Inconsistencies in Antitrust Decision-Making: Evidence from Global Shipyard Mergers*

Chuyue Tian †

November 10, 2024
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Abstract

This paper examines market and non-market factors determining whether an antitrust authority approves a proposed merger. In the shipbuilding industry, descriptive evidence and merger simulations using a random coefficients logit model highlight inconsistencies in antitrust decisions: similarly anti-competitive shipyard mergers are not uniformly blocked, and smaller jurisdictions adopt a laissez-faire approach despite non-trivial welfare losses. The inconsistencies indicate the influence of factors beyond market outcomes in antitrust decisions. To account for the influence of these factors on merger approval, I develop and estimate a Bayesian persuasion model for an antitrust authority' decision-making process. In the counterfactual, removing extraneous factors from the authority's decision-making process lowers the average merger approval probability by 8.59 percentage points, yielding a consumer welfare gain amounting to 3.7% of the median market's consumer surplus.

Keywords: antitrust, horizontal merger, demand estimation, discrete choice model, Bayesian persuasion, shipbuilding
JEL Codes: C11, G34, L40, R41

*I thank Hsin-Tien (Tiffany) Tsai for her unwavering support and guidance; Kwok-Hao Lee, Kenneth Khoo, Joris Mueller and participants at the Carroll Round Conference for helpful comments. All mistakes are mine. The previous version of part of this paper was circulated under the title "Simulating the Impact of the Merger between Hyundai and Daewoo".

†National University of Singapore, Department of Economics. Email: tiancy@nus.edu.sg

1 Introduction

Rising markups and market power (see e.g., De Loecker, Eeckhout, and Unger (2020)) have ignited a debate about whether the current antitrust enforcement is too lenient (Berry, Gaynor, and Morton 2019; Miller and Sheu 2021; Shapiro 2020). While the economics literature analyzes the flaws of specific antitrust regulations (Nocke and Whinston 2022; Salop and Morton 2021), legal scholars recognize that antitrust enforcement, especially in developing countries, can also be heavily influenced by political considerations or even ulterior motives (Mariotti 2023; Zhang 2021). While sub-optimal rules and regulations create deadweight loss, arbitrary antitrust enforcement can also be inefficient (Gennaioli and Shleifer 2008). These observations motivate the research question: to what extent do in-principle irrelevant factors[1] obfuscate antitrust decisions?

This paper examines the influence of market and non-market factors on antitrust decision-making in the context of global shipyard mergers. Through the lens of a random coefficients logit demand model, I identify inconsistencies in antitrust rulings with respect to shipyard mergers: similarly anti-competitive mergers are not uniformly rejected, and smaller jurisdictions are consistently less interventionist despite non-trivial welfare losses. To systematically account for the inconsistencies, I model an antitrust authority's decision problem as a Bayesian persuasion game, estimating the model primitives accounting for the merger's market and non-market impact. The estimates suggest that extraneous factors reduce the perceived anti-competitive effect of an average merger by 15% in antitrust decision-making. In the counterfactual, removing those factors lowers the average merger approval probability by 8.59 percentage points. The lower probability of approving an anti-competitive merger entails an annual global consumer welfare gain of $12.98 million, which amounts to 3.7% of consumer welfare in the median market. Shielding antitrust regulators from the extraneous factors therefore better protects consumer welfare, which is commonly perceived to be the paramount duty of antitrust (Almunia 2010).

[1] Although there are academic discussions on alternative goals of antitrust (Cseres 2006), the mainstream antitrust regulators, such as the Federal Trade Commission and the European Commission, still largely adopt the consumer welfare standard: the antitrust regulator intervenes only when consumers are harmed (Almunia 2010; European Commission 2004; Wilson 2019). Antitrust law in younger jurisdictions like China's also purports to place consumer welfare as the primary focus (Shan et al. 2012).

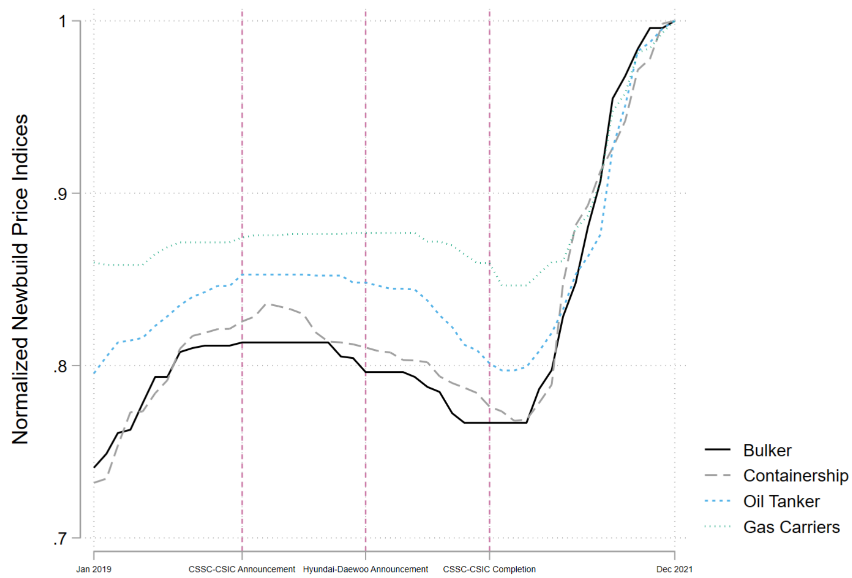
This paper's context is the shipbuilding industry. A symbol of national "pride and machismo" (Barwick, Kalouptsidi, and Zahur 2024; Strath 1987), shipyard mergers are enmeshed with political considerations that extend beyond firm profits. The contrasting fates of two mega shipyard mergers in 2019 highlight how extraneous factors may then influence antitrust decisions. While the merger between China State Shipbuilding Corporation and China Shipbuilding Industry Company (CSSC-CSIC) smoothly consummated within a year, the similar-in-scale Korean merger between Daewoo Shipbuilding and Hyundai Heavy Industries (Hyundai-Daewoo) was ultimately blocked by the European Commission (EC) three years later.[2] Given the steep price surge post the CSSC-CSIC merger (Figure 1), the more visible distinction between the two mergers is that the CSSC-CSIC deal was ordered by China's highest executive body (CSSC 2021).[3] Conversely, the Hyundai-Daewoo merger was an attempt by Daewoo to restructure and boost competitiveness (Shen 2019). The potential presence of non-market factors shaping antitrust decisions renders the shipbuilding industry well-suited for my analysis.

The empirical analysis proceeds as follows. First, I combine data of vessel sales with news of shipyard mergers to assess the impact of mergers. The transaction-level proprietary dataset covers sales from the four most common commercial vessel categories - bulk carriers, containerships, gas carriers, and tankers - between 2006 and 2023. This data allows me to observe and compute key market outcomes, such as prices and consumer welfare, across market and time. Moreover, I compile merger news from a shipping news agency to build a dataset of proposed horizontal shipyard mergers between 2010 and 2023, along with the corresponding antitrust decisions or press releases related to each merger.

Second, using a differences-in-differences design, I find that an average shipyard merger is not associated with a price surge or quality drop. However, the subset of

[2]Despite having received approval from China, Kazakhstan, and Singapore, the EU rejected the merger one month before Russia launched a full-scale invasion of Ukraine. In the ground of decision, the EC cited, among other things, the need to ensure competition in the market of liquefied natural gas (LNG) carriers and to improve Europe's "energy security" (European Commission 2022). Hyundai subsequently initiated a legal appeal against the EC's decision at the EU's General Court, but the action was withdrawn in 2024 (Practical Law Competition 2024). Daewoo was eventually acquired by another Korean shipyard Hanwha Group in 2023.

[3]Directed by the State Council, the CSSC-CSIC merger happened against the backdrop China's nationwide reform to consolidate state-owned enterprises and create "national champions" (Leutert 2016). After the merger, China's northern and southern shipbuilding groups were unified into one giant conglomerate.



Note: This graph shows the monthly price indices of newly built bulker, containership, oil tanker, and gas carrier between 2019 and 2021. Each time series is normalized by its highest value. Source: Clarksons Research.

Figure 1: Monthly Price Trend of Newbuilt Commercial Vessels around CSSC-CSIC Merger

mergers scrutinized by at least one antitrust agency worldwide exhibits stronger anti-competitive effects. For each merger, I compare the merged shipyards with the never-treated - the shipyards that did not undergo any merger or acquisition between 2010 and 2023 - two years before and after the merger. When all thirteen mergers are included in the analysis, I find no statistically significant changes in vessel prices, capacity, or time to build for the merged shipyards. Yet, a 4.5% increase in newly built vessel prices two years post-merger is detected in the sub-sample of mergers subject to antitrust scrutiny, and there is no significant improvement in vessel capacity or delivery time. The empirical evidence suggests that antitrust scrutiny over these mergers was well justified, although it raises the further question about why most of them received eventual approval.

Third, I evaluate the heterogeneous impact of individual shipyard mergers by simulating their market outcomes using a random coefficients logit demand model (Berry, Levinsohn, and Pakes 1995; Nevo 2000). Consistent with the reduced-form evidence, the merger simulations suggest that shipyard mergers subject to antitrust scrutiny generally lead to a larger price increase and a greater loss of consumer welfare. While average shipyard merger is associated with a \$5-8 million loss in consumer welfare per year, the largest mergers (Hyundai & Daewoo and CSSC & CSIC) could result in an annual welfare loss around \$30 million. The differences in mergers' market outcomes and the corresponding antitrust decisions highlight inconsistencies of antitrust decisions. Mergers that would bring about similar welfare losses or price increases may receive different rulings due to protectionism; smaller authorities are consistently less interventionist despite the non-trivial losses incurred. Non-market factors, such as the political backlash from rejecting a merger, may lead antitrust regulators to be overly lenient.

Fourth, to systematically understand the source of inconsistencies in merger decisions, I formulate a structural model of the decision-making process used by antitrust authorities. Following the information acquisition framework developed by Wald (1945) and Henry and Ottaviani (2014, 2019), I conceptualize the authority's problem as deciding whether to approve or reject a proposed merger. A rejection yields zero payoff, while the payoff from approval depends on the true nature of the transaction, which is either anti-competitive or not. The magnitude of the payoff from approving an anti-competitive merger is influenced by market characteristics, such as changes in the HHI and the market shares of the merging shipyards. Additionally, non-market factors, such as the global prominence of the shipyards and whether they are domestic companies, also affect the payoff. The authority may choose to acquire additional information about the true state of the merger at a cost, with the information generated by a Wiener process. Wald (1945) has shown that the authority's optimal strategy involves two threshold beliefs: approval occurs when the belief about the merger's true state (whether anti-competitive) crosses the upper threshold; rejection occurs when it crosses the lower threshold. One key departure of the model from the single-agent Wald (1945) problem is that a merger can only proceed when all authorities involved have granted their approval.

I structurally estimate the model parameters by maximizing the likelihood of observing the authority's actual merger decision and the time taken for deliberation. The estimates highlight the weight an authority places on both market and non-market factors. An authority is more cautious about wrongly approving a merger when it involves a higher degree of market consolidation. On the other hand, the authority is more hesitant to reject a merger between two global conglomerates, even after controlling for the shipyards' market presence within its own jurisdiction. Furthermore, an authority is more likely to approve a merger between domestic shipyards, signaling protectionist considerations. For an average shipyard merger sampled, extraneous factors reduce the perceived anti-competitive effect by 15% in the authority's decision-making process, revealing the distortionary effect of non-market factors on merger outcomes.

I simulate a counterfactual scenario that removes the extraneous considerations by setting the authorities' payoffs derived from non-market factors to zero. I find that the likelihood of an authority approving a merger decreases by 8.59 percentage points on average. Specifically, extraneous factors increase the probability of approval for the CSSC & CSIC merger by 4.38 percentage points, while the Hyundai & Daewoo merger benefits by only 0.23 percentage points.[4] As such, the different trajectories of the two mergers are indeed partially explained by factors beyond their market outcomes. For the mergers sampled, the lower likelihood of approving anti-competitive mergers leads to a $12.98 million gain in expected consumer welfare per year, which amounts to 3.7% of consumer welfare in the median market. Removing the influence of extraneous considerations from antitrust decision therefore carries welfare consequences.

1.1 Literature Review

The central theme of this paper is exploring how non-market factors, such as the political influence of conglomerates, protectionism, and potential trade retaliation, influence antitrust decisions. It is therefore tied to several distinct strands of literature, including retrospective review of merger(s), Bayesian persuasion, studies of the shipbuilding industry, and geoeconomics.

Merger Review. First, this paper connects to the industrial organization literature that retrospectively reviews the impact of mergers. The effects of mergers and acquisitions on various market outcomes have been studied, including prices (Ashenfelter, Hosken, and Weinberg 2013; Gowrisankaran, Nevo, and Town 2015), product quality and variety (Berry and Waldfogel 2001; Eliason et al. 2020; Fan

[4] Probability of success refers to the likelihood that all relevant antitrust authorities approve the given merger.

2013), investment and cost efficiency (Demirer and Karaduman 2024; Pesendorfer 1998), buyer power (Craig, Grennan, and Swanson 2021), post-merger collusive behavior (Miller and Weinberg 2017), employment (Geurts and Van Biesebroeck 2019), lobbying (Moshary and Slattery 2024), and more. In light of the recent push for stricter antitrust enforcement (Shapiro 2020), the legal doctrines governing merger control have received increased attention. Bhattacharya, Illanes, and Stillerman (2022) estimates the price threshold above which US regulators would likely challenge a merger, while Nocke and Whinston (2022) questions the effectiveness of concentration-based thresholds used by regulators. This paper adds to this literature by exploring the factors influencing an antitrust regulator's internal decision-making and underlining more subtle sources of inefficiency apart from the black-and-white antitrust regulations.

Bayesian Persuasion. Second, the framework in this paper is related to the extensive theoretical literature on Bayesian persuasion, and more specifically, on approval decision-making. A typical Bayesian persuasion game involves a sender transmitting signals to a receiver, with the signals being functions of the true state of nature. The receiver updates their belief based on the signal and chooses the optimal action (Kamenica and Gentzkow 2011).[5] In the approval decision-making context, Carpenter (2004) is an early example that shows how large pharmaceutical firms benefit from faster and more likely approval of new drugs. Expanding on the classical single-agent framework of Wald (1945), where the receiver receives a stochastic series of signals, Henry and Ottaviani (2014, 2019) study a sequential game between the company sender and the drug authority receiver. Bardhi and Guo (2018) and Chan et al. (2018) consider cases where approval is contingent on a simple majority or unanimous approval by heterogeneous receivers. Beyond drugs, the approval process model has also been applied to political parties' persuasion of voters and other contexts (Gul and Pesendorfer 2012). Empirical works have applied the Bayesian persuasion framework to settings such as scoring system (Decker 2022; Vatter 2022) and disclosure by physicians (Xiang 2021). This paper relates to the literature by adapting the classical single-agent information acquisition model to the antitrust decision-making context.

[5] See Kamenica (2019) for a comprehensive review of the work on Bayesian persuasion.

Shipbuilding. Third, this paper relates to the growing body of literature on the shipbuilding industry. Previous studies have developed methods to detect subsidies and other industrial policies and have evaluated the welfare implications of these policies in the Chinese shipbuilding industry (Barwick, Kalouptsidi, and Zahur 2019, 2024; Kalouptsidi 2018). This paper focuses on mergers and acquisitions and how they can affect competition and welfare in the shipbuilding industry.

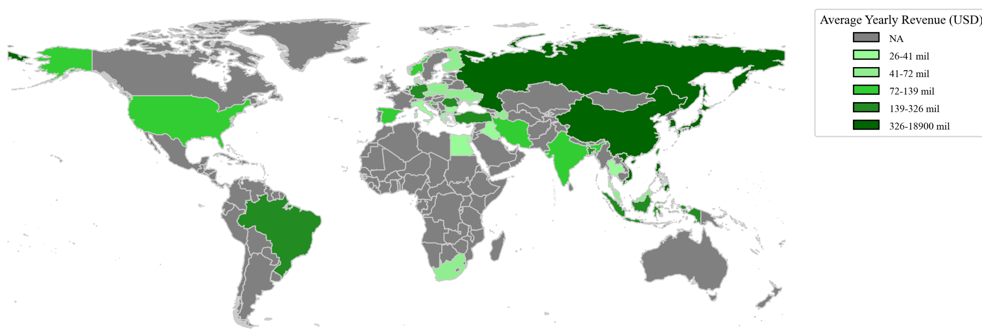
Geoeconomics. Lastly, the paper's empirical findings relate to the burgeoning literature on geoeconomics and economic coercion. Clayton, Maggiori, and Schreger (2023, 2024) formulate a hegemonic country's geoeconomic power as its ability to coordinate the suspension or alteration of financial or trade relationships with another country, thereby coercing compliance. Liu and Yang (2024) models how a hegemon's coercive power can be projected via trade, where increased international power leads to more bilateral negotiations. The influence of political considerations in antitrust decisions suggests that coercive power can materialize more subtly - the fear of provoking threats from the hegemon may have already seeped into the smaller countries' decision-making process, making explicit threats redundant.

The remaining parts of this paper are organized as follows: In the rest of Section 1, I explain the institutional background of the shipbuilding industry and the merger control scheme. In Section 2, I discuss the data used for the analysis and present reduced-form and BLP evidence on the market impact of shipyard mergers. In Section 3, I present the structural model of the antitrust authority's merger approval process, the estimation procedure, and the model estimates. Additionally, I discuss the counterfactual analysis that removes non-market factors from the authority's decision-making process. Section 4 offers concluding remarks.

1.2 Institutional Background

Shipbuilding Industry. Shipyards typically produce four kinds of commercial vessels: bulkers, containerships, gas vessels, and tankers (henceforce "vessel category"). Each category of vessels is tailored to transporting a particular type of good, such as grain and ore (bulkers), containers (containerships), volatile liquids (gas vessels), and oil and relatively stable chemicals (tankers). Shipyards can also manufacture more specialized vessels by installing special equipment or adjusting the vessel size or capacity. The sub-categories of the four categories of vessels are denoted as "ship type" henceforth. [6] This paper focuses on these four most common categories of commercial vessels, although there are also niche vessel types, such as ro-ro vessels (for car transportation) and yachts.

Shipyards active today are concentrated in East Asia, while the buyer shipping companies are more evenly distributed across the globe. Although there are hundreds of operating shipyards worldwide, most vessels are built by shipyards in China, Korea, and Japan. Figure 2 shows the global distribution of shipyards' annual sales revenue. In contrast, ship buyers are more evenly spread around the world.[7] The global distribution of expenditure on vessel purchases is shown in Figure 3, which is much less concentrated and more correlated with the size of the economy.

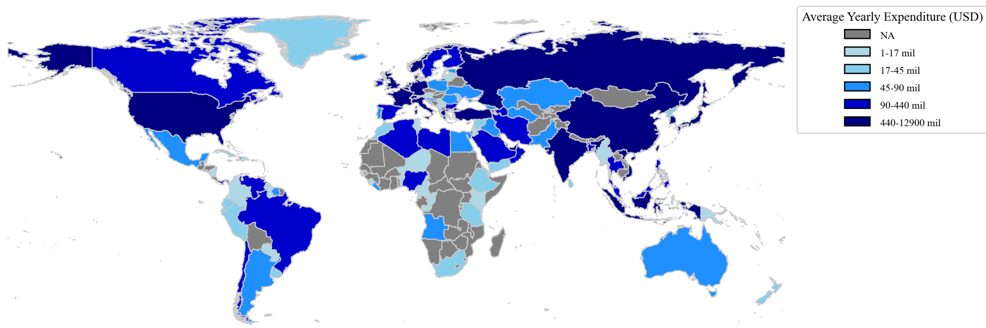


Note: This graph shows the average annual revenue shipyards earn from selling bulkers, containerships, gas vessels, and tankers in each country. Source: Clarksons Research.

Figure 2: Global Distribution of Annual Revenue from Selling Commercial Vessels

[6]For example, transporting liquefied natural gas (LNG) requires refrigeration devices, as LNG must be stored at low temperatures. Liquefied petroleum gas, on the other hand, requires high pressure to remain in liquid form, making a compressor essential.

[7]Most ship buyers are shipping companies that purchase vessels to transport goods, although some bank subsidiaries also purchase vessels for leasing and investment.



Note: This graph shows each country's average annual expenditure on purchasing newbuild and secondhand bulkers, containerships, gas vessels, and tankers. Source: Clarksons Research.

Figure 3: Global Distribution of Annual Expenditure on Purchasing Commercial Vessels

Scheme of Merger Control. The central duty of an antitrust regulator is typically to promote market competition, often boiling down to protecting consumer welfare in practice (Wilson 2019). For instance, it is the duty of the EC to ensure that "competition in the internal market is not distorted" by the transaction when reviewing merger applications, a litmus test of which is the merger's "potential harm to consumers" (Council of the European Union 2004). Similarly, promoting competition and innovation and protecting consumer welfare are the central tenets of many major antitrust authorities (Federal Trade Commission 2024b; Japan Fair Trade Commission 2023; Korean National Assembly 2016). Even though the legislation in some younger jurisdictions carry more ambiguities (National People's Congress 2022), fair competition is still the regulator's alleged critical objective (State Administration for Market Regulation 2024). Therefore, the influence of non-market factors on antitrust decisions *should* be minimal in principle.

When two shipyards intend to merge, they must obtain approval from an antitrust authority if the parties' sales volume exceeds certain thresholds in the authority's jurisdiction. For example, the EC requires the merging parties to notify the Commission about the intended transaction if the parties' combined global turnover exceeds €5,000 million and their individual EU-wide turnover exceeds €250 million (European Commission 2024b). If the parties complete the merger without clearance from the Commission, the EC may choose to impose a fine of up to 10% of their annual global revenue (European Commission 2024a).[8] Similar regulations are imposed in major ship-buying countries such as China, India, Indonesia, Japan, Korea, Russia, and Türkiye, although the exact threshold values may differ (Clifford Chance 2019; Gönenç, K Korhan, and Görkem 2024; Hideto, Etsuko, and Anderson 2015; Kim, Choi, and Shim 2020; Medina 2023; National People's Congress 2022; Shandilya, Thakur, and Mishra 2024).[9] Therefore, a successful merger requires approval from all antitrust authorities that have jurisdiction over the transaction.

An antitrust authority typically aims to complete a merger review within one month, though the actual timeline is flexible. For instance, the EC has 25 days to complete an initial review, during which 90% of merger applications are unconditionally approved (European Commission 2013). However, if the Commission has further competition concerns about the merger, it can initiate a Phase II review that may last for 90 to 125 working days. Failure to supply information requested by the Commission can trigger the "stop-the-clock" mechanism, where the review process halts until the merging parties provide the information to the Commission's satisfaction (European Commission 2013). The 30-day initial review timeline is also applicable in China, Japan, Korea, and Russia (Bai and Man 2023; Clifford Chance 2019; Hideto, Etsuko, and Anderson 2015; Jeong et al. 2024).

2 The Effect of Mergers and Authorities' Responses

2.1 Data

Shipyard Merger. This paper examines horizontal shipyard mergers proposed between 2010 and 2023 that had received agreement from the transacting parties. To identify shipyard mergers during this period, I collect news articles related to

[8] Some jurisdictions also require notification if the merging parties' asset value in the jurisdiction exceeds a given threshold (Medina 2023).

[9] While the Federal Trade Commission (FTC) of the United States also has a Pre-merger Notification Program and requires notification if the transaction value exceeds certain thresholds (Federal Trade Commission 2024a), neither the FTC nor the Department of Justice (DOJ) has explicit rules governing when a merger between two foreign entities requires notification. Furthermore, neither the FTC nor the DOJ has the power to directly prohibit a merger; they must apply to the court to stop a merger deemed anti-competitive or reach a settlement with the merging parties (Federal Trade Commission 2024b). The FTC or DOJ did not issue any decisions or initiate any legal action with respect to the shipyard mergers studied in this paper.

mergers and acquisitions from Lloyd's List Intelligence, a journal specializing in shipping news, published between 2010 and 2023. Additionally, I supplement these news articles with shipyard merger decisions published by antitrust authorities, including the Chinese State Administration for Market Regulation, the Competition and Consumer Commission of Singapore (CCCS), the European Commission (EC), the Korea Fair Trade Commission (KFTC), and the Japan Fair Trade Commission (JFTC).

I focus on horizontal shipyard mergers, so cases where a shipping company acquires a shipyard or that a shipyard acquires the dock of another shipyard do not fall within the paper's ambit. Within horizontal mergers, I concentrate on shipyards that produce bulkers, containerships, gas vessels or tankers.[10] I also exclude mergers that were canceled because the transacting parties failed to reach a final agreement. I thereby end up with thirteen shipyard mergers listed in Table 1.

For each merger, the date the deal was announced and the date of amalgamation, if it succeeded, are recorded. Additionally, the dates when an antitrust authority issued a decision regarding the merger, if applicable, are included. In cases where the merging parties withdrew the application, such as the Hyundai & Daewoo case with the KFTC and JFTC following the EC's rejection, the withdrawal date is also documented.

Vessel Transaction. The transaction data includes sales of new or secondhand bulkers, containerships, gas vessels, and tankers from 2006 to 2023 at the individual transaction level. The transaction data is sourced from the proprietary database of Vessel Value Veson Nautical, which tracks worldwide commercial vessel transactions. For each transaction, the price, the buying and selling parties, the builder shipyard, the ship's capacity and age, the time taken to build the ship, and the date of the ship order are recorded.

Some transactions contain missing prices in the data. To resolve this, I follow Barwick, Kalouptsidi, and Zahur (2019) and impute the missing prices using monthly vessel valuations from Clarkson Research, another shipping intelligence company, based on the ship's category, capacity, and age.

[10]As such, mergers between shipyards that focus on producing other categories of vessels, such as cruise ships and naval vessels, are excluded from the analysis.

Table 2 presents summary statistics for key variables in the analysis. In total, 44142 vessel transactions are recorded, with 16109 being new vessel orders and 28033 being secondhand transactions. The sample includes 335 shipyards and 6341 buyer companies.[11] The average HHI across ship categories are between 1780 and 2800, which is considered as "moderately concentrated" or "highly concentrated" in the U.S. DOJ's Horizontal Merger Guidelines (DOJ and FTC 1997).[12]

[11]A shipbuilding company may own multiple subsidiaries operating at different dockyards. For the purpose of this paper, a shipyard is defined at the corporate group level, with the holding company making decisions to maximize the group's joint profits.

[12]The HHI calculated in Table 2 is higher than that reported by Barwick, Kalouptsidi, and Zahur (2019) as I define a market by ship buyer country-year-ship category pair, whereas Barwick, Kalouptsidi, and Zahur (2019) examines the world market of vessels supplied by Chinese, Japanese, and Korean shipyards. Additionally, no distinction between different ship categories were made in their paper for HHI calculation. See Section 2.3 for further discussion on market definition.

Merging Shipyards	Shipyard Countries	Merger Announcement	Merger Completion	Formal Decision Issued by
Japan Marine United & IHI Corporation	Japan	27 Aug 2012	1 Jan 2013	China, Japan
Fincantieri & STX OSV	Italy, Norway, Korea	21 Dec 2012	23 Jul 2013	Singapore
Guangzhou Shipyard International (CSSC) & Longxue Shipbuilding	China	30 Sep 2013	17 Jun 2014	
Namura Shipbuilding & Sasebo Heavy Industries	Japan	23 May 2014	1 Oct 2014	Japan
Guangzhou Shipyard International (CSSC) & Huangpu Wenchong Shipyard	China	16 Oct 2014	3 Nov 2014	
CIMC Enric (China Merchant) & Sinopacific Offshore	China	6 Jul 2017	1 Aug 2017	
Yangzijiang Shipbuilding & Mitsui E & S	China, Japan	12 Oct 2018	2 Aug 2019	China, EU, Japan
Hyundai Heavy Industries & Daewoo Shipbuilding	Korea	31 Jan 2019	Blocked	China, EU, Kazakhstan, Singapore
Imabari Shipbuilding & Japan Marine United	Japan	27 Mar 2019	1 Jan 2021	China, EU, Japan
China Merchants & AVIC Weihai Shipyard	China	28 Aug 2019	1 Nov 2019	
CSSC & CSIC	China	26 Nov 2019	21 Sep 2020	China
STX & Daehan Shipbuilding	Korea	27 Jun 2022	1 Sep 2022	
Hanwha Group & Daewoo Shipbuilding	Korea	26 Sep 2022	24 May 2023	China, EU, Japan, Singapore, Turkiye, Vietnam

Notes: This table shows the horizontal shipyard mergers that were proposed from 2010 to 2023. "Shipyard Countries" refers to the countries in which the shipyards' headquarters are located. Merger announcement and merger completion indicate the dates at which the merger was first announced and declared complete, if successful. A jurisdiction is considered to have issued a formal decision with respect to the proposed merger if it has issued a written decision or that there is news reporting about the authority's decision. The Japanese and Korean antitrust authorities were also notified for the proposed merger between Hyundai Heavy Industries and Daewoo Shipbuilding, but the applications were withdrawn after the European Commission blocked the transaction.

Table 1: List of Horizontal Shipyard Mergers

Variable	Count	Mean	SD	Min	Max
Overall					
Price (mil USD)	44142	34.76	36.64	0.22	350.00
Time to Build (Year)	44142	0.99	1.54	0.00	18.00
HHI	1971	2247.63	1564.01	60.04	6914.63
Bulker					
Price (mil USD)	17597	23.53	13.88	3.50	160.00
Capacity (ton)	17597	75617	54942	20000	404400
Time to Build (Year)	17597	0.97	1.56	0.00	13.00
HHI	617	1781.10	1313.52	60.04	6521.51
Containership					
Price (mil USD)	7930	42.04	44.24	1.03	225.00
Capacity (TEU)	7930	5062	5316	80	24346
Time to Build (Year)	7930	1.06	1.48	0.00	14.00
HHI	412	2651.73	1544.82	286.07	6721.35
Gas Carrier					
Price (mil USD)	4258	89.62	65.05	0.75	350.00
Capacity (Cubic Meter)	4258	149142	121047	437	441600
Time to Build (Year)	4258	1.30	1.57	0.00	10.00
HHI	305	2759.99	1726.66	218.06	6817.62
Tanker					
Price (mil USD)	14357	28.24	20.89	0.22	167.00
Capacity (ton)	14357	47761	46799	100	193100
Time to Build (Year)	14357	0.88	1.54	0.00	18.00
HHI	637	2192.82	1578.82	63.54	6914.63

Notes: This table shows descriptive statistics of vessel transactions between 2006 and 2023. Price , Time to Build, and Capacity are from the transaction-level dataset; Herfindahl–Hirschman index (HHI) is from the dataset aggregated to market level. A market is defined by unique combinations of buyer country, year and vessel category. See Section 2.3 for further discussion on market definition. Capacity for bulkers and tankers is measured in tonnage; capacity for containerships is measured in Twenty-foot equivalent unit (TEU); capacity for gas carriers is measured in cubic meter.

Table 2: Summary Statistics

Supplementary Data. I obtain data from the Federal Reserve Economic Data (FRED) to construct exogenous shocks to ship supply. The cost-shifters include historical exchange rates of various countries' currencies relative to the USD, as well as steel, aluminum, and timber prices at yearly level. Moreover, I use manufacturing sector wage data from the International Labour Organization, adjusted for purchasing power parity at the country-year level, to construct an additional cost-shifter.

For the demand-side shifter, I collect data on the returns from owning a ship to construct exogenous shocks to vessel demand. The return of owning a ship is measured by its charter rate obtained from Clarkson's Research. It represents the prevailing market price paid to the shipowner for using the vessel for a year based on its category and capacity.

2.2 Reduced-form Evidence

A differences-in-differences design is used to compare merged firms with those that did not undergo any merger and acquisition, two years before and after the merger. A shipyard merger does not lead to a significant change in vessel prices or observed qualities, measured by capacity and construction time, on average. However, mergers subject to legal review are associated with a 4.5% price increase.

Table 3 shows the average effect of a horizontal shipyard merger on the price, capacity, and time to build for a newbuild vessel, corresponding to the following regression:

$$Y_{ijt} = \beta \mathbf{1}\{\text{Firm Undergone Merger } d\}_{ijt} + X'_{ijt}\gamma + \alpha_d + \delta_{ij} + \tau_t + \lambda_{jt} + \epsilon_{ijt}, \quad (1)$$

where i indexes the shipyard, j the vessel type, t the quarter, and d the merger deal. X_{ijt} is a vector of observed ship characteristics, including the brand's average capacity and time to build. [13] In the baseline, I include merger fixed effects α_d, brand or ship type-shipyard fixed effects δ_{ij}, as well as quarter fixed effects τ_t.

I use the shipyards that never underwent a merger between 2010 and 2023 as the control group.[14] The specification compares the outcome variables two years before and after each merger. However, since other merger(s) might have taken place during the pre- or post-treatment period, the coefficient β may be biased by the confounding events. To alleviate this concern, I include ship type-quarter fixed effects to absorb any shocks that are common to a ship type in a given quarter. Adding these granular fixed effects also addresses potential anticipation issues, where shipyards decide to merge based on their expectations of future vessel demand. Table 3 suggests that after addressing potential spillover and anticipation

[13] A brand is defined as a type of vessel j produced by shipyard i.

[14] If a merger weakens the level of competition in the entire market, the never-treated shipyards would also increase their prices. Therefore, the estimates provided in Table 3 should be interpreted as a lower bound of the merger's effect.

effect concerns, a shipyard merger does not lead to a statistically significant change in the observed vessel attributes.

	(1) Log Price	(2) Log Price	(3) Log Vessel Capacity	(4) Log Vessel Capacity	(5) Time to Build	(6) Time to Build
Post Merger * Merging Shipyards	0.0214	0.00725	-0.0576	-0.0372	-0.0291	-0.150
	(0.0174)	(0.0174)	(0.0367)	(0.0439)	(0.130)	(0.146)
Log Vessel Capacity	0.242***	0.246***			0.142*	0.147
	(0.0389)	(0.0384)			(0.0816)	(0.0904)
Time to Build	0.00270	0.00126	0.0177*	0.0180*		
	(0.00352)	(0.00435)	(0.00972)	(0.0107)		
Log Price			1.116***	1.187***	0.0997	0.0498
			(0.0629)	(0.0668)	(0.134)	(0.174)
Merger FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ship Type-Shipyard FEs	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ship Type-Quarter FEs	No	Yes	No	Yes	No	Yes
Adjusted R-squared	0.912	0.919	0.962	0.964	0.405	0.421
Observations	3252	3252	3252	3252	3252	3252

Notes: This table shows the effect of horizontal shipyard mergers on newbuild vessel prices, capacity, and time to build 2 years before and after the merger. The data is aggregated to shipyard-ship type-quarterly level. All mergers in the sample are used for the regression except for the merger between Guangzhou Shipyard Internationl (CSSC) & Huangpu Wenchong Shipyard to avoid repeated treatment. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. Standard errors are clustered at shipyard level.

Table 3: The Effect of Shipyard Mergers on Newbuild Vessel Attributes

The outcomes from shipyard mergers show a more significant change when I focus on the mergers that were notified to and subsequently reviewed by at least one antitrust authority.[15] I re-run Equation 1 using the five successful mergers subject to legal review. As shown in Table 4, despite the granular ship type-quarter fixed effects in column 2, the prices of the merging shipyards still increase by approximately 4.5% compared to their prices two years prior to the merger. Therefore, scrutiny over these mergers seems well-justified. Furthermore, there is no evidence that the mergers lead to any quality improvement in terms of vessel capacity or building time.

I further examine the merger's dynamic effect based on the following specification:

$$\begin{aligned} Y_{ijt} = &\sum_{t=-8, t\neq -1}^{8} \beta_t \mathbf{1}\{t \text{ Quarter(s) relative to Merger } d\}_{ijt} + X'_{ijt}\gamma \\ &+ \alpha_d + \delta_{ij} + \tau_t + \lambda_{jt} + \epsilon_{ijt}. \end{aligned}$$

Figure 4 shows that the merging parties do not start raising prices instantaneously after completing the merger. Instead, a persistent upward price trend begins to

[15]The Hyundai & Daewoo merger is excluded from the analysis as it failed to materialize.

	(1) Log Price	(2) Log Price	(3) Log Vessel Capacity	(4) Log Vessel Capacity	(5) Time to Build	(6) Time to Build
Post Merger * Merging Shipyards	0.0580***	0.0449**	-0.0475	-0.00559	0.0889	0.0000122
	(0.0204)	(0.0208)	(0.0447)	(0.0550)	(0.137)	(0.159)
Log Vessel Capacity	0.222***	0.231***			0.156*	0.127
	(0.0376)	(0.0378)			(0.0850)	(0.0917)
Time to Build	0.00268	0.00339	0.0194*	0.0156		
	(0.00339)	(0.00431)	(0.00998)	(0.0108)		
Log Price			1.096***	1.166***	0.106	0.139
			(0.0722)	(0.0750)	(0.138)	(0.183)
Merger FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ship Type-Shipyard FEs	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FEs	Yes	Yes	Yes	Yes	Yes	Yes
Ship Type-Quarter FEs	No	Yes	No	Yes	No	Yes
Adjusted R-squared	0.910	0.915	0.961	0.963	0.413	0.428
Observations	2910	2910	2910	2910	2910	2910

Notes: This table shows the effect of horizontal shipyard mergers on newbuild vessel prices, capacity, and time to build 2 years before and after the merger. The data is aggregated to shipyard-ship type-quarterly level. All successful mergers subject to at least one antitrust authority's merger control review are included in the analysis. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. Standard errors are clustered at shipyard level.

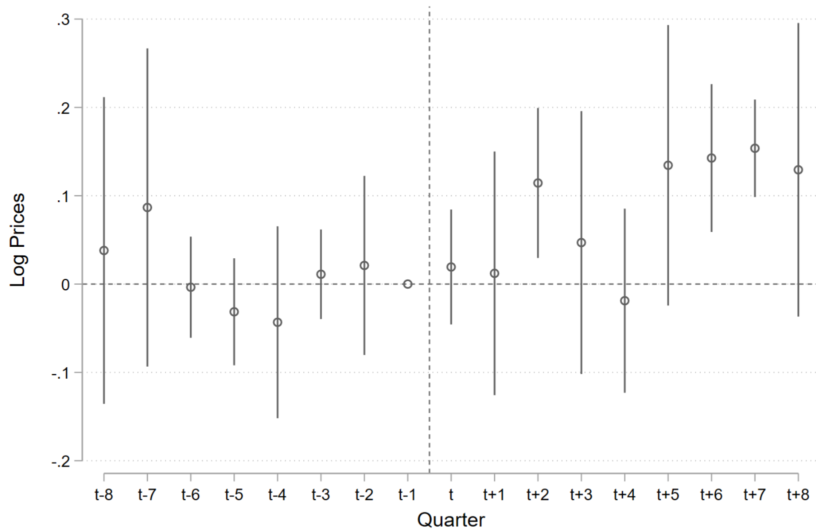
Table 4: The Effect of Shipyard Mergers Subject to Legal Review on Newbuild Vessel Attributes

materialize in the fifth quarter after the merger's completion, indicating that the shipyards need time to consolidate production capacity and coordinate business decisions. This result is consistent with Demirer and Karaduman (2024)'s finding that power plant acquisitions do not immediately improve the efficiency of the acquired power plant.[16] However, once the business consolidation is complete, the merged entity's price is approximately 12% higher than its pre-merger prices. In Figure A3 and A4 of the Appendix, I present the merger's dynamic effect on other vessel attributes and find no systematic evidence that the merger leads to any quality improvement, consistent with the findings in Table 4. The result is robust to alternative event study estimators, as shown in Table A3.

2.3 Heterogeneous Effect of Shipyard Mergers

The earlier analysis indicates that large shipyard mergers can be anti-competitive. Yet, out of the six mergers subject to antitrust review, five were eventually approved. While this may be due to the regulator's limited capacity to review every transaction in depth (Salop and Morton 2021), I show that there are further inconsistencies in antitrust decisions with respect to the thirteen sampled mergers

[16]The result is also consistent with the results in Figure A2 in the Appendix, where I conduct a placebo test by looking at a merger announcement's effect on prices three quarters before and after the announcement. I find no evidence that the announcement itself leads to a price increase, suggesting that the price increase seen in Figure 4 is more likely due to a long-term increase in market power rather than short-term market speculation.



Note: This graph shows the effect of horizontal shipyard mergers on log newbuild vessel prices 2 years before and after the merger. The data is aggregated to shipyard-ship type-quarterly level. All successful mergers subject to at least one antitrust authority's merger control review are included in the analysis. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. The coefficient on *t-1* is normalized to 0. Standard errors are clustered at shipyard level. The intervals plotted are 95% confidence intervals.

Figure 4: The Effect of Shipyard Mergers Subject to Legal Review on Newbuild Vessel Prices

with merger simulations. Mergers with similar market impact resulted in different decisions by the authorities; smaller authorities are consistently less interventionist despite the losses suffered. This suggests the presence of other factors affecting antitrust decision-making.

2.3.1 Empirical Strategy

Demand Estimation. To understand the heterogeneous impact of individual mergers beyond prices, I follow Berry, Levinsohn, and Pakes (1995) to estimate ship demand using a random coefficients model. The utility of buying a brand l vessel[17] in market m and year y by buyer k is represented by:

[17] A brand is defined as a type of vessel produced by a given shipyard.

$$u_{klm} = a_k \log(p_{lm}) + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm} + \epsilon_{klm}. \tag{2}$$

A market m is defined by the buyer country, year, and the ship category (bulker, containership, gas carrier, and tanker). Following Barwick, Kalouptsidi, and Zahur (2019), I define a separate market for each of the four vessel categories, as ships designed to transport one type of good cannot be repurposed for another without substantial modification. p_{lm} represents the per unit capacity ship price; X_{lm} is a vector of observed ship characteristics including log capacity and whether it is newbuild; ξ_l and ξ_y are brand and year fixed effects respectively; ξ_{lm} is the market-specific deviation from brand l's mean utility in a given year; ϵ_{klm} is buyer k's idiosyncratic valuation of the brand.

I use two sets of instruments to construct demand-side moments. The first set includes the typical BLP instruments, including the exogenous product characteristics of the vessel brand (log capacity and whether it is a newbuild), as well as the total vessel capacity of other brands sold by the same shipyard. I also use cost-shifters as another set of instruments, reflecting potential customization the shipyard can offer regarding vessel capacity. These cost-shifters include the exchange rate of the shipyard country's currency relative to the USD, which affects the cost of importing raw materials, the average manufacturing sector wage in the shipyard country, and global steel, aluminum, and timber prices.[18] In addition, I include steel prices lagged by one year as an instrument, as shipyards may invest in steel reserves in anticipation of future price fluctuations. The full estimation procedure is explained in Appendix C.

Supply Estimation. I assume that the shipyards and firms selling secondhand vessels compete in a Bertrand game with product differentiation. Suppose firm i located in market m sells J_l brands of vessels in the market; it solves the following

[18]For newbuild orders, I use the cost-shifter from the year the ship was ordered. For secondhand vessels, the reference year is the year in which the ship was built.

profit maximization problem:

$$\max_{p_{im}} \Pi_{im}(p_{im}, p_{-im}) = \sum_{l=1}^{J_l} (p_{lm} - c_{lm}) s_{lm}(p_{im}, p_{-im}), \tag{3}$$

where p_{im} is a price vector for the J_l brands sold, and p_{-im} tracks the price vectors of competitors. c_{lm} is the marginal cost of producing brand l vessels, which is parameterized by

$$c_{lm} = \zeta_1 \log(\text{Capacity}_{lm}) + \zeta_2 \text{Time to Build}_{lm} + \nu_{lm}, \tag{4}$$

where ν_{lm} is the unobserved brand-market-specific cost shock. By solving Equation 3 using the first-order necessary conditions, the marginal cost can be obtained from the following equation:

$$\begin{bmatrix} s_1(p_{im}, p_{-im}) \\ \cdot \\ \cdot \\ s_{J_l m}(p_{im}, p_{-im}) \end{bmatrix} + \begin{bmatrix} \partial s_{1m}/\partial p_{1m} & \cdot & \cdot & \partial s_{J_l m}/\partial p_{1m} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \partial s_{1m}/\partial p_{J_l m} & \cdot & \cdot & \partial s_{J_l m}/\partial p_{J_l m} \end{bmatrix} \begin{bmatrix} p_{1m} - c_{1m} \\ \cdot \\ \cdot \\ p_{J_l m} - c_{J_l m} \end{bmatrix} = 0$$

Supply-side moment conditions are constructed by interacting the random cost shocks ν_{lm} with demand shifters (Conlon and Gortmaker 2020). Specifically, I use ship type-specific yearly charter rates for bulkers, containerships, gas carriers, and tankers as measures of a shipping company's expected returns from owning a ship. Higher charter rates should raise the current demand for vessels, while a decrease in charter rates should have the opposite effect. On the other hand, charter rates have little impact on shipyards' production costs except in remote cases.[19]

Merger Simulation. After consummation of a merger, I assume that the shipyards re-solve Equation 3 to maximize their joint profits. Denoting the new Nash Equilibrium prices in market m as p'_m, the new market share of brand l is then

[19] For instance, charter rates affect shipping companies' production costs and, consequently, the freight rates. Higher freight rates further impact the shipyards' costs of importing materials such as metals and timber for ship construction. However, as the logic suggests, higher freight rates may only be indirectly passed to the shipyards through the shipping companies, so charter rates are unlikely to have an immediate effect on shipbuilding costs.

given by (Berry, Levinsohn, and Pakes 1995).

$$s'_{lm} = \int \frac{\exp(a_k \log(p'_{lm}) + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm})}{\sum_{q=1}^{L} \exp(a_k \log(p'_{qm}) + X_{qm}\beta_k + \xi_q + \xi_y + \xi_{qm})} dF(\alpha_k, \beta_k),$$

where L denotes the total number of brands offered in market m. Using the vessel prices and other exogenous vessel attributes, I follow Small and Rosen (1981) to compute the consumer surplus for an individual k as

$$E(CS_k) = \frac{1}{\alpha_k} \log(\sum_{l=1}^{L} \exp(\alpha_k p_{lm} + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm})) + C,$$

where C is an unknown constant that cancels away when comparing the consumer surplus before and after merger. Suppose the taste parameters (α_k, β_k) for K types of ship buyers are simulated for the market, an average buyer's consumer surplus is therefore

$$\sum_{k=1}^{K} w_k E(CS_k), \tag{5}$$

where w_k is the integration weight assigned to type k ship buyers.[20]

Estimation Results. Table 5 presents the parameter estimates for the demand and supply model. Ship buyers prefer cheaper and larger ships that are newly constructed. Buyers do not place a significant premium on ships delivered over a short period (unreported); however, this may be attributed to the limited variation in delivery time within the data. There is little variation in buyers' valuations of price, capacity, and whether the ship is newly built. Since most buyers are shipping companies that assess ships based on their commercial value, idiosyncratic taste variation is expected to be limited.

On the supply side, producing a ship with larger capacity is associated with lower marginal costs, suggesting that shipyards may benefit from economies of

[20] In practice, the integration weights are created using the Gaussian-Hermite Quadrature rule, employing n nodes and a polynomial of degree $2n - 1$ or less to conduct the numerical integration.

scale at the current ship size level. Additionally, delivering a brand-new vessel is costlier than delivering a secondhand one, as the latter typically requires only maintenance costs before delivery. In Table A4, I also present the similar demand estimation results using only the cost-shifters as instruments.

Demand-side Variables	Means	Standard Deviations	Supply-side Variables	Estimates
Log Prices	–16.236***	2.622	Log Capacity	-.094***
	(1.302)	(2.285)		(.004)
Log Capacity	5.874***	2.017	Newbuild Vessel	1.955***
	(1.000)	(2.904)		(.167)
Newbuild Vessel	10.178***	1.187		
	(1.196)	(2.898)		
Brand FEs	Yes			
Year FEs	Yes			
Observations	23962			

Notes: This table shows the parameter estimates of the demand and supply model specified by equation 2 and 4. Prices are measured by the price of the vessel per unit capacity in thousands of USD. A brand is defined by a unique combination of shipyard and vessel type. Standard errors are clustered at brand level.

Table 5: Parameter Estimates for Vessel Demand and Supply Model

2.3.2 Market Outcomes of Individual Mergers

Inconsistencies between Merger Impact and Authority Decisions. I conduct merger simulations for all thirteen mergers. The mergers' heterogeneous impact on prices and consumer welfare highlight the inconsistencies underlying antitrust authorities' approval decisions.[21] Table 6 shows the global consumer welfare loss and profit gain associated with each merger. In Table A5, I further illustrate the the mergers' impact on average vessel prices. Consistent with the reduced-form evidence in Table 3 and Table 4, a merger reduces competition in the market, thereby exerting upward pressure on vessel prices and reducing consumer welfare. Mergers subject to legal review are also generally associated with a larger price increase and a steeper fall of consumer welfare. Besides the mergers' global welfare impact, Table 7 also shows the welfare loss breakdown in the three most affected economies for each merger.

Two patterns emerge from Table 6 and Table 7. First, although most shipyard mergers pose relatively small market impact, the largest mergers make consumers

[21] For each merger simulation, I exclude data from years following the completion of the merger and take the yearly average of the simulation results to best approximate the information available to the antitrust authorities when making their decisions.

substantially worse off. As shown in Table 6, the majority of shipyard mergers would only result in a \$5-8 (4-7) million loss of consumer welfare (net societal welfare). However, the largest mergers would result in an annual consumer welfare loss over \$10 million. Particularly, both the Hyundai & Daewoo and CSSC & CSIC merger would lead to an approximately \$30 million fall of consumer welfare, doubling the effect of the third most anti-competitive merger (Imabari & Japan Marine United). While the \$32.4 million annual loss associated with the Hyundai & Daewoo merger surely provides grounds to block the transaction, it is puzzling that the runner-up and second runner-up in terms of consumer welfare loss were approved in a time frame similar to the smaller mergers.[22]

Second, the jurisdiction most adversely affected by a merger need not be the one that formally reviewed the transaction. For instance, Table 7 indicates Canada, Qatar, and Singapore are the jurisdictions most severely affected by the Yangzijiang & Mitsui E & S merger. Yet, it was China, the EU, and Japan that formally reviewed the case.[23] Moving down the list towards smaller mergers, a considerable share of welfare loss induced by Chinese and Japanese shipyard mergers would realize in countries such as Qatar and Indonesia. However, I find no evidence that either country had intervened in any of the shipyard mergers by issuing a formal decision.

Political Considerations. The inconsistencies point to factors beyond market outcomes that rationalize antitrust authorities' decisions with respect to the mergers, and political considerations offer a plausible explanation. In the CSSC & CSIC merger and the Imabari & Japan Marine United merger, most of the consumer welfare loss would occur in jurisdictions in which the shipyards are based. Should the Chinese or Japanese authorities block the merger, it might provoke strong domestic backlash. In contrast, the welfare loss resulting from the Hyundai & Daewoo merger would be more evenly distributed across Greece, Korea, and Norway, two of which are members of the EEA. It is noteworthy that the prohibi-

[22] In fact, I find no formal decision issued by any antitrust authority regarding the CSSC & CSIC merger. The only evidence found indicating that the CSSC & CSIC merger was subject to legal review is a shareholder notice issued by CSSC on 18 May 2021, stating that the merger had received clearance from most major jurisdictions within a year, thanks to the "tremendous support, help, guidance, and coordination" offered by multiple Chinese ministries. Source: http://www.sse.com.cn/disclosure/listedinfo/announcement/c/new/2021-05-18/600150_20210518_4.pdf.

[23] Interestingly, the Chinese company Yangzijiang Shipbuilding is even listed in Singapore.

tion decision came from the European Commission, while the Korean authority was still reviewing the merger when the shipyards withdrew their application following the European prohibition (Practical Law Competition 2024). Protectionist policy might be the underlying explanation.

Furthermore, the smaller jurisdictions' less interventionist approach could be attributed to the imbalance of economic and political power. Admittedly, it is possible that smaller jurisdictions are less interventionist with business transactions because some of them might be less sophisticated antitrust enforcers with more limited capacity. However, another explanation is that smaller jurisdictions may be more wary of the political or economic repercussions of blocking mergers between foreign companies from a large economy. More fundamentally, such concerns may result in infrequent antitrust enforcement, perpetuating a relatively low level of sophistication and capacity.

Merging Parties	Countries	Δ Consumer Welfare (mil USD)	Δ Profit (mil USD)	Δ Total Welfare (mil USD)
Hyundai Heavy Industries & Daewoo Shipbuilding	Korea	-32.414	3.852	-28.563
CSSC & CSIC	China	-29.073	4.478	-24.595
Imabari Shipbuilding & Japan Marine United	Japan	-14.682	2.717	-11.966
Yangzijiang Shipbuilding & Mitsui E & S	China, Japan	-10.385	1.688	-8.697
Guangzhou Shipyard International (CSSC) & Longxue Shipbuilding	China	-9.267	1.043	-8.224
Namura Shipbuilding & Sasebo Heavy Industries	Japan	-8.258	.888	-7.37
Fincantieri & STX OSV	Korea, Italy	-7.847	.846	-7.001
Guangzhou Shipyard International (CSSC) & Huangpu Wenchong Shipyard	China	-7.816	.893	-6.924
Hanwha Group & Daewoo Shipbuilding	Korea	-7.583	1.024	-6.559
Japan Marine United & IHI Corporation	Japan	-7.093	1.038	-6.055
China Merchants & AVIC Weihai Shipyard	China	-6.913	.699	-6.213
STX & Daehan Shipbuilding	Korea	-6.539	1.006	-5.533
CIMC Enric (COSCO) & Sinopacific Offshore	China	-4.961	.88	-4.081

Notes: This table shows the effect of each merger's average annual impact on total consumer welfare and ship seller profits, worldwide. Consumer welfare in each market is calculated according to Equation 5, which is then aggregated to world level after taking into account the size of each market. Profits are calculated by assuming ship sellers have constant marginal costs. Consumer welfare and profit changes are winsorized at 1% and 99% level. ΔTotal Welfare = ΔConsumer Welfare + ΔProfit. Consumer welfare, profits, and total welfare are measured in millions of USD.

Table 6: The Effect of Individual Mergers on Consumer Welfare and Seller Profits Worldwide

Merging Shipyards	Shipyard Countries	Worldwide Consumer Welfare Impact (mil USD)	Buyer Country 1	Share of Welfare Loss (%)	Buyer Country 2	Share of Welfare Loss (%)	Buyer Country 3	Share of Welfare Loss (%)
Hyundai Heavy Industries & Daewoo Shipbuilding	Korea	-32.414	Greece	14.31	Korea	11.46	Norway	9.18
CSSC & CSIC	China	-29.073	China	29.74	Hong Kong	9.48	Singapore	7.24
Imabari Shipbuilding & Japan Marine United	Japan	-14.682	Japan	44.08	Switzerland	8.87	Qatar	6.12
Yangzijiang Shipbuilding & Mitsui E & S	China, Japan	-10.385	Canada	10.45	Qatar	10.09	Singapore	9.66
Guangzhou Shipyard International (CSSC) & Longxue Shipbuilding	China	-9.267	Qatar	33.94	Indonesia	10.42	Russia	8.63
Namura Shipbuilding & Sasebo Heavy Industries	Japan	-8.258	Qatar	38.08	Indonesia	11.7	Japan	11.24
Fincantieri & STX OSV	Italy, Norway, Korea	-7.847	Qatar	40.08	Indonesia	13.84	Russia	11.65
Guangzhou Shipyard International (CSSC) & Huangpu Wenchong Shipyard	China	-7.816	Qatar	40.24	Indonesia	12.36	Russia	10.24
Hanwha Group & Daewoo Shipbuilding	Korea	-7.583	Luxembourg	11.04	Qatar	10.37	Russia	10.15
Japan Marine United & IHI Corporation	Japan	-7.093	Qatar	44.34	Japan	28.32	Russia	15.03
China Merchants & AVIC Weihai Shipyard	China	-6.913	Qatar	15.16	Spain	13.83	Indonesia	8.98
STX & Daehan Shipbuilding	Korea	-6.539	Luxembourg	12.8	Russia	12.51	Qatar	12.02
CIMC Enric (COSCO) & Sinopacific Offshore	China	-4.961	Qatar	31.69	Spain	22.5	Indonesia	14.59

Notes: This table shows the effect of each merger's average annual impact on total consumer welfare worldwide and the share of consumer welfare loss distributed among the top three most affected economies. Consumer welfare in each market is calculated according to Equation 5, which is then aggregated to world/country level after taking into account the size of each market. Consumer welfare changes are winsorized at 1% and 99% level. Consumer welfare is measured in millions of USD.

Table 7: The Heterogeneous Effect of Individual Mergers on Consumer Welfare

3 The Role and Implication of Political Considerations

In this section, I argue that the seeming inconsistencies in antitrust authorities' decisions can be attributed to extraneous factors such aspolitical considerations using an approval process model. Counterfactual simulations suggest that efficiency improves when antitrust authorities are forced to focus solely on the merger's market impact.

3.1 Approval Process of an Antitrust Authority: a Theoretical Model

Model Setting. An antitrust authority is to decide whether to approve or block a proposed merger. The merger is either anti-competitive (defined as the low state) or not anti-competitive (defined as the high state).[24] The market impact of the merger, if the authority approves a non-anti-competitive merger, is defined as u_H. On the other hand, the market impact is u_L if the authority approves an anti-competitive merger. The low state payoff is strictly lower than the high state payoff, $u_L < u_H$. When the authority blocks the merger, the proposed merger has no effect on the market.[25] The rejection decision may incur a non-market related cost $C_{pol} \geq 0$, which may arise if the merging shipyards are based in a country with which the authority's jurisdiction has close trade ties, or if blocking the merger makes the jurisdiction appear business-unfriendly (henceforth "political cost"). The authority's payoff matrix is summarized in Table 8, where the payoff for blocking the merger is normalized to 0. As the smaller shipyard mergers only have very subtle effects on prices and consumer welfare, as shown in Tables 3 and A5, I also assume that a high-state merger has no anti-competitive effect for simplicity ($u_H = 0$).

Authority's Payoff Matrix

Decision/State	High	Low
Approve	$u_H = 0$	u_L
Reject	$-C_{pol}$	$-C_{pol}$

Payoff after Normalization

Decision/State	High	Low
Approve	$V_{HA} = C_{pol}$	$V_{LA} = u_L + C_{pol}$
Reject	0	0

Notes: The table shows the payoff matrices for the antitrust authority before and after normalization. The payoff for rejecting the merger is normalized to 0 in the table on the right.

Table 8: An Antitrust Authority's Payoff Matrix

Authority's Decision Process. The antitrust authority does not know the true state ω of a proposed merger before it is realized. It therefore makes its decision based on its belief about the merger's state. At the beginning of the merger review

[24]For the purpose os this paper, a merger is considered "anti-competitive" if its net welfare impact, considering both buyers and sellers, is negative.

[25]As shown in Table A2, I find no evidence that the announcement of a merger itself affects ship prices, which is consistent with this assumption.

process, the authority has a prior belief about how likely the merger is to be anti-competitive, based on pre-existing information Ω_0. Following Henry and Ottaviani (2019), I denote the authority's prior belief as the log odds-ratio of having a non-anti-competitive merger ($\omega = H$) relative to having an anti-competitive merger ($\omega = L$), which can be written as

$$\sigma_0 = \log \frac{\Pr(\omega = H)}{\Pr(\omega = L)}.$$

When the merger review process begins, the authority continuously receives new information about the merger's true state, which is assumed to follow a Wiener process $d\Sigma$. When the merger is not anti-competitive, the stochastic process has a positive drift $\mu > 0$ and variance ρ^2; otherwise, the process has a drift of $-\mu$ and the same variance ρ^2.

At period t, the accumulated evidence Ω_t is a sufficient statistic for all information available as of period t (Chan et al. 2018; Henry and Ottaviani 2019). The log-odds ratio of observing Ω_t in period t is

$$\log \frac{\phi((\Omega_t - \mu)/\rho)}{\phi((\Omega_t + \mu)/\rho)}) = \frac{2\mu\Omega_t}{\rho^2},$$

where $\phi(.)$ is the probability density function of the standard normal distribution. According to Bayes' rule, the authority updates its belief about the merger's log-odds ratio as follows:

$$\sigma_t = \sigma_0 + K_t,$$

where the differential change dK_t is also a Wiener process with drift $\mu' = \pm\frac{2\mu^2}{\rho^2}$, positive for the high state and negative for the low state, and variance $\frac{4\mu^2}{\rho^2}$ (Henry and Ottaviani 2014, 2019).

The authority decides whether to approve, reject, or continue reviewing the merger based on the updated belief σ_t in each period t. This problem is analogous to the standard optimal stopping problem (Wald 1945), where the agent's optimal strategy is to select a pair of threshold values (a, A), with $a < A$, such that it approves the merger if σ_t surpasses A at any time, rejects if σ_t falls below a at any time, and continues reviewing when $\sigma_t \in (a, A)$. The process terminates once the authority approves or rejects the merger.

The authority chooses a pair of threshold values (a, A) that maximizes its expected utility:

$$\begin{aligned}\arg\max_{a,A} E[U(a,A)] = &-\frac{c}{r} + \Pr(\omega = H)(V_{HA} + \frac{c}{r})\Psi(\sigma, H) + \Pr(\omega = L)(V_{LA} + \frac{c}{r})\psi(\sigma, L) \\ &+ \Pr(\omega = H)(\frac{c}{r})\psi(\sigma, H) + \Pr(\omega = L)(\frac{c}{r})\psi(\sigma, L),\end{aligned} \tag{6}$$

$$\begin{aligned}\Psi(\sigma,\omega) &= E[e^{-rT}|\sigma(T) = A, \omega] \Pr[\sigma(T) = A|\omega], \\ \psi(\sigma,\omega) &= E[e^{-rT}|\sigma(T) = a, \omega] \Pr[\sigma(T) = a|\omega],\end{aligned}$$

where T denotes the earliest time period at which σ_t crosses either a or A, c is the review cost incurred each period, which may include administrative expenses and losses from delaying the transaction, and r is the discount factor.[26]

Equation 6 contains four components: (1) the present value of the expected payoff from approving the merger in the high state; (2) the payoff from approving the merger in the low state; (3) the payoff from rejecting the merger in the high state; and (4) the payoff from rejecting the merger in the low state. $\Psi(\sigma,\omega)$ is the discount factor used when the authority approves the merger, as the information process crosses the upper threshold A; $\psi(\sigma,\omega)$ is the discount factor used for rejection, as the process crosses the lower threshold a.

Following Henry and Ottaviani (2014), the optimal thresholds (a^*, A^*) are solutions to the system of equations based on the first order necessary conditions:

$$\begin{aligned}\frac{e^A}{1+e^A}V_{HA} + \frac{1}{1+e^A}V_{LA} &= \frac{c}{r}\beta_1(a,A), \\ -\gamma(a,A)V_{LA} &= \alpha(a,A)(\frac{e^A}{1+e^A}V_{HA} + \frac{1}{1+e^A}V_{LA}) + \frac{c}{r}\beta_2(a,A),\end{aligned} \tag{7}$$

[26] When the antitrust authority's goal aligns with maximizing social welfare, c can be interpreted as including not only the administrative expenses of reviewing the merger but also the societal cost of delaying the transaction.

where

$$
\begin{aligned}
\alpha(a, A) =& e^f e^{a-A}(1+e^A),\\
\beta_1(a, A) =& \frac{1}{1+e^A}[e^g e^A(1+e^{-a}) - (1+e^A) - e^{g'}],\\
\beta_2(a, A) =& e^f e^a(1+e^{-A}) - (1+e^a) + e^{f'},\\
\gamma(a, A) =& e^{f'},
\end{aligned}
$$

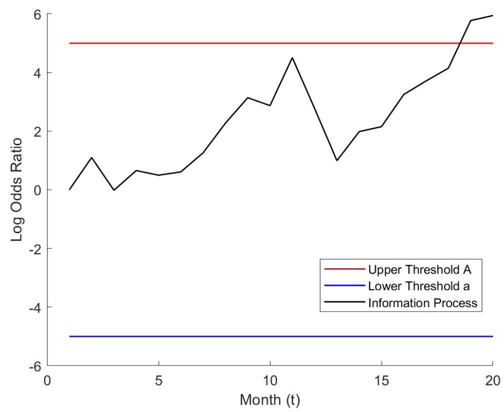
$$
g = \log \frac{R_2 e^{-R_1(A-a)} - R_1 e^{-R_2(A-a)}}{R_2 - R_1}, g' = \log \frac{e^{R_2(A-a)} - e^{R_1(A-a)}}{R_2 - R_1},
$$

$$
f = \log \frac{R_2 e^{R_1(A-a)} - R_1 e^{R_2(A-a)}}{R_2 - R_1}, f' = \log \frac{e^{-R_1(A-a)} - e^{-R_2(A-a)}}{R_2 - R_1},
$$

$$
R_1 = \frac{1}{2}(1 - \sqrt{1 + \frac{4r}{\mu'}}), R_2 = \frac{1}{2}(1 + \sqrt{1 + \frac{4r}{\mu'}}).
$$

The comparative statics with respect to (a^*, A^*) follow the intuition outlined below. The upper threshold A^* decreases with higher V_{HA} and/or V_{LA}, while the lower threshold a^* increases with lower V_{HA} and/or V_{LA}. A worse consequence of wrongly approving the merger (i.e., more negative u_L is) prompts the authority to acquire more evidence before granting approval, resulting in higher values for both a^* and A^*. On the other hand, a higher C_{pol} raises the opportunity cost of rejecting the merger, regardless of its true state. The authority is therefore less demanding in determining whether the merger is anti-competitive, which lowers both a^* and A^*.

Equation 7 indicates that the optimal thresholds (a^*, A^*) are independent of the authority's belief in period t, σ_t. Once the authority has determined the threshold values, its decision completely depends on whether the information process crosses these thresholds. Figure 5 illustrates this process. In Appendix A, I also consider the possibility that authority i's payoff, and thus its best response (a_i^*, A_i^*), depends on whether and when other authorities approve or reject the merger (a_{-i}, A_{-i}). The alternative model yields similar empirical results.



Note: This graph offers an illustration of the antitrust authority's simulated decision-making process. The blue and red lines correspond to the lower and upper thresholds (a^*, A^*) the information process must cross before the authority rejects/approves the merger. The black line is the information the authority receives per period, which is simulated to follow a Wiener process.

Figure 5: An Illustration of the Antitrust Authority's Decision-making Process

3.2 Estimation

Model Primitives. Since the payoff of rejecting a merger is normalized to 0, and a non-anti-competitive merger has no adverse impact, Equation 7 can be written as

$$\begin{aligned} C_{pol} + \frac{1}{1+e^A} u_L &= \frac{c}{r} \beta_1(a, A), \\ -\gamma(a, A)(u_L + C_{pol}) &= \alpha(a, A)\left(\frac{u_L}{1+e^A} + C_{pol}\right) + \frac{c}{r} \beta_2(a, A). \end{aligned} \tag{8}$$

Moreover, for each merger-authority pair, the parameters are estimated based on the following parametric functions:

$$\begin{aligned} u_L &= X'\beta + \epsilon_1, \\ C_{pol} &= Z'\gamma_1 + \gamma_2 \mathbf{1}\{\text{Merging Shipyards are Domestic}\} + \epsilon_2, \text{and} \\ \mu &= \delta_0 + \delta_1 \hat{\Delta}_p + \epsilon_3, \end{aligned} \tag{9}$$

where X and Z are vectors of observed characteristics with respect to the merger, and $\hat{\Delta}_p$ is the expected percentage price change resulting from the merger, based on the estimates in Section 2.3.

In practice, the vector X includes the merging party's market shares in the authority's jurisdiction and the jurisdiction-specific change in the HHI.[27] The variable Z represents the political significance of the transaction, for which I use the merging parties' joint annual global sales as a proxy. Larger firms are more likely to engage in corporate political activities such as lobbying and funding campaigns that influence government decisions given their richer financial and intangible resources (Hillman and Hitt 1999). Meanwhile, sales revenue is a common proxy for firm size (Bhuyan 2000; Hillman, Keim, and Schuler 2004). Then, the drift of the information process μ is parameterized by a constant δ_0 and the expected percentage price change resulting from the merger. Greater upward pressure that the merger imposes on prices implies a stronger signal to the authority that the merger is anti-competitive.

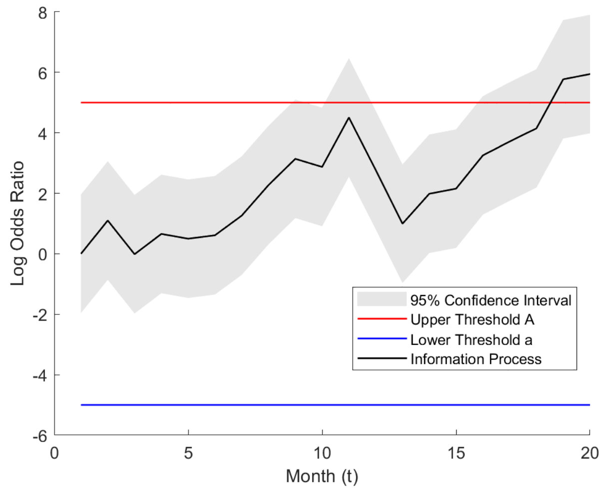
In addition to the variance of the information process ρ^2, another source of randomness that helps rationalize the empirical data is the i.i.d. error term u_t added to the authority's per period belief σ_t. The updated posterior belief at period t is thence $\sigma_t = \sigma_0 + K_t + u_t$, where $u_t \sim N(0, \sigma^2)$.[28] The error term u_t reflects the practical difficulty for an antitrust authority to pin down the exact probability that a merger will be anti-competitive, the imprecision of which is captured by an interval around σ_t. The variance of u_t captures the degree of imprecision in the authority's assessment.[29] Since both the drift and the variance of the information process are to be estimated, I assume that the starting point of the information process σ_0 is fixed at $\frac{a^*+A^*}{2}$ without loss of generality, as shown in Figure 6.

The four sets of model primitives $\theta = (\beta, c, \gamma, \delta, \rho, \sigma)$ to be estimated for the approval process are summarized below: β (merger's market impact), c (per period review cost), (γ_1, γ_2) (political cost of rejecting the merger), and $(\delta_0, \delta_1, \rho, \sigma)$ (information process). The discount factor is assumed to be 0.95.

[27]As shown by Nocke and Whinston (2022), the change of market outcomes associated with a merger, especially efficiency gain, is closely related to the *change* of HHI the merger would bring about instead of the *level* of HHI.

[28]In Table A6, I present qualitatively similar estimation results without adding u_t to the information process.

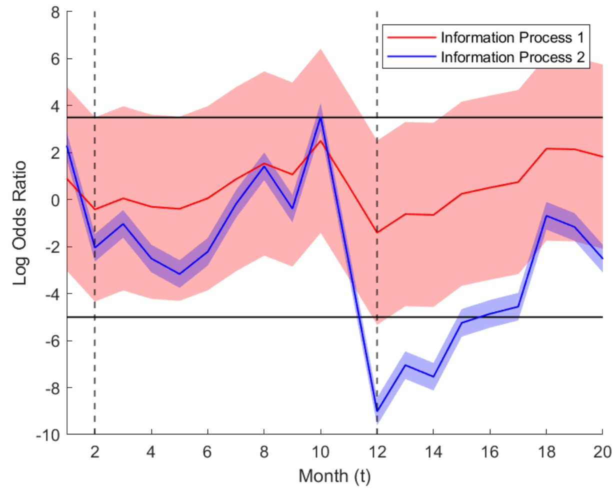
[29]The variance of the information process ρ^2 and the error term u_t therefore reflect two kinds of uncertainties in the decision-making process. ρ^2 captures noisy information supplied to the authority, such as incomplete or misleading information supplied by the merging parties; u_t captures the imprecision in the authority's assessment of how likely the merger will be anti-competitive, even if the information supplied to the authority is flawless.



Note: This graph offers an illustration of the antitrust authority's simulated decision-making process. The blue and red lines correspond to the lower and upper thresholds (a^*, A^*) the information process must cross before the authority rejects/approves the merger. The black line is the information the authority receives per period, which is simulated to follow a Wiener process. The shaded area reflects the 95% confidence interval of σ_t given $\sigma_0 + K_t$.

Figure 6: An Illustration of the Antitrust Authority's Decision-making Process with Random Shock

Identification. Among the model primitives, the parameters β, γ and δ are identified via merger-jurisdiction specific variation in the merging parties' market shares, change of HHI, whether the merger is domestic, and price change associated with the merger. Once the market impact and political cost associated with the merger are pinned down, the review cost c is identified via variation in the time taken for the authority to reach a decision. Separate identification of the variances ρ^2 and σ^2 is less straightforward as both of them affect the uncertainty of the decision process. Yet, the variance ρ^2 affects the "slope" of the information process, the effect of which cumulates over time. Conversely, σ^2 is a measure of the constant-width interval around σ_t, the effect of which does not vary over time. Figure 7 offers an illustration: the two information processes have the same drift, but they differ in the magnitude of ρ^2 and σ^2. At t = 2, for instance, whether the process will cross the upper threshold largely depends on the level uncertainty σ^2; at t = 12, the divergence of trajectories have become so large that the probability of information process 2 being below the lower threshold is 1. Focusing on the initial period of the decision process, where the effect of ρ^2 remains small, I am able to first identify σ^2 and then disentangle the two variances.



Note: This graph offers an illustration of two simulated information processes. The drift of both processes is 0.2; $\sigma = 2$ and $\rho^2 = 1$ for information process 1; $\sigma = 0.3$ and $\rho^2 = 3$ for information process 2. The red (blue) solid line represents the information the authority receives in process 1 (2); the red (blue) shaded area reflects the 95% confidence interval of process 1 (2). The two horizontal solid black lines correspond to the lower and upper thresholds (a^*, A^*) the information process must cross before the authority rejects/approves the merger.

Figure 7: An Illustration of the Antitrust Authority's Decision-making Process, Different Parameter Value for ρ^2 and σ^2

Maximum Likelihood. I use maximum likelihood to estimate the model primitives θ that maximize the probability of observing the empirical merger outcomes. For merger m and jurisdiction/authority j, the likelihood is as follows:

$$\arg\max_{\theta} L(X, Z, \hat{\Delta}_p, \theta) = \prod_{m=1}^{M} \prod_{j=1}^{J} \Pr(i_{mj}, t_{mj} | X, Z, \hat{\Delta}_p, \theta), \tag{10}$$

where i_{mj} is authority j's decision with respect to merger m, which can be to approve, reject, or no decision if the application is withdrawn. The variable t_{mj} represents the time taken for the authority to reach the decision.[30] The probability

[30]For a given merger, I focus on the set of jurisdictions that have issued a formal decision regarding the merger, as well as those negatively affected by the merger as per the estimates in Section 2.3, but that did not issue a formal decision. For the latter, where no formal decision was

of an observed merger-jurisdiction outcome, $\Pr(i_{mj}, t_{mj}|X, Z, \hat{\Delta}_p, \theta)$, is calculated using the following three-step procedure for a given value of θ:

1. Estimate $(\hat{u}_L, \hat{C}_{pol}, \hat{\mu})$ using Equation 9.

2. Given $(\hat{u}_L, \hat{C}_{pol}, \hat{\mu})$, simultaneously solve the system of equations in Equation 8 to obtain the authority's optimal threshold pair (a^*_{mj}, A^*_{mj}).

3. Simulate the probability of the authority approving the merger in period T by making N draws of the information process for each merger and authority, with drift $\hat{\mu}$ and variance $\hat{\rho}^2$. That is, suppressing the subscript,

$$\Pr(\text{approve}, T|X, Z, \hat{\Delta}_p, \theta) = \frac{1}{N}\sum_{n=1}^{N}\{\left[\prod_{t=1}^{T-1}\Pr\left(a^* < \sigma_t^n < A^* \mid X, Z, \hat{\Delta}_p, \theta\right)\right] \Pr\left(\sigma_T^n \geq A^*|X, Z, \hat{\Delta}_p, \theta\right)\}.$$

   As the information is subject to a random shock u_t such that $\sigma_t^n \sim N(\sigma_t^n, \sigma^2)$, the two terms $\Pr(a^* < \sigma_t^n < A^*|X, Z, \hat{\Delta}_p, \theta)$ and $\Pr(\sigma_T^n \geq A^*|X, Z, \hat{\Delta}_p, \theta)$ can be computed using the cumulative distribution function of the normal distribution. See Equation A1 in the Appendix for a similar calculation of the probabilities of other merger outcomes.

3.3 Estimation Results

Figure 8 assesses the model fit. The distribution of the predicted time taken to approve a merger resembles the empirical distribution.

Table 9 displays the model estimates. A merger between shipyards with higher market shares that results in a greater HHI increase is associated with higher costs of approving the merger (i.e., more negative u_L), which is consistent with expectations. The per-month review cost is estimated to be relatively small but not negligible. Additionally, a merger associated with a greater price increase is more likely to be rejected, as the drift of the information process becomes more negative.

Political cost is estimated to have a significant impact on an antitrust authority's decision. The cost of rejection is higher when the merger involves large global

issued, I assume that this implies implicit approval was granted within one month after the merger announcement, as this is the average time taken to assess a merger in most jurisdictions.

conglomerates or domestic companies. The positive sign on whether the merger involves domestic shipyards offers evidence of protectionist policies. In my sample of mergers, the merging parties' average combined market share is 3.2% , and the merger increases concentration (measured by HHI) by 5.05 on average. The average u_L is therefore $|-30 \times 0.032 - 82.1 \times 5.05| = 415.565$, whereas the average political cost for a foreign merger is $24.8 \times 2.51 = 62.248$, approximately 15% of u_L. For the authority, the consequence of approving such a hypothetical anti-competitive merger (i.e., V_{LA}) is only 85% of the merger's full adverse market impact u_L.

Parameter	Estimate	SE	Variable	Value
Market Shares (β_1)	-30.0***	(0.255)	Mean Combined Market Shares	0.032
Δ HHI (β_2)	-82.117***	(0.285)	Mean Δ HHI	5.053
Review Cost (c)	8.16***	(0.105)	Mean Sales Volume	2.512
Global Sales Volume (γ_1)	24.789***	(0.084)	Mean $\hat{\Delta}_p$	0.360
Merger Domestic (γ_2)	15.0***	(0.105)		
δ_0	3.967***	(0.224)		
$\hat{\Delta}_p$ (δ_1)	-0.20*	(0.105)		
σ	10.076***	(0.105)		
ρ	9.533***	(0.119)		

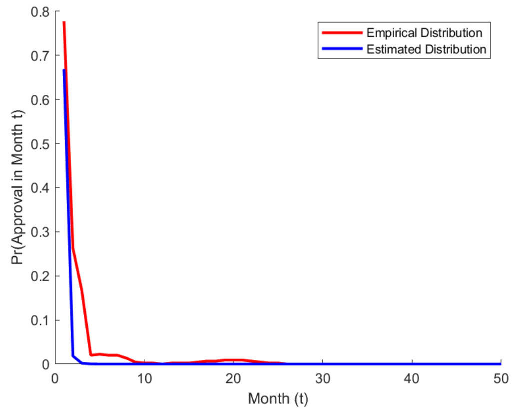
Notes: This table shows the coefficient estimates of $(\beta, c, \gamma_1, \gamma_2, \delta, \rho, \sigma)$ using the maximum likelihood method as per Equation 10. Market shares refers to the merging parties' average market shares (in fraction) in the jurisdiction; HHI is measured on a scale of 10,000; sales volume refers to the merging parties' combined annual global sales revenue, measured in billions of USD; merger domestic is a binary variable indicating whether the merging parties are based in the authority's jurisdiction; $\hat{\Delta}_p$ is the percentage change of price brought about by the merger as per Section 2.3's estimates; σ^2 and ρ^2 are the variances of the shock u_t and the Wiener process, respectively.

Table 9: Model Estimates

3.4 Counterfactual Analysis

I simulate a counterfactual scenario where the antitrust authority disregards political costs and focuses solely on the market outcome of a merger (i.e., $V_{LA} = u_L$, $C_{pol} = 0$) when making decision. In the counterfactual scenario, the authority is more likely to reject mergers and to do so in a shorter time. Therefore, eliminating political cost considerations expedites the merger review process and enhances consumer welfare by increasing the likelihood of blocking an anti-competitive merger.

Figure 9 illustrates the effect of removing political costs from the antitrust authority's decision-making process on the probability of approving or rejecting a merger. The main changes occur within the first four months, as most merger applications are decided during the time frame. Eliminating political costs results



Note: This graph assesses model fit by comparing the empirical probability that an antitrust jurisdiction approves the merger in month t with the average model-predicted probability that the merger is approved in month t among the merger-jurisdiction pairs I observe. The y-axis is the empirical/model-predicted probability that the merger is approved in month t.

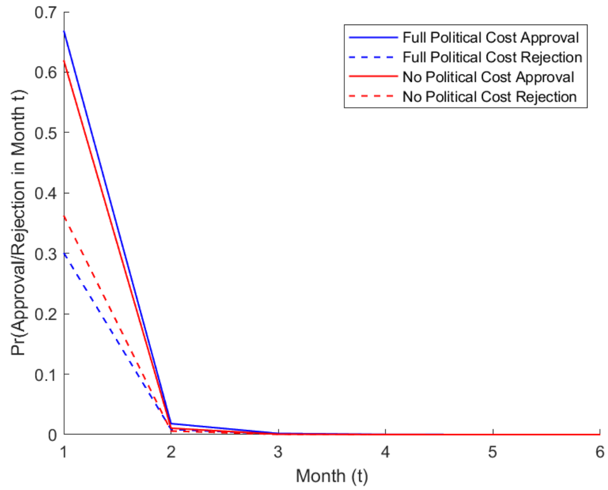
Figure 8: Model Fit

in an approximate 6 percentage point decrease in the probability of the authority approving the merger in the first month, while the probability of rejecting the merger in the first month increases by 6 percentage points. When political cost is set to zero, the opportunity cost of approving an anti-competitive merger increases. As a result, the optimal thresholds shift from (a^*, A^*) to $(a^{*'}, A^{*'})$, where $a^* \leq a^{*'}$ and $A^* \leq A^{*'}$. Since the information process remains unchanged, the merger is more likely to cross a^* (i.e., lead to rejection) and less likely to exceed A^* (i.e., lead to approval).

The increased probability of rejecting an anti-competitive merger translates into an approximately $12.98 million gain in consumer welfare per year, as shown in Table 10. Consumer welfare is calculated by comparing

$$\sum_{m=1}^{M} \text{Pr}(\text{Merger } m \text{ is approved within } t \text{ month(s)}|C_{pol} = \hat{C}_{pol})\hat{\Delta}_{CS_m}, T \in \{1,3,12\}, \text{ with}$$
$$\sum_{m=1}^{M} \text{Pr}(\text{Merger } m \text{ is approved within } t \text{ month(s)}|C_{pol} = 0)\hat{\Delta}_{CS_m}, T \in \{1,3,12\}. \tag{11}$$

The term $\hat{\Delta}_{CS_m}$ denotes the change in consumer welfare resulting from merger



Note: This graph shows how political consideration affects the average probability for an antitrust authority to approve/reject a proposed merger in month t. The blue lines (solid and dash) show the average probability for an authority to approve/reject the merger if political cost is taken into account, which is the reality. The red lines (solid and dash) show the average probability for an authority to approve/reject the merger if political cost is irrelevant, which is the counterfactual.

Figure 9: Effect of Political Considerations on Authority's Merger Control Decisions

m, as estimated in Section 2.3. Each row of Table 10 corresponds a t-month cutoff, meaning that a merger not approved within t months is considered rejected ($t \in \{1, 3, 12\}$). Under this assumption, the influence of political considerations has caused an additional \$10.86 to \$12.98 million annual consumer welfare loss across the thirteen mergers studied. A \$12.98 million loss amounts to 3.7% of total consumer welfare in the median market, which is \$350.7 million. Although the additional welfare loss brought about by political consideration is relatively small in magnitude, it is approximately 12.9 times of the expected consumer welfare loss had the authorities treated political cost as irrelevant. The results hold even if an authority's decision depends on the decisions of other authorities, as shown in Appendix A.

Cutoff	Expected CS Loss (Full Pol. Cost)	Expected CS Loss (No Pol. Cost)	Additional Welfare Loss
1 Month	-12.61	-1.75	10.86
3 Months	-14.94	-2.08	12.86
12 Months	-15.05	-2.08	12.98

Notes: this table shows the cumulative expected consumer welfare loss incurred by ship buyers worldwide arising from antitrust authorities' political considerations with respect to the shipyard mergers studied in this paper. An "X-month(s)" cutoff means that a merger that is not approved within X months is assumed to be rejected. Expected Consumer welfare loss is in millions of USD and calculated as per Equation 11. Consumer welfare loss brought about by merger is as per the estimate in Section 2.3.

Table 10: Effect of Political Considerations on Consumer Welfare

Heterogeneous Effect Across Cases. Table 11 breaks down the change in consumer welfare and the probability of receiving approval in the counterfactual for each merger case under the 12-month cutoff. Political considerations raise the probability of approval for a shipyard merger by 8.59 percentage points on average, which is associated with a \$11.76 million consumer welfare loss. Political cost therefore increases the annual expected loss from an average merger by \$1.01 million. Mergers with smaller negative impacts on consumer welfare tend to benefit more from antitrust authorities' political considerations. For instance, the merger between China Merchants and AVIC Weihai Shipyard enjoys an approximately 15 percentage points increase in the probability of receiving approval. On the other hand, large shipyard mergers like Hyundai & Daewoo and CSSC & CSIC tend to gain less from removing political considerations. As large mergers usually carry a stronger anti-competitive effect, resulting in a more negative u_L and a more negative drift of the information process, the political cost is relatively less important in determining the optimal thresholds (a^*, A^*).

Merging Parties	Δ Approval Probability	Δ Consumer Welfare (mil USD)
China Merchants & AVIC Weihai Shipyard	15.53	-6.913
STX & Daehan Shipbuilding	15.35	-6.539
Japan Marine United & IHI Corporation	15.22	-7.093
Namura Shipbuilding & Sasebo Heavy Industries	15.13	-8.258
Guangzhou Shipyard International (CSSC) & Huangpu Wenchong Shipyard	15.13	-7.847
Fincantieri & STX OSV	15.1	-4.961
CIMC Enric (China Merchant) & Sinopacific Offshore	11.3	-14.682
Imabari Shipbuilding & Japan Marine United	5.14	-10.385
Yangzijiang Shipbuilding & Mitsui E & S	5.12	-5.503
CSSC & CSIC	4.38	-29.073
Hanwha Group & Daewoo Shipbuilding	1.23	-7.583
Hyundai Heavy Industries & Daewoo Shipbuilding	0.23	-32.414
Guangzhou Shipyard International (CSSC) & Longxue Shipbuilding	-7.23	-9.267

Notes: This table compares the probability for each merger studied in this paper to be approved within 12 months when political cost is taken into account with that when political cost is irrelevant. The approval probability for each merger is calculated as the probability that all jurisdictions negatively affected by the merger would approve the merger in 12 months. The change in approval probability within 12 months is expressed in percentage points. The column Δ Consumer Welfare (mil USD) indicates the consumer welfare associated with the merger worldwide as per the estimate in Section 2.3.

Table 11: Effect of Political Considerations on the Probability of Approving a Merger

4 Conclusion

In the context of the shipbuilding industry, this paper assesses the factors influencing antitrust authorities' merger control decisions, including market factors and other considerations. I first present empirical evidence suggesting that antitrust regulators are effective at identifying potentially anti-competitive mergers. However, merger simulation results using the standard BLP framework reveal inconsistencies in antitrust decisions regarding different mergers, suggesting that factors beyond market outcomes play a role. The structural analysis of an antitrust authority's approval process model highlights the significant distortionary effect of non-market factors, such as political considerations, in antitrust decision-making. This paper, therefore, contributes to the recent debate on reforming the antitrust enforcement scheme. The antitrust process is ultimately a social enterprise shaped by human discretion. An effective antitrust system requires not only revisions to the written rules and regulations but also an institutional design that shields decision-makers from irrelevant considerations. If trade retaliation by a foreign country can trigger substantial welfare losses, closer regional antitrust collaboration may be a solution to make individual jurisdictions more resilient to economic coercion.

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A Alternative Specification of the Approval Process Model

Alternative Model Setting. I consider an alternative approval process model where the authorities' payoff depends on other authorities' decisions as well. The key departure from Section 3.1 is that at period t of the merger review process, authority i believes that there is a probability ρ_i^e that at least one authority from another jurisdiction will block the merger this period. The probability ρ_i^e is a function of the other authorities' decision thresholds (a_{-i}, A_{-i}). If such a prohibition order has been issued, the merger would be canceled and the political cost of rejecting the merger becomes zero.[31] Table A1 shows the authority's payoff matrix, taking its belief about other authorities into account.

The effect of adding ρ_i^e into the model is ambiguous ex ante. On the one hand, the prospect that other authorities might still reject the merger makes the consequence of wrongly approving the transaction less severe. On the other hand, the possibility of simultaneous rejection by multiple authorities discounts the political cost of rejecting the merger. Thus, the effect of the belief ρ_i^e is an empirical question.

Authority's Payoff Matrix

Decision/State	High	Low
Approve	$(1-\rho_i^e)u_H = 0$	$(1-\rho_i^e)u_L$
Reject	$-(1-\rho_i^e)C_{pol}$	$-(1-\rho_i^e)C_{pol}$

Payoff after Normalization

Decision/State	High	Low
Approve	$V_{HA} = (1-\rho_i^e)C_{pol}$	$V_{LA} = (1-\rho_i^e)(u_L + C_{pol})$
Reject	0	0

Notes: The table shows the payoff matrices for the antitrust authority before and after normalization. The payoff for rejecting the merger is normalized to 0 in the table on the right.

Table A1: An Antitrust Authority's Payoff Matrix, Alternative Specification

The authority's expected utility maximization problem is reformulated as the equation below. Unlike Equation 6, authority i's payoff of approving the merger is now a function of its belief ρ_i^e, which depends on the thresholds chosen by other authorities (a_{-i}, A_{-i}).

[31]The assumption here is that if multiple authorities reject the merger simultaneously, the rejection becomes a collective decision that is unlikely to attract targeted retaliation from the country with which the merging shipyards are associated.

$$\begin{aligned}
&\arg\max_{a_i, A_i} E[U(a_i, A_i, a_{-i}, A_{-i})] \\
&\quad = -\int_0^T ce^{-rt}dt + Pr(\omega = H)V_{HA}\Psi(\sigma, H) + Pr(\omega = L)V_{LA}\psi(\sigma, L), \\
&\qquad V_{HA} = [1 - \rho_i^e(a_{-i}, A_{-i})]C_{pol}, \\
&\qquad V_{LA} = [1 - \rho_i^e(a_{-i}, A_{-i})](u_L + C_{pol}), \\
&\qquad \Psi(\sigma, \omega) = E[e^{-rT}|\sigma(T) = A_i, \omega]Pr[\sigma(T) = A_i|\omega], \\
&\qquad \psi(\sigma, \omega) = E[e^{-rT}|\sigma(T) = a_i, \omega]Pr[\sigma(T) = a_i|\omega].
\end{aligned}$$

The first order necessary conditions, like Equation 8, can be written as (suppressing the subscript indexing for authority):

$$\begin{aligned}
(1-\rho_i^e)C_{pol} + \frac{1-\rho_i^e}{1+e^A}u_L &= \frac{c}{r}\beta_1(a, A), \\
-\gamma(a, A)(1-\rho_i^e)(u_L + C_{pol}) &= (1-\rho_i^e)\alpha(a, A)(\frac{u_L}{1+e^A} + C_{pol}) + \frac{c}{r}\beta_2(a, A).
\end{aligned}$$

where $\alpha(a, A)$, $\beta_1(a, A)$, $\beta_2(a, A)$, and $\gamma(a, A)$ are defined in Equation 7. Note that the two equations above do not allow for separate identification of ρ from u_L and C_{pol}. As such, under the alternative model specification, the value of u_L and C_{pol} estimated in Section 3.3 should be interpreted as $(1-\rho)u_L$ and $(1-\rho)C_{pol}$ instead. The true value of the two parameters is $\frac{1}{1-\rho}$ larger.

Identification of ρ. In equilibrium, an arbitrary authority i's belief ρ_i^e should be equal to the actual probability that there exists an authority j ($j \neq i$) blocking the merger this period. More formally, the equilibrium condition states[32].

$$\rho_i = \frac{1}{I-1}\sum_{j \neq i}^{I} \text{Pr(Rejection in Period } T)_j = \rho_i^e, \tag{A1}$$

[32] By writing the actual probability that there exists another authority blocking the merger as per A1, I implicitly simplify the mutli-authority game into a two-agent game. For each authority, there is the authority itself and the rest of the world. $\frac{1}{I-1}\sum_{j\neq i}^{I}\text{Pr(Rejection in Period } T)_j$ should therefore be interpreted as the average probability that one authority from the rest of the world would reject the merger. Another formulation of the equilibrium, however, is $\rho_i^e = 1 - \prod_{j\neq i}^{I}[1 - \text{Pr(Rejection in Period } T)_j]$

$$\Pr(\mathbf{1}\{\text{Rejection in Period } T\}_j) = \frac{1}{N}\sum_{n=1}^{N}\{\left[\prod_{t=1}^{T-1}\Pr\left(a_j^* < \sigma_{t,j}^n < A_j^* \mid X_j, Z_j, \hat{\Delta}_p^j, \theta\right)\right]$$
$$\Pr\left(\sigma_{T,j}^n \leq a_j^* | X_j, Z_j, \hat{\Delta}_p^j, \theta\right)\},$$
$$\Pr(\mathbf{1}\{\text{No Decision until Period } T\}_j) = \frac{1}{N}\sum_{n=1}^{N}\{\left[\prod_{t=1}^{T}\Pr\left(a_j^* < \sigma_{t,j}^n < A_j^* \mid X_j, Z_j, \hat{\Delta}_p^j, \theta\right)\right]$$

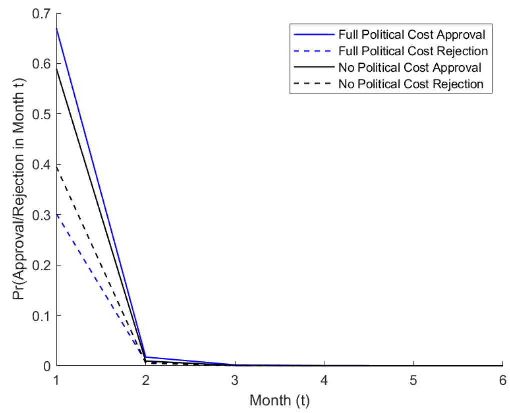
where I denotes the total number of authorities involved and N the number of draws of the information process explained in Section 3.2.

Empirical identification of ρ becomes possible after removing across-authority variation of ρ_i^e. I assume that every authority's belief is the same, and the belief does not vary over time. The simplifying assumption becomes plausible when the merger's impact is evenly distributed across jurisdictions and the case involves many jurisdictions. The authorities then have similar tendencies to approve or reject the merger. Under the homogeneous belief assumption, ρ^e is directly identified by the average probability of rejection across authorities in the data.[33]

Estimation Outcome and Counterfactual. The average probability for an antitrust authority to reject a merger is 0.0062, which reveals the authorities' belief in equilibrium. Figure A1 shows the counterfactual probability of approving or rejecting a merger each month if political cost is removed from an authority's consideration.[34] Like Figure 9, removing political cost lowers the probability of approving the merger and raises the probability of rejecting the merger. The effect is even stronger here as compared to Figure A1. Consequently, the welfare loss that can be avoided by setting political cost to zero is also larger relative to Table 10, as shown in Table A2.

[33]Although there could be across-time variation in an authority's belief as well, I assume that the authority's per period belief is well-approximated by its average over-time belief for simplicity.

[34]In the counterfactual with no political cost, the equilibrium belief ρ^e jumps to 0.0081.



Note: This graph shows how political consideration affects the average probability for an antitrust authority to approve/reject a proposed merger in month t. The blue lines (solid and dash) show the average probability for an authority to approve/reject the merger if political cost is taken into account, which is the reality. The black lines (solid and dash) show the average probability for an authority to approve/reject the merger if political cost is irrelevant, which is the counterfactual.

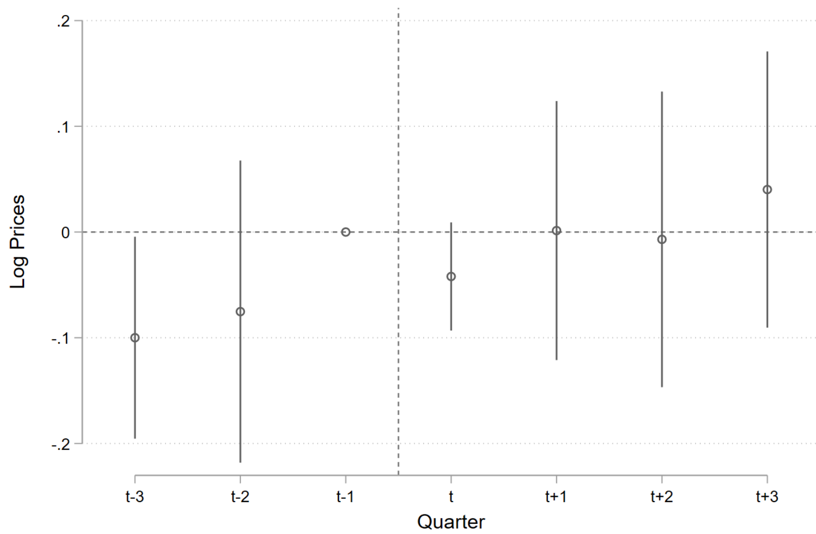
Figure A1: Effect of Political Considerations on Authority's Merger Control Decisions, Alternative Model Specification

Cutoff	Expected CS Loss (Full Pol. Cost)	Expected CS Loss (No Pol. Cost)	Additional Welfare Loss
1 Month	-12.61	-0.05	12.56
3 Months	-14.94	-0.06	14.88
12 Months	-15.05	-0.06	14.99

Notes: this table shows the cumulative expected consumer welfare loss incurred by ship buyers worldwide arising from antitrust authorities' political considerations with respect to the shipyard mergers studied in this paper. An "X-month(s)" cutoff means that a merger that is not approved within X months is assumed to be rejected. Expected Consumer welfare loss is in millions of USD and calculated as per Equation 11. Consumer welfare loss brought about by merger is as per the estimate in Section 2.3.

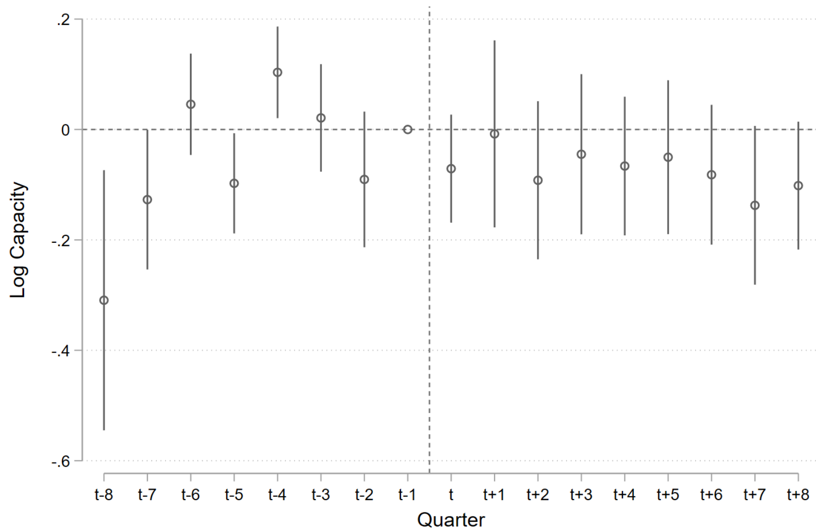
Table A2: Effect of Political Considerations on Consumer Welfare

B Supplementary Figures and Tables



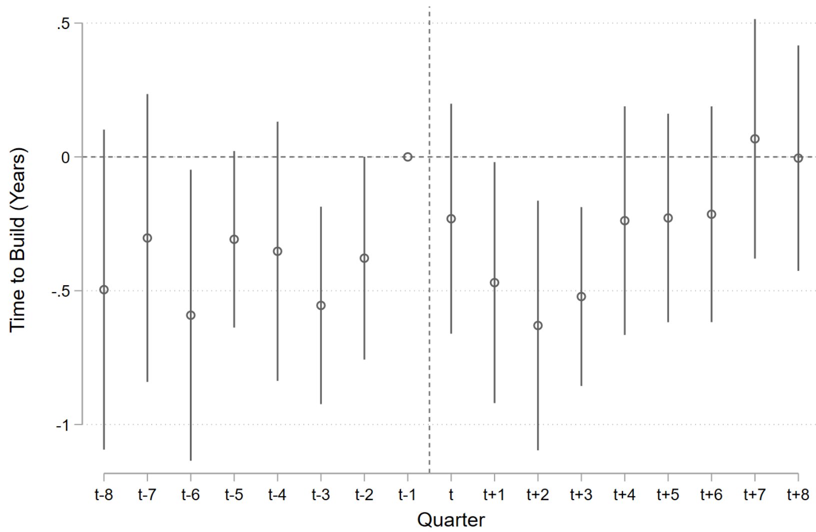
Note: This graph shows the effect of horizontal shipyard mergers on log newbuild vessel prices 3 quarters before and after the merger announcement. The data is aggregated to shipyard-ship type-quarterly level. The merger between Imabari and Japan Marine United, CSSC and CSIC, Yangzijiang Shipbuilding and Mitsui E & S, and Hyundai Heavy Industry & Daewoo Shipbuilding. The other mergers do not have an at least 3-quarter time gap between merger announcement and merger completion. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD. The coefficient on *t-1* is normalized to 0. Standard errors are clustered at shipyard level. The intervals plotted are 95% confidence intervals.

Figure A2: The Effect of Shipyard Mergers Subject to Legal Review on Newbuild Vessel Prices



Note: This graph shows the effect of horizontal shipyard mergers on log newbuild vessel capacity 2 years before and after the merger. The data is aggregated to shipyard-ship type-quarterly level. All successful mergers subject to at least one antitrust authority's merger control review are included in the analysis. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. The coefficient on *t-1* is normalized to 0. Standard errors are clustered at shipyard level. The intervals plotted are 95% confidence intervals.

Figure A3: The Effect of Shipyard Mergers Subject to Legal Review on Newbuild Vessel Capacity



Note: This graph shows the effect of horizontal shipyard mergers on time to build new vessel 2 years before and after the merger. The data is aggregated to shipyard-ship type-quarterly level. All successful mergers subject to at least one antitrust authority's merger control review are included in the analysis. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. The coefficient on *t-1* is normalized to 0. Standard errors are clustered at shipyard level. The intervals plotted are 95% confidence intervals.

Figure A4: The Effect of Shipyard Mergers Subject to Legal Review on Time to Build New Vessel

	(1) Log Price	(2) Log Vessel Capacity	(3) Time to Build
Post Merger * Merging Shipyards	0.0833***	-0.183***	-0.0506
	(0.0203)	(0.0435)	(0.194)
Log Vessel Capacity	0.531***		0.424
	(0.0320)		(0.416)
Time to Build	-0.0124	0.0344	
	(0.0191)	(0.0289)	
Log Price		1.569***	-0.452
		(0.123)	(0.674)
Merger FEs	Yes	Yes	Yes
Ship Type-Shipyard FEs	Yes	Yes	Yes
Quarter FEs	Yes	Yes	Yes
Ship Type-Quarter FEs	Yes	Yes	Yes
Observations	890	890	890

Notes: This table shows the effect of horizontal shipyard mergers on newbuild vessel prices, capacity, and time to build 2 years before and after the merger following the methodology of Borusyak, Jaravel, and Spiess (2024). The data is aggregated to shipyard-ship type-quarterly level. All successful mergers subject to at least one antitrust authority's merger control review are included in the analysis. The control group used are the shipyards that had never undergone any merger between 2010 and 2023. Prices are in millions of USD, and time to build is measured in years. Standard errors are clustered at shipyard level.

Table A3: The Effect of Shipyard Mergers Subject to Legal Review on Newbuild Vessel Attributes, Robustness to Heterogeneous Treatment Effect

Demand-side Variables	Means	Standard Deviations	Supply-side Variables	Estimates
Log Prices	–15.341***	1.821	Log Capacity	–34.612
	(2.136)	(2.836)		(46.625)
Log Capacity	10.031**	1.383	Newbuild Vessel	212.299
	(4.444)	(7.484)		(235.217)
Newbuild Vessel	11.457***	1.086		
	(1.429)	(31.659)		
Brand FEs	Yes			
Year FEs	Yes			
Observations	23962			

Notes: This table shows the parameter estimates of the demand and supply model specified by equation 2 and 4. Prices are measured by the price of the vessel per unit capacity in thousands of USD. A brand is defined by a unique combination of shipyard and vessel type. Standard errors are clustered at brand level. Instruments used in this specfication does not include the BLP instruments.

Table A4: Parameter Estimates for Vessel Demand and Supply Model, Robustness

Merging Shipyard	Price Change Overall (%)	Shipyard Countries	Year of Merger	Price Change Merging Shipyards (%)	Price Change Other Shipyards (%)
CSSC & CSIC	.001	China	2020	.0121	.0007
Hyundai Heavy Industries & Daewoo Shipbuilding	.001	Korea	NA	.0108	.0007
Imabari Shipbuilding & Japan Marine United	.0006	Japan	2020	.0139	.0005
Yangzijiang Shipbuilding & Mitsui E & S	.0005	China, Japan	2019	.0095	.0004
Japan Marine United & IHI Corporation	.0003	Japan	2012	.0143	.0003
Fincantieri & STX OSV	.0003	Korea, Italy	2013	0	.0003
Guangzhou Shipyard International (CSSC) & Huangpu Wenchong Shipyard	.0003	China	2014	.0015	.0003
Namura Shipbuilding & Sasebo Heavy Industries	.0003	Japan	2014	.0068	.0002
Guangzhou Shipyard International (CSSC) & Longxue Shipbuilding	.0003	China	2014	.0024	.0003
CIMC Enric (COSCO) & Sinopacific Offshore	.0002	China	2017	.0028	.0002
China Merchants & AVIC Weihai Shipyard	.0002	China	2019	.0017	.0002
STX & Daehan Shipbuilding	.0002	Korea	2022	.0037	.0002
Hanwha Group & Daewoo Shipbuilding	.0002	Korea	2023	.0027	.0002

Notes: This table shows the effect of each merger's annual impact on the average price of a vessel worldwide, measured by percentage change in the prices. Years after merger completion are excluded from the analysis. Prices post merger are solved using Equation 3. Price changes are winsorized at 1% and 99% level. "Price Change Overall" shows the merger's effect on the entire market, including the merging shipyards themselves and their competitors; "Price Change Merging Shipyards" shows the merger's effect on the vessels sold by the merging shipyards; "Price Change Other Shipyards" shows the merger's effect on the vessels sold by the merging shipyards' competitors. Year of Merger is left as "NA" if the merger did not materialize.

Table A5: The Effect of Individual Mergers on Vessel Prices Worldwide

Parameters	Estimate	SE	Variable	Value
Market Shares (β_1)	-30.133***	(0.105)	Mean Combined Market Shares	0.032
Δ HHI (β_2)	-94.775***	(0.007)	Mean Δ HHI	5.053
Review Cost (c)	8.641***	(0.105)	Mean Sales Volume	2.512
Global Sales Volume (γ_1)	24.949***	(0.021)	Mean $\hat{\Delta}_p$	0.36
Merger Domestic (γ_2)	15***	(0.105)		
δ_0	8.62***	(0.066)		
$\hat{\Delta}_p$ (δ_1)	-0.305***	(0.005)		
ρ	7.173***	(0.011)		

Notes: This table shows the coefficient estimates of $(\beta, c, \gamma_1, \gamma_2, \delta, \rho)$ using the maximum likelihood method as per Equation 10. The model estimated in this table does not impose additional random shock to the information process as explained in Section 3.2. Market shares refers to the merging parties' average market shares (in fraction) in the jurisdiction; HHI is measured on a scale of 10,000; sales volume refers to the merging parties' combined annual global sales revenue, measured in billions of USD; merger domestic is a binary variable indicating whether the merging parties are based in the authority's jurisdiction; $\hat{\Delta}_p$ is the percentage change of price brought about by the merger as per Section 2.3's estimates; ρ^2 is the variance of the Wiener process, respectively.

Table A6: Model Estimates without Uncertainty in the Information Process

C Estimation Procedure for the Random Coefficients Model

As explained in Section 2.3, I assume that the utility of purchasing a vessel to be

$$u_{klm} = a_k \log(p_{lm}) + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm} + \epsilon_{klm},$$

where k indexes the buyer, l the brand, m the market, and y the year. A market m is defined by the buyer country, year, and the ship category (bulker, containership, gas carrier, and tanker).

Assuming that ϵ_{klm} follows an i.i.d. extreme value distribution, it can be shown that the probability for individual k in market m to opt for vessel l would be (Nevo 2000)

$$s_{lm} = \int \frac{\exp(a_k \log(p_{lm}) + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm})}{\sum_{q=1}^{L} \exp(a_k \log(p_{qm}) + X_{qm}\beta_k + \xi_q + \xi_y + \xi_{qm})} dF(\alpha_k, \beta_k),$$

where L is the total number of brands offered in the market. If we know the distribution of buyers' taste parameters α_k and β_k in the buyer population, the market share of product j in market t is

$$s_{lm} = \int s_{klm} dF(\alpha_k, \beta_k).$$

But since the distribution of the taste parameters is unobserved, it has to be simulated. Following Nevo (2000), I first re-write the vector of taste parameters $\begin{bmatrix}\alpha_k & \beta_k\end{bmatrix}'$ as a combination of the mean taste parameters $\begin{bmatrix}\alpha & \beta\end{bmatrix}'$ and an interaction between the variance-covariance matrix Σ and unobserved individual attribute v_k: Σv_k [35]. I assume that v_k follows a standard multivariate normal distribution. Given these assumptions, one can make a reasonably large (ns) number of random draws from the distribution of v_k to approximate the market share s_{lm} by

$$\hat{s}_{lm} = \frac{1}{ns} \sum_{k=1}^{ns} \frac{\exp(a_k \log(p_{lm}) + X_{lm}\beta_k + \xi_l + \xi_y + \xi_{lm})}{\sum_{q=1}^{L} \exp(a_k \log(p_{qm}) + X_{qm}\beta_k + \xi_q + \xi_y + \xi_{qm})}.$$

[35] There is no observed buyer characteristics in my dataset, so I do not interact observed product attributes with observed buyer demographics.

In order to estimate the set of parameters $\theta = (\theta_1, \theta_2) = (\begin{pmatrix}\alpha & \beta\end{pmatrix}', \Sigma)$, I search for the θ that minimizes the Euclidean distance between the vector of predicted market shares $\begin{pmatrix}\hat{s}_{1m} & . & . & \hat{s}_{Qm}\end{pmatrix}' = \hat{S}(\theta, p_m, x_m)'$ and the vector of observed market shares S_m in market m. As this involves a non-linear search of parameters, I leverage on the approach by Berry, Levinsohn, and Pakes (1995). Denoting the mean utility derived from purchasing brand l in market m as $\delta_{lm} = \alpha p_{lm} + x_{lm}\beta + \xi_{lm}$, which is uninfluenced by individual idiosyncratic tastes, BLP's contraction mapping algorithm computes a sequence of vectors (δ_m^n) for each market where[36]

$$\delta_m^n = ln(S_m) - ln(\hat{S}_m(p_m, x_m, \delta_m^{n-1}, \theta_2)).$$

The true mean utility δ_m is approximated by δ_m^H, where $\|\delta_m^H - \delta_m^{H-1}\|$ is smaller than a specified tolerance value.

Given the approximated value of δ_m, following Nevo (2000), I calculate the difference between δ_{lm} and $\alpha p_{lm} + x_{lm}\beta$ for each brand l, which I denote as ω_{lm}. Since the unobserved buyer characteristics (v_k, ϵ_k) are (numerically) integrated over when computing the market shares, what remains in the error term ω_{lm} is ξ_{lm}, the brand's market-year-specific deviation from its mean yearly utility. ξ_{lm} should be independent of supply shocks purely affecting the shipyards' costs and, arguably, the characteristics of vessel l's competing products. Given this assumption, the moment conditions can be constructed as

$$E[Z\omega(\theta\}] = E[Z\xi] = 0,$$

where Z is a Q by M matrix of instruments assumed to be orthogonal to the error term $\omega(\theta)$, (Q is the maximum number of brands sold in a market, and M is the total number of markets). Equation 4 thereby allows me to construct a generalized methods of moment (GMM) estimator of $\theta = (\theta_1, \theta_2)$ as per Nevo (2000)

$$\hat{\theta} = \arg\min_{\theta} \omega(\theta)' Z \Phi^{-1} Z' \omega(\theta),$$

where Φ is a consistent estimator of $E[Z'\omega(\theta)\omega(\theta)'Z]$.

[36] δ_m is $(\delta_{1m} \quad . \quad . \quad \delta_{Qm})'$. θ is a set of initial guess values supplied by the researcher.

The GMM estimates from equation 5 can be used compute the own and cross price elasticity of brand l (Train 2009, p.67):

$$\eta_{lqm} = \begin{cases} \frac{p_{lm}}{s_{lm}} \int \alpha_k s_{klm}(1 - s_{klm}) dF(\alpha_k, \beta_k), & \text{if } l = q, \text{ which is l's own price elasticity;} \\ \frac{p_{qm}}{s_{lm}} \int \alpha_k s_{klm} s_{kqm} dF(\alpha_k, \beta_k), & \text{if } l \neq q, \text{ which is } l\text{'s cross price elasticity w.r.t. } q. \end{cases}$$

In practice, the elasticities can be numerically estimated by making random draws of simulated individuals and taking mean value of η_{klqm} across the individuals.