An integrated risk estimation methodology: Ship specific incident type risk

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Econometric Institute Report 2013-11

Abstract

Shipping activity has increased worldwide, including parts of Australia, and maritime administrations are trying to gain a better understanding of total risk exposure in order to mitigate risk. Total risk exposure integrates risk at the individual ship level, risk due to vessel traffic densities, physical environmental criteria, and environmental sensitivities. A comprehensive and robust risk exposure metric can be beneficial to maritime administrations to enhance mitigation of potential harm and reduce vulnerability to the marine environment as well as to safeguard lives and property. This report outlines an integrated methodology to estimate total risk exposure, with specific attention for the ship specific risk for different types of incident. Some related application aspects of the models are discussed.

Keywords: Total risk exposure, binary logistic model, incident models, company risk estimation, visualization of risk dimensions

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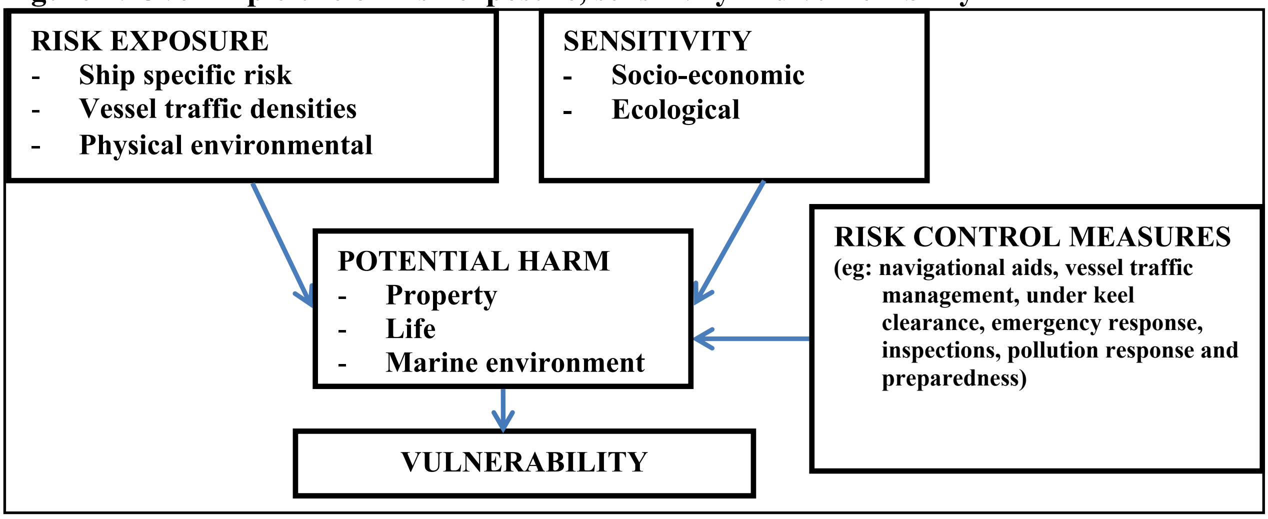
1. Introduction

Most global trade is carried by sea, and shipping activity has increased by more than 300% since 1970 (UNCTAD, 2011). Growth in shipping activity increases the risk to marine ecosystems from pollution, shipping accidents, and spills. Figure 1 presents the framework for an integrated risk methodology. Total risk exposure integrates risk at the individual ship level, risk due to vessel traffic densities and composition, and physical environmental criteria. Risk exposure combined with sensitivities can be used to measure potential harm to property, life, or the marine environment, which can be reduced by risk control measures. A comprehensive and robust risk exposure metric can be beneficial to maritime administrations to enhance mitigation of potential harm and reduce vulnerability to the marine environment as well as to safeguard lives and property.

Figure 1: Overall picture on risk exposure, sensitivity and vulnerability



The Australian Maritime Safety Authority (AMSA) has refined a set of econometric models (Mueller, 2002, 2007, Knapp, 2011, 2006) that allow the estimation of various types and degrees of seriousness of risk, such as the probability of detention and incident types at individual ship and company level. The estimated models do not test for causality but rather identify relations between observed variables. This report provides a summary of the underlying methodology, building on Knapp (2006), to estimate incident risk, a crucial component of ship specific risk.. The data are presented in Section 2, the model outcomes in Section 3, and the interpretation of these outcomes in Section 4. Finally, Section 5 presents application examples of the incident type probabilities, such as company specific incident type risk and the combination and visualization of risk dimensions.

2. Underlying dataset and variables for incident type models

The underlying sample data is a combination of ship particular data of the commercial world fleet, past inspection outcomes (number of deficiencies), and past ship incident data for the period January 2006 to December 2010. The data sources used for the analysis are IHS-Fairplay (IHSF), Lloyd's Maritime Intelligence Unit (LMIU), the Global Integrated Ship Information System (GISIS) of the International Maritime Organization (IMO), and the Australian Maritime Safety Authority (AMSA). Data preparation for modeling is very important with respect to classification of incidents and the preparation of the dataset in general. Global incident information was combined from four different sources, and duplicates were eliminated. The remaining incidents were manually reclassified according to IMO definitions for seriousness which are very serious (including total loss), serious, and less serious incidents, defined as follows (IMO, 2000):

- ***Very serious casualties (VS)****: are casualties to ships which involve total loss of the ship, loss of life, or severe pollution, the definition of which, as agreed by the Marine Environment Protection Committee at its thirty-seventh session (MEPC 37/22, paragraph 5.8), is as follows:*
    - *Severe pollution: is a case of pollution which, as evaluated by the coastal State(s) affected or the flag Administration, as appropriate, produces a major deleterious effect upon the environment, or which would have produced such an effect without preventive action.*

- ***Serious casualties (S)****: are casualties to ships which do not qualify as very serious casualties and which involve a fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking, or suspected hull defect, etc., resulting in:*
    - *immobilization of main engines, extensive accommodation damage, severe structural damage, such as penetration of the hull under water, etc., rendering the ship unfit to proceed, or pollution (regardless of quantity); and/or*
    - *a breakdown necessitating towage or shore assistance.*

- ***Less serious casualties****: are casualties to ships which do not qualify as very serious casualties or serious casualties and for the purpose of recording useful information also include marine incidents which themselves include hazardous incidents and near misses.*

AMSA's incident data provides some near misses which were kept separate and used in lagged format with less serious incidents. Besides manual reclassification per seriousness, incident initial events were identified when possible which forms the basis of the models. This allows a better distinction between incident initial events and consequences. Missing data was whenever possible complemented to improve data quality.

The initial variables in the models and their respective groupings were selected based on Knapp and Franses (2007), Bijwaard and Knapp (2009) and Heij et al. (2011) but are extended due to the new and unique combination of data. The groupings vary per incident type model. Depending on the amount of observations, variables are grouped to facilitate implementation. Due to the amount of variables with respect to the DoC company[2] and beneficial ownership, the individual companies cannot be incorporated directly in the models as individual variables. Their country of location was grouped using UNCTAD's classification (UNCTAD, 2010) providing an indication of the level of development of a nation. These groups are developed nations, countries in transition, developing countries, and a category for unknown country of residence. The groups allow accounting partially for the effect of the company and provide a better basis to estimate risk at individual company level where the estimated probabilities are used. The explanatory variables included in the models are the following:

- Ship type, age, and size (GRT) at the time of incident;
- Classification society, flag;
- Country where the vessel was built grouped into four groups as suggested by AMSA surveyors, and interaction effects with age groups (0-2 and above 14 years represent high age risk, while 3-14 years represent low age risk);
- DoC company and group beneficial[3] owner country of location classified according to country groups by UNCTAD;
- Number of deficiencies within 360 days prior to the incident;
- Number of incidents within 360 days prior to the incident;
- Double hull indicator for tankers;
- Changes of ship particulars overtime, such as flag changes, ownership changes, DoC company changes, class changes, and class withdrawals (within 3 years and within 5 years).

Deficiency history information was aggregated and classified according to AMSA deficiency groups as follows: 1) Ship Certificates and Documents, 2) Human Factor – Crew Certificates, 3) Human Factor – Living and Working Conditions, 4) Human Factor – Operational, 5) ISM and

[2] Approximately 8000 companies could be identified by IMO company number.
[3] Group beneficial ownership is defined by IHS- Fairplay.

Emergency Systems, 6) Life Saving Appliances, 7) Fire Fighting and Prevention, 8) Safety of Navigation and Communication, 9) Ship Structural and Machinery, 10) Pollution Prevention (split into noxious substances, air and all other.

3. Model combinations and model outcomes

The models are estimated using historical data of the world fleet and global incident data for the time period January 2005 to December 2010. A list of model types, dependent variables, and samples is given in Table 1. When possible, the incident type models are split up per seriousness and separate models are estimated.

Table 1: Overview of models, dependent variables, and samples

Dependent variable	Seriousness	Models	Data source
Total loss of vessel	VS	1	Combined global incident data
Loss of life (indicator)	VS	1	from IHS-Fairplay, LMIU,
Pollution (indicator)	All, VS, S	3	GISIS and AMSA with
Fire/explosion	VSS, VS, S	3	manual reclassification of
Collision	VSS, VS, S	3	incident type seriousness and
Contact	VSS	1	incident type first events
Wrecked/stranded/grounded	VSS, VS, S	3	
Other hull rel. incidents	VSS, VS, S	3	Depending on the amount of
Machinery related incidents	VSS, S	2	observations, separate models
Main engine failure	VSS, S	2	are estimated for total
Mobility failure	VSS	1	loss/very serious incidents
Equipment failure	VSS	1	than for serious incidents
Anchor and mooring failure	VSS	1	while less serious/near misses
Navigation.& communication equipment	All	1	are only included in the
Combined for all equipment failure	VS	1	Sample size: 278,194

VS = very serious (including total loss), VSS = very serious and serious combined, S = serious, All = all observations irrespective of seriousness

The base model used to estimate the detention and incident type models is the binary logistic model. The end product is a set of formulas which can be used to estimate detention and incident probabilities at the individual ship level. It has been demonstrated (Bijwaard and Knapp, 2009, Heij et al., 2011) that other models, such as duration analysis and the use of survival gains, provide alternative methods to quantify risk.

In all models considered here, the dependent variable (y) is binary, with two possible outcomes: "incident (1)" or "no incident (0)" Let x_i contain the explanatory factors such as age, size, flag, classification society, and owner, then the logit model postulates that $P(y_i = 1|x_i) = F(x_i\beta)$, where the weights β consist of a vector of unknown parameters and F is a cumulative distribution function (CDF). A popular choice is the CDF of the logistic distribution, which gives the well-known logit model. This model states that

$$P(y_i = 1 | x_i) = \frac{e^{x_i\beta}}{1 + e^{x_i\beta}} \qquad (1)$$

where $x_i\beta$ is a weighted average of all explanatory factors:

$$\begin{aligned} x_i\beta = {} & \beta_0 + \beta_1 \ln(\mathrm{AGE}_i) + \beta_2 \ln(\mathrm{SIZE}_i) + \sum_{k=1}^{n_3-1} \beta_{3,k}\, \mathrm{ST}_{k,i} + \sum_{k=1}^{n_4-1} \beta_{4,k}\, \mathrm{CL}_{k,i} + \beta_5\, \mathrm{CLInd}_i + \beta_6\, \mathrm{CLWdr}_i \\ & + \sum_{k=1}^{n_7-1} \beta_{7,k}\, \mathrm{FS}_{k,i} + \beta_8\, \mathrm{FSInd}_i + \sum_{k=1}^{n_9-1} \beta_{9,k} \mathrm{OWN}_{k,i} + \beta_{10}\, \mathrm{OWNInd}_i + \sum_{k=1}^{n_{11}-1} \beta_{11,k} \mathrm{DoC}_{k,i} + \beta_{12}\, \mathrm{DoCInd}_i \\ & + \sum_{k=1}^{n_{13}-1} \beta_{13,k}\, \mathrm{SY@AGE}_{k,i} + \beta_{14}\, \mathrm{HistA}_i + \beta_{15}\, \mathrm{HistB}_i + \sum_{k=1}^{n_{16}-1} \beta_{16,k}\, \mathrm{HistDef}_{k,i} \end{aligned}$$

The probabilities are estimated at the individual ship level (i), and the notation is explained in Table 2 (ℓ is the variable group counter, n_ℓ is the total number of classes within group ℓ, and k is an index from 1 to n_ℓ).

Table 2: List of variables

Variable	**ℓ**	**Variable description**	**Type**	**n_ℓ**
Ln(AGE)	1	Vessel age at the time of incident	C	1
Ln(SIZE)	2	Vessel size in gross tonnage	C	1
ST	3	Ship Type	D	6
CL	4	Classification Society at time of incident	D	3
CLInd	5	Indicates if classification society changed over time	D	1
CLWdr	6	Indicates if classification society withdrew	D	1
FS	7	Flag State at the time of incident	D	4
FSInd	8	Indicates if flag changed over time	D	1
OWN	9	Country of location of beneficial owner	D	4
OWNInd	10	Indicates if beneficial ownership changed over time	D	1
DOC	11	DoC Company at time of incident	D	4
DoCInd	12	Indicates if DoC Company changed over time	D	1
SY@AGE	13	Interaction variable of ship yard country with age	D	12
HistA	14	Past inspection history	C	1
HistB	15	Past incident history	C	1
HistDef	16	Past deficiency history	D	10

C = continuous, D = dummy for categorical variables

The coefficients are estimated by quasi-maximum likelihood (QML, Greene, 2000) to allow for possible misspecification of the assumed logistic CDF. Some summary statistics are presented in Appendix A.

4. Model results and interpretation

The main purpose of the models is to fit probabilities and to estimate the effect of explanatory factors on these probabilities. For variables with positive (negative) coefficient, the risk increases (decreases) if the variable gets larger values. Categorical variables (e.g. flag, class, ship types) are compared to a benchmark, usually the class that is most common. The models are simplified by omitting insignificant variables (at the 5% or 1% significance level). Table 3 summarizes the main outcomes of the incident risk models, where the attention is restricted to the highest level of seriousness of incidents. For most incident types, age increases the risk (except for collisions, where younger vessels are more risk prone). Ship size is significant for certain incident types and mostly increases the risk (except for main engine problems, where smaller vessels are more risk prone).

The effect of ship type is more often negative than positive, indicating that general cargo ships (the benchmark) are in most respects more risky than other ship types. This does not apply for incidents involving pollution and wrecked, stranded or groundings were no difference was found with respect to ship types. The variables indicating changes in ship particulars give mixed results. Class withdrawals increase the risk of incidents. Most combinations of where the vessel was built (country built) with age show a positive effect as compared to the benchmark (except for loss of life and equipment related incidents). Unknown country of location for DoC companies and ownership increases the risk. For developing nations and countries in transition, the results are mixed. Non IACS class or unknown class are not more risky than the benchmark (IACS class). With respect to flag groups, black listed flags provide extra risk for about half of the models.

Lagged deficiency and incident history mainly show positive signs towards incident type risk. Lagged very serious incidents and lagged serious incidents show a negative relationship with machinery related incidents and equipment related incidents (navigation/communication). For most other incident types, lagged serious and less serious incidents show a positive sign towards further incident type risks with the exception of incident types fire and explosion and collisions.

Lagged deficiencies which have been evaluated with predictive value are deficiencies found in the area of ISM, crew certificates and qualifications, ship certificates and documentation, Living and Working Conditions, operational deficiencies, Fire Fighting (FFP) and prevention, Radio Communications and Life Saving Appliances (LSA). Recall that the models do not test for causality. The deficiency types are evaluated for predictive value.

Table 3: Signs of estimated coefficients *(β)* for various incident type models

Variable evaluated	B-1 Total Loss	B-2a (VS) Loss of Live	B-3a (VS) Pollution	B-4 (VS) Fire and Expl.	B-5a (VS) Collision	B-5b (VSS) Contact	B-6 (VS) WSG
Age	+	ns	+	+	-	ns	+
Size (GRT)	+	+	ns	+	+	ns	ns
General cargo	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Dry bulk	-	-	ns	-	-	ns	ns
Passenger	-	+	ns	+	ns	+	ns
Tanker	-	-	ns	ns	-	-	ns
Container	ns	-	ns	ns	ns	ns	ns
Other ship types	ns	+	ns	ns	ns	ns	ns
Flag changes	-	ns	ns	ns	-	ns	ns
Classification changes	-	-	ns	ns	-	-	-
Class withdrawals	+	mixed	mixed	+	+	+	mixed
DoC company changes	-	ns	ns	ns	ns	ns	ns
Owner changes	-	ns	-	ns	ns	ns	ns
Country Built*Age	mixed	-	+	+	-	+	+
DoC-developed	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
DoC-in transition	-	-	ns	ns	ns	-	ns
DoC-developing	-	-	ns	ns	-	-	ns
DoC-unknown	+	+	ns	+	ns	+	+
OWN-developed	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
OWN-in transition	ns	+	ns	ns	ns	ns	ns
OWN-developing	+	+	ns	ns	+	-	ns
OWN-unknown	ns	+	+	-	+	ns	ns
IACS	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Non IACS	ns	-	ns	ns	ns	-	+
Unknown class	+	-	ns	ns	+	-	+
Flag - White	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Flag - Grey	+	ns	ns	ns	+	-	-
Flag – Black	ns	+	ns	+	ns	+	+
Unknown flag	ns	ns	ns	ns	ns	ns	ns
Lagged insp/det history	+	+	+	ns	+	+	ns
Lagged incident history	+(S)	+ (S)	+(S)	ns	ns	+(S),+(LS)	+(S)
Lagged deficiencies	mixed	mixed	mixed	+	mixed	ns	+
Lagged deficiency areas	ISM,LSA, Ship Cert.	LSA	Crew certificates Operational def.	Crew certificates	Safety of Navigation	ns	LSA

Variable evaluated	B-7 (VS) Hull/Deck	B-8a (VSS) Machinery	B-8b (VSS) Main Engine	B-8c (VSS) Mobility	B-9a(VSS) Equipment	B-9b(VSS) Anchor/mooring	B-9c(all) Navig/Comm.
Age	+	+	+	ns	+	+	+
Size (GRT)	ns	ns	-	ns	+	+	+
General cargo	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Dry bulk	-	-	-	-	ns	ns	+
Passenger	ns	+	ns	+	ns	ns	-
Tanker	-	-	-	-	-	ns	-
Container	ns	-	-	-	ns	-	ns
Other ship types	ns	-	-	ns	+	+	ns
Flag changes	ns	+	+	ns	ns	-	ns
Classification changes	-	ns	ns	ns	ns	ns	ns
Class withdrawals	mixed	mixed	mixed	mixed	ns	+	-
DoC company changes	-	+	+	ns	+	mixed	ns
Owner changes	mixed	ns	+	ns	+	+	ns
Country Built*Age	+	+	+	+	mixed	+	-
DoC-developed	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
DoC-in transition	ns	-	-	-	-	ns	ns
DoC-developing	-	-	-	ns	-	ns	-
DoC-unknown	+	+	+	+	+	+	+
OWN-developed	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
OWN-in transition	ns	-	-	ns	+	ns	ns
OWN-developing	+	-	-	-	ns	ns	ns
OWN-unknown	ns	ns	+	ns	+	ns	+
IACS	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Non IACS	-	-	-	-	ns	ns	-
Unknown class	ns	-	-	-	ns	ns	-
Flag - White	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark	benchmark
Flag - Grey	ns	-	-	ns	ns	ns	ns
Flag – Black	+	ns	ns	ns	+	+	-
Unknown flag	ns	-	-	ns	ns	ns	ns
Lagged insp/det history	+	+	+	+	ns	ns	ns
Lagged incident history	+(S), +(LS)	-(VS),+(S,LS)	+(S), +(LS)	+(S)	+(LS), +(NM)	+(LS)	-(S),+(S,LS)
Lagged deficiencies	+	+	+	+	+	+	+
Lagged deficiency areas	Ship Cert.	ISM, Ship Cert. Living cond.	FFP, ISM Ship Cert.	Radio comm.	FFP Crew cert.	Crew cert.	ISM

5. Model applications examples and visualization of risk dimensions

Besides the application of the incident type models to account for ship specific risk in the estimation of total risk exposure (Figure 1), some other applications are presented here. One of such applications is to use the incident type probabilities to estimate risk for individual DoC companies or beneficial ownership companies. The topic to estimate risk at individual DoC company level was treated by AMSA in a previous report by the CSIRO (Mueller (2007)) with restricted application to AMSA inspection data. Heij and Knapp (2012) built on this methodology and present two other methods to estimate the risk of very serious and serious incidents.

The analysis of global fleet data and incident data revealed some weaknesses, in particular missing company data. This issue was raised recently at IMO Council, since it is connected to the evaluation of the management of the IMO numbering schemes (IMO, 2011). Due to the large amount of DoC companies and beneficial ownership, the companies cannot be evaluated individually in the models. Their country of location was grouped using UNCTAD's classification (UNCTAD, 2010) providing an indication of the level of development of a nation. The results are mixed, but the groups account partially for the effect of the company and provide a better basis to estimate risk at individual company level.

The underlying idea to estimate risk at individual company level is based on the following concept. Given the number of ships (N) under the management of a certain company, its number of observed incidents, and its model based mean probability of incident (p), tail probabilities are calculated by means of the binominal distribution. A company is risky if its actual number of incidents is higher than expected from the model probabilities, and the right-tail probability is the probability to observe the actual number of incidents or more given N trials with model-based incident probability. If this right-tail probability is small, the company is riskyFor incident risk, 3785 companies could be evaluated. The method identified 80 companies (2.1%) as risky for the class of very serious incidents and 137 (3.6%) as risky for series incidents.

Another possible application of the model-based probabilities is to visualize risk dimensions – that is to combine various risk types in two dimensions. For that we refer to the underlying methodology developed by Heij and Knapp (2012), which is briefly summarized here to demonstrate application aspects. Ship specific risk has two dimensions – preventive type of risk (detention) and incident type risk. The correlation between the two at individual ship level turned out to be relatively low. This means that ships with a high probability of detention do not necessarily show a high probability of incident. It has been demonstrated in the literature (Knapp, 2006, Bijwaard and Knapp, 2009) that inspections decrease incident type risk, hence a vessel benefits from an inspection.

Ship specific incident type risk can be expressed in terms of probabilities with a possible extension to estimate the monetary value at risk (MVR), a measure for consequences. MVR is a combination of the total insured value (TIV) of a vessel of five damage types and incident type probabilities (Knapp et all, 2011). The five damage types are 1) hull and machinery damage, 2) insured value of life, 3) oil pollution, 4) third party liability limits, and 5) cargo values and the corresponding incident type probabilities to combine with the TIV values are as follows:

1) Probability of damage to hull or machinery for all ships,
2) Probability of loss of life for passenger vessels,
3) Probability of pollution for oil tankers,
4) Probability of third party liability for all ships and
5) Probability of cargo damage for all ships except passenger vessels.

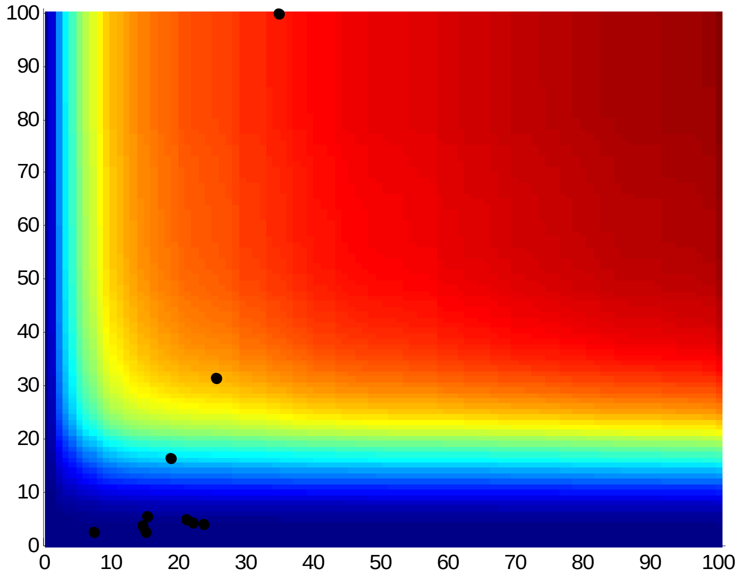
The calculation of MVR according to Heij and Knapp (2012) is given in equation 2 where p_{inc} is the probability of an incident, p_j is the conditional probability of damage type j in case of an accident, and V_j is the monetary value of this damage type. The conditional probability of damage type j and the values V_j are constructed in Knapp et al. (2011).

$$\text{MVR} = p_{inc} \times \sum_{j=1}^{5} p_j V_j \qquad (2)$$

For the combination and visualization of risk dimensions, Heij and Knapp (2012) estimate three major components at individual ship level as follows: 1) probability of detention, 2) probability of five incident types and 3) the estimated monetary value at risk (MVR). If all components are known, the estimated monetary value at risk (MVR) at individual ship level can be calculated and graphically combined with the probability of detention.

A simple example is given in Figure 2 based on vessels that arrived during a three day period in the port of Newcastle in Australia. In this example, the ships are dry bulk carriers of a certain profile. Detention risk is plotted on the horizontal axis while MVR is plotted on the vertical axis. Risk graduation is visualized by color from blue (low risk) to red (high risk). It visualizes in two dimensions how each ship relates to the full fleet in terms of overall risk. The plot can be accompanied with a set of numerical values which describe the location of each vessel.

Figure 2: Risk comparison of vessels arriving in Newcastle between 1st to 3rd July 2010



Source: Heij and Knapp (2012)
Note: detention risk is plotted horizontally, the MVR at risk vertically

Acknowledgements

The author wishes to thank the Australian Maritime Safety Authority, IHS-Fairplay, and LMIU for providing the necessary data. The author also wishes to thank Dave Nagle from RightShip for his support provided in preparing the underlying data matrix and numerous data matching routines. The author further likes to acknowledge the contribution of co-author Christiaan Heij for the application examples presented in section 5.

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Appendix A: Summary statistics of incident type models

	Nr observations		McFad	Hit Rate %		H-L	H-L
Model Type	**1**	**0**	**R-sq**	**Correct**	**Incorrect**	**Statistic**	**Prob**
Total Loss	600	277,594	0.1127	72.44	27.56	17.0790	0.0293
Lives Lost Indicator VS	488	277,706	0.0828	71.78	28.22	15.5280	0.0497
Pollution Indicator all	840	277,354	0.0742	70.40	29.60	47.0275	0.0000
Pollution Indicator VS	124	278,070	0.0892	67.70	32.30	10.5216	0.2303
Pollution Indicator S	203	277,991	0.0399	67.17	32.83	12.1502	0.1446
Fire and Explosion VSS	988	277,206	0.0921	72.90	27.10	11.6974	0.1652
Fire and Explosion VS	105	278,089	0.0652	70.80	29.20	6.7938	0.5590
Fire and Explosion S	883	277,311	0.0960	73.63	26.37	11.8885	0.1564
Collision VSS	1,202	276,992	0.0518	66.38	33.62	30.4332	0.0002
Collision VS	153	278,041	0.0805	7067	29.33	25.5444	0.0013
Collision S	1049	277,145	0.0522	67.33	32.77	25.5669	0.0012
Contact VSS	376	277,818	0.0818	71.62	28.38	5.7047	0.6803
WSG VSS	1,343	276,851	0.0624	69.46	30.54	27.3068	0.0006
WSG VS	135	278,059	0.1010	71.90	28.10	12.4866	0.1308
WSG S	1,208	276,986	0.0615	69.99	30.11	39.1932	0.0000
Hull and Deck VSS	834	277,360	0.0699	68.10	31.90	12.6927	0.1229
Hull and Deck VS	348	277,846	0.1081	74.70	25.30	26.4644	0.0009
Hull and Deck S	486	277,708	0.0641	69.46	30.54	7.99020	0.4344
Machinery VSS	1,759	276,435	0.0874	70.69	29.31	23.0572	0.0033
Machinery S	1,715	276,479	0.0887	70.89	29.11	30.9881	0.0001
Main Engine VSS	1,271	276,923	0.0871	71.37	28.63	18.3214	0.0189
Main Engine S	1,246	276,948	0.0798	70.48	29.52	23.7219	0.0026
Mobility Failure VSS	218	277,976	0.0760	70.99	29.01	10.6252	0.1687
Combined VS	44	278,150	0.0924	74.62	25.38	5.9345	0.6546
Other equipment TLVSS	208	277,986	0.0883	73.03	26.97	5.3222	0.7226
Anchor/ mooring VSS	118	278,076	0.0790	72.19	27.81	5.0873	0.7482
Navig. and Comm. VSS	299	277,895	0.2916	86.59	13.41	125.1855	0.0000

Note: VS=very serious, S=serious, VSS = very serious and serious combined