The Limits of Coase:

A Study of Financial Distress in the Shipping Industry*

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Abstract

A generally accepted view is that sophisticated bankruptcy procedures are required to mitigate coordination failures and fire sale discounts arising from financial distress. In this paper, we provide empirical evidence addressing this issue using the shipping industry, where the resolution of distress is largely distanced from sovereign bankruptcy procedures. We find that significant institutional and contractual innovations have strengthened the rights of creditors thereby reducing the direct cost of financial distress, for example by lowering coordination failures and reducing fire sale discounts. However, those innovations may have come at a cost to other stakeholders, including crew, port authorities, and the environment, leading to oil spills and the abandonment of under-maintained low valued ships.

"*There is only one law in shipping: there is no law in shipping*".

Sammy Ofer (shipping magnate)

1 Introduction

In a somewhat contentious article, Stigler (1989) describes the Coase 'Theorem': "when it is to the benefit of people to reach an agreement, they will seek to reach it." To the question "does the proposition require proof" he answers "one would think not." He later concedes that "[this] cannot be the entire story" since "there are people who do not care for wealth, more who do not reason well, and vastly more who are incompletely informed, though it is unlikely that such people govern important markets." Corporate bankruptcy provides an important laboratory to test Stigler's proposition. A conventional view, put forward by Jackson (1986), is that bankruptcy, by its very nature, raises a common pool problem. As a result, creditors runs destroy companies' value through under investment and premature asset sales. These problems are exacerbated by insufficient market liquidity, so that forced sales of assets are not fairly priced. Shleifer and Vishny (1992) make the connection to bankruptcy law: "assets in liquidation fetch prices below value in best use ...Hence, automatic auctions..., without the possibility of Chapter 11 protection, is not theoretically sound."

In this paper, we provide empirical evidence addressing these issues using data from the shipping industry where the resolution of financial distress is largely distanced from sovereign bankruptcy procedures such as the US Chapter 11. The fact that ships operate across different jurisdictions, or on the high seas outside any jurisdiction, has loosened (although not completely eliminated) the grip of national bankruptcy laws. Advocates of legal activism might expect to find an industry plagued by coordination failures, costly seizure of assets and liquidations at large fire sale prices. In contrast, Stigler would expect private institutions to evolve so as to resolve private disputes and limit the deviations from Coase.

The focus of our paper is on the potential costs of financial distress. First, the financially distressed vessel owner as the residual claimant would find that once its equity stake is depleted, so is its incentive to retain ownership. A testable implication of the Coase Theorem is that upon default the transfer of title is 'voluntary', that is, without the explicit intervention of a law-enforcement agency the creditor can 'buy' the owner's cooperation. Failing cooperation, a coercive transfer of title would take place, requiring direct legal costs and, more significantly, a loss of charter income. In this event, a creditor has the right to arrest a vessel in a port, that involves the vessel's "colours being [literally] nailed to the mast". While

some ports are inefficient and corrupt, there are a significant number that are not, and they compete on the basis of the efficiency of the repossession process.[1] We report the incidence of arrest and the trigger, measure its length and demonstrate that such breakdowns of the Coase theorem are relatively few, and take place at the low end of the value distribution.

Second, any practical interpretation of the Coase Theorem has to accept that incomplete information imposes a constraint on the arrangements that can be reached to the mutual benefit of the parties. Market frictions will inevitably prohibit some arrangements which would be feasible in a first-best world. One friction for example, is the forced sale of vessels by financially constrained firms. A second is the quality impairment of a vessel caused by its under-maintenance while its operator is in distress. We interpret under-maintenance as an example of Myers (1977) under investment problem, where a distressed operator chooses to under-maintain, knowing that some of the cost might fall on the uninformed creditors.[2]

In the absence of strong connections with onshore bankruptcy procedures, the rights of owners, creditors and other contractual parties have been (partially) protected by institutional and contractual innovations. For example, the registration of the vessel is often made in flag-states, like the Marshall Islands, that compete with one other by offering a register of ownership and liens that protect the integrity of the parties' contractual rights. It is a common practice in the shipping industry to register (or flag) vessels outside the jurisdiction of the beneficial owner, and about 73% of the world's fleet by tonnage being so flagged. However, some flag states have been criticised for inadequate protection and regulation of other stakeholders including the crew and the environment, often resulting from under maintained vessels, an issue we take up in this paper.

Another innovation, is the formation of holding companies for shipping groups, where each vessel (or a group of vessels) is owned by a different subsidiary of the holding company, so that default on one vessel does not entitle the creditor to seize another vessel in a different subsidiary. In our sample, the average number of subsidiaries increases with the size of the fleet, reflected in the fact that 86% of the subsidiaries hold only one vessel. An advantage of this organizational form of ownership, is that it reduces the risk of co-ordination failures since creditors of a single vessel are relatively less dispersed than for the group as a whole (Bolton and Scharfstein (1996), Gertner and Scharfstein (1991)).

Separate subsidiaries has also enabled another innovation, referred to as the 'double mortgage,' which permits the lender, in the event of default, to take in addition to a mortgage on the physical vessel, control

[1]The Gibraltar Maritime Authority on its website describes itself as: "Widely recognized for its speed and efficiency in handling ship arrests, Gibraltar provides shipowners and mortgagors with a tried and tested maritime legal system based on English law conducted in English."

[2]Such occurrences are not always evidence of a breakdown of the Coase Theorem, if third parties would find that they are constrained by similar information problems.

rights on the shares of the subsidiary owning the vessel. This allows the lender to sell the control rights (shares) in the event of default, without disrupting the operations of the ship, thereby, reducing the costs of distress. We describe the mechanism in greater detail using the Eastwind case, a large U.S. operator that became distressed and formally entered U.S. bankruptcy procedures in 2009. Its main lender held a double mortgage on 13 of the company's vessels and when default occurred, ownership of the shares in the companies holding the vessels were transferred to the lender, prior to bankruptcy , without the need to arrest the vessels in port. On gaining ownership rights the lender was able to immediately sell the ships to another operator to repay the debt outstanding.

Our data include the ownership details on 100,000 vessels in the world shipping fleet from 1995 to 2020, and in particular the sales of 2,000 vessels made when the shipping company was distressed, either inside or outside bankruptcy. We also identify separately the sale of 100 financially distressed vessels which were made after the arrest of the vessel, where triggered by outstanding debts. The arrests are frequently costly to the vessel's operator since they add to the operating costs as well as imposing delays to the owners of the cargo; this is clearly a violation of Coase.

The dataset also contains a significant sample of 681 vessels that have been abandoned by their owner. Abandonment often occurs after the vessel has been arrested when the owner has little or no equity in the vessel's residual value. It may also impose costs on both related and unrelated parties. For example, it often leaves the crew with large unpaid wages and no means of sustenance in a foreign port. They must await the sale of the ship and the proceeds of realisation to stand any chance of repayment and repatriation to their home port, such delays often span several years. In about 85% of abandonment cases, the absence of sufficient residual value, meant that the vessel had to be towed at the port's expense to a breaker's yard.

Abandonments can impose costs on other stakeholders, as illustrated by the recent explosion caused by the *Rhosus* vessel abandoned in the port of Beirut, which resulted in both loss of life and enormous damage to the city. Under maintenance of vessels, so often preceding abandonment, can impose a cost on the environment, by increasing the probability of oil spills, particularly, when they are insufficiently insured. In our sample we find that a large number of oil spills are caused by low value, and under maintained vessels. Such problems often cannot be resolved by private agreements and call for interventions by public law-enforcement bodies. For example, the United States will not allow any vessel into its ports that cannot show in advance a proof of adequate insurance (i.e. the COFR certificate).

Finally, we measure the fire sale discount on vessels owned by distressed operators, where the vessel is either sold after a port arrest or voluntarily by the operator. Such vessels have an average value of

$7.9 million compared with the average value of ships of $10.9 million sold by non-distressed operators. We find that after controlling for vessel characteristics, such sales involve a large raw fire sale discount of about 23%, although about one half is accounted for by under-maintenance. The fire sale discount after adjusting for the lower quality of arrested vessels is around 11%. This is much lower than that documented in other asset markets, for example by Pulvino (1998, 1999) in aircraft, and in houses (see, Campbell et al. (2011)). We also find that other non-arrested vessels sold by financially distressed firms face similar quality adjusted discounts of 9%. Moreover, the quality adjusted fire sale discount is influenced by the institutional quality of the port of arrest: for vessels sold in low corruption ports the liquidity discount is only 8%, compared with 16% in high corruption ports.

Our paper documents how creditor rights have evolved in an industry which is largely unregulated by sovereign bankruptcy laws. Contractual innovations and jurisdictional competition, have largely had the effect of strengthening creditor rights, although at the expense of negative externalities. The analysis and evidence are relevant to the debate between those advocating competition between jurisdictions and those advocating harmonization. Romano (2002, 2005) has argued for competitive federalism in US securities regulation instead of a centralized SEC. LoPucki and Kalin (2001) have responded that competition between states is intended to minimize tax liabilities within Chapter 11 filings and has led to a race to the bottom. This debate between competition and harmonization extends to laws between different sovereign jurisdictions. The European Union has strongly supported harmonization, developing common standards in a wide range of financial activities including insolvency law and banking regulation.[3] We also see this debate in the more general context of the "spontaneous" generation of law and institutions through the decentralized interaction of traders within competitive markets: see Hayek (1979), Bernstein (1992) and Greif, Milgrom and Weingast (1994).

While the shipping industry provides an interesting laboratory to test the Coase theorem, because of the absence of sophisticated state bankruptcy procedures, the question remains, whether our results extend to other industries. There are several important features of the shipping industry that may contribute to an efficient resolution of distress without the aid of mandatory bankruptcy procedures: the fact that ships consist of discrete assets which allow them to be separated from each other for the purposes of limited liability and collateral, the fact that assets can be marketed to potential buyers around the world thereby increasing the liquidity of the market for second-hand ships, and that the intangible value of a ship may be relatively low compared with other assets. This will be a much more significant issue

[3]See for example, Regulation (EU) 2015/848 on insolvency law which came into law in 2017, and The Single Rulebook, a phrase coined by the European Council in 2009 which seeks to provide a single regulatory framework for the EU financial sector that would complete the single market in financial services.

for companies with significant intangible assets, like teams. While generalizing our findings to all other industries is beyond the scope of this paper, there are several industries that exhibit similar characteristics to shipping, such as real estate, airlines, oil and gas, and mining companies.[4]

The rest of the paper is organized as follows. In section 2 we discuss the institutional structure of the industry including how property rights are registered and enforced particularly in the case of an arrest of a ship. Section 3 tests whether coordination failures can explain vessel arrests and provides some evidence of the economic costs of arrest, immobilization and abandonment. Section 4 estimates the fire sale discount for arrested and auctioned vessels. In section 5, we explore the externalities imposed by the industry on other stakeholders, including crew, port authorities, and the environment. Section 6 concludes the paper.

2 Institutional Description

The shipping industry is responsible for 90% of global trade.[5] Until the 1970s, the industry was largely controlled by maritime states, and in the case of oil tankers was dominated by the oil majors. Now both have largely been replaced by independents, including Greek and Norwegian shipowners.[6] Couper (1999) has described the pre-1970s period as one "of relative stability and prosperity for shipowners... although since 1970s shipping has become more international but much less stable. There is now virtually unimpeded international mobility of capital and labor in the industry, few barriers to entry and a free choice to shippers of competing ships." Technological changes in ship building have had a dramatic impact on the size and cost of ships: oil tankers have increased in size almost ten times, from 28,000 DWT pre-1970s to 250,000 DWT (supertankers), and containerization has revolutionized cargo traffic. All this has resulted in huge capital investment in both ships and port facilities. At the same time crew size has been reduced from an average of 40-50 per vessel to 20-30, an important factor in an industry where the crew accounts for 40% of operating costs. During the same period the financing in the industry has radically changed. As recently as the 1950s it was largely equity financed, and in recent decades it has become highly levered and very dependent on bank finance, as we describe below.

[4] Congress has already recognised the value of limiting the intrusion of bankruptcy law into some of these industries by exempting them from an automatic stay, for example, aircraft under the Capetown Convention (Section 1110, 1994 Bankruptcy Act), and private-label mortgage collateral (2005, BAPCPA); see Lewis (2019). In addition, Section 363(b) of the US Bankruptcy Code allows a company to sell its assets outside the ordinary course of its business during Chapter 11 bankruptcy proceedings.

[5] See Ernst Frankel (1989), "Shipping and its role in economic development", 1989 Butterworth and Co Publishers. See also, UNCTAD Review of Maritime Transport Report (2017)

[6] "Greek shipping accounts for 20% of the world merchant shipping fleet" New York Times, May 27, 1997

In the rest of this section, we discuss the influence of legal jurisdictions and the enforcement of creditor rights through an arrest in port and through more innovative contractual procedures.

2.1 Ship Registration, Jurisdiction and Flags of Convenience

Ships must be registered in a jurisdiction; like the registration of a house, it confirms 'title' or ownership. However, while houses are usually registered in the jurisdiction of the owner, ships are not necessarily attached to any particular nation state, by virtue of the fact that they are for the most time on the high seas, outside any jurisdiction. Thus, the practice has emerged of registering the ownership of a ship outside the jurisdiction of the owner, and in places that are not necessarily near any maritime route; the places of registration are often known as flags of convenience. One such flag-state is The Marshall Islands, which has developed a highly efficient register of vessels despite it having less than 100,000 inhabitants and being far from any shipping route. In 2020, 73% of vessels by tonnage were registered with flags of convenience, outside the country of their beneficial ownership. Table 1 illustrates this dispersion in the country of vessel registration and its ownership. 3 of the world's largest flags - Panama, Marshall Islands and Liberia account for 44% of ship registrations, but only account for 0.3% of vessels' beneficial ownership (columns (2) and (4)). We also find that the top 6 countries dominating vessel ownership, own around 58% of vessel fleet by tonnage, but account for only 11% of the registered fleet.

The flag is important because owners and creditors do not wish the ownership to be tampered with. Since this threat of tampering is perceived as sufficiently important, the mortgage deed or loan will frequently specify a particular flag-state that is recognized for its efficiency and honesty. The mortgage and any other liens will be registered side by side with the registration of the ship. The public register of ownership and mortgage together protect the buyer against a fraudulent change of ownership, and lenders against any sale of the ship that does not recognize their financial interest.

The flag states, like The Marshall Islands, are the primary regulators of vessels flying their flags, and the flag states set out the conditions that ships must meet to retain their registration (for example, the insurance of ships, minimum safety conditions, environmental standards, and crew conditions). Some flag states specify low standards or more often tolerate sub-standard ships and poor conditions for the crew. The flexibility of flags also allows shipping firms to hire labor from international markets, whereas, the traditional places of registration like the UK restricted the employment of foreign nationals and

maintained minimum wages. This is important as the monthly wage of a Chief Officer from an emerging country is only $2000 compared with $7500 for western European officers.[7]

The uneven quality of regulation imposed by flag states, has led to efforts by UN agencies and state blocs like the EU, to prevent the dilution of safety standards or a race to the bottom.[8] International regulations by the UN and EU in theory permit the enforcement of these regulations when vessels enter the port-state of those countries which are signatories to the international rules. However, ships spend only a short time in port, and they have some discretion to choose ports with lax enforcement.

A consequence of jurisdictional choice is that a single ship may be subject to a multiplicity of jurisdictions that may affect enforcement of creditor rights, as well as the enforcement of other rules and regulations. The owner, with the agreement of the mortgage holder, may choose the flag, the port-state, and in the event of disputes between creditors and the owners, the place of arbitration e.g. Singapore or the Virgin Islands. International agreements, like the UN or EU provide a potential fourth jurisdiction.

In addition, there is significant competition between jurisdictions, particularly for those ports wishing to attract ships for refueling and maintenance, or flags wanting to attract the registration of ships. Owners of ships may 'flag hop,' although creditors may have incentives to prevent it. Port competition is important to creditors who, in the event of default or non-payment, may wish to have the ship arrested in a friendly port where it will be quickly seized, and then sold with the proceeds distributed to the creditors. This multiplicity of jurisdictions has the potential to produce a race to the bottom in the face of jurisdictional conflicts, and coordination failures resulting in creditors 'asset grabbing' and immobilizing the ships. Lenders might respond to these chaotic conditions by offering low levels of leverage or high interest rates.

2.2 Competition between Ports for Arrests and Enforcements of Creditors' Claims

Conditional on default, a creditor may instruct the port authorities to arrest a vessel and organize its sale to repay creditors. The choice of port of arrest will be influenced by the location of the vessel at the time of default. The task of locating a vessel and identifying the closest ports, is greatly facilitated by

[7] Although safety and conditions of service for the crew will be specified by the flag, there are other societies that certify the safety of ships like Lloyds and Bureau Veritas. These societies inspect the ships to ensure minimum standards of maintenance.

[8] For example, the convention on health and safety of the crew, ILO 147 (1981), has been ratified by only about half of the countries operating the world's fleet and even then surveyors of ships often do not have the time to review thoroughly the conditions of the ship, particularly those pertaining to the crew.

the development of GPS technology which allows every vessel to be tracked, and the data to be made public and continuously available.

To initiate an arrest, most port authorities will need to verify that the creditor has a valid contractual right to seize the vessel, execute a sale (if no settlement between debtor and creditor is reached) and distribute the proceeds among the creditors according to their priority. There are some material differences in procedures across ports. Some, for example, Gibraltar, place great stress on the speed of arrest and subsequent sale of the vessel. In their port handbook, they state "In general, these matter are addressed with a minimum of delay and inconvenience... Modern IT technology is used to speed the process of appraisal and sale once the court has made the relevant order. Particulars of an arrested ship can be made available online within days of a survey." In addition, Gibraltar allows a sale by private treaty where the creditor identifies a buyer and the sale is executed without a public auction, at a price that the Admiralty Court deems fair on the basis of expert opinion. A sale by private treaty can be resolved in a matter of days. Other ports, such those in the Netherlands, accept only a public (Dutch) auction. There are also important differences in the speed of implementing the procedure, with some ports being more sensitive to the costs imposed by the immobilization of the vessel. Other ports have proven corrupt and inefficient and are to be avoided by creditors where possible, eg Lagos in Nigeria.

Six countries stand out for the effectiveness of their arrest procedure: Gibraltar, Hong Kong, Singapore, South Africa, The Netherlands and the UK. As a result, there are more arrests, initiated by creditors, in these specialized ports, relative to the volume of trade. Using our data on 3,470 arrests, Table 2 shows that these six ports' share of the world's cargo trade is only 11%, while they have 34% share of arrest activity. In contrast, in some of the world's busiest ports, such as Japan, China or the USA, the arrest volume is small relative to the volume of trade, in part at least because their arrest and sale procedures are not conducive to a speedy resolution. Arrest specialized ports also provide relatively quicker resolutions, with typical arrest durations ranging from 2-4 months.

As described above, competition between ports is targeted at creditors who wish to seize their collateral. Over the period of our sample the average duration of arrest to resolution declines from roughly 250 days in 1995 to around 50 days in 2006.[9] The intensity of competition between ports is illustrated by the case of Rotterdam, which until recently, was willing to arrest ships without independent evidence of debts outstanding, and obliged the owner to sue the creditor for the costs in the event of wrongful arrest. This illustrates how competition between jurisdictions can 'over-tighten' creditor rights. As we show later, strong creditor rights may enhance the borrowing capacity of shipping firms, and thereby influence

[9]This decline in the duration of arrest over time is robust to controlling for the port of arrest, vessel type, and trigger for arrest. Results are available on request.

the way the industry is organized, in terms of both its size and ownership structure. Although higher borrowing capacity is valuable it might be offset by a more costly ownership structure, for example, one that is widely fragmented.

The sale of ships is facilitated by specialist dealers who have had long experience as shipping valuers and brokers. They disseminate information about the ship's quality and condition, the equivalent of housing survey reports, to would be buyers around the world.[10] Using a sample of hand collected data on UK shipping auctions, we found that the average number of bidders is 8, which is consistent with the view that the second-hand vessel market is a liquid one. In one auction, the number of bidders reached 23.

In principle, any creditor may arrest a ship, including the mortgage holder, the crew for non payment of wages, a ship's supplier (a bunker supplying fuel or a ship's 'chandler'), or a bank with an unsecured claim. An important difference between defaults in other industries, is that the arrest of a vessel immobilizes the asset, incurring direct costs and the indirect opportunity costs of lost business. In most other industries a creditor can lay a claim against a company but not stop its operations. One exception is airlines, where creditors can seize an aircraft in some jurisdictions.

2.3 Contractual Innovations and Organizational Form

Here, we describe the corporate organization of a typical shipping company, and important features concerning collateral and the seniority of particular creditors' claims.

A shipping operator is frequently organized as a holding company with multiple subsidiaries, each one owning a single vessel or a group of vessels. A creditor facing a debtor default may try and immobilize a ship through a port arrest and an auction of the ship. In the event the ships are sold by the arresting authority, they will advertise the sale and reach out to potential creditors before they distribute the proceeds. The distribution will be made according to the priority of the claims.

Table 3 describes organization of ownership structure in the shipping industry. Using data on detailed multi-level ownership, we aggregate vessels across all subsidiaries of a holding company (or firm). Table 3 is a snapshot of the industry at the end of 2020. There are about 5,000 shipping firms in the industry, and about a third of these firms own only 1 vessel. We partition the shipping firms on the basis of their fleet size, and find that the average number of subsidiaries (or silos) increases in lockstep with the increasing

[10] An example in the UK is CW Kellock who are internationally recognised ship valuers and auctioneers of ships. Founded in 1820, they have acted for the Admiralty Marshall of the Courts of Justice of England and Wales as brokers and valuers for more than 150 years. They have a worldwide data base of shipping sales going back more than 50 years.

size of the fleet. Thereby, the median number of vessels per subsidiary fluctuates around 1, irrespective of the size of the firms' fleet. This is further reflected in the fact that 86% of the subsidiaries hold only 1 vessel. Creating single vessel silos, ensures that the number of creditors on a single vessel is relatively less dispersed than for the group as a whole. It is also evident from Table 3 that bigger firms maintain a much younger fleet and operate larger size vessels. The average fleet size for the top 100 firms in the industry is 76,000 DWT, compared with the industry average fleet size of 28,000 DWT.

Where the debts are non-recourse, the creditors can only pursue claims against the particular company or subsidiary with the debts outstanding. In this case each ship, or sometimes a group of ships, will be held in a separate company with the shares of the company held by the group. It is likely that the ships will be financed with a mortgage secured on the physical vessels (known as a maritime mortgage). In that event a creditor of one company may not pursue a claim against ships in a different company in the group. In shipping, a significant proportion of the lending tends to be on a non-recourse basis using ship mortgages.

The holder of the mortgage, like any secured lender, has the most senior claim on the ship, with some important exceptions. Most state-ports like the UK have introduced a maritime lien, which has the effect of making the crew's claims for wages and other benefits senior to most other creditors, including the mortgage holders. The rationale for this seniority (for what is normally an unsecured claim in bankruptcy), is that while ships are on the high seas, the crew may desert the ship in the event of non payment of their wages. This might threaten the value of the vessel and the cargo, but also pose a risk of collision with other shipping. This may expose the owner (and in some circumstances the lender) to a lawsuit. In addition, the maritime lien in many states protects the cargo owners, since their claim is also made senior to the mortgage holder. In a survey report of maritime laws and policies across 18 major jurisdictions, Rutkowski (2014) reports that the pollution claims and damages are also a part of the maritime lien, and these claims have priority over ship mortgage holders and other secured/unsecured creditors. The maritime lien was a contractual innovation originally introduced by private contract, and subsequently standardised by statute in many countries.[11]

A second contractual innovation in shipping is the double mortgage. Assuming the ship is owned by a company which is financed on a non recourse basis, and the shares are held by the holding company, a lender with a mortgage on the physical vessel may also take collateral on the shares of the subsidiary that owns the particular vessel. Thus, the lender has both a mortgage on the physical vessel and on the shares of the company owning the same vessel; this is the basis of the 'double mortgage'. We describe in

[11] Refer to Teiniu (2013) and Hill (1998) for a historical background of maritime liens.

the Eastwind case study below how this double mortgage can, in the event of default, allow the lender to repossess a ship on the high seas. The double mortgage is executed by the lender, at the time the loan is agreed, and permits the lender to acquire the collateral of the shares and signed but undated letters of resignation of the owner's board of directors. When default occurs, the lender dates the letters of resignation and appoints its own board of directors, thereby acquiring ownership and control of the shares on the vessel from the borrower. The lender is then in a position to sell the vessels, discharge the mortgage without sailing it to a port and having it arrested. The result is that this procedure minimizes the costs associated with enforcing its collateral by seizing the ship in port. This is even more important if the nearest efficient port is some days sailing.[12]

The costs of arrest and auction include the direct costs of sale, the port fees and crew costs while in port prior to sale, or until the creditor discharges the debts by some other means. Most of these costs can be avoided by the exercise of the repossession rights on the high seas using the double mortgage. Also, because the sale of the ship can take place without the participation of the state-port, this will reduce not only direct transactions costs, but also reduce any potential fire sale costs associated with a sale undertaken by the port authorities, who may try for a speedy sale. Finally, if the ship is laden with cargo, seizing a ship in a port, other than that designated in the cargo contract, exposes the creditor to a lawsuit in the event of a delay in the delivery of the cargo and possible damage in transit.[13] As a result, it is a rule in shipping that a creditor should try and avoid an arrest when the vessel is laden with cargo. There are no such constraints on repossession on the high seas using the double mortgage.

2.4 Abandonment, breakup of vessels and oil spills

While contractual innovations have strengthened the rights of creditors, both secured and unsecured, they may have had unintended consequences for other stakeholders, including the crew, ports, and the environment. It is well documented that when owners have little or no equity in the vessel, they may abandon the vessel. At the same time the crew may also share the cost of abandonment through unpaid wages, and an absence of maintenance support while in port. If the creditors see some value in the abandoned vessel they will arrange for its sale. In that event, the proceeds of realization would first be used to repay the crew debts, and any port fees under the maritime lien. However, if the vessel is of sufficiently low value and creditors have no residual value in the vessel, the crew wages will not be paid,

[12] The port authorities will want to see evidence of default, usually provided by a lawyer for the shipping firm

[13] It is for this reason that seizures and arrest often take place in the port where the cargo has been discharged; if, however, the port is corrupt or inefficient that may not be possible.

and the port will be responsible for the ultimate fate of the vessel. In this event, the port will have to pay for the ship to be towed to a break-yard, probably in Pakistan or Bangladesh.

A third stakeholder is the environment. Low valued and under-maintained vessels are particularly prone to oil spills and other costly environmental incidents. In Figure 1, we show that an increasing proportion of vessels are being broken up in countries with low environment standards, in particular Bangladesh, India, Pakistan and China.

In Table 4, we analyse all incidents of crew abandonment in our sample period, from the incident narratives collected by ILO. We find in Panel A that between 1995-2020, there were 618 incidents of crew abandonment, involving more than 10,000 seafarers. We report that the average age of vessels at the time of their abandonment was 25 years, and the average size of these vessels was only 12,000 DWT (and median size of 4,500 DWT). This shows that the abandoned vessels are much older, and lower valued compared with the industry averages reported below (an average vessel in the industry is roughly 12.6 years old, weighs 61,000 DWT, and is valued at $11 million). Also an abandoned vessel has a salvage value of only 15% of its original value, implying that the vessel has almost fully depreciated.

In Panel B, we split the abandonment incidents by their resolution. In around 17% of the cases, the abandoned vessel was arrested, and typically had some residual value that was realized upon its sale. The crew members were unpaid and were deserted in foreign ports for 1-2 years, while they awaited their outstanding wages and repatriation. These are some of the better cases in our sample. In the remaining 83% of the cases, involving around 9,500 seafarers, the abandoned vessel had little or no resale value, and the crew were not paid. In Panel B, we compare the characteristics of abandoned vessels that were arrested with those that were not, and find that arrested vessels are significantly younger, bigger, and higher valued.

Table 5 describes the oil spill incidents in our sample, for the time period 1980-2020. Panel A summarizes the serious casualty incidents that led to oil spills and marine pollution. We find that 44% of the incidents resulted from mechanical damage to the vessel, 23% of the incidents were due to collisions, while 22% were caused by abandoned or stranded vessels. The remaining 10% of the incidents resulted from an explosion or fire in the vessel containers carrying oil, liquefied gas, or other chemicals. We also report the characteristics of vessels involved in serious casualty incidents. The median age of vessels at the time of incident was 17 years, and the median size of these vessels was 7,000 DWT. Substandard vessels causing oil spills are on average older, and lower valued compared with the industry averages reported in Table 6.

Panel B summarizes flag-level yearly casualty incidents, fleet statistics, and country performance indices. The average flag state is responsible for 6.64 serious casualty incidents every year, though the median number of incidents is much smaller at 1. This indicates a large dispersion between the quality of vessels flagged under different jurisdictions, with some flag states being responsible for majority of the incidents. The average flag has around 440,000 DWT of fleet registered under its jurisdiction. Across years roughly 22% of the flag states are on at least one of the *targeted* flag lists published by port state authorities (of Paris MoU, Tokyo Mou, or UNCG).[14] Therefore, inspections reveal that vessels flagged by these *targeted* jurisdictions might not meet the international safety standards. Panel C explores this hypothesis by splitting the sample between incidents for which *targeted* flags were responsible, versus incidents for which other flag states were responsible. We find that the average number of yearly casualty incidents by vessels sailing under *targeted* flags is much higher at 11.6, compared to an average of 4.2 incidents (and a median of 0 incidents) for non-targeted flags, while, on average *targeted* flags are also responsible for maintaining a larger fleet. On average, compared to non-targeted flags, the *targeted* flags have a much lower corruption index (indicating higher corruption), and a slightly lower law and order index (indicating weak rule of law).[15]

2.5 How is the Industry Financed?

Notwithstanding the contractual innovation, there may remain considerable uncertainty surrounding the enforcement of creditor rights in particular jurisdictions. One response by creditors might be to reduce lending to this industry. However, the evidence suggests that the industry is the most highly levered among the transportation industries. Drobetz et al. (2012) show that debt has traditionally been the most important source of external financing for the industry where, "More than 80% of all external funding needs in the shipping industry were traditionally covered by debt finance." The study reports leverage ratios of large listed shipping companies as being more than two thirds higher than the average of other industrial firms. For a sample of companies spanning a period from 1995 to 2020, they report leverage ratios of 41% compared with 25% for other firms.

These findings tell only part of the story, since typically shipping companies are formed as groups with multiple subsidiaries, where debt is netted out at the subsidiary level. To investigate the impact of this netting out, we obtained private data from a shipping consultancy firm for the financial accounts of 27

[14] These three lists of *targeted* flags were published by port authorities from the beginning of 1999.

[15] One caveat of using these indices, is that The Law and Order and Corruption indices are not available for several island countries (that are independent flag states).

subsidiaries of various shipping firms, registered in several jurisdictions; see Table A.1.[16] The average loan to value ratio, at the inception of the loan, was 65% (median 70%). The loans had original maturities of between 4 and 12 years, amortized quarterly, although some also had balloon loan payments. The average interest rate spread (above LIBOR) on the loans was 2.35 percent.

To better benchmark against other industries, we use COMPUSTAT (North America and Global), comparing a sample of 647 shipping firms with 923 firms in other transportation industries (e.g. airlines, railroads, and trucking companies). The interest rates in shipping average 6.5% compared with 7.7% in other transportation industries, although leverage in shipping is higher at 40.4% compared with 35.2% in other transportation firms. In Table A.2, we regress the leverage ratio and interest rate, respectively on firm level controls such as asset tangibility, profitability and an indicator variable for whether the firm belongs to the shipping industry. We find that leverage ratios in shipping firms are higher than other transportation firms, even after accounting for leasing.[17] Also, the interest rates in shipping are significantly lower than other transportation industries.

2.6 Data Sources and Summary Statistics

We combine data from several sources for the empirical analysis that follows in the paper. This section describes the key features of our data and the sample construction process.

Ownership and Vessel Database: Our main data sources are Lloyd's List Intelligence (henceforth LLI) and IHS Markit SeaWeb. LLI was originally part of Lloyd's of London, the famous syndicate of insurance underwriters.[18] Lloyd's has been collecting vessels' technical information (type of vessel, size, construction date etc.) and ownership information for more than two hundred years, but the data have existed in electronic form only since the mid 1990s.[19] Our sampling window begins in 1995 and ends in 2020. We focus on merchant vessels (bulk, containers, reefers and tankers), but exclude passenger ships and highly specialized technical vessels (e.g. oil exploration vessels). We also exclude small vessels below 10 dead-weight tons (DWT). Effectively, this is a survey of the world fleet during the sample period. The data contain information about both active and scrapped vessels.

[16] We are grateful to Captain Kaizad Doctor for supplying us with these data.

[17] Leverage Ratio inclusive of capital and operating lease obligations is computed using definition from Graham, Lemmon, and Schallheim (1998). That is, operating lease is defined as the discounted sum of minimum rental commitments over the next 5 years.

[18] The intelligence unit is currently owned by Informa, a publisher.

[19] Lloyd's List, is an industry news bulletin, in existence since 1734 and Lloyd's vessel register has been in existence since 1764.

Each vessel is identified by an International Maritime Organization (IMO) number, which is attached to the body of the vessel, and remains intact when the vessel changes owner or name. IHS Markit is the sole issuer of IMO number to any vessel in the entire world under the authority of United Nations. This ensures high level accuracy of the vessel-level data, as it is collected from vessels' registration and ownership details at the time of issuing the IMO number. Technical information for the vessel, including the vessel type, size, hull type, country of built, built date, and scrap date are also included in the database.

Vessel ownership is identified by the IHS database at multiple levels. The 'registered owner' of a vessel is the legal title of ownership of the vessel that appears on the ship's registration documents.[20] In our empirical analysis, we link the registered owners (that are generally *brass-plate* companies) of the ships to their parent companies or the group-level beneficial owners.[21]

Vessel Arrest Database: The data on vessel arrest is also collected from Lloyd's List Intelligence. This database provides detailed information about vessel arrests including, the vessel IMO number, port of the arrest, and the duration of arrest along with the arrest start date and arrest end date. In many cases the database contains a short narrative describing the circumstances of the arrest. As we will describe below, we use this information in the narratives to classify the trigger for arrest and the resolution of arrest.

Transaction Level Database: The vessel transaction data is collected from Clarkson Research Services Limited (CRSL), a shipping broker, which supplies price information for secondary market transactions. This database includes the vessel IMO number, date of sale, sale price, and the seller and buyer identity. Technical characteristics of the vessel that impact its sale price are also included: these are details on vessel age, size, length, depth, special units, draft and freeboard. Appendix A.4 reports the definitions of these vessel related variables. The CRSL, IHS and LLI data sets are merged through IMO numbers, to identify the vessel sales of arrested vessels. Our sample period is from 1995 to 2020.

Oil Spills Casualty Data: The IHS Markit Casualty database reports vessel-level casualty incidents. Data on serious casualties responsible for oil spills are available from 1970. These casualties include accidents, collisions, machinery damage, and other incidents of marine pollution. Incident reports include

[20] Registered owner may be an owner/manager or a wholly owned subsidiary in a larger shipping group; or a bank or one ship company vehicle set up by the bank; or in many cases, it may be a "brass plate" company created on paper to legally own a ship and possibly to limit liability for the "real" owners and/or benefit from off shore tax laws. It may also be created to satisfy a legal requirement of the flag state with whom the ship is registered for the legal owner to be a company registered in that country.

[21] A group beneficial owner is a parent company of the registered owner. It represents the controlling interest and it is the ultimate beneficiary from the ownership. A group beneficial owner may or may not directly own ships itself as a registered owner.

vessel name, vessel IMO number, location of the incident, and flag and registered owner of the vessel at the time of incident.

Vessel Abandonment Database: A database on vessel and crew abandonment incidents is maintained by the International Labour Organization (ILO). The data includes information on abandoned vessels' IMO numbers, specific details on the seafarers that have been abandoned, and the resolution or current status of the incident.

Records of Arrests in UK Ports: We augment our LLI arrest database with detailed records of a sample of vessel arrests in UK ports. This vessel survey is carried out by the Admiralty Marshal, an officer of the maritime courts. The records provide more detailed information about the direct costs of the arrest, including those for keeping the vessel in port and auctioning it, as well as a description of the state and quality of the vessel provided to all potential bidders in the auction, and finally, the value of all the bids submitted.

COMPUSTAT: Financial data for the transportation industry is collected COMPUSTAT North America and COMPUSTAT Global. Annual financial data on firms is collected from 1965-2018. In this sample we have 647 shipping firms, and 923 other transportation firms (including airlines, railroads, trucking companies, etc.).

With expanding international trade, the world's merchant fleet has grown steadily over the sample period, from 19,424 vessels in 1995 to 34,988 in 2020, an annualized growth rate of 3.2%. Technological advances coupled with the economies of scale of larger ships, have resulted in a steady increase in the average vessel size during our sample period. The merchant vessel fleet in 2010 comprises bulk carriers (29%), tankers (43%), container ships (17%), reefer ships (5%), and roll-on/roll-off ships (6%).

Since the early 2000s the shipping industry has seen an unprecedented boom, with the Baltic Dry Index (tracking world-wide charter rates in bulk carrying, mainly raw materials such as coal or iron ore), increasing more than four times before crashing to half its 2003 level shortly after the 2008 financial crisis. As Figure 2 shows, charter rates in the tanker business[22] have gone through a similar cycle, albeit of a less erratic nature. Figure 2 also plots a price index for vessels.

[22]We use the "Dirty tanker" index for crude oil.

3 Distressed Sales of Vessels: Voluntary and Involuntary

In this section, we empirically examine the extent to which the shipping industry is disrupted by frequent and costly arrests of ships, the identity of the creditor triggering the arrest and, the proportion of vessels arrested for companies that are liquidated.

3.1 Involuntary Sales: Arrest of Vessels

An arrest followed by the repossession and sale of the vessel is the ultimate remedy available to a secured creditor to obtain repayment. Therefore, we use arrests as a proxy for coordination failures. Anecdotal evidence indicates that to negotiate a workout, banks prefer to use their right to arrest the vessel as a potential threat. Unless the owner has lost all hope of recovery, it is in his best interest to avoid the vessel arrest and accept a Coasian bargain. The data presented below is consistent with the view that such Coasian bargains, which avoid the direct cost of arrest and the opportunity cost of foregone cash flows during the arrest, are negotiated in the vast majority of cases. A simple workout would be a "voluntary" sale of the vessel, sometimes to a buyer found and even funded by the bank, using the proceeds to repay the bank, but allowing the owner to operate his remaining, downsized, fleet. We are also aware of more complicated workouts. For example, Pillarstone, a platform set up by KKR to manage the distressed shipping loans for banks is willing to inject cash into distressed loans. In return, the bank, itself capital constrained but recognizing the going concern value of the vessel, typically allows the new loan to be senior to the mortgage. Such a Coasian bargain is akin to Chapter 11 debtor in possession financing, albeit executed as a privately negotiated voluntary transaction.

During the sample period, LLI reports 3,470 arrests. This is a small number relative to the total capacity of 291,000 vessel-years of the entire industry. Figure 4 plots the fraction of the fleet's capacity, measured in DWT, that is under arrest, computed on a daily frequency. We exclude from the measure non-financial arrests, namely those with an "other" trigger (see Table 8 below).[23] Capacity under arrest, measured in DWT years is 0.5% during industry recessions and close to zero otherwise.

LLI narratives[24] reveal a variety of factors that provoke an arrest apart from financial distress: a drunken shipmaster, contraband, violation of international sanctions, fire, collision with another vessel, or disputes with suppliers. It is not always possible to distinguish financial from other factors that

[23]The bottom (red) line also excludes the bankruptcy of Adriatic Tankers, a sizable Greek operator that went bust following a labor dispute, and some ex-soviet companies that went bankrupt with old and sub-standard fleets following the break-up of the Soviet Union.

[24]Based on a system of agents that Lloyd's has in major ports all over the world to report mainly insurance-related events.

might trigger an arrest. For example, a client may have a vessel arrested on the grounds that the owner mishandled a cargo and caused damage. In such an event, it would be easy for a financially sound owner to find a bank that would guarantee payment, conditional on a ruling in favor of the client, and thereby quickly lift the arrest warrant. However, a distressed owner may not be able to obtain such a guarantee, thereby prolonging the arrest and exacerbating its own distress.

In the case of financial distress there are a variety of creditors that might trigger an arrest. Creditors may be divided into several categories: (i) operational creditors, e.g. the suppliers of fuel (i.e. bunker suppliers) and suppliers of ship stores, known as ship chandlers, (ii) voyage related creditors, e.g. the crew and cargo owners, (iii) Government creditors, e.g. port authorities, and (iv) financial creditors e.g. mortgage holder(s). While the number of creditors maybe fewer than in other industries their ability to immobilise a vessel via a ship arrest provides far stronger control rights than in other industries.

Table 8 classifies arrests by trigger and resolution. The classification is made on the basis of LLI narratives in conjunction with other information such as a transfer of ownership. With reasonable confidence, we identify 538 arrests that are not directly related to debt collection, and another 803 arrests as being unlikely to be related, leaving 854 arrests as being definitely related to the failure to repay secured debt, as well as the wages of the crew and unsecured creditors e.g. bunkers. Of these 854 cases, 20% of the vessels are auctioned and the proceeds distributed to the creditors. 11% (of these 854) are "broken up" – industry jargon for scrap, against only 6% for the rest of the population – another indication of low quality in arrested vessels, a matter on which we shall elaborate in the next section. Most of vessel breakups take place in poor countries with weak environmental regulation like Pakistan or Bangladesh. The cost of supplying a vessel for a lengthy journey to a breakup destination might incentivise a distressed owner to abandon a vessel under arrest, biasing the length of arrest statistics.

3.2 Voluntary Sales by Distressed Firms

We extend what we have learnt from Eastwind's decline (see Figure 3) to the entire sample. Since we lack comprehensive financial data, we identify financial distress using the event of arrest. For a given arrest event, irrespective of the trigger, we assume that the owner of the arrested vessel is distressed during a 3 year period straddling the arrest event. We use two additional tighter definitions to identify distress: first, where there are multiple (at least two) arrests for the same owner within a three year calendar period, and second, where the firm is financially distressed and has defaulted on its debt or has filed for bankruptcy protection.[25] For each of these three definitions of distress, we look for sales of ships that

[25]LLI narratives and news articles from Factiva and Lloyds List are used to identify financially distressed firms.

occurred over the three year window straddling the event year of arrest. We also identify companies at the extreme level of distress which went bust. We define a bust company that had at least one vessel arrest and subsequently disappeared from the ownership register. We only classify a company as a bust if it had suffered an arrest to ensure we do not capture a non-distressed company that disappeared from the ownership register because of a merger or other reasons, unrelated to distress.

To provide some validation for our metrics for distress and bust, we undertook a Factiva search for distress and bankruptcy in the shipping industry. We found twenty six firms that were seriously distressed or entered bankruptcy (the list is available on request). All 26 show up in our distressed sample, and 22 show up in the bust sample. Eastwind shows up in the distress sample, but not the bust one, because at the end of 2010 the company was still registered and owned 7 ships.

During the three year window straddling the arrest event for a given company, we locate all the vessels sold at the holding company level. We classify the non-arrested vessels sold by these distressed firms as distressed sales. Table 6 reports the arrest rates for different definitions of distress. The unconditional probability of arrest in DWT years is just 0.20% (see Panel A) which is consistent with Figure 4 above. The arrest rate increases to 0.55% when capacity is measured in vessel years. The difference reflects the smaller size of arrested vessels. While the unconditional vessel size is 60,528 DWT, the average size of an arrested vessel is only 35,798 DWT.

In Panel B of the table, we report the number of arrests and sales (of non arrested ships) for distressed firms, where a distressed firm is classified as one with at least one or multiple arrest events, respectively. The number of arrests for distressed firms with at least a single arrest event is 299, and the number of arrests for distressed firms classified on the basis of multiple arrest events is 137. More significantly, the number of sales of ships during the distressed episode is 749 for firms with at least one arrest and 313, for those with multiple arrests. In Panel C, we further restrict distress events to financially distressed firms that have defaulted on their debts and/or filed for bankruptcy. These comparative statistics confirm the effectiveness of our proxies for distress.

3.3 Coordination Failures, Arrests and Firm Liquidation

If all vessels were separated into limited liability companies with non recourse lending, we would not expect a coordination failure on one vessel to spillover to another vessel. However, where the financing of vessels is recourse, that is the debt is issued at the holding company level, then we would expect spillovers and to observe multiple vessels being arrested. We draw on the insight presented in Figure 3

above, tracking Eastwind's decline: that an arrest rate well below 100% throughout the distress cycle, is not consistent with a creditors run. In a run, creditors are driven by a first-mover advantage, and would thus grab any asset that has not already been seized by another creditor. We might infer from Eastwind that either the ships were financed with non-recourse debt or the company was able to strike a Coasian bargain with its creditors. In fact we know that twelve of Eastwind's vessels were subject to a double mortgage with Nordea Bank, the equivalent of non-recourse financing. In contrast, Hanjin had large amounts of unsecured debt at the holding company level and many of their ships were financed on a recourse basis.[26] As we discussed earlier in the paper, this created what looked like a creditors run.

We apply the analysis used in Eastwind to the firms in our sample. We measure the proportion of ships that were arrested during the period of distress, for companies that disappeared from the ownership register following an arrest; we refer to those companies as bust companies. If there was a creditors run, we would expect to observe a high proportion of arrests, close to 100%. For each company that went bust, we record the number of vessels owned by the company before it entered into distress. As previously defined, a distress episode is a 3 year window straddling the arrest of a vessel (eighteen months either side of the arrest event). Therefore, we record the fleet size of a company 18 months before the first arrest is triggered, and compute the arrest rate for the firm, as the ratio of the number of vessels arrested to the total fleet size pre-distress.

We focus on the shipping companies that had at least 5 vessels prior to entering distress, and identify 165 companies that went bust. In Table 7 we report the distribution of arrest rates for these companies. A low arrest rate implies that either most of the company's debt was non-recourse, or the company was able to negotiate a Coasian bargain with most of its creditors. In columns (1) and (2), we find that only 7 of the 165 firms had an arrest rate of more than 80%. We conjecture that these cases are likely instances of a creditors run. In columns (3) and (4) of Table 7, we further condition our sample on shipping companies with at least 10 vessels pre-distress. We find that 4% of the 80 shipping companies that went bust had an arrest rate over 80%.[27] If we lower the threshold of a creditors run to an arrest rate of 60% or more, the proportion of companies in this category would rise to 9%.

The 7 companies with an arrest rate of 80% or more (see columns (1) and (2)), owned a total of 138 ships, of which 118 were under arrest. One company, Adriatic Tankers owned 86 of these ships, of which 73 were arrested. An investigation of the circumstance of their failure suggests the company entered formal bankruptcy largely due to economic distress. This culminated in a dispute with an international

[26] Loans which are recourse are often called 'sister ship clauses' because creditors of one company in the group (or of the holding company) may grab assets of another company in the same group.

[27] When we condition on at least 20 vessels pre-distress, 2 out of 29 companies had an arrest rate greater than 80%. Results available on request.

labour union, triggered by the large scale abandonment of ships by crews in European ports because of non-payment of wages (see Couper (1999)).[28] In addition, a significant amount of the company's debt was in the form of (unsecured) private placement debt with a large number of US insurance companies and pension funds rather than the traditional ship mortgage. One result of this financing would have been the common pool problem described earlier by Jackson (1986), and an increase in coordination failures. A second company, Abu Dhabi Container Line, had 10 ships of which 8 were arrested. The ships were only about 2 years old, and their failure was due to systemic mechanical (engine) failure that affected most of their vessels; the failure sharply diminished their earning power.[29] Like Adriatic, this is a case of economic distress. Metrics for the quality of these arrested ships suggest they were below the average of our sample: of the 118 arrested ships, 10, or about 8%, were broken up. The arrested vessels are also smaller (on average 29,310 DWT versus 46,497 DWT for non arrested vessels owned by bust companies).

This analysis also suggests that many bust companies managed to liquidate their assets without resorting to a significant proportion of arrests. 82 of the bust companies had arrest rates of below 20% of their capacity. The relatively low rate of arrests for the whole industry, and for bust companies in particular, is likely to be a direct consequence of the fact that contractual rights of creditors on individual ships were well defined. Notwithstanding, a small proportion of bust companies were subject to a high arrest rate and coordination failures which bore a resemblance to a creditors run. However, there is some indication that these coordination failures may have been more the result of economic distress rather than financial distress. Chapter 11-like procedures are usually justified on the basis of financial distress, so as to avoid premature liquidation of economically solvent firms.

4 Estimating Fire Sale Discount

LLI's arrest narratives, which we have used in order to classify arrests by trigger and resolution (see Table 8 above), make frequent references to the poor technical condition of arrested vessels: "auxiliary engines and boiler trouble", "ingress of water into engine-room; hull in bad condition; cargo holds water contaminated", "cracks in hull", "survey revealed unseaworthiness", "bottom damage requiring considerable steel renewal" etc. These descriptions suggest that one aspect of Myers (1977) underinvestment problem is poor maintenance of assets. They also suggest that the standard technique of measuring the

[28] "Many of Adriatic Tankers' seafarers fell foul of the police in Rotterdam while abandoned ashore awaiting their wages...they were required to see that they were repatriated whether they had been paid or not." (page 44 of Couper (1999))

[29] As a result, the quality discount on these ships was much higher than on other arrested ships, 22% versus 13%. See section 4 for a description of the quality discount.

fire sale discount, pioneered by Pulvino (1998) may be biased as it takes into account assets observed characteristics that affect the price of the vessel or the aircraft, like age or model, but not unobserved characteristics such as the quality of maintenance. In this section, we suggest a method that can proxy for this unobserved maintenance. More specifically, we use duration analysis that measures the vessel's "economic life expectancy", that is the expected number of years of service until it is "broken up", conditional on its "registered age", that is the number of years since it started service. We first demonstrate a vessel under arrest is effectively older compared with a non arrested vessel. We then price this effect using the standard hedonic price regression. As a result, the Pulvino measured discount is reduced by about one half.

4.1 Hedonic Regression

Fire-sale discounts are measured against a price benchmark: the counterfactual sales price of a given arrested ship, i.e., had the sale not been forced. We apply our technique in two stages. In the first stage, we estimate a hedonic model, based on observed characteristics, to calculate a ship's benchmark price. The equation is given by:

$$log(Price)_{it} = \beta_t + \beta X_{it} + \epsilon_{it} \tag{1}$$

where $Price_{it}$ denotes the price of vessel i transacted in period t. β_t is year fixed effect. X_{it} denotes a vector of technical characteristics (such as DWT, vessel length, breadth, freeboard, hull type and draft), transaction characteristics (such as whether the transaction was part of a block sale of several vessels and the age (Age_{it}) of the vessel at sale) and the vessel's type (bulk carrier, tanker, container etc.). We also include controls for the country of built of the vessel, and buyer and seller country. Definitions of vessel-related variables are provided in Appendix A. The results are reported in column (1) of Table 9. An adjusted R^2 of 87% indicates that the predicted ship price from the hedonic model can serve as a good benchmark. There is a significant discount of 9% on the sale of single-hull ships, as these ships have been disproportionately responsible for oil spills. Following the major 63,000 tonne oil spill from the single-hull vessel *Prestige* in 2002, IMO mandated that single hull tankers cannot be used to carry heavy gradient oil.

4.2 Quality-adjusted Fire Sale Discount

Following the methodology of Franks et al. (2020), we proxy for an unobserved quality component of the vessel by including the imputed life expectancy of the vessel in the hedonic regression. We can only make this correction because vessels (unlike houses) have a finite life and are eventually broken up.[30]

We denoted the hazard function by $\lambda_i(Age)$. The hazard function gives us the hazard rate for a ship i as a function of its age. The hazard rate corresponds to the probability of vessel i breaking up at a certain age conditional on surviving upto that age. Furthermore, we define the economic life expectancy of a vessel at a given age as:

$$L_i(Age) = t + (1 - \lambda_i(Age)) \cdot \lambda_i(Age + 1) + (1 - \lambda_i(Age)) \cdot (1 - \lambda_i(Age + 1)) \cdot \lambda_i(Age + 2) \cdot 2 + ... \quad (2)$$

Using the above method, we calculate the life expectancy and hazard rate separately for the arrested, distressed and non-arrested groups. It should be noted that in calculating the hazard rate, we pool all ships irrespective of their type. We find that for a ship at any given age, the probability of an instantaneous breakup, i.e. hazard rate, is higher for arrested and distressed vessels relative to non-distressed vessels, as plotted in the top panel of Figure 5. In robustness tests, we estimate a Cox proportional hazard model that allows us to partially control for the characteristics of ships. The results are qualitatively very similar. The relevant methodology is described briefly in Appendix B.

In the bottom panel of Figure 5, we plot the life expectancy of arrested, distressed and non-arrested vessels. We find that a 15 years old arrested vessel has a life expectancy of 24.7 years, compared with a non-distressed vessel having a life expectancy of 25.4 years. This suggests that arrested vessels have a 7% lower remaining life expectancy than non-distressed vessels. In column (2) of Table 9 we add the derived 'Life expectancy' ($L_i(Age)$) variable to the hedonic price regression. It shows that an extra year of life expectancy commands a 21% higher price and is significant at the 1% level, confirming the importance of imposing a quality correction.

In the second stage, the fire sale discount is calculated by regressing the residual from the hedonic model on a dummy indicating whether a ship is a forced sale, to derive the fire sale discount on arrested ships.

In Table 10 we report the price discount partitioned by whether the sale was made after an arrest, or whether the sale was made by a distressed owner but without an arrest. In column 1 (without quality

[30] Such a correction would be difficult in housing because houses do not usually die.

correction, W/O QC) we examine the fire sale discount on arrested ships and find that, on average, they are sold at a discount of 23% relative to normal ship transactions. These estimates are quite similar to those that have been reported in Pulvino (1999) on the sale of used commercial aircraft by airlines operating under bankruptcy protection. In column 2, where we control for the quality of the ship by adding life expectancy of ships, this discount reduces to 10.8%, suggesting that roughly half of the raw fire sale discount is driven by differences in quality of ships, which we interpret as maintenance-related. We also find that the raw fire sale discount on the sale of (non-arrested) distressed vessel is 15%, and it reduces to 7% once we control for the lower quality of distressed vessels.

In columns (3) and (4), we use a tighter definition of forced sales, by using only multiple arrests events *(Arrests(*> 1*))*. We find that multiple arrests also fetch a raw fire sale discount of 22%, that reduces to 10% on controlling for quality. In columns (5) and (6), we focus on firms that are financially distressed. We find that sales of arrested vessels by financially distressed firms occur at a 25% raw fire sale discount, that reduces to 12% after controlling for quality. Non-arrested ships by financially distressed firms ($Distressed(Fin)$) are also sold at a quality adjusted discount of 9%. The fire sale discount on arrested and distressed vessels is therefore, robust to different definitions of distress.

After correcting for the quality discount in column (6), we estimate the fire sale discount at 12% for arrested ships; which is very similar in magnitude to the discount of 9% for sales of (non arrested) ships by distressed firms. Their similarity suggests that the cost of the forced sale resulting from an illiquid market for arrested ships is modest. We may have expected the liquidity component to be larger for arrested ships because the forced cash auction might have been expected to accelerate the sale, which could have reduced the number of bidders and the auction price compared with distressed sales, where more patience can be exercised during the sale process. The small discount attributable to illiquidity may be less surprising given that the auctions of arrested ships take place in an international marketplace and the information on bids is circulated to potential buyers electronically. Consistent with this observation, we report in Table A.4, a relatively high number for the median number of bidders for a sample of auctions.

In summary, we find that arrested ships generate a raw fire sale discount of roughly 23%, which is similar to what has been documented in prior studies on aircraft and foreclosed homes. Interestingly, however, we find that as much as half of this discount is due to the unobserved low quality of arrested ships. Moreover, the fire sale discount with quality correction is similar to the liquidation discounts on distressed sales, indicating that the costs of delay (and by inference, the benefits of automatic stay) are

small in the shipping industry. In the next sub section, we explore some other determinants of the fire sale discount.

4.3 Institutional Quality of Ports and Business Cycles

In Table 11, we conduct additional cross-sectional tests to investigate the heterogeneity in the fire-sale discount. This test examines how the fire-sale discount varies with institutional differences such as the quality of the ports. We expect that the low quality of a country's jurisdiction will add some additional costs that the buyer of the vessel might face following the sale, such as higher port charges, payments to suppliers and crew, and any side payments (bribes) to officials. An arrested ship can be sold within six weeks of the arrest in an efficient port while the period of immobilization may take years in an inefficient port (average days of arrest are 213 for corrupt ports and 142 for less corrupt ports). For this purpose, we use a country corruption index described below. We would expect the fire sale discount of the arrested ship to be positively correlated with the corruption index. For defining a corruption index, we use the one devised by La Porta et al. (1999).

We split the data regarding arrested ships into two sub samples, depending on whether they were arrested in high or low corruption countries. A median cutoff is used to separate the two samples, and provides the following two groups of countries.[31] As can be seen in Table 11, ships arrested in countries with less corruption, incur a smaller quality-adjusted fire sale discount: 8% in low corruption countries compared with 16% in high corruption countries; this difference is statistically significant (at the 10% level) and economically significant (columns (3) and (4)).

Another interesting observation is how the fire-sale discount varies with business cycles in the shipping industry. As argued by Shleifer and Vishny (1992), due to a decrease in the number of potential buyers when the industry environment is unfavorable, the fire-sale discount can be higher than that in the boom years. To test this hypothesis, we split the data of all ship sales into three sub-samples depending on the Baltic Dry Index (high index, regular times and low index). The results are displayed in Table 12. We can see from column (3) that in the relative boom years, the fire-sale discount for arrested ships is 13% without a quality correction in the first stage. If we add in the quality correction, the discount largely disappears and is insignificant, as reported in column (6). In contrast, when the industry struggles, the

[31]The high corruption countries include: the Bahamas, Chile, Cyprus, Greece, India, Italy, Malaysia, Malta, Mexico, Panama, Sri Lanka, Trinidad and Tobago, Turkey and Venezuela. The low corruption countries include: Australia, Belgium, Canada, Denmark, France, Germany, Gibraltar, Holland, Hong Kong, Israel, Japan, Montenegro, the Netherlands, the Antilles, South Africa, Singapore, Tahiti, the UK and the US.

discount is significantly higher, reaching 26% in column (1). Even if we control for quality of the ship in the first stage, it is still high at 14.5%, as shown in column (4).

In summary, the raw fire sale discount in our paper is very similar to the fire sale discount that has been documented by Pulvino (1999). On decomposing the fire sale discount, we find that about half of this discount is due to quality differences between arrested and non-arrested ships. If the forced sales are confined to low corruption ports the discount is reduced to 8%. Where the fire sales are a result of a large liquidity discount, they can be mitigated by a bankruptcy procedure with an automatic stay so as to overcome coordination problems among creditors and forced sales of assets. However, the evidence in this section suggests that the value of an automatic stay may be limited because the implied liquidity component of the fire sale discount in cash auctions is quite similar to those for sales by distressed companies. The lack of a large liquidity discount is also consistent with the evidence in earlier sections that costly coordination failures are largely absent from this industry.

4.4 Benchmarking the Fire Sale Discount

In this section we discuss whether the absence of state mandated bankruptcy procedures results in larger fire sale discounts on disposition of assets by a firm. We benchmark our results in the shipping industry against fire sale discounts reported in assets operating under different bankruptcy regimes. In Table A.5 Panel A, we show that the 23% raw fire discount on the sale of arrested ships, is comparable to the 27% fire sale discount documented in foreclosed home sales (Campbell et al. (2011)), and the 20-30% fire sale discount documented on the sale of commercial aircraft by airlines operating under U.S. bankruptcy protection (Pulvino (1999)).

The under-maintenance effect on ships raises the question as to whether the same effect could be present in other empirical studies documenting large fire sale discounts. For example, in an analysis of Eastern Airlines' bankruptcy Weiss and Wruck (1998) have noted that "the discount on Eastern's airplanes could be due to many factors including its distressed situation and/or poor maintenance." It is fairly common for airlines to swap engines and other parts of an airplane, and subsequently sell aircraft that have been fitted with second hand parts. Franks et al. (2020) document an under-maintenance effect in aircraft sold by airlines operating under bankruptcy protection. Identical patterns of longevity can be identified for aircraft owned by airlines operating under bankruptcy protection, and such aircraft have a significantly lower remaining economic life expectancy versus the aircraft owned by non-bankrupt

airlines. Moreover, these aircraft also have lower flying hours compared to other similar aircraft flown by the new operator.

The quality correction due to under-maintenance is also well documented in the real estate literature. Even though the raw fire sale discount on sale of foreclosed houses is 27%, Campbell et al. (2011) express concerns over the vandalism and poor maintenance of foreclosed houses. They also document around 8-9% poor maintenance discount on houses sold by older sellers. In a separate study of forced house sales in Denmark, resulting from sudden death of house owners Andersen and Nielsen (2017) report an average fire sale discount of 8.9%. In their setup sudden deaths provide a close to random draw of house owners, which ensures that individual and house characteristics are exogenous. Therefore, we can conclude that the under-maintenance effect is not specific to the shipping industry, rather it has been recorded in other real assets as well.

Pulvino (1999) finds evidence indicating that neither protection under Chapter 11 of the bankruptcy code nor court-supervised liquidation under Chapter 7 of the code are effective at eliminating fire sale discounts. Our paper complements this finding by documenting similar fire sale discounts in freedom of contracting regimes. Empirically the findings do not support the contention that mandatory bankruptcy procedures help mitigate fire sale discounts and improve resource allocation. We even observe that after controlling for the lower quality of arrested ships, the quality-adjusted fire sale discount is similar in magnitude to the fire sale discount reported in financial assets (see Table A.5 Panel B).

5 Costs of Financial Distress to Other Stakeholders

We have demonstrated that contracts in the shipping industry have evolved to strengthen creditor rights, and several contractual innovations in the industry have reduced the direct cost of financial distress, by lowering coordination failures and fire sale discounts. However, an excessive strengthening of credit rights in the shipping industry, has encroached on the rights of other stakeholders, including crew, port authorities, and the environment. In this section, we demonstrate a clear breakdown of the Coase Theorem, owing to the negative externalities an operator inflicts on other stakeholders that, while being fully informed, have no legal means to protect themselves against harm.

5.1 Costs of Abandoned Vessels

In 1999 the IMO published a report on the abandonment of seafarers. The Report recorded that during a four year window, between July 1995 and June 1999, there were 212 cases, i.e. vessels of crew abandonment involving 3,759 crew members. Of the 212 about one third were flying the flag of Panama, regarded at the time as a low quality flag.

Most cases of abandonment occur where a ship has been placed under legal arrest following bankruptcy or insolvency, non payment of bills for example to suppliers or crew, grounding etc. In principle, providing there is some value in the sale of the vessel, unpaid wages of the master, officers and members of the crew are secured by way of a maritime lien, described earlier in the paper. The maritime lien is senior to the mortgage and other charges on the vessel but is of equal seniority i.e. pari passu with certain other charges such as port dues.

Using the case study of Adriatic Tankers we will illustrate how financial distress and insolvency of an operator may impose costs on labour and other parties. Adriatic Tankers was a Greek shipping company that owned around 100 vessels in the early 1990s. 85% of the fleet was flagged with Panama and only one vessel was registered in Greece. The flag is the primary regulator of the vessel flying its flag. Panama is often chosen as the preferred flag because it exercises no constraint on the nationality of the crew and, it exercises little effective regulation over crew wages and conditions.[32]

In 1993 the ITF (international Transport Workers Federation) identified several forms of complaints directed at Adriatic including non payment of crew wages, and extremely poor working conditions. An IMO Report (1999) reported that for many years prior to 1993 when a strike by crew was commenced, it was common practice for Adriatic to take crew off ships when a vessel was arrested, place them in hotels around the world, and not pay their wages. According to the IMO report, most of the time these payments were never paid.

The protracted strike against Adriatic led to the bankruptcy of the company. 85% of the ships were arrested, and some 55 were abandoned by the operator with crews left in foreign ports for months without wages or any other means of support. In the Appendix, we reproduce from the IMO report the outcome of 3 arrests in terms of payments to the crew. In all 3 cases the crew were eventually paid by the bank that held the mortgage on the vessels. Their payment is attributable to the fact that the vessel had resale value to the mortgage holder and the wages were paid out of the proceeds of the sale of vessels. However,

[32] In contrast, Greek labor laws require the master, officers, and crew must be Greek for large ships (unless Greeks are not available)

the crew waited for between 1-2 years for payment and repatriation. There are also several cases where the vessel was abandoned and had no resale value and the crew were not paid.

Our results show that incidents of seafarer abandonment are not infrequent. In case the abandoned vessels has some residual value for its creditors, private parties are incentivized to arrest the vessel, and use its proceeds to pay the crew and port dues. While, in the absence of sufficient residual value for the creditors, the vessel and its crew are stranded for several years in the port, until eventually the vessel is towed at the port's expense to a breaker's yard to be sold for scrap. Aside, from the crew not being repatriated, an abandoned vessel can have devastating consequences on local communities. An example, is the recent explosion caused by the *Rhosus* vessel abandoned in the port of Beirut. The massive explosion killed more than 190 people, and caused enormous harm to the city.

5.2 Marine Pollution and Oil Spills

The International Tanker Owners Pollution Federation (ITOPF) estimates that between 1970 to 2019 approximately 5.86 million tonnes of oil were spilled into marine waters as a result of tanker incidents. Large oil spills from tankers often result from collisions, grounding, structural damage, fire or explosions. The largest oil spill resulting from a tanker incident was caused by *Atlantic Empress*, a Greek oil tanker spilling 287,000 tonnes of crude oil into the Caribbean Sea in 1979. Oil spills can result in large costs for the responsible firm, insurance company, and affected fishing communities. They also impose very high reputational penalties on firms for environmental violations. For example, in a study of the impact of *Exxon Valdez* spill on Exxon's stock price, Jones (1994) estimated costs to its shareholders ranging from $4.7 billion to $11.3 billion.[33]

These incidents raise the important question of who is responsible for ensuring the seaworthiness of vessels sailing the seas, and the certification of crew members operating these vessels? The United Nations Convention on the Law of the Sea (UNCLOS) provides for the primary responsibility for ships to rest with the flag state, particularly when the vessel is operating on the high seas. Every vessel needs to be registered with the flag of a particular state under whose regulatory control it consequently falls. The flag state is, for instance, responsible for the inspection of the vessel and its seaworthiness, ensuring minimum safety standards and pollution prevention, and certifying the crew (Heidegger et al. (2015)). Perepelkin et al. (2010) document that the first line of defense against substandard shipping is the flag state, as rights and obligations under international law are mainly imposed on to the vessels via the

[33] *Exxon Valdez*, an oil tanker owned by Exxon Shipping Company spilled 38,800 tonnes of crude oil in Gulf of Alaska in 1989. It is considered the worst oil spill worldwide in terms of damage to the environment (refer to Exxon Valdez Oil Spill Trustee Council Report, 2010).

flag states. Following a series of major oil tanker accidents in the 1970s, port state controls (PSC) have evolved as a second line of defense, allowing port states to conduct safety inspections on foreign flagged vessels entering their ports.[34]

Since some jurisdictions are more tolerant of lower maintenance standards, we analyze whether the seaworthiness of vessels is affected by their flags of registration. We use a database of vessel-level serious casualty incidents, and link these vessels to their flags of registration at the time of the incident. We find that weak rule of law, and high corruption in the flag state predict higher number of pollution incidents for vessels registered with the flag state. Therefore, ships registered in jurisdictions that possess weak administrative power to effectively enforce international regulations or to control the shipping companies are more likely to be responsible for oil spills. Further, we document that a flag state that was *targeted* by port state authorities for its lower safety performance,[35] has a higher probability of causing a pollution incident.

However, to circumvent these regulations *flag hopping* has become a common practice in the maritime industry, which allows ship owners to easily and quickly change the flag of their ships, to reduce costs. This has led to competition between jurisdictions, with flag states competing for ship registrations by offering policies that lower costs and reduce regulatory burden for owners. In this section we examine whether this practice of jurisdiction shopping by ship owners coupled with the competition between flag states, has resulted in a race to the bottom in the maritime industry, increasing the likelihood of severe accidents resulting from substandard shipping practices.[36]

As discussed previously, some jurisdictions are more tolerant of lower maintenance standards of vessels registered under them. In Table 13, we analyze whether the seaworthiness of vessels is affected by their flags of registration. $NumberofIncidents_{i,t}$ aggregates the total number of serious casualty indices for flag i in year t. We use three separate indices to measure the variability in institutional quality across flag states. Following La Porta et al. (1999), we use the lagged Law and Order, and Corruption indices for measuring the quality of governance in the flag state. We also classify the flag as *targeted*, if it had

[34] If the vessel while being inspected at a port, does not meet the international safety standards it can be detained by the port state authority.

[35] Flag states are added to the 'targeted list' of the port state authorities if inspections reveal that ships registered under these flags have very high detention rates.

[36] A key theme across the regulations is that those responsible for discharging hazardous materials are liable for cleanup costs and, in some cases, for any other damages caused by the spill. The 'polluter pays' principle is the commonly accepted practice in marine pollution, requiring that those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment. Further, fines may also be imposed on firms that act negligently. In a survey report of maritime laws and policies across 18 major jurisdictions, Rutkowski (2014) reports that the pollution claims and damages are a part of the maritime lien, and these claims have priority over ship mortgage holders and other secured/unsecured creditors. The 1992 Civil Liability Convention (CLC) governs the liabilities of ship owners for oil pollution damages. Under the CLC, the liability of the ship owner increases with the size (gross tonnage) of the ship, with the maximum liability being capped at SDR 90 million.

been targeted by a port state authority in the previous year. $ln(FleetRegistered)_{i,t}$ is the logarithm of the total tonnage (DWT) of fleet registered with a flag. Year fixed effects are included to control for time trends in vessel casualties.

Table 13 presents our results. In all specifications the number of incidents significantly increase with an increase in the tonnage of ships being registered under the flag state. In column (1), we find that a higher Law and Order Index predicts lower number of spills by the flag. In column (2), we find that high corruption (or low corruption index) at the flag state is linked to higher number of serious casualties by vessels registered under the flag. In column (3) we report that even after controlling for the total tonnage of vessels registered with a flag, vessels registered under targeted flag states are at a greater risk of causing an oil spill. Therefore, ships registered in jurisdictions that possess weak administrative power to effectively enforce international regulations, or to control the shipping companies are more likely to be responsible for oil spills.

The table also presents preliminary research attempting to establish the environmental impact of jurisdiction shopping by firms. We have used oil spills in the shipping industry as a laboratory to answer this question, as oil spills have a huge impact on the environment, and firms operating in this industry are free to self select into a jurisdiction that will monitor their safety standards. As described in the institutional details section, there are several players involved in governance and enforcement of safety standards for ships. The role of port states, classification societies, P&I Clubs, and creditors in ensuring the safety of the vessels is not to be taken lightly. Notwithstanding, the flag states where the vessels are registered act as the first line of defense against substandard shipping practices. Ships that are certified as *seaworthy* by the flag states, might sail undetected on the high seas, avoiding inspections by strict port state authorities.

6 Conclusion

Shipping provides an important laboratory for testing Hayek's natural experiment in "spontaneous order." Because ships move from one jurisdiction to another, and may "go bust" on the high seas outside any country's territorial waters and jurisdiction, the creditor (with or without the debtor's assistance) can arrest and auction a ship at a maritime port. Ideally, they will wish to choose the port of arrest to minimize costs. The proceeds from the auction will then be used to repay creditors, according to the contract.

There are two important qualifications. First, creditors of shipping companies rely on maritime courts to arrest ships, in the event of default, and auction them in a timely and cost efficient manner. Thus, enforcement plays an important role in the debt contract. Second, the courts of some countries, for example the US, may sometimes try to thwart the arrest or auction of ships in foreign ports, where the debtor claims some connection with the US and seeks protection under Chapter 7 or Chapter 11 of the 1978 Bankruptcy Code. However, the exercise of US "imperium" in shipping bankruptcies can and has been mitigated by contractual innovations, as illustrated in the case of Eastwind.

This paper has addressed the question of how costly are bankruptcy procedures? These procedures have largely evolved out of private commercial contracts, with the courts largely playing the role of contractual enforcer. There are three measures of costs. First, how frequently do creditors of distressed and defaulting shipping companies resort to the bankruptcy procedure of arrest and auction in maritime ports? We find a relatively low proportion of arrests, with the debtor frequently resorting to the private sale of ships. Only when the debtor seems to have run out of cash, or when the ships are of such a low value that the debtor or owner's equity is far out of the money, do we find arrests and forced sales taking place.

Second, using a hand-collected sample of ships arrested and auctioned in UK ports, we find that the direct costs of arrest and sale are around 8% of the proceeds of auction. The arrests are triggered by the mortgage holder, crews (who are owed wages) and unsecured creditors including suppliers to the ships.

The third cost is the "fire sale discount." Following Pulvino (1998) we might expect a significant discount from the arrest and forced sale of ships due to the illiquidity of the market for second-hand ships. We find a discount of 26% on average compared with ships of similar age and use. This is very similar to the discount estimated by Pulvino. However, we also find that ships which are arrested and sold are of lower quality than comparable ships sold outside distress. In forced sales, ships tend to be under-maintained and are therefore of lower quality. In effect this lower quality is equivalent to an age premium of 1.7 years compared with sales by non-distressed companies. Adjusting for this factor reduces the discount from 26% to 13%. This average discount is for ships sold in both inefficient and efficient ports. When we re-estimate the index for arrests and sales at low corruption ports we find the discount is 11%, compared with 21% for high corruption ports.

A few comments are worth highlighting. First, it should be noted that we are not running a horse race between freedom of contracting and Chapter 11. In fact, freedom of contracting could potentially include

off the shelf procedures like Chapter 11. Second, we are not making any efficiency claims here.[37] Chapter 11 was introduced based on the rationale that absent such a reorganization mechanism, we would witness severe coordination problems and large fire-sale discounts. There was also a concern that innovation in contracts would be slow under a freedom of contracting regime because of free rider problems. We find that such fears are largely misplaced at least for the shipping industry. That being said, we do believe that state sponsored bankruptcy procedures have a role to play. In particular, such procedures have the potential for solving free rider problems associated with contractual innovation. But we question whether the procedures should be made mandatory or optional. We recognize that in the case of large firm failures like Hanjin, mandatory Chapter 11 might be desirable to internalise the externalities.

Even ignoring the externalities associated with large firm failures, the question remains, whether our results extend to other industries. There are several important features of the shipping industry that may contribute to an efficient resolution of distress without the aid of mandatory bankruptcy procedures: the fact that ships consist of discrete assets which allow them to be separated from each other for the purposes of limited liability and collateral, the fact that assets can be marketed to potential buyers around the world thereby increasing the liquidity of the market for second-hand ships, and that the intangible value of a ship may be relatively low compared with other assets. There may be other industries which exhibit similar characteristics to shipping, such as real estate, airlines, oil and gas, and mining companies. Congress has already recognised the value of limiting the intrusion of bankruptcy law into some of these industries by exempting them from an automatic stay, for example, aircraft under the Capetown Convention (Section 1110, 1994 Bankruptcy Act), and private-label mortgage collateral (2005, BAPCPA); see Lewis (2019). In addition, Section 363(b) of the US Bankruptcy Code allows a company to sell its assets outside the ordinary course of its business during Chapter 11 bankruptcy proceedings.

However, there are many industries where asset complementarities make the segregation of assets more difficult. In this respect, we would be cautious in generalizing our results to other industries. Nevertheless, even here we might speculate that contractual innovations and well-developed capital markets might mitigate many of the costs claimed as justifying a mandatory and highly active bankruptcy code.

[37] It is practically impossible for an empirical paper to make normative claims. We understand that ex-post efficiency may be ex-ante inefficient. Moreover, the theory of second best a la Lipsey and Lancaster (1958) cautions us against welfare claims.

References

[1] Andersen, Steffen and Kasper Meisner Nielsen (2016). "Fire Sales and House Prices: Evidence from Estate Sales due to Sudden Death", *Management Science*, 63.1, 201-212.

[2] Ayotte Kenneth M. and Edward R. Morrison (2009). "Creditor Control and Conflict in Chapter 11", *Journal of Legal Analysis*, 1(2), 511-551.

[3] Baird, Douglas G. and Robert K. Rasmussen (2002). "The End of Bankruptcy", *Stanford Law Review*, 55.

[4] Bolton, Patrick and Ernst Ludwig Von Thadden (1998). "Blocks, Liquidity and Corporate Control", *Journal of Finance*, 53, 1-25.

[5] Bebchuk, Lucien and Alma Cohen (2003). "Firms' Decisions Where to Incorporate", *Journal of Law and Economics*, 46(2), 383-425.

[6] Bernstein, Lisa (1992). "Opting out of the Legal System: Extralegal Contractual Relations in the Diamond Industry", *Journal of Legal Studies*, 21(1), 115-157.

[7] Bris, Arturo.,Ivo Welch, and Ning Zhu (2006)"The Costs of Bankruptcy: Chapter 7 Liquidations versus Chapter 11 Reorganization, Journal of Finance 61, 3, June, 1253-1303.

[8] Campbell, John Y. (2011). Stefano Giglio, and Parag Pathak. "Forced Sales and House Prices", *American Economic Review*, 101(5), 2108-2131.

[9] Couper, A. D. (1999). "Voyages of abuse: Seafarers, human rights and international shipping", Pluto Press.

[10] Coval, Joshua., and Eric Stafford (2007). "Asset fire sales (and purchases) in equity markets", *Journal of Financial Economics*, 86 (2007), 479–512.

[11] Davydenko, Sergei A., and Julian Franks (2008). "Do Bankruptcy Codes Matter? A Study of Defaults in France, Germany, and the U.K.", *Journal of Finance*, 63(2), 565–608.

[12] Diamond, Douglas D, and Phillip H. Dybvig (1983). "Bank Runs, Deposit Insurance and Liquidity", *Journal of Political Economy*, 91(3), 401-419.

[13] Djankov, Simeon., Oliver Hart, and Andrei Shleifer (2008)."Debt Enforcement Around the World", *Journal of Political Economy*, 116(6), 1105 -1149

[14] Drobetz, Wolfgang, Gounopoulos, Dimitrios, Merikas, Andreas and Schroeder, Henning (2012). "Capital structure decisions of globally-listed shipping companies", Working Paper

[15] Eckbo, B. Espen, and Karin S. Thorburn (2008), "Automatic Bankruptcy Auctions and Fire-sales", *Journal of Financial Economics*, 89(3), 404-422.

[16] Ellul, Andrew, Chotibhak Jotikasthira, and Christian T. Lundblad (2011). "Regulatory Pressure and Fire Sales in the Corporate Bond Market", *Journal of Financial Economics*, 101.3, 596-620.

[17] Franks, Julian and Oren Sussman (2005). "Financial innovations and corporate bankruptcy", *Journal of Financial Intermediation*, 14(3), 283–317.

[18] Franks, Julian, Gunjan Seth, Oren Sussman, and Vikrant Vig (2020). "Revisiting the Asset Fire Sale Discount: Evidence from Commercial Aircraft Sales", Working Paper.

[19] Florencio López de Silanes, Rafael La Porta, Andrei Shleifer, and Robert Vishny (1998). "Law and Finance", *Journal of Political Economy*, 106(6), 1113-1155.

[20] Graham, John R., Michael L. Lemmon, and James S. Schallheim (1998). "Debt, leases, taxes, and the endogeneity of corporate tax status", *The Journal of Finance*, 53.1, 131-162.

[21] Greif, Avner, Paul Milgrom and Barry R. Weingast (1994). "Coordination, Commitment and Enforcement: The Case of the Merchant Guild", *Journal of Political Economy*, 102(4),745-776.

[22] Grossman, Sanford J. and Oliver D. Hart (1986). "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy*, 94(4), 691-719.

[23] Hill, C. (1998). "Maritime Law", 5th edition. Lloyd's London, 430.

[24] Hayek, Friedrich (1979). "Law, Legislation and Liberty: a new statement of the liberal principles of justice and political economy", Routledge.

[25] Jensen, Michael (1989),"Active Investors, LBOs, and the Privatisation of Bankruptcy", *Journal of Applied Corporate Finance*, 2(1), 35-44.

[26] Jackson, Thomas H, "the Logic and Limits of Bankruptcy Law", *Harvard University Press*, 1986

[27] Kahan, Marcel and Ehud Kamar (2002). "The myth of state competition in corporate law", *Stanford Law Review*, 55(3), 679-749.

[28] Klein, Benjamin, Crawford, Robert G. and Alchian, Armen A. (1978). "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process", *Journal of Law & Economics*, 21(2), 297-326.

[29] Lewis, B. A. (2020). "The Effect of Dealer Leverage on Mortgage Quality", Working Paper.

[30] Lilienfeld-Toal, U. V., Mookherjee, D. and Visaria, S. (2012). "The distributive impact of reforms in credit enforcement: Evidence from Indian debt recovery tribunals", *Econometrica*, 80(2), 497-558.

[31] Mitchell, Mark, and Todd Pulvino (2012). "Arbitrage Crashes and the Speed of Capital", *Journal of Financial Economics*, 104.3, 469-490.

[32] Myers, Stewart C. (1977), "Determinants of Corporate Borrowing", *Journal of Financial Economics*, 5(2), 147-175.

[33] Nowak, Adam, and Patrick Smith (2017), "Textual analysis in real estate", *Journal of Applied Econometrics*, 32.4, 896-918.

[34] Pulvino, Todd C. (1998). "Do Asset Fire Sales Exist? An Empirical Investigation of Commercial Aircraft Transactions", *Journal of Finance*, 53(3), 939–978.

[35] Pulvino, Todd C. (1999). "Effects of bankruptcy court protection on asset sales", *Journal of Financial Economics*, 52.2, 151–186.

[36] Rodano, G., Serrano-Velarde, N. and Tarantino, E. (2016). "Bankruptcy law and bank financing", *Journal of Financial Economics*, 120(2), 363-382.

[37] Romano, Roberta (2005). "Is regulatory competition a problem or irrelevant for corporate governance?", *Oxford Review of Economic Policy*, 21(2), 212-230.

[38] Shleifer, Andrei, and Robert W. Vishny (1992). "Liquidation Values and Debt Capacity: A Market Equilibrium Approach", *Journal of Finance*, 47(4), 1343–66.

[39] Shleifer, Andrei, and Robert Vishny (2011). "Fire Sales in Finance and Macroeconomics", *Journal of Economic Perspectives*, 25(1): 29-48.

[40] Strömberg, Per (2000). "Conflicts of Interest and Market Illiquidity in Bankruptcy Auctions: Theory and Tests", *Journal of Finance*, 55(6), 2641–2692.

[41] Suarez, Javier and Oren Sussman (2007). "Financial distress, bankruptcy law and the business cycle", *Annals of Finance* 3(1), 5–35.

[42] Sussman, Oren (2008), " The economics of the EU's corporate-insolvency law and the quest for harmonization by market forces", Freixas, Hartmann and Mayer (eds.), *Financial Markets and Institutions: A European Perspective*, Oxford University Press.

[43] Teiniu, Eric J (2013). "Maritime liens and its application: a case study of Solomon Islands", *World Maritime University Dissertations*

[44] Warren, Elizabeth and Westbrook, Jay Lawrence (2004). "Contracting out of Bankruptcy: an Empirical Intervention", *Harvard Law Review*, 118, 1197.

[45] Weiss, Lawrence A., and Karen H. Wruck (1998), "Information problems, conflicts of interest, and asset stripping: Chapter 11's failure in the case of Eastern Airlines", *Journal of Financial Economics*, 48.1, 55-97.

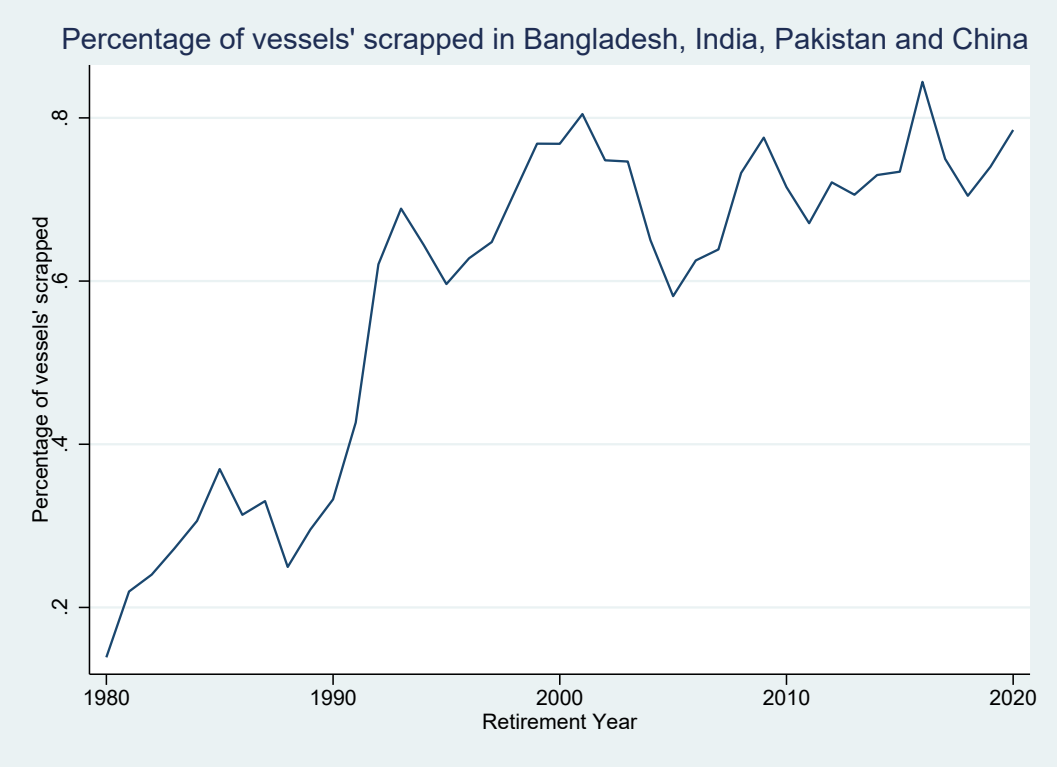

Figure 1: Time series of vessel scrapping in low environmental standard countries. In this figure, we show the total proportion of vessels being broken down in countries with low environmental standards, like Bangladesh, India, Pakistan and China.

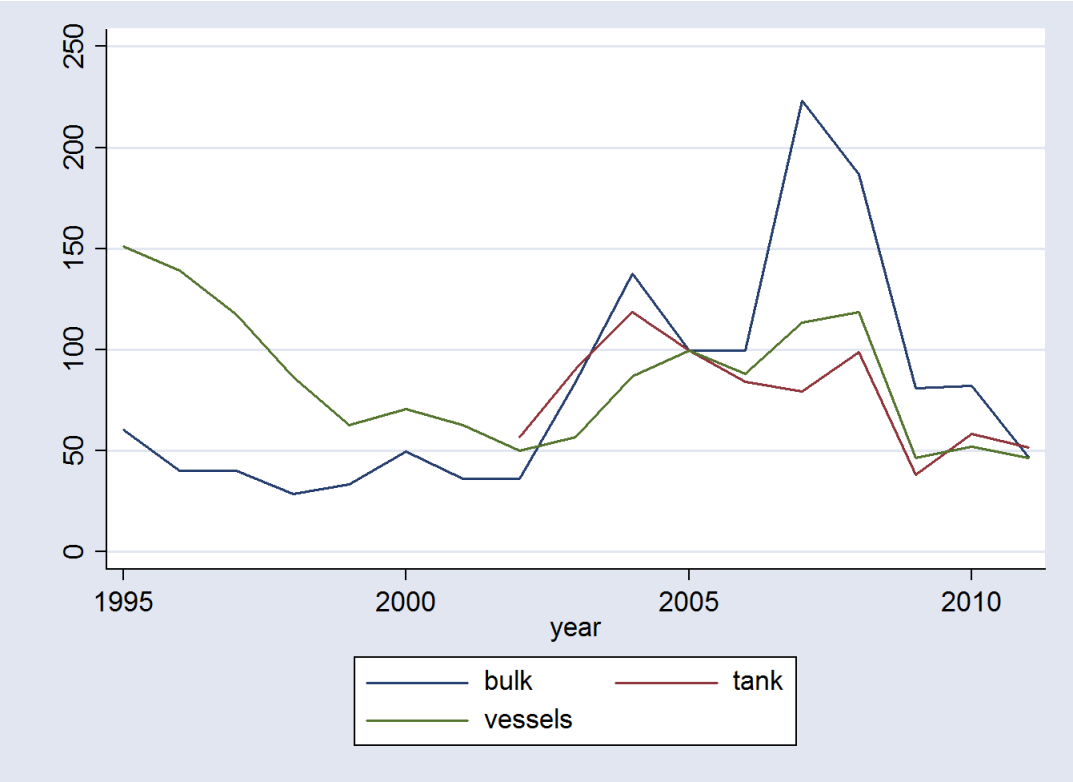

Figure 2: Charter Rates and Vessel Price Indexes, $P_{2005} = 100$**.** In this figure, we show the charter rates in the tanker and bulk rate businesses and the price indexes of vessels from 1995 to 2011.

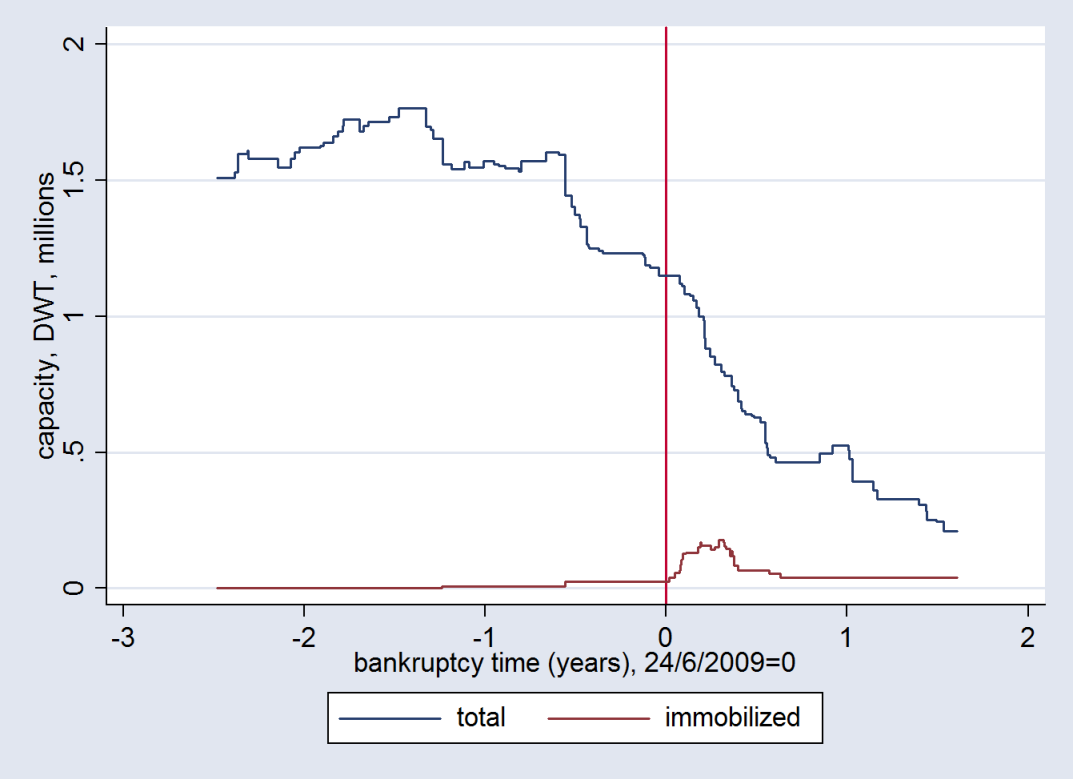

Figure 3: Eastwind's Cycle of Distress. In this figure, we track Eastwind's cycle of distress on a daily frequency. The top (blue) line tracks the company's total capacity (in millions of DWTs) while the bottom (red) line tracks capacity that is immobilized due to arrest.

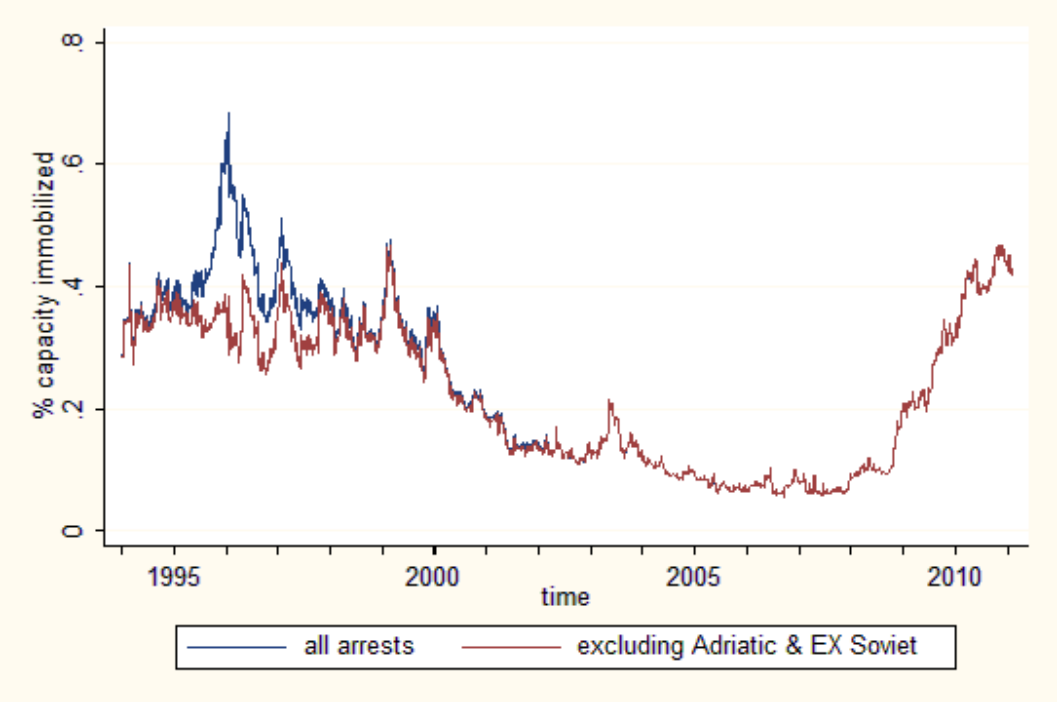

Figure 4: Capacity under Arrest as a Percentage of Total Capacity. In this figure, we track the amount of immobilized capacity (that is, capacity under arrest) as a percentage of total industry capacity, measured in DWT. The bottom (red) line excludes the bankruptcy of Adriatic Tankers and some ex-soviet companies that went bankrupt with old and sub-standard fleets following the break-up of the Soviet Union.

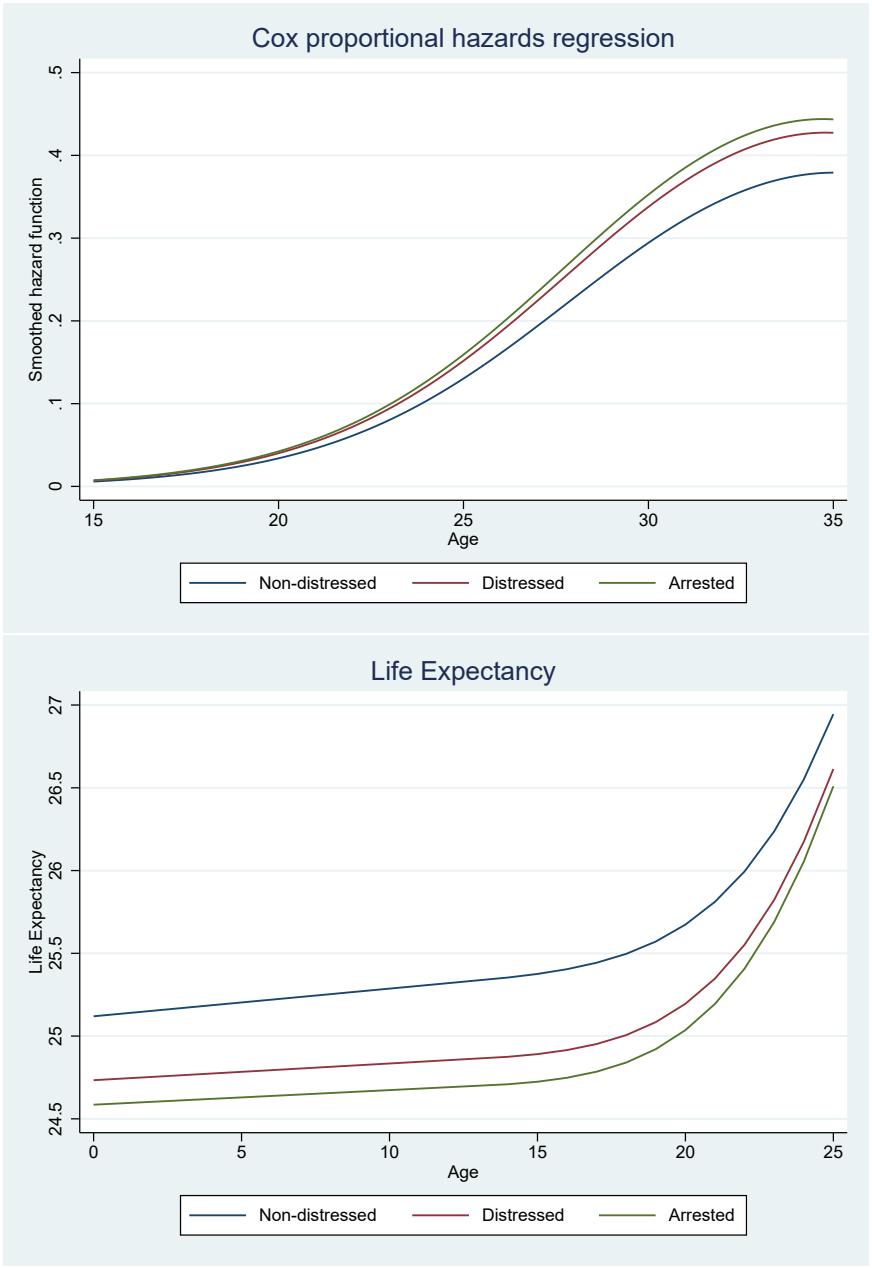

Figure 5: Hazard Rate and Life Expectancy for Arrested, Distressed and Non-distressed Vessels. In the top panel of this figure, we plot the probability of a breakup, i.e. hazard rate, for the arrested (green/top curve), distressed (red/middle curve) and non-distressed (blue/bottom curve) vessels at any given age. In the bottom panel, we plot the life expectancy of arrested (green/bottom curve), distressed (red/middle curve) and non-distressed vessels (blue/top curve).

Table 1: Vessel registration and beneficial ownership in some specialized flag states

This table reports the vessel registration and beneficial ownership details for the world fleet in 2020. Fleet statistics are reported for top flag states, and countries with highest share of beneficial ownership. *% World Fleet Registered* reports the number of vessels registered (or *flagged*) with a country as a percentage of the world's total fleet. *% DWT Registered* reports the proportion of world fleet (measured in units of deadweight tons) registered with a country. *% World Fleet Owned* reports the proportion of world fleet owned by firms belonging to a given country. *% DWT Owned* reports the proportion of world fleet (measured in units of deadweight tons) with beneficial ownership in the country.

	(1)	(2)	(3)	(4)
	% World Fleet Registered	% DWT Registered	% World Fleet Owned	% DWT Owned
Flags Specialized for Registration				
Panama	12.8%	15.9%	0.2%	0.2%
Liberia	8.8%	14.1%	0.0%	0.0%
Marshall Islands	8.7%	13.5%	0.2%	0.1%
Hong Kong	6.2%	11.0%	3.0%	3.5%
Singapore	5.6%	7.1%	3.8%	3.9%
Malta	4.8%	6.0%	0.1%	0.1%
Top 6 flags states	46.9%	67.6%	7.3%	7.8%
Others	53.1%	32.4%	93%	92%
High Beneficial Ownership Countries				
China	5.7%	3.8%	11.7%	14.3%
Greece	1.4%	3.6%	10.0%	17.9%
Japan	4.4%	2.0%	13.8%	14.5%
South Korea	1.9%	0.8%	3.7%	4.4%
Germany	0.5%	0.5%	5.7%	3.9%
USA	0.5%	0.5%	2.4%	3.4%
Top 6 ownership states	14.4%	11.2%	47.3%	58.4%
Others	85.6%	88.8%	52.7%	41.6%

Table 2: Arrest and traffic activity in some specialized and high volume ports

This table reports the arrest and traffic activity in some arrest specialized ports and high volume ports. Six countries stand out for the effectiveness of their arrest procedure: Gibraltar, Hong Kong, Singapore, South Africa, the Netherlands and the UK. This table considers all the 3,470 vessel arrest cases from 1995-2020. *N (Arrests)* reports the number of arrests by each port. *% Arrests* reports arrests as a percentage of total arrests. *% Traffic* reports the traffic on the port as a percentage of global shipping traffic. *Duration of Arrest (days)* measures the average length of time taken by the port to resolve an arrest. *Age (years)* reports the average age of vessels that were arrested at a port. *Size (DWT)* reports the average size (measured in deadweight tons) of vessels that were arrested at a port. *Hedonic Value ($ million)* reports the average estimated price of vessels that were arrested in a port.

	(1) N (Arrests)	(2) % Arrests	(3) %Traffic	(4) Duration of Arrest(days)	(5) Age (years)	(6) Size (DWT)	(7) Hedonic Value ($ million)
Arrest Specialized Ports							
Singapore	427	12.3%	5%	84	13.00	55,336	10.22
Netherlands	267	7.7%	2%	119	15.40	34,610	11.38
UK	181	5.2%	1%	63	17.02	24,251	6.30
Hong Kong	104	3.0%	2%	102	14.68	47,638	12.62
Gibraltar	98	2.8%	0%	88	15.84	48,180	8.24
South Africa	90	2.6%	1%	103	15.94	45,384	9.74
Top 6 arrest specialized ports	1,167	33.6%	11%	92	18.03	43,718	9.89
Others	2,303	66.4%	89%	213	18.03	31,779	6.90
High Volume Ports							
China	30	0.9%	28%	173	16.10	50,229	7.10
USA	171	4.9%	7%	75	12.48	36,883	13.65
South Korea	39	1.1%	4%	180	14.56	33,670	10.68
Malaysia	60	1.7%	3%	83	20.00	31,214	5.48
Japan	6	0.2%	3%	46	10.83	19,786	15.99
Germany	28	0.8%	2%	226	17.07	35,014	10.65
Top 6 high volume ports	334	9.6%	47%	110	14.75	36,224	11.04
Others	3,136	90.4%	53%	174	17.16	35,751	7.61
All Arrests	3,470			170	16.93	35,798	7.89

Table 3: Organization of ownership structure in the shipping industry

This table describes the holding company and subsidiary level ownership structure of shipping firms. We classify the shipping firms based on the size of their fleet. The unit of observation is at the holding company level. Columns (1)-(3) report the fleet and subsidiary information for *All Firms* in our sample. In columns (4)-(6), we restrict our sample to holding companies (or firms) that own at least 2 vessels (*Firms: Fleet>= 2 vessels*). In columns (7)-(9), (10)-(12), and (13)-(15), we restrict our sample to holding companies that own at least 5, 10, and 50 vessels, respectively. *Number of vessels* reports statistics (median, mean, and standard deviation), on the number of vessels owned by the holding company. *Number of silos* refers to the number of separate silos (registered owners/subsidiaries), operating under the holding company. *Vessels per silo* reports statistics on the number of vessels owned by each subsidiary of the holding company. *Fleet Age* is calculated as the average age (in years) of all vessels owned by the holding company. *Fleet DWT* measures the average size (in deadweight tons) of all vessels owned by the holding company. *Number of Firms* documents the total number of holding companies in each fleet size category.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
	All Firms			**Firms: Fleet>= 2 vessels**			**Firms: Fleet>= 5 vessels**			**Firms: Fleet>= 10 vessels**			**Firms: Fleet>= 50 vessels**		
	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD
Number of Vessels	3	6.98	15.39	5	9.99	18.15	9	16.83	23.29	17	27.14	29.52	69	87.62	52.98
Number of Silos*	1	4.38	10.71	2	6.08	12.79	5	10.05	16.86	10	16.18	22.08	51	52.62	44.00
Vessels per Silo	1	2.18	3.07	1.6	2.78	3.62	1.67	3.71	4.78	1.67	4.54	6.25	1.2	5.85	10.12
Fleet Age	13.67	16.63	9.91	12.6	14.86	8.40	11.63	13.34	6.99	10.82	12.07	6.02	10.21	10.79	4.16
Fleet DWT	8,592	27,874	41,142	13,920	33,185	43,192	28,153	42,444	46,727	40,343	51,138	48,343	72,759	75,919	55,316
Number of Firms		5,012			3,333			1,717			858			98	

Total number of vessels	34,988
Total number of silos	21,790
Silos with 1 vessel	18,699

*Separate registered owners/subsidiaries for ships

Table 4: Crew abandonment incidents and vessel arrests

This table reports incidents of seafarers' abandonment by the owner of the vessel. Panel A, reports our full sample of abandonment incidents. In Panel B, we split abandonment incidents by their resolution: that is, whether the vessel was arrested (*Arrested Vessels*), or if it was not arrested (*without vessel arrest*). *Abandonment incidents* reports the total number of abandonment incidents in our sample period, and *Seafarers abandoned* reports the total number of crew members that were abandoned on these vessels. *Vessel age (years)* reports the age of the vessel at which the its crew members were abandoned. *Vessel size (DWT)* reports the size of the abandoned vessel in deadweight tons. *Hedonic Value ($ million)* estimates the market price of the abandoned vessel, in the year of its abandonment. The variable *Salvage Value* measures the depreciation of a vessel, and is estimated by the proportion of vessel's current market value as a fraction of its replacement value (i.e. the current market price of an identical new vessel). The last column reports the p-values for mean comparison tests between the abandoned vessels that were arrested, and those that were not arrested, without the assumption of equal variance

Panel A	**All Incidents**						
Abandonment incidents	681						
Seafarers abandoned	10,197						
Vessel characteristics	Median	Mean	SD				
Vessel Age (years)	25.00	25.34	11.35				
Vessel Size (DWT)	4,469	12,176	26,381				
Estimated hedonic value ($ million)	1.48	2.71	5.06				
Salvage Value	0.15	0.20	0.18				
Panel B	**Crew Abandonment incidents classified by resolution**						
	Arrested Vessels			Without vessel arrest			Difference
Abandonment incidents	117			564			
Seafarers abandoned	631			9,566			
Vessel characteristics	Median	Mean	SD	Median	Mean	SD	p-value
Vessel Age (years)	20	19.76	7.22	27.00	26.43	11.80	0.0000
Vessel Size (DWT)	14,958	27,700	48,837	3,407	8,896	16,755	0.0000
Estimated hedonic value ($ million)	3.26	3.97	3.06	1.20	2.39	5.41	0.0048
Salvage Value	0.21	0.26	0.16	0.12	0.19	0.18	0.0001

Table 5: Description of Oil Spills

The table describes the statistics for serious casualty incidents causing marine pollution and oil spills. Panel A reports our sample of serious casualty incidents that resulted in oil spills from 1980-2020, listing their causes and vessel characteristics. *Vessel age (years)* reports the age of the vessel at the time of the incident. *Vessel size (DWT)* reports the size of the vessel in deadweight tons. *Hedonic Value ($ million)* estimates the market price of the vessel involved in the accident. The variable *Salvage Value* measures the depreciation of a vessel, and is estimated by the proportion of vessel's current market value as a fraction of its replacement value (i.e. the current market price of an identical new vessel). Panel B, reports the summary statistics for flag-level casualty incidents, fleet size, and governance variables. *Number of Incidents* refers to the total annual number of casualty incidents by vessels registered in a particular flag. *ln(Total Fleet Registered in DWT)* refers to the log of total annual tonnage (in DWT) of vessels registered with a particular flag. The *Law and Order Index* from ICRG measures the quality of law enforcement in the flag state, and a high index implies better rule of law. The *Corruption Index* from ICRG measures the level of corruption in the flag state, and a high index implies low corruption in the government. *Targeted Flag* takes value 1 if in a given year the flag state was targeted by the port state control authorities (i.e. by Paris MoU, Tokyo MoU, or USCG). Panel C splits the sample of flag-level casualty, fleet, and governance indices between targeted flags (Targeted Flag = 1) and non-targeted flags (Targeted Flag = 0).

Panel A	**Serious Casualty Incidents resulting in Oil Spills**		
Number of Casualty Incidents		33,242	
Cause of Incident			
Hull/Machinery Damage		44%	
Collision/Contact		23%	
Stranding/Grounding		22%	
Fire/Explosion		10%	
Vessel characteristics	Median	Mean	SD
Vessel Age (years)	17.00	17.84	10.00
Vessel Size (DWT)	6,929	21,421	38,559
Estimated hedonic value ($ million)	2.85	6.67	12.31
Salvage Value	0.29	0.35	0.24

Panel B	**Flag Level Casualty Incidents**		
	Median	Mean	SD
Number of Incidents	1	6.64	15.82
ln(Total Fleet Registered in DWT)	13.28	12.99	2.86
Law and Order Index	4	3.70	1.48
Corruption Index	3	3.00	1.36
Targeted Flag	0	0.22	0.41

Panel C	**Casualty Incidents for Targeted Flags**					
	Targeted Flag = 1			Targeted Flag = 0		
	Median	Mean	SD	Median	Mean	SD
Number of Incidents	4	11.61	22.35	0	4.22	10.41
ln(Total Fleet Registered in DWT)	14.22	14.40	1.87	12.05	12.09	3.19
Law and Order Index	4	3.65	1.11	4	3.78	1.42
Corruption Index	2	2.24	0.87	2.5	2.80	1.25

Table 6: Describing Capacity under Arrest

This table reports the capacity under arrest as a percentage of total industry capacity. Panel A describes the results for the entire sample. Panel B reports the characteristics of sales by firms with arrested fleet. Panel C reports the characteristics of sales by financially distressed firms. *Total capacity* measures the entire capacity of the industry in 2 units. Total capacity in vessel years, is calculated by multiplying the average age of the vessels with the total number of vessels in service. Total capacity in DWT years (10^6), is calculated by multiplying the average DWT of the vessels with the total number of vessels in service. *Number of arrest events* reports the total number of arrest events in our sample period. *Avg. duration of arrest (in years)* measures the average time it takes for a port to resolve an arrest event. *Capacity under arrest* measures the arrested capacity in 2 units: vessel years and DWT years. In vessel years, it is calculated by multiplying the average years vessels spend in arrest with the total number of arrested vessels. In DWT years (10^6), it is calculated by summing over the product of DWT of arrested vessels and average years spent by the vessel in arrest (for all arrests). *Probability of arrest* is estimated by dividing capacity under arrest with total capacity of the industry. *Age of vessel (years)* reports the current age of the vessel (for *Entire Industry*), or its age at arrest (for *Arrested vessels*). Similarly, *Vessel size (DWT)* reports the size of the vessels in deadweight tons for each group. *Hedonic Value ($ million)* for the entire industry estimates the current market price of all the fleet in service. *Hedonic Value ($ million)* for an arrested vessel estimates the market price of the vessel, in the year of its arrest. The variable *Salvage Value* measures the depreciation of a vessel, and is estimated by the proportion of vessel's current market value as a fraction of its replacement value (i.e. the current market price of an identical new vessel). In Panel B, we identify distressed firms by the occurrence of an arrest event ($Arrest >= 1$), or multiple arrest events ($Arrest > 1$). *Number of vessel sales* reports the total number of fleet (arrested and non-arrested) sold by a distressed firm, and we report the characteristics of these vessels. In Panel C, we restrict our sample to financially distressed firms (that default on their debts and/or file for bankruptcy)

Panel A	**Full Sample**					
	Vessel Years			DWT years (10^6)		
Total capacity	291,693			28,595		
Number of arrest events	3,470					
Avg. duration of arrest (years)	0.465					
Capacity under arrest	1,615			58		
Probability of arrest	0.55%			0.20%		
	Entire Industry			Arrested Vessels		
Vessel characteristics	Median	Mean	SD	Median	Mean	SD
Age of vessel (years)	11	12.65	8.53	18	16.93	9.58
Size of vessel (DWT)	45,000	60,528	65,929	23,487	35,798	47,451
Hedonic Value of vessel ($ million)	8.08	10.91	11.48	4.64	7.89	10.30
Salvage Value of vessel	0.37	0.37	0.20	0.25	0.33	0.24
Panel B	**Downsizing by firms with arrested fleet**					
	Arrest>= 1			Arrest>1		
Number of vessel sales*	749			313		
Number of arrested vessels sold	299			137		
Vessel Characteristics at sale	Median	Mean	SD	Median	Mean	SD
Age of vessel (years)	11	11.96	7.51	10	11.39	7.38
Size of vessel (DWT)	30,950	45,539	52,312	23,840	45,525	62,781
Hedonic Value of vessel ($ million)	7.19	11.64	12.58	6.57	12.19	14.16
Salvage Value of vessels	0.41	0.45	0.24	0.46	0.48	0.24
Panel C	**Downsizing by financially distressed firms**					
Number of vessel sales*	399					
Number of arrested vessels sold	98					
Vessel Characteristics at sale	Median	Mean	SD			
Age of vessel (years)	16	14.45	7.70			
Size of vessel (DWT)	31,652	42,441	40,842			
Hedonic Value of vessel ($ million)	5.99	10.19	13.11			
Salvage Value of vessels	0.32	0.39	0.23			

*These include the sales of non-arrested ships during an arrest episode (distress event)

Table 7: The distribution of arrest rates for companies that went bust

This table focuses of *bust* companies, that disappeared from the ownership register following an arrest event. *Arrest Rate* is defined as the proportion of vessels arrested to the total number of vessels owned by the firm pre-distress (i.e. 18 months prior to the arrest of the firm's first vessel). The table reports the frequency and the percentage of companies that went bust using 6 different partitions of arrest rate. In columns (1) and (2), we condition on companies having at least 5 vessels pre-distress, and in columns (3) and (4) on companies having at least 10 vessels pre-distress.

	At least 5 vessels		At least 10 vessels	
	frequency	percentage	frequency	percentage
(0,20%)	82	49.7	50	62.5
[20%,40%)	48	29.1	14	17.5
[40%,60%)	19	11.5	9	11.3
[60%,80%)	9	5.5	4	5.0
[80%,100%)	5	3.0	3	3.8
100%	2	1.2	0	0
Number of bust firms	165	100	80	100

Table 8: Arrests, by trigger and resolution

This table reports the number of arrests triggered by various creditors, and how the arrest event was subsequently resolved. The classification is made on the basis of LLI narratives in conjunction with other information including data on transfer of ownership and, break-up of vessels.

		Party Triggering Arrest					
		crew	mortgage	other	unknown	unsecured	total
Resolution	auction	11	131	10	50	32	234
	break-up	11	59	39	38	21	168
	sale	20	123	57	126	42	368
	same owner	35	83	428	402	283	1231
	unknown	1		4	187	2	194
	total	78	396	538	803	380	2,195

Table 9: Hedonic Model, with and without quality correction

This table reports the results from the first stage hedonic regression as in equation 1. The dependent variable is log of the sales price of ships. Column (1) includes a range of characteristics of ships, defined in Appendix A1. Column (2) further includes the estimated life expectancy of ships. The regressions include ship type, ship size categories, vessel country of build, seller country, buyer country and year of sale fixed effects. Standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

	log(Sales Price)	
	(1)	(2)
Age	-0.060***	-0.027***
	(0.002)	(0.002)
Age^2	-0.0006***	-0.0025***
	(0.000)	(0.000)
log(DWT)	0.238***	0.255***
	(0.072)	(0.074)
log(Gross weight)	0.320***	0.327***
	(0.071)	(0.070)
Length	0.0005	0.0006
	(0.001)	(0.001)
Breadth	0.007*	0.008**
	(0.004)	(0.004)
Depth	-0.0005	-0.0008
	(0.005)	(0.005)
Draft	0.003	0.003
	(0.005)	(0.004)
Freeboard	0.000	0.000
	(0.000)	(0.000)
Block Sale	0.014*	0.010
	(0.008)	(0.008)
Single Hull	-0.089***	-0.077***
	(0.013)	(0.013)
Life Expectancy		0.209***
		(0.011)
Vessel Type FE	YES	YES
Year of Sale FE	YES	YES
Vessel Size Category FE	YES	YES
Vessel Build Country FE	YES	YES
Seller Country FE	YES	YES
Buyer Country FE	YES	YES
Observations	15,027	15,027
Adjusted R^2	0.873	0.878

Table 10: Fire Sale Discount: Difference between actual price and imputed price

This table reports the results from the second stage which regresses the price discount (residual from the hedonic regression) on a dummy indicating whether the ship is arrested (*Arrested*) or whether the owner is distressed (*Distressed*). Columns (1) and (2) use *Arrested* as the explanatory variable, without (W/O QC) and with quality correction (with QC) respectively. Quality correction means including life expectancy as an explanatory variable in the first stage hedonic regression. We classify the other (non-arrested) sales by firms with at least one arrest episode in the 3 year event window straddling the arrest as *Distressed*(>= 1) sales. In columns (3) and (4), we restrict *Arrested*(> 1) to arrested vessel sales by firms facing multiple arrest (more than one) events in a 3 year event window straddling the arrests. We classify the other (non-arrested) sales by firms with multiple arrest episodes in the 3 year event window straddling the arrests as *Distressed*($Ar > 1$) sales. In columns (5) and (6) we restrict *Arrested*(*Financial*) to arrested vessel sales by firms identified as being financially distressed. Financially distressed firms are identified as those shipping firms that have defaulted on their debts, and/or are operating under bankruptcy. *Distressed*(*Financial*) refers to the other (non-arrested) sales made by financially distressed firms. Standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

	W/O QC	With QC	W/O QC	With QC	W/O QC	With QC
	(1)	(2)	(3)	(4)	(5)	(6)
Arrested	-0.227***	-0.108***				
	(0.032)	(0.032)				
Distressed(>= 1)	-0.152***	-0.070***				
	(0.025)	(0.025)				
Arrested (> 1)			-0.217***	-0.095**		
			(0.050)	(0.048)		
Distressed (Ar> 1)			-0.196***	-0.127***		
			(0.044)	(0.045)		
Arrested (Financial)					-0.252***	-0.122***
					(0.042)	(0.042)
Distressed (Financial)					-0.140***	-0.090***
					(0.029)	(0.029)
Constant	0.003	0.001	-0.000	0.000	0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	15,239	15,239	15,239	15,239	15,239	15,239
Adjusted R^2	0.009	0.002	0.004	0.001	0.006	0.002

Table 11: Fire Sale Discount: Institutional Quality of the Port of Arrest

This table reports the results from the second stage which regresses the residual from the hedonic regression on an indicator variable that takes on a value of 1 if the ship is arrested and 0 otherwise. Column (1) and (2) report the raw fire sale discounts, while columns (3) and (4) report the quality adjusted fire sale discounts. We further split the sample of arrested ships into high corruption (columns (1) and (3)) and low corruption (columns (2) and (4)) ports. *** denotes significance at 1%, ** at 5%, and * at 10%.

	Raw Fire Sale Discount		Quality-adjusted Discount	
	High Corruption	Low Corruption	High Corruption	Low Corruption
	(1)	(2)	(3)	(4)
Arrest	-0.274***	-0.192***	-0.156***	-0.081**
	(0.044)	(0.038)	(0.044)	(0.038)
Constant	0.001	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
Observations	14,300	14,664	14,300	14,664
Adjusted R^2	0.004	0.003	0.001	0.001

Table 12: Fire Sale Discount: Business Cycles

This table reports the results from the second stage which regresses the residual from the hedonic regression on an indicator variable that takes on a value of 1 if the ship is arrested and 0 otherwise. The sample is divided into three subsamples based on industry cycles (value of the annual Baltic Dry Index): Low index, Regular Times, and High Index. Columns (1)-(3) report the results without quality correction (W/O QC) for the low index, regular times and high index subsamples, respectively. Column (4)-(6) report the quality adjusted fire sale (With QC) discounts in the three subsamples. *Number of arrested vessel sales* reports the number of arrested vessels sold during low index, regular times, and high index. Standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

	Raw Fire Sale Discount			Quality-adjusted Discount		
	Low Index	Regular Times	High Index	Low Index	Regular Times	High Index
	(1)	(2)	(3)	(4)	(5)	(6)
Arrest	-0.260***	-0.232***	-0.131*	-0.145**	-0.102**	-0.041
	(0.060)	(0.044)	(0.071)	(0.058)	(0.044)	(0.071)
Constant	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)	(0.004)
Observations	3,865	4,046	7,328	3,865	4,046	7,328
Number of arrested vessel sales	115	147	37	115	147	37
Adjusted R^2	0.007	0.010	0.001	0.002	0.002	0.000

Table 13: Governance of Flags states and Oil Spills

The table shows how the governance standards of the flag state affect the number of casualty incidents. The dependent variable *Number of Casualty Incidents* aggregates the total annual number of serious casualty incidents by vessels registered by a particular flag. *ln(Total Fleet Registered)* refers to the log of total annual tonnage (in DWT) of vessels registered with a particular flag. The *Law and Order Index* measures the quality of law enforcement in the flag state, and a high index implies better rule of law. The *Corruption Index* measures the level of corruption in the flag state, and a high index implies low corruption in the government. *Targeted Flag* takes value 1 if in the flag state was targeted by the port state control authorities (i.e. by Paris MoU, Tokyo MoU, or USCG) in the year prior to the incident. Year fixed effects are included in all specifications. The unit of observation is flag-year (flag i and year t). Robust standard errors are reported in parentheses. *** denotes significance at 1%, ** at 5%, and * at 10%.

	Number of Casualty Incidents$_{i,t}$		
	(1)	(2)	(3)
Law and Order Index$_{i,t-1}$	-1.028***		
	(0.189)		
Corruption Index$_{i,t-1}$		-0.475**	
		(0.189)	
Targeted Flag$_{i,t-1}$			1.579**
			(0.647)
ln(Total Fleet Registered)$_{i,t}$	3.093***	2.962***	2.390***
	(0.145)	(0.136)	(0.108)
Year FE	YES	YES	YES
Observations	3,946	3,946	3,142
Adjusted R^2	0.314	0.308	0.307

Appendix

A.1 A Tale of Two Shipping Bankruptcies

In this section we review two shipping companies that entered bankruptcy, Eastwind and Hanjin Shipping. Eastwind entered Chapter 7 in the US while Hanjin Shipping entered bankruptcy procedures in South Korea and in the US. We chose these two companies because they illustrate in one case a very orderly disposal of assets without significant coordination failures and in the other case, a disorderly disposal of assets. The empirical part of our paper is aimed at resolving the question as to which case study better characterizes the outcome of financial distress in this industry.

A.1.1 Eastwind

The distressed New York based shipping company Eastwind owned, at the time of default, around 90 vessels. Nordea, a Scandinavian bank with an extensive portfolio of maritime loans, had double mortgages on 12 of Eastwind's vessels. These mortgages entitled the company to acquire ownership of the vessels in the event of default. To facilitate these rights, the board members of each of these subsidiaries had pledged, at the time of loan origination, signed but undated resignation letters. In the event of default, the lender could date those letters replacing the board with its own appointees thereby facilitating a rapid and unopposed transfer of ownership and the sale of the ships to a third party.

Although Eastwind was delinquent, Nordea made many attempts to restructure the distressed company without repossession. However, at some point it received news that Eastwind was about to file for bankruptcy in the US. Fearing the direct legal costs as well as the dilution of their rights in bankruptcy,[38] Nordea declared Eastwind in default on June 21, 2009. At the same time they dated the resignation letters of the current Eastwind directors, and appointed new directors for each of the subsidiaries. Simultaneously, the new directors approved the sale of the twelve ships, on behalf of the bank, to Samama's Draften Shipping, a company controlled by the Ofer family. We are informed that the value of the proceeds of sale were more than $50 million.

Eastwind filed for Chapter 7 bankruptcy one day later on June 22. The Chapter 7 Trustee sued Nordea on the grounds that the ships belonged to the bankruptcy estate and were subject to the automatic stay, and therefore Nordea was not entitled to sell the ships. The judge decided that the sale by Nordea of the subsidiaries was valid, and that the pre-default managers lacked the appropriate authority to file for bankruptcy.[39]

There are several issues that this case clarifies. First, that Nordea did not have to arrest the vessels in a port in order to gain control of its collateral and sell the vessels. The immediate sale of vessels on the high seas avoided the cost of sailing the vessels to a port to arrest and auction the vessels. This saved

[38]The fact that Eastwind was an American company is not a prerequisite for a filing of bankruptcy in the US. Any debtor with assets in the US can file for US bankruptcy. In re Theresa McTague, Debtor, 198 B.R. 428. July 15, 1996, a precedent was established to the effect that a non-US company holding a US bank account with $194 qualifies

[39]The case was settled with Nordea paying the trustee $750k, in return for the Trustee's recognition that the sale was valid.

the direct costs of arrest and auction, which we have estimated below at 8% of the vessels value, but it also saved the costs of immobilising the vessels and the opportunity to charter out the vessels. Second, had Nordea delayed by just a day, the entry of Eastwind into US bankruptcy would have triggered an 'automatic stay' on the assets by a US court, with a corresponding delay to the recovery of Nordea's debt and the potential dilution of their claims. Even so, Nordea still had the option of arresting the vessels in a non-US port, despite entry of the company into Chapter 7 and the automatic stay, but that might have placed Nordea in conflict with the US court.[40] The ruling in this case highlights the potential for jurisdictional conflict that the shipping industry has faced on the enforcement of creditor rights. It also shows that although the industry has largely managed to distance itself from national jurisdictions, in a way described below, it has not achieved full separation.

While we have discussed the sale of Eastwind's twelve ships, it is also important to report evidence of coordination failures across its entire fleet of ships. The top line in Figure 3 tracks the company's total capacity (in millions of DWTs) while the bottom line tracks capacity that is immobilized due to arrest. The two time series are plotted against "bankruptcy time," with zero being the day of the Chapter 7 filing. Several points merit elaboration. First, Eastwind started to downsize at least a year before it filed for bankruptcy. That downsizing was achieved with hardly any arrests. Presumably, at that time Eastwind still had equity in the vessels and was willing to cooperate with its creditors. Second, the arrest rate started to pick up following the bankruptcy filing, consistent with the hypothesis that financial distress leads to vessel arrests. Over the entire cycle, Eastwind divested around 1.5 million DWT, while the capacity under arrest amounted to roughly 0.2 million DWT-years. Hence, on average, 13% of the downsized capacity was immobilized for one year. Third, throughout Eastwind's decline, capacity under arrest was well below total capacity. Even at its peak, a few months after the Chapter 7 filing, the arrest to total capacity ratio was only 22%. This finding is not consistent with standard theories of a creditors run, whereby creditors driven by a first-mover advantage would grab any asset that has not already been seized by another creditor. It is consistent, however, with the view that once property rights are efficiently allocated to different mortgages and properly prioritized amongst all other creditors, coordination failures do not occur because no creditor can "jump the queue" by grabbing an asset.[41] We formally test this hypothesis in Section 3 on a large sample of vessel arrests, and a sample of shipping companies that went bust.

[40] In another case concerning Eastwind, the same federal judge refused to enforce the rights of another creditor. Upon Eastwind's default, the UK insurer to Eastwind had terminated the insurance of its vessels. The Trustee in Chapter 7 litigated against the insurers, arguing that under US law they were obliged to continue the insurance until the bankruptcy procedures were completed. The Trustee's reasoning was that without insurance, vessels away from the home port would be unable to complete their voyages or, the bankruptcy estate would have had to use its scarce funds to pay the insurance. The federal judge, while recognizing that an English court would likely rule in favor of the insurer, applied US law and ruled in favor of the trustee, contrary to the contract which specified that in the event of a dispute English law would apply. The judge dismissed the insurers claim that they did not anticipate such a result, on the grounds that "with more than 30 years experience with US bankruptcy law," they should have been aware of such an event and accounted for the consequences. By forcing the British insurers to continue the contract, their unpaid fees were pooled with other Eastwind's unsecured creditors, and subject to a "haircut."

[41] We do not exclude a run on an individual vessel, although with fewer creditors, this becomes easier to avoid.

A.1.2 Hanjin Shipping

A more recent bankruptcy, in August 2016, with quite different outcomes, is that of Hanjin Shipping. Hanjin was the seventh largest shipping company in the world operating with 142 ships, 38 under ownership and the rest under charter. Its business was badly hit by low freight rates, overcapacity in the industry and with bought-in charter contracts with very high daily charges, relative to their spot rates. Hanjin filed for bankruptcy in a number of jurisdictions, including South Korea and the United States, the latter under Chapter 15 of the US code which limited the court's jurisdiction to US-based assets. The Wall St Journal (October 13, 2016) stated that as a result of the bankruptcy, eight vessels had been arrested, 43 were at sea, and 39 were outside ports at risk of arrest.

While many of these problems were resolved within days or weeks of the filing, it is likely that significant costs were imposed on various stakeholders, particularly the cargo owners. For example, Reuters reported that the collapse caused 'worldwide supply chain and shipping disruption as cargo ships were left stuck at ports and canals waiting for cash payments.'[42] Another publication (Ocean Insights) claimed that the bankruptcy stranded more than $14 billion in cargo, ranging from televisions to textiles to spicy kimchi, scattered all over the globe, and represented 3.2% of the world's global container capacity. This case illustrates the costs of externalities associated with the failure of large firms.[43]

It was largely the unplanned nature of the bankruptcy and the way Hanjin was financed that precipitated the crisis and contributed to the costs.[44] The bankruptcy was triggered by a refusal of Hanjin's shareholders and main creditor banks to re-negotiate an out of court restructuring. It is highly likely that they did not internalise the costs of supply chain disruption; nor, could those affected by the disruption, particularly the owners of the cargo, coordinate in a timely manner and participate in any out of court restructuring with creditors. It is likely that an automatic stay and debtor in possession financing would have avoided some of those costs to Hanjin's creditors and customers. The case raises the important question whether state sponsored bankruptcy codes are desirable, and whether they should be made mandatory or optional.[45]

[42] See "Hanjin Shipping files for receivership, as ports turn away its vessels." Reuters. 31 August 2016.

[43] See "Lessons Learned From Hanjin collapse-visibility is the key to success", Matthias Dyck, Oct 18, 2017

[44] A significant part of Hanjin's debt was on a recourse basis, an issue discussed later. See "Lessons Learned From Hanjin Shipping's Bankruptcy", Peter S Goodman, Law 360

[45] Since 2011 there have been approximately ten shipping companies that have filed for Chapter 11 protection. The majority have been non-US companies with virtually no assets in the US, for example, Genco Shipping and Marco Polo Seatrade (see Thomas J. Belknap, 2013, Does Chapter 11 Work for Foreign Shipping Companies, Maritime Reporter and Engineering News, April.) In all, the ten companies that filed for Chapter 11, only those companies that filed with creditor support succeeded in maintaining the company as a going concern. Those companies that filed without creditor support were liquidated (see 'Creditor Support Essential for Smooth Sailing in Shipping Restructurings,' Scott Greissman, White & Case LLP, Marine Money, October/November 2016). In six cases, the company filed without secured creditor support, and 'all vessels were ultimately sold or returned to the applicable secured lenders' (see Greissman, 2016). In four cases, for example Nautilus Shipping, the companies filed with support from secured creditors. These filings were accompanied by pre-packaged plans of reorganization, emphasizing the consensual nature of the reorganization. They were 'large or more complex/non traditional corporate capital structures.' Importantly, these cases attracted support from new investors or existing lenders. One interpretation of these cases is that major creditors have used these State-sponsored procedures voluntarily, as a substitute for private recontracting. It may be that off the shelf standardized procedures provide a low cost way of executing such plans. In this respect, State procedures may provide standardized contracts, which are cheaper than private contracts and which are less open to legal challenge. Such State contracts also avoid the free riding that accompanies contractual innovations. An example was the floating charge privately introduced as part of a debt contract in England in the 19th century and still in widespread use today. The contract was challenged in the courts, and its refinement and standardization took decades to complete (see Franks and Sussman, 2005).

A.2 Direct costs of arrests and auctions in UK ports

A.2.1 Direct Costs of Arrests

While the loss of income is the main cost of immobilization, it is not the only one. There are additional direct costs due to port fees, crew wages and supplies while in port, court costs, brokerage fees etc. The existence of these additional fees does not change the analysis: in a perfect Coasian world there would be no arrests and, therefore, no additional costs of arrest. For the sake of completeness, however, we used the files of the Admiralty Marshall (the agency responsible for executing arrest warrants) in London to hand collect data for 22 vessel arrests in England over the 1995-2010 period. The results are described in Table A.3: the median period for which the vessel was immobilized was 71 days or about two months (much lower than the sample mean). The median direct costs of arrest are 8% of the sale price. Consistent with the observation that arrested vessels tend to be small, the median sale value of a vessel is only $1 million, compared with an average value of ships sold of $9 million dollars for our entire sample. The costs of immobilization are not particularly small when we take into account the fact that these do not include the loss of any forgone income during arrests. Bris, Welch and Zhu (2006), in an analysis of direct and indirect costs of US bankruptcies, state "Bankruptcy costs are very heterogeneous and sensitive to the measurement method used...". They document a range of 2% to 20%. Our estimates of direct costs for shipping lie within this range.[46]

A.2.2 Auctions

An important result in this paper is that auctions of arrested ships result in low fire sale discounts after corrections for under-maintenance and for low quality ports. A key issue here is how efficient the auction process is in high quality ports. One aspect of efficiency is the number of bidders for a vessel that is being auctioned. Using the same hand-collected sample of UK auctions used in Table A.3, Table A.4 shows that the average number of bidders is high at 8, which is consistent with the view that the second-hand vessel market is liquid. In one case, the number of bidders reached 23. The bids come from all over the world. However, the spread between the top two bidders is large, 24% on average.

The liquid market in these auctions reflects the sophisticated dealer network, where dealers are long established and therefore can more easily communicate with potential buyers. Some of these dealers, for example CW Kellock, have been trading in this market for more than 100 years. The ability to survey a ship quickly and accurately, possibly in a distant port, expedites the process of sale. This is particularly important because many of the arrested vessels might have defects and will be of low quality.

A.3 Description of Seafarer Abandonment cases

Here we describe in detail, the 3 examples from the Adriatic fleet cited by the IMO report.

[46] They cite much longer periods for both Chapter 7 and Chapter 11 bankruptcies. The average time spent in a Chapter 11 bankruptcy is 828 days (median time is 866 days)and 709 days (median time is 672 days) for Chapter 7 bankruptcies.

Annapurna - The vessel flying the Panama flag was abandoned on the ports of Dubai. Crew left for two years on board an arrested vessel. The agent became party to the arrest and decided to stop supplying the ship. The crew survived thanks to the local Mission to Seamen. US Trust (one of the creditors) took charge of the case in early 1996. Conditions of living on board improved dramatically following the visit of a US Trust surveyor and the crew - even ex-crew were later paid and repatriated. Some crew remained on board to take vessel to Hong Kong and they were then paid in full and repatriated from there.

Assos Bay - In November 1994 the crew on board this VLCC were abandoned outside the port limits off Fujairah, UAE. The agent decided to stop supplying the ship with fuel, water and food when the shipowner showed no interest in paying his debts to the agent. Crew were eventually paid and repatriated by the mortgagee bank (US Trust) in November 1995.

Cape Breeze - After the arrest of the ship on behalf of the agents in June 1995 the ship was left with no supplies for the crew on board. In November 1995 the Burmese crew arrested the ship for unpaid wages and eventually were repatriated at the expense of the mortgagee bank. The ship remained under arrest in Valencia, Spain, and the crew remained unpaid until 1997 when the ship was auctioned. In October 1997 the proceeds of sale were remitted from Spain.

A.4 Vessel-related Variables

Age: Year since year of build at sale.
Block: Indicator which equals to 1 if the vessel is part of a block sale of several vessels, and zero otherwise.
Special Unit: Types of container units, including dry storage container, tanks, drums, car carriers, etc.
DWT: Deadweight tonnage of a vessel.
Gross Weight: The weight of the cargo plus the weight of the container, trailer, shipment or packaging.
Length: The maximum length of a vessel's hull measured parallel to the waterline Breadth extreme The maximum breadth including all side plating, straps, etc.
Depth: The vertical distance between the moulded base line and the top of the beams of the uppermost continuous deck measured at the side amidships.
Draft: The vertical distance between the waterline and the bottom of the hull (keel), with the thickness of the hull included.
Freeboard: The vertical distance from the waterline to the upper deck level.

A.5 Life Expectancy Estimates from Cox Regression

In the main specification, life expectancy is calculated separately for the arrested and the non-arrested group, based on the distribution of vessels' age at death, regardless of their characteristics. We can also calculate the ship-specific life expectancy after using Cox regression. Cox relative hazard regression yields estimation for coefficients ($\hat{\beta}$) on ship characteristics (X) and baseline hazard rate ($h_0(t)$). Therefore, $h_0(t) \times e^{\hat{\beta}' X}$ gives the predicted hazard rate for each ship, taken into effects of ship-specific characteris-

tics. We can further calculate ship-specific life expectancy based on the post-Cox predicted hazard rate. Concerned about the fact that there may be too much noise in the above predicted hazard rate and hence the new ship-specific life expectancy measure, we group vessels according to their vessel type (bulk carrier, fully cellular container, reefer, general cargo tramp, etc). Because of this grouping procedure, we state in the paper that we "partially" control for the characteristics of ships. We use several methods to group the vessels in order to reduce the noise in the estimation, and the main findings are robust to those different specifications.

Table A.1: Funding data for twenty seven vessels

This table reports capital structure information at vessel level from the accounts of 27 subsidiaries of 7 shipping firms registered in several jurisdictions. Statistics on five variables are reported, as listed in column 1. Source: Data supplied by a shipping consultancy firm.

	mean	median	min	max
maturity of loans (years)	7	6	4	12
loan amount ($, million)	43.5	51.3	14.7	70
loan/value (%)	64.8	70.1	44	76
balloon payments (n=25, $ million)	18.3	14.4	0	48.1
spread over LIBOR (%)	2.35	2.75	1.4	2.75

Table A.2: Comparison of Leverage in Shipping versus other Transportation Industries

This table compares the leverage ratio and interest rates on shipping loans versus other transportation loans. In columns (1) and (2), the dependent variable is the book leverage ratio (Total Debt/Total Assets). In columns (3) and (4), the leverage ratio includes capital and operational lease obligations. In columns (5) and (6), the dependent variable is the Interest Rate. The leverage ratio and interest rate are regressed on an indicator variable for whether the firm belongs to the shipping industry, and firm level controls such as asset tangibility and profitability. *Shipping Firm* is the indicator variable that takes value 1 if the firm is a shipping firm. The variable *Tangibility* equals Tangible Assets/Total Assets. *Profitability* is defined as operating income after depreciation scaled by (lagged) total assets. Country and year fixed effects are included. Source: Data is from COMPUSTAT (North America and Global)

	(1)	(2)	(3)	(4)	(5)	(6)
	Leverage Ratio	Leverage Ratio	Leverage Ratio	Leverage Ratio	Interest Rate	Interest Rate
	(W/O Leasing)	(W/O Leasing)	(With Leasing)	(With Leasing)		
Shipping Firm	0.046***	0.026***	0.047***	0.047**	-0.005***	-0.002**
	(0.002)	(0.002)	(0.017)	(0.020)	(0.001)	(0.001)
Tangibility		0.229***		-0.225***		-0.047***
		(0.008)		(0.036)		(0.002)
Profitability		-0.354***		-1.047***		-0.044***
		(0.017)		(0.121)		(0.006)
Year FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Observations	22,203	20,070	5,393	4,538	22,203	20,070
Adjusted R^2	0.103	0.185	0.020	0.276	0.103	0.179

Table A.3: Direct costs of arrests

This table reports the direct costs of arrests for 22 vessel arrests in England over the period 1995-2010. Column 2 shows the number of immobilization days, column 3 shows the sales price and column 4 shows the total cost as a percentage of sales price.

	Immobilization (days)	Sales price (USD, millions)	Total costs as % of sales price
mean	111	3.25	18%
median	71	1.09	8%
st.dev	165	8.16	30%
min	19	0.04	2%
max	835	38.65	105%
Observations	22	22	21

Table A.4: Auction data from UK ports

This table describes the number of bidders for vessels arrested and sold in UK ports. Column 2 reports the number of bidders, column 3 reports the spread between the top 2 bidders as a percentage of the sales price, and column 4 reports the spread between the top 3 bidders as a percentage of the sales price.

	No. of bids	Spread between Top 2	Spread between Top 3
mean	8.5	24%	30%
median	8	22%	31%
st. dev	4.9	20%	10%
min	1	1%	10%
max	23	79%	60%

Table A.5: Comparison of Fire Sale Discount across Asset Classes

This table lists the fire sale discounts reported by several papers across different asset classes in real assets and financial assets. The table also reports the quality-adjusted fire sale discounts for real assets.

Panel A		**Real Assets**			
Asset Class	Reason for Fire Sale	Raw Fire Sale Discount	Paper	Quality-Adjusted Fire Sale Discount	Paper
Ships	Arrested Sales	23%	This Paper	11%	This Paper
Houses	Foreclosures or Forced Sales	27%	Campbell et al.(2011)*	9%	Andersen et al.(2016)
Aircraft	Distressed Sales	15%	Pulvino(1998)	8%	Franks et al.(2020)
Aircraft	Sales in Chapter 11 Bankruptcy	20%	Pulvino(1999)	9%	Franks et al.(2020)
Aircraft	Sales in Chapter 7 Bankruptcy	30%	Pulvino(1999)	12%	Franks et al.(2020)

Panel B	**Financial Assets**		
Asset Class	Reason for Fire Sale	Fire Sale Discount	Paper
Equity	Forced stock sales by distressed Mutual Funds	8-10%	Coval et al.(2007)
Bonds	Downgraded corporate bond sales by constrained Insurance Firms	6-7%	Ellul et al.(2011)
Debentures	Hedge Fund deleveraging during 2008 crisis	10-15%	Mitchell et al.(2012)

*Campbell et al. (2011) extensively document that the discount on foreclosed homes could be due to vandalism and/or poor maintenance. In a separate set of non-foreclosed houses sold by old homeowners they document an 8-9% discount, which is interpreted as an under-maintenance discount as old people have lower incentives to maintain their homes.