses on disentangling endogenous merger incentives while ignoring future competition in the market owing to data limitations. Thus, a welfare evaluation of the post-merger market was not investigated. Combining ﬁrms’ strategic interactions with estimations of demand and supply sides with the endogenous matching merger model remains a challenging and open research question in the ﬁeld of industrial organization (Agarwal and Budish 2021). An exceptional study is that of Igami and Uetake (2020), which constructed a stochastic sequential-move game but needed monthly-level merger data and allow only a single merger each month. Developing their approach might resolve the relationship between matching and competition. Second, our matching model does not incorporate unobserved heterogeneity, which is identiﬁed nonparametrically (Fox et al. 2018). Pursuing this direction will require a diﬀerent econometric approach such as the simulated method of moments in Fox et al. (2018) and multiple market data.

# Conclusion

We construct a novel uniﬁed list of mergers in the global container shipping industry between 1966 (the beginning of the industry) and 2022. Combining the list with proprietary data, we construct a structural matching model to describe the historical transition of the importance of ﬁrm’s age, size, and geographical proximity on merger decisions. We ﬁnd diﬀerent transition patterns of the importance of ﬁrm’s age, size, and geographical proximity. In counterfactual simulations, we ﬁnd that prohibiting mergers between ﬁrms in the same country aﬀects the merger conﬁguration of ﬁrms involved in prohibited and permitted mergers.

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2. § Faculty of Commerce, Takushoku University. Email: [tmatsuda@ner.takushoku-u.ac.jp](mailto:tmatsuda@ner.takushoku-u.ac.jp) [↑](#footnote-ref-3)
3. Stahl (2011) is the first to use a dynamic strategic framework to estimate a merger activity model. Jeziorski (2014) estimated the sequential merger process to analyze ownership consolidation in the United States radio industry after the enactment of the 1996 Telecommunications Act. Igami and Uetake (2020) applied a stochastic sequential bargaining model to merger processes in the hard-disk industry. Hollenbeck (2020) enriches the Gowrisankaran-type dynamic endogenous merger model. Using different dynamic approaches, Nishida and Yang (2015) compare post-merger and pre-merger beliefs and equilibrium behaviors in a Markov perfect equilibrium in the Japanese retail chain industry. Perez-Saiz (2015) incorporated mergers as bidding games by incumbents and investigated the eﬀect of the Reagan-Bush administration’s merger policy on the reallocation of assets in the United States cement industry. [↑](#footnote-ref-4)
4. As a theoretical merger analysis, Nocke and Whinston (2022) demonstrate that in a general Cournot model, only the naively-computed change in the HHI due to a merger (twice the product of the per-merger market shares of the merging ﬁrms), but not the level of the HHI, is valuable in screening mergers for welfare assessment. Spiegel (2021) shows that the HHI reflects the ratio of producer surplus to consumer surplus in Cournot markets under some theoretical conditions. The empirical maritime literature follows the direction of Spiegel (2021), focusing on the relationship between market concentration, prices, and consumer surplus without considering the endogeneity problem of prices, HHI, etc., for example, Hirata (2017). This has been criticized in industrial organization literature (Bresnahan 1989) since the 1980s. Policymakers and practitioners sometimes use the HHI to measure the concentration of the container shipping market. For example, the Federal Maritime Commission (FMC), the administrative agency that oversees shipping in the United States, cited the competitive nature of the HHI as one of a reason why the Transpaciﬁc route is extremely competitive (Federal Maritime Commission 2022). [↑](#footnote-ref-5)
5. In 1964, the Japanese ocean shipping industry experienced consolidation induced by the government, and 95 ﬁrms were merged into six large groups. Otani (2021) investigates an event using a structural matching model. [↑](#footnote-ref-6)
6. The relevant studies are Wilson and Casavant (1991), Pirrong (1992), and Clyde and Reitzes (1998). Wilson and Casavant (1991) provided evidence of regime change by the Shipping Act of 1984 using data on quarterly freight rates and shipping quantities of ﬁve selected commodities only on the Transpaciﬁc route. Pirrong (1992) tested the model prediction of the core theory surveyed in Sjostrom (2013) using data from two speciﬁc trade routes between 1983 and 1985. Clyde and Reitzes (1998) studied the relationship between market power and the market share of shipping conferences after the Act. [↑](#footnote-ref-7)
7. Falling freight rates also led to alliance restructuring and mergers and acquisitions. In 2012, GA and TNWA began joint operations on Asia-Europe routes, forming the G6 alliance. The three European companies, Maersk, MSC, and CMA-CGM, have had a vessel-sharing agreement on transpaciﬁc routes since 2008 and had also been strengthening their alliance among the three companies. In 2013, the three companies announced the formation of a new alliance called the P3 Network. However, this was terminated due to lack of approval from the Chinese Ministry of Commerce. This was because it would have had too large a market share on the Far East-Europe route. Following the failure of the P3 alliance, Maersk and MSC immediately signed a 10-year vessel-sharing agreement to form the 2M alliance. The remaining CMA-CGM also announced the formation of Ocean Three (O3) with China Shipping Container Line (CSCL) and Arab-owned United Arab Shipping Company (UASC), and began partnering on key routes in 2015. The CKYH alliance was also joined by Evergreen in April 2014, replacing the CKYHE alliance. [↑](#footnote-ref-8)