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Evaluation of total risk exposure and insurance premiums in the maritime industry

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A B S T R A C T

The empirical evaluation of maritime risk exposure is based on the monetary value at risk (MVR) that incorporates individual safety quality data of about 130,000 vessels, insurable values related to various potential damages, and proxies for fractions of values lost at incidents. MVR provides a tool to enhance strategic planning of maritime administrations and insurance providers, which is illustrated by a high level comparison of annual risk exposure with insurance premiums for 2010–2014. The analysis reveals a global annual insurable value of 30.6 trillion USD with associated annual MVR of 38.8 billion USD for very serious and serious incidents. Although oil tankers show the highest risk exposure (1.75 million USD per tanker per year), safety qualities are found to be best for this ship type (1.4% annual incident risk) and worst for container vessels (2.8%). Annual growth rates in total risk exposure are mostly positive with highest value for dry bulk carriers (27.8%), whereas risk exposure tends to decline for pollution of oil tankers (−2.0%) and passenger vessels (−11.3%), and for loss of life of oil tankers (−1.9%) and dry bulk carriers (−1.4%). Comparison across administrative dimensions reveals that most risk exposure lies with old open registries and with beneficial owners and the Document of Compliance companies located in high income countries. Comparison with global insurance premiums suggests reasonably adequate coverage of maritime risks (excluding cargo) with underinsurance of risk by around 5% (about 1 billion USD per year), with some uncertainties remaining for actual loss fractions of the involved damages.

1. Introduction

The continual growth of international trade over the last decades caused increasing maritime activities with associated magnifications of risk. Shipping is exposed to ship economic cycles (Stopford, 2009), and economic pressure to minimize costs in downward cycles can affect safety at sea (Bijwaard and Knapp, 2009), implying upward trends in risk exposure in the maritime industry. The purpose of this study is to provide an empirical evaluation of total risk exposure expressed as the monetary value at risk (MVR). This concept was employed in Heij and Knapp (2012), but has been refined and extended here to allow for comparison with insurance figures from marine underwriters and Protection and Indemnity Insurance (P&I) Clubs. The main components of MVR consist of the individual safety qualities of vessels, the total insurable value of vessels, and proxies for fractions of various types of values that can get lost due to damages from shipping incidents.

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The total insurable value (TIV) of a vessel is defined in terms of the total insurable values of hull and machinery, cargo values, and insurance limits based on international conventions for marine liabilities including loss of life and pollution costs but excluding damages to marine ecosystems. The vessel-specific monetary value at risk is defined as the weighted average of potential damages of these values, with weights based on the conditional probability for each damage type (Knapp et al., 2011; Heij and Knapp, 2012) and on expected loss fractions per damage type. The associated incident and damage type probabilities for each vessel are estimated from empirical data based on a unique dataset covering the world fleet.

In our risk assessment, we distinguish between two levels of seriousness of shipping incidents, according to definitions from the International Maritime Organization (IMO, 2000). The first level is that of very serious (including total loss) and serious (TLVSS) incidents. This incident class has been identified as most relevant for the analysis of risk exposure in a wider context (Vander Hoorn and Knapp, 2015). Its applications include operational and strategic planning to mitigate risk exposure by means of risk control options, such as alerting for high risk vessels or situations, improved targeting of vessels for inspections, and developing risk prediction scenarios for planning and allocation of assets across large areas. The MVR based on TLVSS incidents can be interpreted as the potential damage value (expressed in USD) for given vessel risk profile and insurable values, which can be combined with other risk layers such as metocean conditions and vessel traffic densities. MVR can be used as risk exposure endpoint to quantity potential damages and it extends the currently usual basis of expected incident numbers in risk assessment routines (Eide et al., 2007; Friis-Hansen, 2008).

The second risk assessment level includes all types of shipping incidents, which provides the appropriate basis to compare MVR with insurance premiums from the International Union of Marine Insurance (IUMI) and the P&I Clubs. The main insurance categories reported by IUMI publicly each year are hull and machinery, transport cargo, and marine liability. Marine liability is primarily covered by the P&I Clubs and includes loss of life, pollution, and other third party liabilities. In order to compare premiums with risk exposure, the monetary values at risk are down-weighted by means of loss fractions specified per class of seriousness and per insurable value type. This kind of information is not readily available in the industry, so that scenarios for loss fractions will be based on empirical sources where possible and augmented by expert insights where needed.

It is worth noting that several factors complicate a direct comparison of premiums with actual risk exposure. Insurance is a global enterprise and involves many parties. It is believed that IUMI and the P&I clubs insure approximately 95 percent of all risk (Siddiqui and Verma, 2015), but public insurance figures provide only a partial view of total risk exposure. A portion of total risk exposure is not insured due to vessel retentions or deductibles that are not reported and that can vary depending on the insurance type and owner. Furthermore, damages to the marine ecosystem vary considerably (Kontovas et al., 2010) and some cannot be valued in monetary terms (Grey, 1999). For the pollution incident of the tanker ‘Prestige’ in 2002, for example, it has been estimated that only two percent of the long-term costs including environmental damages of 8.5 billion euro were paid out, so that the society at large had to pay 98 percent of the burden (Liu and Wirtz, 2006). Another more recent example is the pollution incident of ‘Sheng Neng 1’ in 2010 in the Great Barrier Reef, for which the Australian Commonwealth sought for compensation of 120 million AUD in damages of which only 39.9 AUD million could be recovered.

2. Data

The employed data consist of a unique combination of multiple sources and covers the years 2010 till 2014. The information used to estimate ship-specific incident and damage type probabilities combines world fleet ship-particular data, incident data, and inspection data. The database contains 509,838 observations of 130,307 individual vessels covering all relevant ship types. Inspection data consist of global port state control inspection outcomes, including deficiency information and detentions.

2.1. Incident data

Global information on 18,602 maritime incidents (24,567 including near misses, and 9549 TLVSS incidents) was combined from four different sources: IMO, IHS Markit, Lloyds List Intelligence Services (LLIS), and the Australian Maritime Safety Authority (AMSA). This combination provides the best possible coverage of incidents and reduces reporting biases for very serious and serious incidents (Hassel et al., 2011). The incident observations were manually reclassified for seriousness according to IMO definitions for very serious (including total loss), serious, and less serious (IMO, 2000), which are as follows. Very serious casualties (‘VS’) are casualties to ships involving total loss of the ship, loss of life, or severe pollution. Here severe pollution is defined as agreed by the Marine Environment Protection Committee (MEPC 37/22, paragraph 5.8), i.e., pollution that, as evaluated by the coastal state(s) affected or by the flag administration, as appropriate, produces a major deleterious effect upon the environment, or that would have produced such an effect without preventive action. Next, serious casualties (‘S’) are casualties to ships that do not qualify as very serious casualties and that involve fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking, suspected hull defect, and other, and that result in immobilization of main engines, extensive accommodation damage, severe structural damage such as penetration of the hull under water, rendering the ship unfit to proceed, or pollution (regardless of quantity), or a breakdown necessitating towage or shore assistance. Finally, less serious casualties (‘LS’) are casualties that do not qualify as very serious or serious casualties and that include hazardous incidents and near misses.