Review of bargaining and transaction prices: future avenues for shipping studies

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Abstract

Purpose – In the shipping industry, both sales and purchases of second-hand ships and freight transport services are prevalently tailormade and traded with intense bilateral negotiations. Price bargaining is the key step of this negotiation process and plays a crucial role in determining mutually agreed prices. Despite its cruciality and applicability, the price bargaining has yet received due conceptual and/or theoretical attention in the shipping literature. This paper attempts to conceptually examine the role of bargaining in shipping transaction prices and subsequently puts forward directions for future research. In doing so, the paper focuses on two types of transactions taking place in shipping markets: asset market trading of second-hand vessels and service market trading shipping freights.

Design/methodology/approach – The paper begins with a systematic literature review of price bargaining in the field of economics and management disciplines from a game-theoretic perspective. This approach does logically lead to the establishment of a conceptual framework for price bargaining in shipping sub-markets as a step toward having taken into consideration a variety of heterogeneities commonly present in trading activities and market dynamics.

Findings – A set of research areas has been consequently identified where price bargaining and mechanisms for the shipping freight and asset markets could be further explored and analyzed in a way to make better pricing decisions under a more tangible framework.

Research limitations/implications – One of the critical challenges when using bargaining mechanisms to make a decision on pricing shipping services and assets is how to operationalize the study for empirical investigation as some of the factors are internal information of the players and are not adequately revealed to externals: that is, an imperfect information sharing case. The current study aims, however, not to conduct an empirical analysis but to initiate a conversation among maritime economists by bringing their attention to this not-yet fully explored and potentially impactful field of research and by asking them to treat bargaining from a perspective for pricing shipping assets and services. It is claimed that, by doing so, one could better understand price differences between individual contracts.

Originality/value – This study would be considered the first of its kind to provide a detailed survey of the bargaining theory and models from a game theoretical perspective as a theoretical lens to understand its importance and relevance in pricing shipping assets and services. It also provides a simplified operational case on utilizing bargaining in practically pricing freight services.

Keywords Price bargaining, Bargaining power, Shipping markets, Pricing assets and services

Paper type Literature review

The authors would like to thank AXS Marine for their kind support when exploring their database containing individual freight fixture–specific information and for their professional feedback on the industry-common practices when developing the conceptual framework for bargaining and transaction prices in shipping, as suggested in this paper. Their voluntary contributions helped to reflect the industry practices from a theoretical perspective. The editor and two anonymous reviewers are duly acknowledged for their professional contributions to the current version of the paper during the reviewing and revising processes.

1. Introduction

The concept and practice of bargaining are extensively used in everyday life to obtain better prices or terms and conditions for trade (Pen, 1952; Maynard, 1984; Nash, 2016). Bargaining could range from simply asking for a discount from a seller while shopping in an open market to exhaustively negotiating the terms of bank loans and even making formal bilateral trade agreements between countries. The essence of bargaining in these contexts is the same: negotiating the terms of a contract between two players and associated prices of tradable products, in the form of either tangible assets or intangible services.

The international shipping industry is no stranger to bargaining, given the extensive interactions between buyers and sellers when negotiating the sale and purchase of a ship or fixing freight services. This is due to the lack of standardization of most shipping transactions in terms of the characteristics of physical ships and freight services. The sellers or buyers of the assets or services actively negotiate through a physical broker to set the transaction prices. The outcome of this bargaining exercise is the resultant price of the physical ship traded in the sale and purchase (S&P) market or freight as a service in the freight market.

Although the average market price provides a general indication of price trends, individual transaction factors hold greater significance when trading assets or services. For example, the price of a particular secondhand ship can vary based on its operational history. Well-maintained vessels favor sellers and command higher prices than similar ships with poor maintenance, despite similar specifications. In the freight market, service offerings have even more diversity, including contract terms like loading ports, discharge ports, cargo volumes and voyage speed. While the dry bulk freight market shows characteristics of near-perfect competition, other shipping markets, such as tanker and container freight, and the S&P markets for bulkers, tankers and container ships display an oligopolistic market structure. Bargaining plays a decisive role in determining individual transaction prices, allowing players to examine pricing mechanisms and consider behavioral aspects. However, there is a lack of literature on bargaining mechanisms in the shipping industry. Addressing this gap through future research can provide valuable insights into negotiation processes and behavioral dimensions that influence transaction prices, enhancing our understanding of pricing mechanisms in the shipping industry.

There has been a long-term academic interest in studying the average market prices in the shipping industry. For instance, Kavussanos and Alizadeh (2002), Alizadeh and Nomikos (2007) and Kalouptsidi (2014) investigate valuation and investment timing in the shipping industry for asset gain, while Kavussanos *et al.* (2014), Tsouknidis (2016), Gavriilidis *et al.* (2018) and Yang *et al.* (2022) attempt to estimate the freight market movements. While investigating the average market prices helps to shed light on the ever-changing market conditions, it misses out on presenting the performance of individual transactions. Along this line, a better understanding of individual transactions and their price drivers is essential for achieving superior business and financial performance. Compared to extensive market-level study on pricing assets and services, there is scarce research on the asset and service prices for individual shipping transactions, not to mention the role of bargaining in price determination. This is striking, considering the great scale of daily ship-level transactions. Over 50,000 international ocean-going ships are continuously involved in international commodity transportation, whose cumulative value of freight rates is over US$500bn annually [1].

This study aims to address the two above-mentioned research gaps by investigating shipping prices at the transaction level, focusing on the role of bargaining in pricing individual ship assets and freight services. The attempt is *first* made by investigating bargaining in shipping markets, followed by reviewing the well-established bargaining fundamentals in economics and management literature. Upon this, we divide the shipping markets into specific suitable segments to which the concept of bargaining is applied. *Second*, this allows us to set up a research framework of price bargaining in shipping sub-markets by considering the heterogeneity in trading activities and market dynamics. The trade-and-bargaining analytical lens helps us unveil how to apply generic bargaining concepts to analyze secondhand ship and freight service prices in particular.

The term *bargaining* might have an idiosyncratic interpretation with a different industrial background. The current study limits the concept of bargaining from a strategic game theoretical approach to estimating the resultant asset or service prices – a concept that is widely used in economics and management studies [2]. This paper could subsequently contribute to the literature by (1) providing an in-depth understanding of price bargaining to set the transaction prices between buyers and sellers strategically and (2) suggesting potential research directions for pricing assets and services in the shipping market. This review paper can initiate a conversation within the maritime academic society to look at the pricing in shipping from a bargaining perspective, thereby creating an applied case study for other areas of studies outside of shipping literature.

The paper is structured as follows. Section 2 presents the role of price bargaining in the shipping markets, followed by Section 3 with an overview and development of bargaining models in economics and management studies. Section 4 looks at the applications of bargaining in the economics literature and its implications for shipping literature. Section 5 proposes a framework to implement the bargaining concept in shipping markets for future research, and finally, Section 6 addresses the concluding remarks.

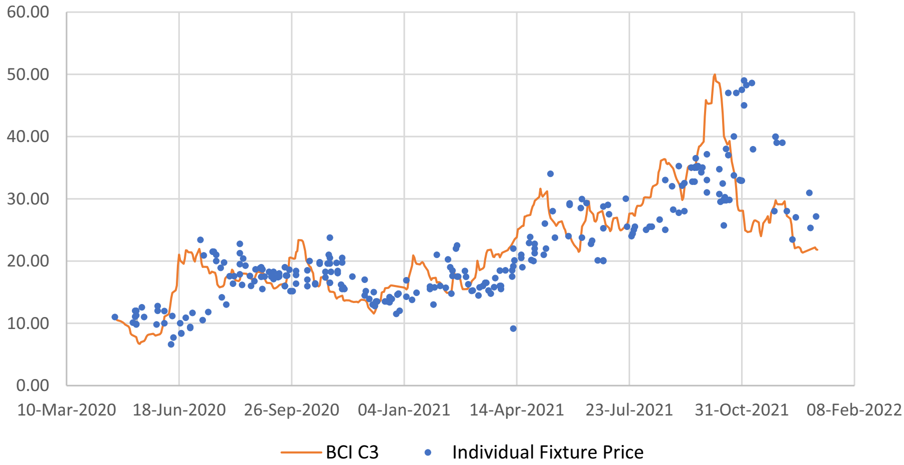
2. Pricing and bargaining in shipping markets

2.1 Pricing of ships and freight services

Several studies in the shipping markets have attempted to understand the factors affecting asset and service prices and their volatilities to anticipate the market for efficient decision-making. Jing *et al.* (2008), Xu *et al.* (2011), Alizadeh and Talley (2011b) and Drobetz *et al.* (2012), among others, investigate the factors affecting the freight prices and volatilities, while Kavussanos and Visvikis (2004), Kavussanos *et al.* (2014), Tsouknidis (2016), Alexandridis *et al.* (2017) and Angelopoulos *et al.* (2020) investigate the cross spillover effects between commodity and security returns and volatilities on freight markets. Similar studies are also observed in the S&P market, where Tvedt (1997) and Kavussanos and Alizadeh (2002) study the valuation of ships, Kalouptsidi (2014) suggests the optimal time to build a new vessel, while Alizadeh and Nomikos (2006) and Alizadeh and Nomikos (2007) develop a strategy for trading ships in the S&P market.

Only a few studies investigate the prices at a per-contract level. For example, Alizadeh and Talley (2011a) and Adland *et al.* (2016) study the impact of charterers and shipowners on freight contract prices, and Merika *et al.* (2019) explore the individual prices of secondhand dry bulk vessels. It is worth noting that the contract prices of individual transactions in the shipping industry can vary significantly from the average market prices. For example, a significant difference in prices is observed between the market-averaged freight index (produced by the London-based Baltic Exchange) and individual transaction prices for carrying iron ore between Tubarao (Brazil) and Qingdao (China) in Figure 1. Analyzing the market average price movement at a macro level provides a good understanding of the market trend but loses substantial information, failing to reflect individual transaction prices. For instance, on May 11, 2020, there were four fixtures with the same loading and discharge location using a single charterer but different ship operators. Interestingly, the freight rates ranged between 9.8 and 12 USD/tonne-mile, while the average market price on that day was 7.79 USD/tonne-mile. This indicates the need for a different perspective to understand individual transaction prices.

Figure 1 illustrates two notable observations: a deviation between transaction prices and aggregate market prices and significant variability in individual freight contract prices. Understanding price variations requires considering individual utility functions and information accessibility. A bargaining theory perspective comprehensively examines transaction prices by integrating market factors and party characteristics. Analyzing the prices from a bargaining standpoint reveals specific price discrepancies from iterative negotiations. Studying the shipping industry enhances our understanding of pricing dynamics and trade-specific factors, illuminating pricing mechanisms.



Note(s): The individual freight fixture data is for shipping iron ore from Brazil to China on a Capesize bulker

Source(s): BCI C3 is extracted from Clarkson's Shipping Intelligence Network, and AXS Marine's AXS Dry database is used to collect the individual freight prices. The increasing demand for data as a decision support system in the shipping industry has led to the emergence of numerous data providers in recent years. In this study, we have opted to utilize data from two prominent companies, namely Clarkson and AXS Marine, for mainly two reasons: Firstly, Clarkson's Shipping Intelligence Network and AXS Marine's AXS DRY and ALPHATANKER platforms offer unprocessed data on individual transactions encompassing sales and purchases, and the freight market. This unadjusted and uncorrected raw data enables us to obtain a comprehensive and unfiltered view of the industry, facilitating a more accurate analysis of the shipping market dynamics. Secondly, both Clarkson and AXS Marine have established themselves as trusted data service providers in the maritime industry, accumulating a track record of over 20 years. This extensive experience underscores the reliability and credibility of the secondary data they offer

Figure 1.
Market price vs individual freight rate

2.2 Bargaining in determining contract ship prices and freight rates

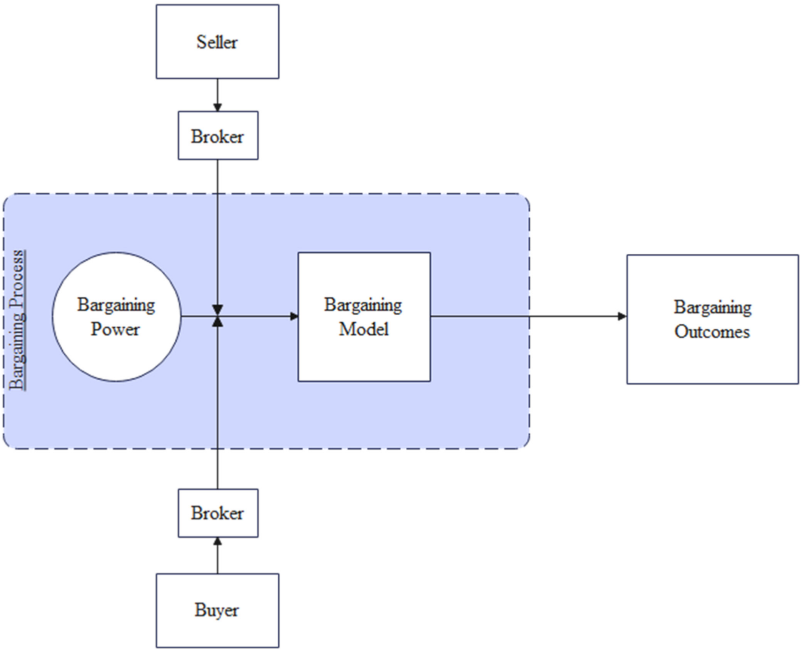
Most shipping transactions involve extensive interactions between buyers and sellers, which are facilitated by market agents or shipbrokers. Bargaining plays a crucial role in determining the prices of individual ships and freight services within these interactions. An illustrative example is the notable disparity observed in 2021 between the highest and lowest monthly secondhand prices of Handysize bulkers (with similar technical specifications), amounting to approximately 43%. Despite similar technical specifications, this significant price variation can be attributed to diverse bargaining practices employed during the negotiation process. This phenomenon is not exclusive to the shipping industry but is shared with other transportation sectors. For instance, a study conducted by Gavazza (2016) utilizing a price bargaining model reveals that approximately 20% of airline prices are misallocated due to information deficiencies and search frictions. These findings suggest the existence of a substantial pool of capital-intensive and volatile transportation markets, including the shipping industry, which can be examined through the lens of bargaining. In comparison with other industries, the shipping industry possesses several unique characteristics that further underscore the significance of bargaining practices. These distinct features contribute to the complexity and dynamics of negotiations, necessitating a comprehensive understanding of the bargaining process within the shipping context.

(1) Heterogeneity nature of shipping contracts

The shipping industry lacks standardization, with heterogeneous shipping contracts for freight services and ship sales and purchases. Liner and tramp shipping are the main types of services in the freight market. Larger container liner companies have more pricing power than small shippers in setting liner shipping service prices. Tramp shipping exhibits even more variations in cargo, ship and route. Secondhand ships are tangible assets with unique specifications and limited customization options. Buyers can only negotiate the price based on the current technical specifications. In summary, the lack of standardization in shipping contracts encourages bargaining, which is crucial in determining transaction prices.

(2) Active interaction between traders

The heterogeneous nature of ships and freight services increases search friction, leading to the involvement of physical brokers in matching buyers and sellers, similar to the stock trade in the past (Brancaccio *et al.*, 2020). In the case of a freight market, the charterer contacts the ship operator through a freight broker, while in the sales and purchase (S&P) market, sellers reach out to S&P brokers to find potential buyers. These brokers act as agents in matching buyers and sellers, sometimes influencing decisions (Hausman and Welch, 2010). Human intervention drives the bilateral bargaining process in each shipping trade, as depicted in Figure 2.



Note(s): The bargaining process is explained in detail in the later part of the text. The major difference between the generalized bargaining process and the shipping industry is the interaction between the buyers and sellers during the negation process through physical brokers presented in this figure
Source(s): Generated by the authors

Figure 2.
Bargaining process in the shipping industry

(3) Asymmetric information

Unlike commodity or equity markets, the shipping industry faces illiquidity risks due to a limited number of buyers and sellers. This scarcity makes it challenging for participants to find suitable counterparties, leading to price jumps (Ådland and Koekebakker, 2004). Information plays a crucial role in this illiquid market as transaction prices do not fully reflect market movements (Benmelech and Bergman, 2018). Although there is a trend of digitization and shipping database companies providing market information, the market transparency remains limited, resulting in asymmetric information. This information asymmetry leads to bounded rationality and sub-optimal decision-making (Simon, 1990). Players with higher information are motivated to trade assets and services through back-and-forth negotiations in an over-the-counter (OTC) market, exploiting the industry's asymmetric nature. Conversely, players with limited information access prefer to trade through trusted brokers or agents to gain better bargaining positions. Price negotiations allow each player to strive for the most favorable rates (Chatterjee and Samuelson, 1987).

Since bargaining is the lodestone to the pricing of individual ship assets and freight services in the shipping industry, the following section presents the concept of the bargaining process from the perspective of shipping.

3. Back to bargaining fundamentals

There is already a vast body of literature on bargaining and its significance in pricing. This section concentrates on the fundamental aspects of bargaining, aiming to establish a solid comprehension of the theoretical underpinnings and provide a framework for the practical application of bargaining in the context of shipping.

3.1 Bargaining process

A trade of assets or services only occurs if a potential buyer has the capacity and willingness to pay at least as much as the seller values it. The bargaining surplus is the difference between the maximum value at which the buyer is willing to buy the asset/services vis-à-vis the minimum value at which the seller is willing to sell it. There are back-and-forth discussions between the potential buyer and seller, negotiating the split of this surplus between them and finalizing the transaction's price (or term) with or without the broker's involvement. This dialogue between the buyer and seller is called the bargaining process. The surplus associated with the bargaining process is graphically presented in Figure 3 and can be calculated as follows:

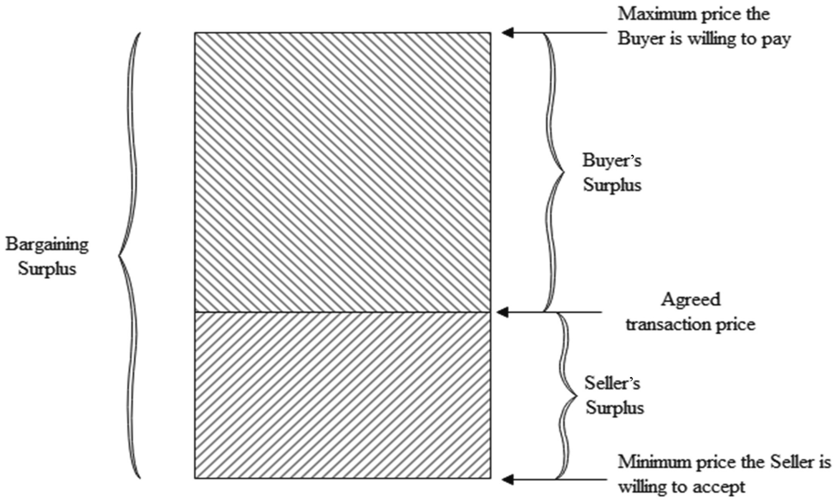
$$S_T = max(P_B) - min(P_S) \tag{1}$$

$$S_B = max(P_B) - \mathrm{TP} \tag{2}$$

$$S_S = \mathrm{TP} - min(P_S) \tag{3}$$

In this context, the bargaining surplus (S_T) is determined by the difference between the maximum price the buyer is willing to pay, $max(P_B)$, and the minimum price the seller is willing to accept, $min(P_S)$. The transaction price is denoted by TP, while S_B and S_S represent the split of surplus between the buyer and seller, respectively.

In practice, the distribution of surplus between the players depends on bargaining power. Academic studies utilize bargaining power to select appropriate choice models for surplus allocation between players. Theoretical frameworks consider players' bargaining power to determine the optimal profit-maximizing split of the surplus. The profitability of the bargaining process is assessed based on the surplus distribution among players.



Note(s): ▨ represents the surplus received by the seller, while ▧ denotes the surplus received by the buyer

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Figure 3. Representation of surplus in the bargaining context

3.2 Bargaining power

The players (buyers or sellers) estimate each other's bargaining power. Bargaining power is the players' relative ability to influence the terms and price of the contract in their favor (Bacharach and Lawler, 1981; Martin, 1992). Higher bargaining power for a player indicates that she/he receives a higher share of the surplus than those with lower bargaining power. Hence, the bargaining power of the buyer/seller can be represented as

$$BP_B = \frac{S_B}{S_T} \quad (4)$$

$$BP_S = \frac{S_S}{S_T} \quad (5)$$

where BP_B and BP_S are the bargaining power of the buyer and seller, respectively. The buyer/seller would receive a higher share of the surplus with higher bargaining power. Studies suggest that the bargaining power of a player is primarily influenced by (1) the proposal she/he provides, (2) patience, (3) the player's past reputation, (4) the amount of information, (5) signaling and (6) the availability of outside options, as explained in the following.

Proposal power is the ability of a player to propose the terms of the contract and how to share the bargaining surplus between the players (Yildirim, 2007). When a player proposes the split of surplus, the counterplayer could either accept or reject the proposal. There is no benefit for the counterplayer by only rejecting the proposal; instead, she could increase her profitability by providing a counter-proposal that benefits her. Furthermore, a player with less urgency to accept the proposal has greater bargaining power. Kousser and Phillips (2009) suggest that a higher level of *patience* increases bargaining power. Studies (Abreu and Gul, 2000; Atakan and Ekmekci, 2014) also suggest that players with a higher market *reputation* generate a better return from the bargaining process as they would be less likely to agree to lesser bargaining terms. The player with greater *information* about the product, market and the counterplayer will get a better deal from the bargaining exercise (Roth and Murnighan, 1982; Chatterjee and Samuelson, 1983; Fudenberg *et al.*, 1987; Mailath and Postlewaite, 1990; Hite, 1998). For example, if a player has adequate information about the market condition, such as if it is going to be bullish or bearish in the future, she can negotiate better vis-à-vis a player with low market information. On the same note, if a player is aware that the counterplayer desperately needs to trade, she can get a better deal for herself. *Signaling* is the information that a player intentionally passes on to the counterplayer. A valuable signal will help the player to make an accurate judgment about the counterplayer and bargain efficiently (Farrell and Gibbons, 1989; Croson *et al.*, 2003). An *outside option* is the opportunity cost of the player for getting into a bargaining agreement; the player with more extensive outside options receives favorable prices during the bargaining exercise (Bulow, 1982; Muthoo, 1995; Compte and Jehiel, 2002).

Patience, reputation and signaling are intangible factors that are difficult to quantify as they are internal to the players empirically. Hence, this study concentrates on using (1) *the availability of outside options* and (2) the *amount of information,* which are tangible factors, to understand various bargaining models and their operationalization in a simplified manner [3].

Availability of Outside Options: If many buyers (sellers) are interested in buying (selling) the same product (asset or service), there is a high demand (supply) for the product, generating higher outside options for the sellers (buyers) in case of bargaining failure. Hence, with a large number of market players, the product's liquidity is higher, and the player would have higher bargaining power.

Amount of Information: Having less information about the product to buy/sell, market or counterplayer can generate uncertainty in the trade, resulting in inefficient trade prices, reduced profitability and bargaining failure under extreme conditions. Under those circumstances, if the player bargains for a higher surplus, she might encounter bargaining failure, and if she agrees to a lower surplus, she might have to give up the opportunity to maximize her profitability. Hence, usually players adopt a marginal risk–marginal return tradeoff strategy to improve their bargaining surplus without bargaining failure.

These two parameters can generate four scenarios to split the surplus between the players, as presented in Figure 4. The x-axis represents the number of players, and the y-axis represents the information available. If there is a high amount of information available but fewer market players, it is denoted as a base model, while having a relatively large number of market players can be considered a *model with outside options*. Contrary to the high amount of market information, if there is low information, a *model with incomplete information* or a *model with incomplete information and an outside option* can be developed, corresponding to a small and large number of market players, respectively. The details of the models under various scenarios for splitting the surplus between the players are presented in Section 3.3.

3.3 Impact of bargaining power on surplus estimation and allocation

The four scenarios considered for the bargaining power determine the surplus allocation between the buyer and seller and subsequently estimate the transaction price efficiently as follows:

High information with a small number of players: This is the simplest form of the bargaining model where each player involved in the trade has a high amount of information about the market and counterplayer, while there are a lower number of market players or competitors. In this bargaining setting, a player proposes the surplus split with the counterplayer, who can either accept the proposal or provide a counter-proposal. This chain of proposals and counter-proposals continues until both the players agree on the outcome. However, the delays in the bargaining process lower the actual payoffs for both players due to discounted cash flows. The players can avoid this delay by splitting the surplus using Rubinstein's (1982) model, calculating the surplus split instantaneously considering their respective discount factors. Hence, Rubinstein's (1982) bargaining model (hereby denoted as

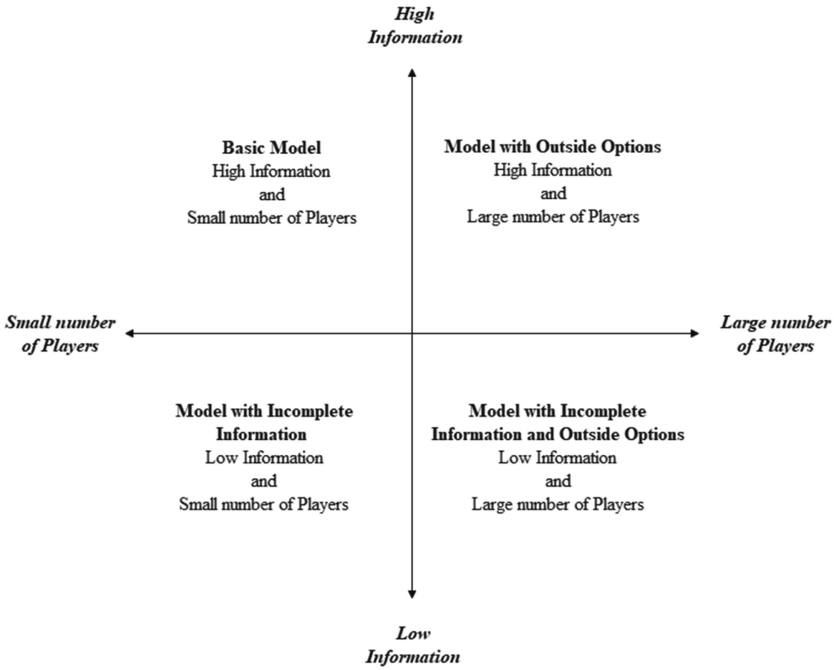

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Figure 4.
Types of price bargaining models

the *basic model*) is sufficient to estimate the split of the surplus between the players instead of indulging in a continuous back-and-forth negotiation (see Figure 5).

In a simple Rubinstein (1982) bargaining game setup, Player 1 (who could be either buyer or seller) can propose to split the surplus between herself and the counterplayer at a ratio of $\frac{1-\delta_2}{1-\delta_1\delta_2}$ and $1-\frac{1-\delta_2}{1-\delta_1\delta_2}$ as presented in Figure 5, where δ_1 and δ_2 denote the discount factor of the players. The loss in bargaining surplus due to the delay in the bargaining process for a Player i is captured in δ_i. Therefore,

$$\delta_i = \frac{\textit{Surplus of Player i at time t}}{\textit{Surplus of Player i at time } t+1} \tag{6}$$

Intuitively, a higher discounting factor represents a higher bargaining power of a player and gets a greater reward as he/she has less urgency to finalize the deal. Hence, if a player's discount factor increases, the surplus share for the counterplayer decreases.

High information with a large number of players: Along with the availability of adequate information, if there exists a large number of counterplayers, the bargaining power of the player can be greater as the player would expect to receive at least certain payoffs from the outside option in case the ongoing bargaining fails (Ponsati and Sákovics, 1998; Mantin *et al.*, 2014; Roson and Hubert, 2015). Hence, the player can combine a Rubinstein (1982) bargaining model with an outside option strategy to estimate the split of surplus between the negotiating players, as presented in Figure 6.

Low information with a small number of players: It can be challenging for the player when there are fewer counterplayers, indicating limited or no outside options in case of bargaining failure, and the player has incomplete information about the market and also about the

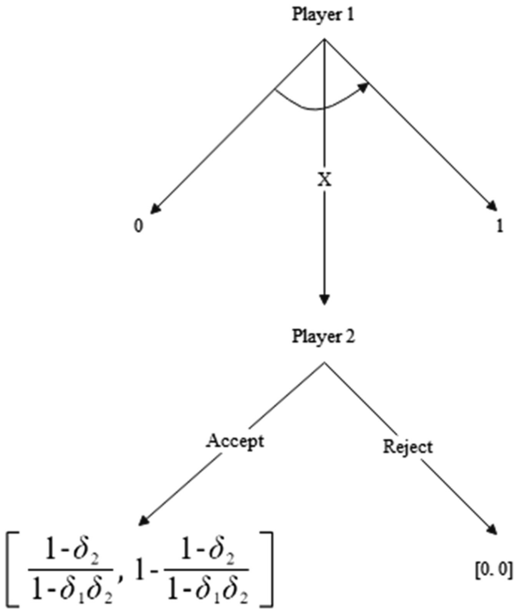

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Figure 5.
Game tree for Rubinstein bargaining model

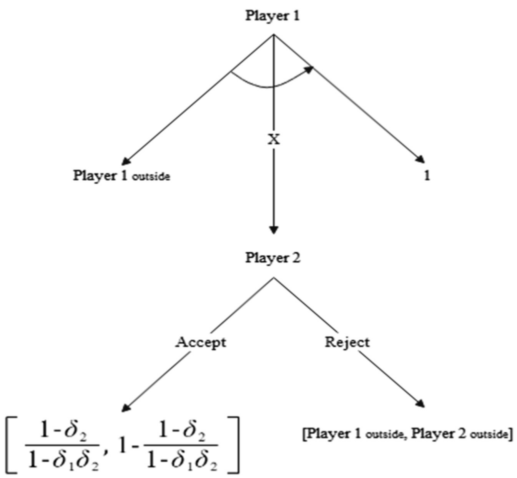

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Figure 6.
Game tree for Rubinstein bargaining model with outside options

counterplayer (Riddell, 1981). Under this scenario, the player can utilize a basic bargaining model with incomplete information similar to Rubinstein (1985) for sharing the surplus with the counterplayer by using a marginal risk–marginal return strategy to maximize her surplus without causing bargaining failure.

Low information with a large number of players: The integration of incomplete information and outside options amplifies the complexity of the bargaining process. Fudenberg *et al.* (1987) develop an outside option bargaining strategy on Rubinstein's (1985) bargaining model with incomplete information, allowing the players to compare the payoffs of the ongoing bargaining process with the outside options. Looking for outside options under this scenario could have a search cost (Chatterjee and Lee, 1998). Hence, while bargaining for the share of surplus involving uncertainty and outside options, the players should keep the following in mind: (1) if the cost of rejection is high, the player should demand a lower share of the surplus, (2) the marginal return of added surplus should be greater than the marginal risk of rejection to demand a higher surplus share and (3) if the outside option is not profitable, the share of the surplus should be lower.

4. Framework for price bargaining in shipping: a future research avenue

Despite the unique characteristics of the shipping industry, it shares some commonalities with other industries. The fluctuations in the asset prices in the shipping markets resemble those in the real estate markets (Greenwood and Hanson, 2015). Both industries experience cyclicality due to lead-lag relationships between new orders and the physical deliveries of the assets. Harding *et al.* (2003), Novy-Marx (2009) and Agarwal *et al.* (2019) have employed bargaining theory to empirically analyze the bargaining power of the players in the real estate industry. Furthermore, the shipping freight market can be compared to the labor, supply chain and healthcare industries as the terms of the services can be customized. Cahuc *et al.* (2006) and Kumbhakar and Parmeter (2009) examined wages and causes of bargaining failure in the labor market. Wu *et al.* (2009) and Leider and Lovejoy (2016) explored the role of information in pricing within the supply chain management literature. Brooks *et al.* (1997) investigated factors influencing insurance prices during negotiations between hospitals and health insurers. However, the utilization of bargaining from a game theoretical approach for pricing assets and services in the shipping industry is limited compared to real estate, labor economics, supply chain and healthcare studies. The authors only found an article by Chen *et al.* (2016) proposing a bargaining model for estimating optimal freight rates in the container sector of the shipping industry.

Given the similarities between the shipping industry and other sectors, exploring the concept of bargaining offers a fresh perspective to analyze the pricing of individual transactions in the shipping literature. The forthcoming section presents specific insights into potential areas of research for pricing shipping assets and services using the bargaining framework.

4.1 Setting the scene: applicable areas in shipping

The shipping industry encompasses four key markets, as identified by Stopford (2008): (1) the newbuilding market for constructing new ships, (2) the S&P market for trading secondhand vessels, (3) the recycling market for selling scrap vessels and (4) the freight market for buying and selling freight services. We categorize these four markets into asset and service markets to explore the potential application of bargaining theory as a future research direction in the shipping industry.

The *asset market* encompasses the trade of ships as assets, which includes the newbuilding, S&P and recycling markets. Among these, the S&P market is particularly intriguing for studying one-on-one trades due to its higher transaction volume compared to the newbuilding and recycling markets. Additionally, the newbuilding and recycling markets can be considered close to oligopolistic due to the limited number of shipyards for building and recycling ships compared to their counterplayers (Garino and Martin, 2000). Due to the notable prevalence of market participants in the S&P markets, using price bargaining models to investigate the factors that impact trade prices can considerably enhance bargaining efficiency. Consequently, this paper concentrates on price bargaining within the S&P markets.

The *service market* pertains to the freight market involving the buying and selling of transportation as services. This market encompasses the spot and time charter markets. The international shipping industry consists of three primary sectors, as outlined by Stopford (2008): (1) dry bulk shipping, which entails the carriage of dry commodities in bulk form, (2) tanker shipping, which involves the transportation of liquid cargoes, and (3) container shipping, which focuses on the transportation of standardized container units carrying manufactured goods. Combining these three major shipping sectors with the two shipping markets (S&P and freight markets) makes it possible to delineate six distinct sub-markets. Figure 7 serves as an illustrative depiction of the potential areas within the shipping industry where price bargaining models can be employed.

Overall, the concept of bargaining could have wide-ranging applications within the shipping industry. This study seeks to engage the maritime academic society in examining the pricing of individual freight services and ship values from a bargaining standpoint. An initial step for researchers is to assess the relative bargaining power between buyers and sellers. Researchers should employ an operational approach integrating game theory and economic models to analyze bargaining dynamics. The subsequent section of the research paper outlines a framework for implementing these bargaining models, enabling researchers to understand the interactive dynamics between participants within these specific shipping markets.

4.2 Freight service pricing

OTC negotiations between ship operators and charterers determine freight rates in the shipping industry. Ship operators provide maritime transportation services to charterers in exchange for a service fee. Freight contracts are mainly of two [4] types: (1) spot/voyage charter contracts providing transportation services for a single voyage and (2) short- or long-term time charter contracts, which span a specific duration. Market information is more observed in the spot charter contracts than in a time charter contract (Kavussanos and Alizadeh-M, 2001), making it relevant to observe the two types of charter agreements separately. Using Clarkson's SIN data, Figure 8 provides insights into the choice of bargaining models for the dry bulk and tanker spot freight markets. The standard deviation and number of transactions are used as proxies for the amount of information and number of

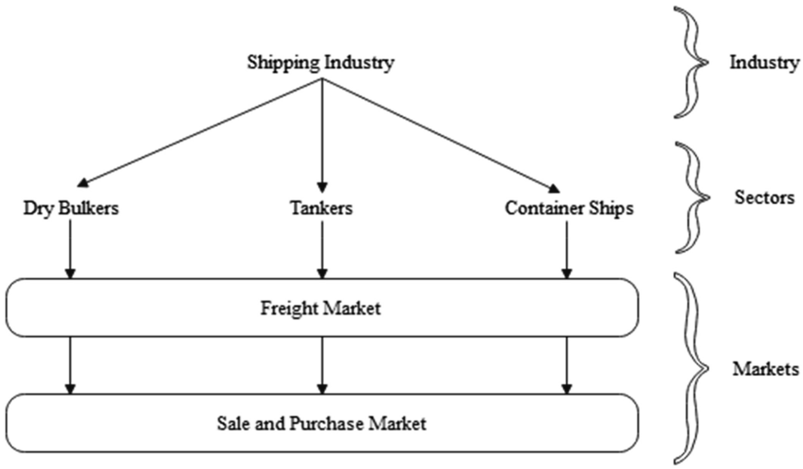

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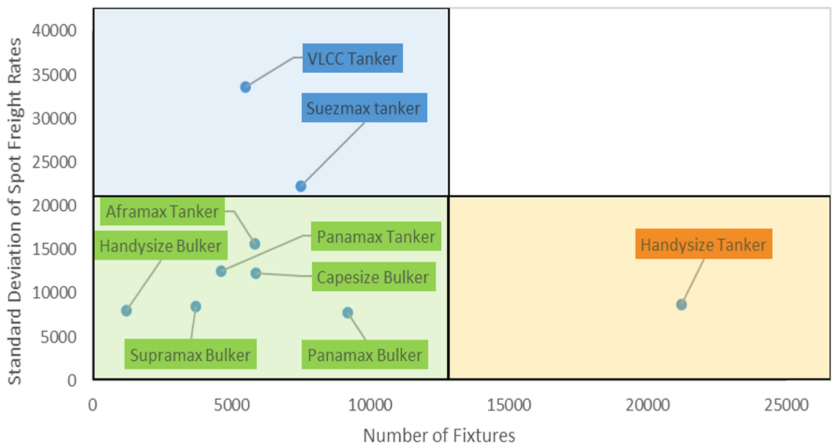
Figure 7.
Shipping markets for individual trade bargaining

players in the market. Hence, Figure 8 serves as an operational representation of Figure 4, with the freight rate's standard deviation on the Y-axis representing the level of information and the number of fixtures on the X-axis denoting the number of players. While the absolute number of players and information availability may vary across sub-sectors, this figure offers a broader understanding of the choice of bargaining models.

For example, the dry bulk freight rates have a high amount of market information with fewer market players than the tanker freight market due to lower uncertainties and a reduced number of transactions. Hence, the basic Rubinstein (1982) bargaining model can be employed to estimate freight prices. However, tanker freight fixtures would require the usage of different bargaining models. Larger tankers such as VLCC and Supramax vessels have relatively higher freight rate standard deviations requiring a bargaining model with incomplete information, such as Rubinstein's (1985) model for freight pricing, while Handysize and Panamax tankers would need to employ Rubinstein's (1982) model with and without outside options, respectively.

Though Figure 8 focuses on price bargaining solely within the spot freight market, the application can also be extended to the time charter freight market. This raises the opportunity for researchers to explore the information availability and outside options within each freight market to determine the appropriate bargaining model. For example, when investigating freight prices in the coal trade within Asia, the freight rates for Panamax and



Note(s): 1. The number of freight fixtures for the data set between January 2018 and November 2021 is presented in the X-axis. The number of sales of the ships is regarded as proportional to the number of market players

2. The standard deviation of spot freight rates is presented in the Y-axis. The higher degree of standard deviation represents higher uncertainties, hence denoting a lower amount of market information (Appendix 1 presents the table of the standard deviation of the spot freight prices and number of fixtures for each vessel type in a tabular format from which this figure is generated)

3. The vessels are clustered and highlighted as per the suitable fitting bargaining mechanisms as follows:
   - (green) Basic Rubinstein (1982) bargaining model
   - (orange) Basic Rubinstein (1982) bargaining model with outside options
   - (blue) Bargaining Model with incomplete information

4. The choice of bargaining model estimated for various vessel types could change with the change of sample period

Source(s): Calculated from Clarkson's SIN Database

Figure 8. Choice of price bargaining in the spot freight market

Supramax dry bulk vessels could be examined together, considering their shared services. Researchers can combine markets with similar characteristics in terms of assets and services to assess the influence of player interaction on the resulting prices. Since the primary purpose of this section is to highlight that there are multiple unexplored areas and emphasize the importance of bargaining in price determination in the S&P and freight markets, this study could provide a potential unexplored but vital research direction in the shipping industry which could improve market efficiency and bridge the gap between theory and practice.

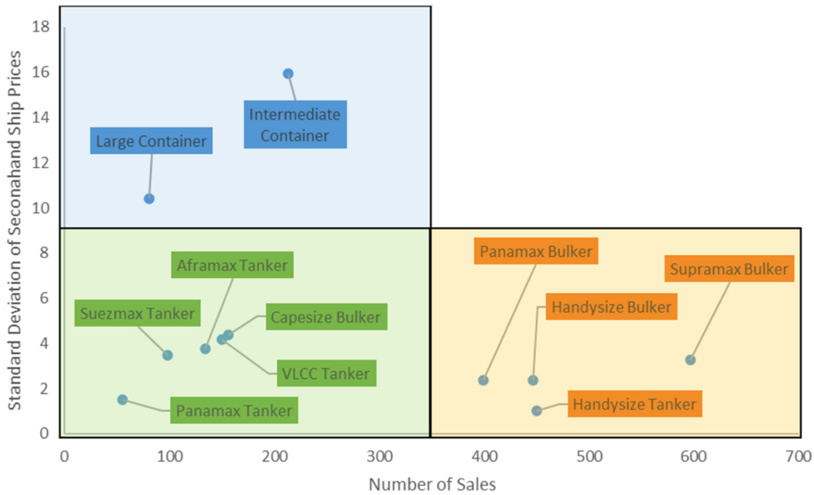
4.3 Secondhand asset pricing

The S&P market in shipping exhibits limited liquidity compared to other sectors like commodities, equities and foreign exchanges, with fewer buyers and sellers (Panayides *et al.*, 2013; Kuester Simic *et al.*, 2016). It is important to note that price uncertainties and risks of ships differ depending on their size (Kavussanos, 1996; Kavussanos and Alizadeh, 2002). Larger vessels face technical constraints and reduced mobility across seaports, resulting in higher price volatility. Conversely, smaller vessels have more market players, making the market relatively more liquid than larger ships. Additionally, the shipping is derived from the demand of the commodity market (Friedlaender and Spady, 1980), with the types of commodities transported varying based on ship size (e.g. larger dry bulk vessels predominantly carry iron ore and coal, while smaller bulk vessels transport agricultural commodities). Consequently, the market characteristics also change in accordance with ship size as individual ships' unique technical specifications restrict their trade among market players.

Thus, the choice of bargaining models for splitting the surplus between the players can vary depending on the ship size and sectors, considering differences in available information and the number of market players. Rather than focusing solely on secondary asset prices for the three major shipping sectors (bulker, tanker and container ship), this article proposes further categorization based on ship size. As a result, bargaining models for pricing assets in the S&P market can be applied to four dry bulk sub-sectors, five tanker sub-sectors and two container sub-sectors [5]. Extending the discussion in Figures 4 and 9 presents the choice of price bargaining model for the shipping S&P market. This paper utilizes the actual transaction data from Clarkson's SIN between January 2018 and August 2021 to calculate the amount of information and number of players in the market for each sector and size to estimate the choice of the bargaining models, as presented in Figure 9.

As presented in Figure 9, larger bulk carriers and oil tankers such as Capesize bulker, VLCC, Suezmax, Aframax and Panamax tankers have low sales numbers and low standard deviation, indicating that there exist a small number of market players and a high amount of market information. Thus, a basic Rubinstein (1982) bargaining model would be sufficient to compute the asset price. Contrary to larger vessels, small- to medium-sized dry bulk and tankers such as Handysize, Supramax, Panamax bulkers and Handysize tankers have a relatively higher number of sales and lower standard deviation; hence, a basic Rubinstein (1982) model with an outside option strategy would be required for efficient pricing. For example, between 2019 and 2021, there are only 160 sales of VLCC tankers involving 69 sellers and 68 buyers, while 466 sales of smaller Handysize tankers are recorded between 218 sellers and 155 buyers. There are limited trades for the larger vessels, so the outside option in the S&P market is non-existent compared to the smaller vessels. Unlike bulkers and tankers, container ships have a high standard deviation and few players. Therefore, a bargaining model with incomplete information would better estimate the asset price in line with the Rubinstein (1982) model.

Around 1,000 vessels (including bulkers, tankers and container ships) are sold in the S&P market annually with a cumulative market value of over US$17bn (computed from Clarkson's SIN). Even though the annual volume of transactions in the S&P market is low, the value of



Note(s): 1. The number of sales of vessels for the data set between January 2018 and August 2021 is presented in the X-axis. The number of sales of the ships is regarded as proportional to the number of market players

2. The standard deviation of secondhand ship prices is presented in the Y-axis. The higher degree of standard deviation represents higher uncertainties, hence denoting a lower amount of market information (Appendix 2 presents the table of the standard deviation of the secondhand ship prices and number of sales for each vessel type in a tabular format from which this figure is generated)

3. The vessels are clustered and highlighted as per the suitable fitting bargaining mechanisms as follows:

Basic Rubinstein (1982) bargaining model

Basic Rubinstein (1982) bargaining model with outside options

Bargaining Model with Incomplete Information

4. The choice of bargaining model estimated for various vessel types could change with the change of sample period

Source(s): Calculated from Clarkson's SIN Database

Figure 9. Choice of price bargaining model in the sale and purchase market

transactions is high due to the capital-intensive shipping assets. Hence, a price bargaining mechanism could be attributed to efficient asset pricing, which can have a larger impact on the high-value S&P shipping market.

4.4 An exemplar case

This section provides a simple case study for an easier understanding of the application of the bargaining model in pricing freight services. Let us consider a simple situation where a charterer and a ship operator want to trade for shipping iron ore from Brazil to China using a Capesize bulk carrier and are interested in determining an acceptable range of freight rates in a spot market. As the spot freight market for the Capesize bulker has fewer players and lower uncertainties, from Figure 8, a simple Rubinstein (1982) bargaining model can be used to estimate the individual freight price. However, the players need to calculate the bargaining surplus and their discount factors for the calculation.

Bargaining surplus calculation: In this voyage charter example, the charterer has two options: (1) to buy iron ore at CIF (cost insurance and freight) price, where the shipper takes care of the transportation-related costs and delivers the cargo in China, or (2) to buy the iron ore at FOB (free on board) price, where the charterer has to hire a ship and pay the transportation-related costs to ship the cargo to China. If the charterer opts for the latter option, rationally, she would be willing to pay a maximum of the difference between the iron ore CIF in China and the iron ore FOB price in Brazil as the freight rates. From the seller's perspective, the ship operator would be willing to accept zero in an extreme situation where the ship operator has no outside options. Hence, the bargaining surplus can be calculated as follows:

$$S_b = P_d^{CIF} - P_l^{FOB} - 0 \tag{7}$$

where S_b is the bargaining surplus, while P_d^{CIF} is the CIF price of iron ore in the discharge country, China, and P_l^{FOB} is the FOB price of iron ore in the load country, Brazil. So, the charterer's surplus and ship operator's surplus from the freight fixtures can be calculated as follows:

$$S_c = S_b - FR_{vc} \tag{8}$$

$$S_{so} = FR_{vc} \tag{9}$$

where S_c and S_{so} represent the charterer's and ship operator's surplus, respectively, and FR_{vc} denotes the voyage charter freight rates. The share of surplus between the charterer and the ship operator can be calculated as $\frac{S_c}{S_b}$ and $\frac{S_{so}}{S_b}$, respectively.

Discount factor calculation: While estimating the bargaining surplus is a relatively straightforward task, calculating the discount factor requires a deeper understanding of game theory. In this context, the charterer aims to determine the minimum freight rate that she can propose, which would be deemed acceptable to the specific ship operator. The discount factor is directly proportional to the bargaining power, whereby a lower discount factor corresponds to a lower share of the surplus for the player. Consequently, the charterer can examine the transaction history of the ship operator to gain insights into their minimum acceptable discount factor. The surplus of players are $\frac{1-\delta_2}{1-\delta_1\delta_2}$ and $1 - \frac{1-\delta_2}{1-\delta_1\delta_2}$ by Rubinstein (1982). As the charterer proposes the split of surplus, she would be Player 1, and the ship operator would take the role of Player 2. The surplus that the particular ship operator had given to any charterer is

$$\frac{S_c}{S_b} = \frac{1-\delta_2}{1-\delta_1\delta_2} \tag{10}$$

If the discount factors for the players are constant, the discount factor of the charterer (δ_1) that corresponds to the minimum acceptable discount factor (δ_2) for the ship operator is zero (proven in the conclusion of Rubinstein (1982)). Hence, the minimum acceptable discount factor for the ship operator is

$$\delta_2 = 1 - \frac{S_c}{S_b}, \textit{when } \delta_1 = 0 \tag{11}$$

Substituting Eq (7) and Eq (8) in Eq (11):

$$\delta_2 = \frac{FR_{vc}}{P_d^{CIF} - P_l^{FOB}} \tag{12}$$

A simple ordinary least square (OLS) regression in δ_2 (minimum discount factor acceptable for the ship operator) is estimated from Eq (12) on various shipping markets, contracts and vessel-specific factors to evaluate the current minimum discount factor of the ship operator. This will help to estimate the minimum acceptable freight rate from the ship operator's perspective. Similarly, the minimum acceptable discount factor for the charterer can be calculated. This will generate the maximum acceptable freight rate from the charterer's perspective. Combining the minimum and maximum acceptable prices for the ship operator and charterer, the researchers can safely evaluate an agreeable price range for future freight fixture transactions between the players.

Hence, this concept of price bargaining can be operationalized to estimate the price range that the ship operator and charterer expect for a particular freight contract. Generalizing this idea, any buyer or seller can employ the bargaining concept in the shipping S&P as well as the freight market to estimate the range of prices which is acceptable for the counter player and thereby (1) increase the bargaining efficiency without indulging in a time-consuming back and forth negotiation and (2) trade profitability by getting a higher surplus for herself.

5. Concluding remarks

This study examines pricing practices in the shipping industry from a bargaining perspective. Buyers and sellers interact in the freight and S&P markets to create customized and heterogeneous contracts. The bargaining concept can help identify factors affecting trade prices. The discussed bargaining model uncovers a seemingly perfect pandora's box for price determination and fixing mechanisms in shipping markets. Applying bargaining studies benefits ship owners, operators and charterers by enhancing transaction pricing and profitability. Mainstream economics and management studies focus on theoretical development, but empirical applications of bargaining theory remain unexplored. This article identifies potential areas for future studies to test bargaining theory in pricing freight services and secondhand vessel prices, contributing to the theory-testing approach of bargaining. The goal is to encourage academic and professional researchers in the shipping industry to consider the bargaining-based framework for pricing assets and services. This approach helps understand complex business transactions, identify factors and contribute to theory-building in the long term.

Notes

1. Calculated from the International Chamber of Shipping and UNCTAD Report for the year 2020.
2. The bargaining theory can be broadly divided into two approached: strategic approach following the study by Rubinstein (1982) and logical axiomatic approach following Nash (1950). The axiomatic bargaining solution by Nash (1950) is generally referred as Nash Bargaining Solution, which is generalized by Binmore *et al.* (1986) and equated to the strategic approach when the bargaining time is close to zero. As the axiomatic and strategic approach of bargaining somewhat converges by limiting the time factor, we prefer to scope our study to the strategic approach of bargaining.
3. The authors acknowledge that there are other ways of categorizing bargaining models, such as (i) static and dynamic bargaining models and (ii) bilateral and group bargaining; however, in the shipping context, the number of players and amount of information available would be a relevant form of classification to most shipping transactions.
4. The freight contracts are classified into two types for simplicity. All other forms of contracts, say the bareboat contract or the contract of affreightment, can be categorized under time charter or voyage charter contract.
5. Using the classification of sub-sectors of ships as per Clarkson's SIN, the bulkers are categorized into four sub-sectors as follows: (i) Capesize bulker (≥100,000 DWT), (ii) Panamax bulker (100,000 > and ≥70,000 DWT), (iii) Handymax bulker (70,000 > and ≥40,000 DWT) and (iv) Handysize bulker (40,000 > and ≥10,000 DWT), while tankers are categorized into five sub-sectors as (i) Very large crude carrier – VLCC tanker (≥200,000 DWT), Suezmax tanker (200,000 > and ≥125,000 DWT), (ii) Aframax tanker (125,000 > and ≥85,000 DWT), (iii) Panamax tanker (85,000 > and ≥55,000 DWT) and (iv) Handysize tanker (55,000 > and ≥10,000 DWT) and container ships are sub-categorized as (i) large container (≥8,000 TEU) and intermediate container (8,000 > and ≥3,000 TEU).

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Appendix 1

Sr. No.	Types of vessels	Number of fixtures	Standard deviation
1	Capesize bulker	5,897	12,362.54
2	Panamax bulker	9,215	7,765.94
3	Handymax bulker	3,722	8,457.42
4	Handysize bulker	1,212	8,043.30
5	VLCC tanker	5,534	33,643.61
6	Suezmax tanker	7,522	22,222.28
7	Aframax tanker	5,843	15,699.37
8	Panamax tanker	4,653	12,513.85
9	Handysize tanker	21,207	8,715.67

Table A1. Standard deviation of spot freight prices vs number of fixtures

Appendix 2

Sr. No.	Types of vessels	Number of sales	Standard deviation
1	Capesize bulker	156	4.37
2	Panamax bulker	399	2.37
3	Handymax bulker	597	3.27
4	Handysize bulker	447	2.39
5	VLCC tanker	150	4.19
6	Suezmax tanker	98	3.49
7	Aframax tanker	134	3.79
8	Panamax tanker	55	1.51
9	Handysize tanker	450	1.01
10	Large container ships	81	10.40
11	Intermediate container ships	213	15.95

Table A2. Standard deviation of sale and purchase ship prices vs number of sales

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