Measuring the effect of perceived corruption on detention and incident risk – an empirical analysis

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Abstract

This manuscript uses a global and comprehensive approach based on 1.14 million observations to investigate whether the effect of corruption can be measured towards safety qualities of vessels. Since safety qualities of vessels are influenced by many factors and the effect of corruption can be confounded by their interactions, a multi-step approach in used at ship. The findings confirm the hypothesis that port states with higher perceived corruption are less likely to detain vessels and that flag states or ship owners located in countries associated with higher perceived corruption are more likely to have very serious incidents as the operating environment might facilitate substandard shipping and weaker enforcement of international conventions or increased operating costs that can influence safety qualities of vessels in economic hardship. The findings also revealed the degree of underreporting for serious incidents by flag states. The results support the establishment of accountability frameworks and current efforts at the International Maritime Organization (IMO) to address corruption to support sustainable development goal 16 (SDG 16). Relevant policy implications could be to strengthen the fight against corruption via IMO's Member State Audit Scheme and Facilitation Committee in general and specifically by strengthening training and enforcement of the Code of Good Conduct for Port State Control Inspectors. To enhance transparency, the Global Integrated Ship Information System could be adjusted to include an option to report corruption directly by ship owners and operators to IMO and flag states and mandatory reporting requirements should be revised to capture all serious incidents to GISIS.

Keywords

detention risk; incident risk; corruption perception index, safety qualities, PSC, binary logistic regression, correlation

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1. Introduction

The topic of corruption in the maritime industry has been analysed from various aspects mainly using qualitative approaches. The topic is complex and multi-dimensional, and data is limited for empirical analysis at the global level. The Maritime Anti-Corruption Network (MACN), an industry led initiative to address corruption has received 38,000 anonymous reports of corruption of 1,365 ports since 2011 (MACN, 2019). In 2020, the International Maritime Organization (IMO) via its Facilitation Committee (FAL) (IMO, 2019a) provided possible ways forward to address corruption in cooperation with the United Nations Office on Drugs and Crime (UNODC) including the possible development of a new module for the Global Integrated Ship Information System (GISIS).

The multi-dimensional nature of corruption means that it can be found in different ways and with different levels of understanding of what constitutes corruption. Corruption hinders sustainable growth and is found to be correlated with long term economic growth and often affects least developed countries disproportionately (United Nations Global Compact and Transparency International 2011, Podobnik et al (2008), Shao et al (2007)). Furthermore, sustainable development goal 16 specifically relates to the fight against corruption (Hutter, 2018). Sequeira and Djankov (2010) investigate corruption at the port state level. Graziano (2018) investigates port state control performance including corruption. Examples of corruption that are experienced by ship owners can come in the form of facilitation payments, a carton of cigarettes, a case of whiskey or cash payments to clear the vessel through port formalities, receive a deficiency free port state control (PSC) inspection or vetting report, or for provision of services, equipment or supplies that are not actually provided. If the ship refuses to pay, it will incur delays or penalties that cannot be insured against or mitigated through other mechanisms. The financial costs of these delays are then often many times the amount of the bribe or facilitation payments sought.

For ship owners or operators, corruption is often part of political risk and factored into the business environment (Salleh et al, 2015, Lindroos, 2019) especially when operating or trading in ports of less developed nations. Sequeira and Djankov (2010) for instance demonstrate different ways of opportunities for corruption in South Africa that can emerge and distinguish between *collusive* and *coercive* types of corruption. They define collusive corruption as a means for shipping companies to reduce their costs while coercive corruption increases their cost of operating. They also conclude that shipping companies adapt to the challenges to work with the public system on hand and measure the effect on demand for services such as ports to be used.

In addition, for a ship owner, the additional costs associated with corruption can impact upon the profitability of the vessel’s operation especially during periods of economic hardship. When this occurs the standard of safety on board declines which is reflected in increased accident risks. Ship management companies often factor the cost of corruption into their budgeting process as an additional operational expenditure and simply accept it as an inevitable cost of doing business in certain parts of the world. Often it is treated as operational expenditure in the same way as other operational costs in order to carry out their lawful business activities. Whilst global shipping continues to absorb these invisible costs, the impact on the bottom-line during times of industry or sector down turns can quickly turn a safe and sustainable operation into a loss-making venture. Rabarijaona (2017) studies the impact of anti-corruption initiatives in the maritime industry and tries to identify the efficiency of the established framework. According to Ravarijaona (2017), 81% of maritime professionals understand corruption to be *“abusive power to obtain personal gain”*.

Shipowners are generally unwilling to report instances of corruption for fear of retribution, either immediately whilst lengthy investigations are carried out, through additional barriers placed in the way when the vessel returns to the port or by other vessels receiving preferential treatment. Often the ship operator suffers an additional loss as a result. Whilst there are appeal processes in place for owners and operators to appeal the outcome of PSC inspections, such an approach citing corruption as the root cause is difficult to substantiate. It is simply easier to pay the inducement and get on with business than to challenge the system particularly in places where corruption extends upwards through government. IMO has established The *Code of Good Conduct* as part of Port State Control Procedures (IMO, 2019b) but enforcement is left to Member States. The Global Integrated Ship Information System (GISSI) of IMO has a mechanism that provides for the reporting of corruption, but the report can only be made by flag State administrations and not directly by the public.

This manuscript takes a wider approach and measures the effect of *corruption* on safety qualities at the vessel level using quantitative methods. Using a unique and comprehensive combination of data, the effect is measured towards an increase or decrease of the probability of detention or incident at the ship level taking a three-step approach. Both end points are considered since they are found to be separate risk dimensions relevant to identify risky vessels (Knapp and Heij, 2020, Heij and Knapp, 2019). Besides the effect of corruption on detention, high corruption can also facilitate weak implementation or enforcement of international conventions and can create loopholes for substandard shipping.

Corruption is expressed by the Corruption Perception Index (CPI) of Transparency International. The CPI score is an index that combines 13 different sources and is based on a combination of surveys to determine how experts and business executives perceive a country's public sector to be corrupt. As by Transparency International (2018), it covers different corrupt behaviours in the public sector such as *bribery, diversion of public funds, use of public funds for private gain, nepotism in the civil service and state capture in addition to some mechanism available to prevent corruption.* It is widely used and has been assessed by the European Commission's Competence Centre on Composite Indicator and by the Joint Research Centre (JRC, 2018) to ensure transparency of the methodology used and to ensure reliability of the scores. JRC (2018) concludes that the CPI provides a more accurate measurement than each of the individual sources separately (JRC, 2018).

Since corruption has several dimensions, the approach used here covers the effect at the level of port state towards detention and at the level of flag state, beneficial owner and safety management company towards incident risk. In order to account for other effects that influence safety quality of vessels to predict detention or incident risk such as age, size, ship type, class society, flag, beneficial owner and Document of Compliance (DoC) company as well as the previous inspection and incident history and the correlation with economic factors (Knapp and Heij 2020, Heij and Knapp 2018, 2011, Knapp et al 2011, Podobnik et al 2008, Shao et al, 2007), a multi-step approach is used to ensure that the effect is filtered out and can be interpreted and visualized. The set of hypotheses to test are as follows:

H1: An increase in the CPI is associated with a negative correlation for the probability of detention as briberies are paid off to ensure that a vessel is not detained.

H2: An increase in the CPI is associated with a positive correlation for the probability of incident since it can influence profitability of vessels and decrease safety qualities of vessels as ship owners need to treat corruption costs as operational costs.

H3: A positive correlation for the probability of incident can also support the hypothesis that vessels that are either registered in or managed or owned by countries with higher perceived corruption have lower safety qualities as enforcement mechanisms of international conventions are weaker.

2. Methodology and data used

The time frame used for the creation of the datasets used for the analysis was 2014 to 2019 and Table 1 provides an overview of data sources used. Three dependent variables are chosen as follows: 1) detention, 2) TLVS (total loss and very serious) and 3) TLVSS. (total loss, very serious and serious combined) resulting in two main matrixes as follows: 1) matrix for detention models: 421,518 observations (12,543 detentions) and 2) matrix for incident models: 721,767 observations (11,896 TLVSS incidents).

Global incident information is combined from at least four different sources and duplicates are eliminated. The remaining incidents are reclassified according to IMO definitions for seriousness which are very serious (including total loss), serious and less serious (IMO 2000). For the analysis presented here, only total loss, very serious (TLVS) and serious (S) ones are considered because less serious (LS) incidents are characterized by underreporting. Less serious incidents are only included as factor accounting for the incident history of a vessel but not as dependent variable.

Table 1: Data sources used for the period 2014 to 2019

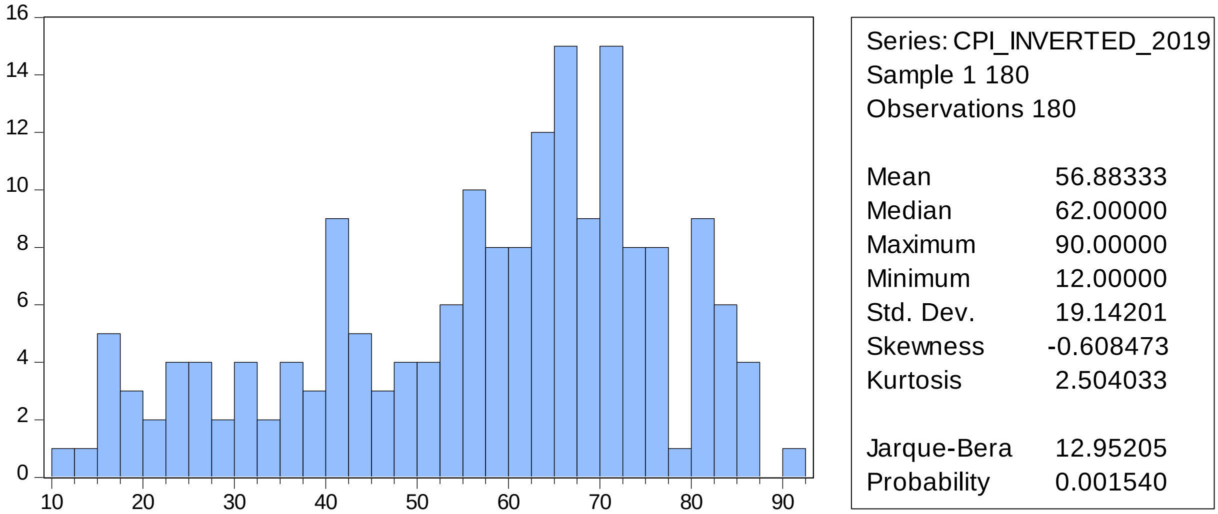
Type of data	Data sources
Ship particulars (global fleet above 100gt) – all ship types	IHS Maritime
Global PSC data (all MoU's)	IHS Maritime
Global Incident data	IHS Maritime, LLIS, IMO, USCG
Corruption Perception Index	Transparency International
Country income classifications	World Bank
Earnings	Ship Intelligence Network (Clarkson)

The selection for global inspection data is based on findings in the literature (Knapp 2006, Knapp and Franses 2007) who conclude that the effects of ship parameters (eg. age, ship type, flag, class etc.) towards the probability of detention do not vary significantly across the PSC regimes evaluated and that on average, inspections decrease incident risk. It was therefore concluded that data can be combined for statistical analysis. For all global inspection data, only initial inspections are considered and follow up inspections were excluded to reduce a possible source of bias. The selection of variables is based on Knapp (2006), Knapp and Franses (2007), Bijwaard et al (2009), Knapp and Heij (2020). To account for other effects that influence safety qualities of vessels including economic factors, we include these risk factors into the regressions when relevant as follows:

- Basic ship particulars such as age, size of vessel, ship type, classification society, beneficial ownership, DoC company, flag at the time of the event of interest
- Flag changes, ownership changes, DoC company changes and class changes (within 3 years prior to the event date of interest)
- Country of build grouped into four groups and interaction effects with three age groups
- Main engine designer (individual company) and Main engine builder (individual country of location) if the model is large enough
- The 'presence of maritime expertise' expressed as concentration of ownership companies, DoC companies, main engine builders, main engine designers in a particular country
- Years of existence of beneficial ownership and DoC company
- Lagged inspection and incident history of the ship within 30 to 360 days prior to the event of interest
- Economic indicator to account for the effect of economic cycles on risk
- Port States for the detention model to account for the differences in port state control inspection qualities at port state level

The main variable of interest is the Corruption Perception Index (CPI) from Transparency International. For this analysis, the CPI scores are merged by respective year and country for port state to inspection data and the flag, owner and Document of Compliance Company (DoC) location to world fleet and incident data. The CPI index was inverted to make interpretation more intuitive, hence 0 means no corruption and 100 means highly corrupt (see Figure 1 for the year 2019). A positive effect therefore means an increasing effect towards the probability of detention (or incident) given an increase in the CPI. For more information about the scores, please refer to JRC (2018). Not all countries are evaluated by the CPI, hence the number of observations is adjusted for each regression. For international registries, the corruption index of the main country was used.

Figure 1: Histogram of inverted CPI (2019)



Note: inverted CPI (0 = no corruption, 100 = high corruption)

All vessels above 100 GRT are included in the analysis and all ship types are considered as follows: 1) general cargo, 2) dry bulk, 3) container, 4) tanker, 5) passenger vessels, 6) other ship types, 7) fishing vessels, 8) tugs, 9) pleasure craft (large yachts with IMO number). For the detention models, the main ship types are 1 to 6 as very few inspections are carried out on fishing vessels, tugs and commercial super yachts. Overall, three dependent variables are used with the main parameters of interest as follows:

– ***Detention:*** *Port State where vessel was inspected and corresponding CPI values*
– ***Incidents (TLVSS, TLVS)*** *– Flag States, county of location of Beneficial Owner and DoC company of vessels at time of incident and corresponding CPI values*

The number of all variables that can affect safety qualities of vessels as listed earlier can be large and a full regression model can contain as many as 600 variables to be tested. Individual coefficients in models with many factors are always hard to interpret as they measure partial effects. By including some covariates that are correlated with the variable of interest such as CPI, parts of the CPI effects can be absorbed into these variables and can also change signs and significance of signs of the coefficients of the parameters of interest. In order to test the hypotheses listed earlier, to enhance the interpretation of the parameters of interest and to be able to visualize the effects of interest, a multi-stage approach is used consisting of three main steps.

Step 1: Estimation of full model without CPI values

In step 1, a full binary logistic regression model is estimated to account for all possible factors that can influence the probability of detention or the probability of incident (TLVSS, TLVS). This model does not include any parameters for CPI values as they might be correlated with other factors of interest. The main parameters of interest in this round are the coefficients for port states for detention and the coefficients for flag, beneficial owner and DoC company for incidents which forms the basis for step 2. The base model to model the probability of detention or incident is binary logistic regression. Let x_i contain the explanatory factors listed in the previous section (e.g age, size, ship type, flag, classification society), 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 $P\ (y_i = 1|x_i) = \exp(x_i\beta)/(1+\exp(x_i\beta)$ where $x_i\beta$ is a weighted average of all explanatory factors and changes plus the intercept. The probabilities are estimated at the individual ship level (*i*) using Eviews. For further details on logit models, refer to Heij et al. (2004) or Verbeek (2008). To estimate the coefficients, quasi-maximum likelihood (QML) is used (Greene, 2000) as method of estimation in order to give some allowance for a possible misspecification of the assumed underlying distribution function.

Step 2: Correlation of step 1 outcome with CPI values

In this step, the coefficients from the binary logistic regression outputs from step 1 are correlated with the inverted CPI values (0=low to 100=high) for the port states for detention and for the country of location (beneficial owner, safety management company) or flag for incident (TLVSS, TLVS). The correlation provides the direction (positive or negative), strength and its significance.

Step 3: Estimation of reduced model to obtain coefficient for CPI for visualization

In this step, a reduced logit model is estimated still containing all important factors that influence safety qualities of vessels plus one parameter for CPI to measure the effect towards the probability. In this step, parameters that are highly correlated with the CPI values are excluded such as for instance port state factor for detention, flag, ownership, or DoC company for the various incident type models. The sign and significance of the coefficient for the CPI parameter is compared with the outcome for step 2 to see whether there is any change in the sign or its significance and to confirm whether the coefficients can be used for visualization of the partial effect of interest.

3. Results and visualization of partial effects of interest

Due the large amount of regression outputs and variables, only the most relevant results of the second stage are presented here. Appendix A and B provides basic model statistics of the logit models for step 1 and 3. For further details on logit model statistics such as the Mc Fadden R-squared, the Schwarz Criteria and hit rate, please refer to Heij et al. (2004).

Table 2 provides the main results of interest from step 2 – that is the correlation coefficients from the parameters of interest from step 1 with the CPI values for the respective parameters of interest for each model. Figure 2 provides the scatter plots (and fitted regression line) of the correlations that are significant in Table 2.

One can see that H1 of CPI values for port states towards detention is confirmed with a negative correlation coefficient. Port States with high perceived corruption are less likely to detain which could be due to briberies and detention avoidance. The results for incident (TLVSS) do not confirm H2 or H3 albeit a positive correlation for beneficial owner and DoC company is found but not significant. For flag, the correlation is negative and significant implying that overall, vessels registered in countries with higher CPI values are less likely to have incidents. This could reflect the degree of underreporting of serious incidents compared to total loss and very serious (TLVS) incidents where correlation is positive. With respect to interpretation, the results are more valid for TLVS compared to TLVSS.

Table 2: Correlation results step 2

Parameter of interest to test correlation	DV	Nr var	Correlation	Prob	
CPI port states with port states (step 1)	detention	74	-0.27780	0.01660	**
CPI beneficial owner with owner location (step 1)	TLVSS	61	0.10462	0.42230	ns
	TLVS	60	0.29514	0.02210	**
CPI DoC company with DoC location (step1)	TLVSS	53	0.06056	0.66660	ns
	TLVS	51	0.09780	0.49480	ns
CPI flag states with flags (step 1)	TLVSS	131	-0.25182	0.00370	*
	TLVS	60	0.39548	0.00090	*

*Note: * significant at 1% level, ** significant at 5% level, - ns = not significant, DV =- dependent variable*

Figure 2: Scatter plots of correlations from step 2

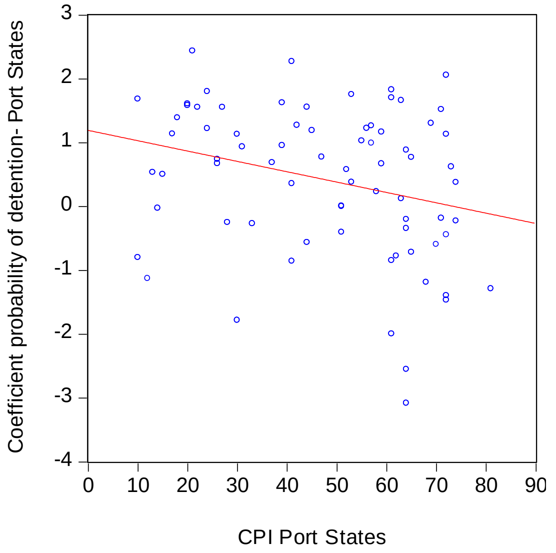


Figure 2a: Detention – Port States

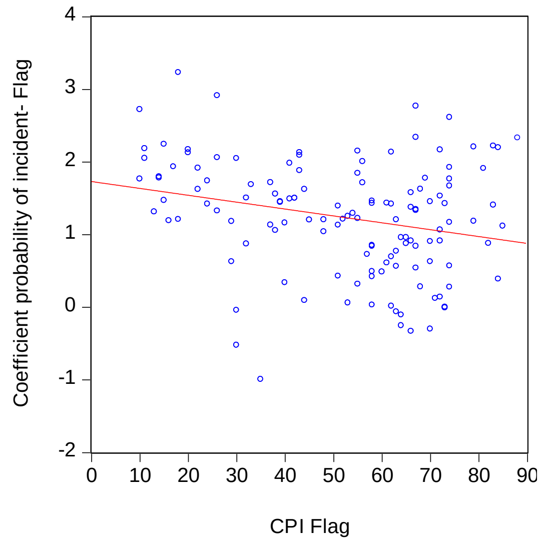
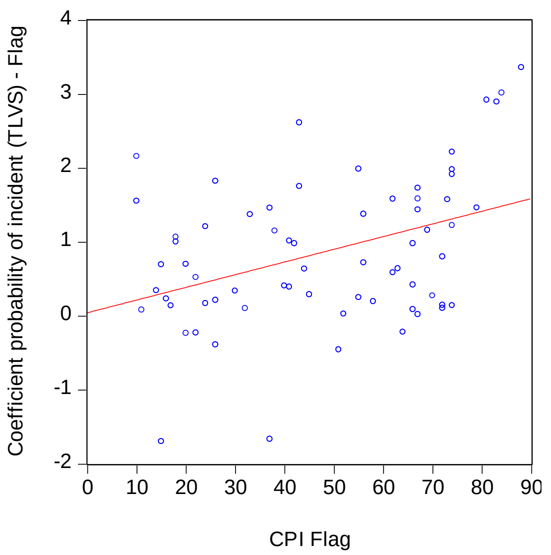
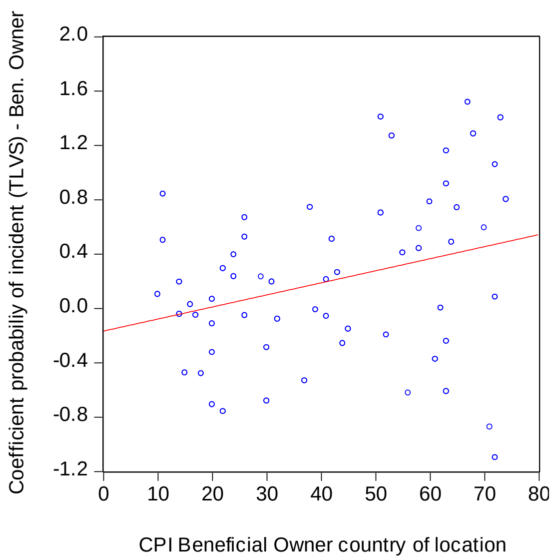


Figure 2b: Incident (TLVSS) – Flag



2c: Incident (TLVS) - Flag



2d: Incident (TLVS) – Ownership

For incidents (TLVS), the results also confirm H2 and H3 for flag states and beneficial owners but not for DoC companies where correlation is positive but not significant. This also be that DoC companies have a higher degree of missing information as the link of vessel to company is not well defined in the IHSM data and 26% of the observations with incidents have missing data compared to 14% for owner or less than 15% for flag.

Vessels registered in a flag state with higher CPI values corruption are more likely to have incidents (TLVS) as the correlation is positive and significant. The same applies for vessels with owners located in a country with higher CPI values. This can confirm weaker enforcement and subsequently a higher degree of substandard shipping. It may also confirm that ship owners are subject to higher costs due to corruption which affects safety qualities negatively.

The last section takes those four combinations and applies step 3 but running a reduced logit model to obtain the coefficient for CPI by entering CPI directly into the logit and excluding the parameters such as port states (detention) and flags and beneficial owner location (TLVSS and TLVS). The results are presented in Table 3. The step 3 models are estimated based on the main ship types excluding fishing vessels, tugs and pleasure craft. CPI values do not exist for all countries so the number of variables in the models are reduced respectively and are given in Table 3.

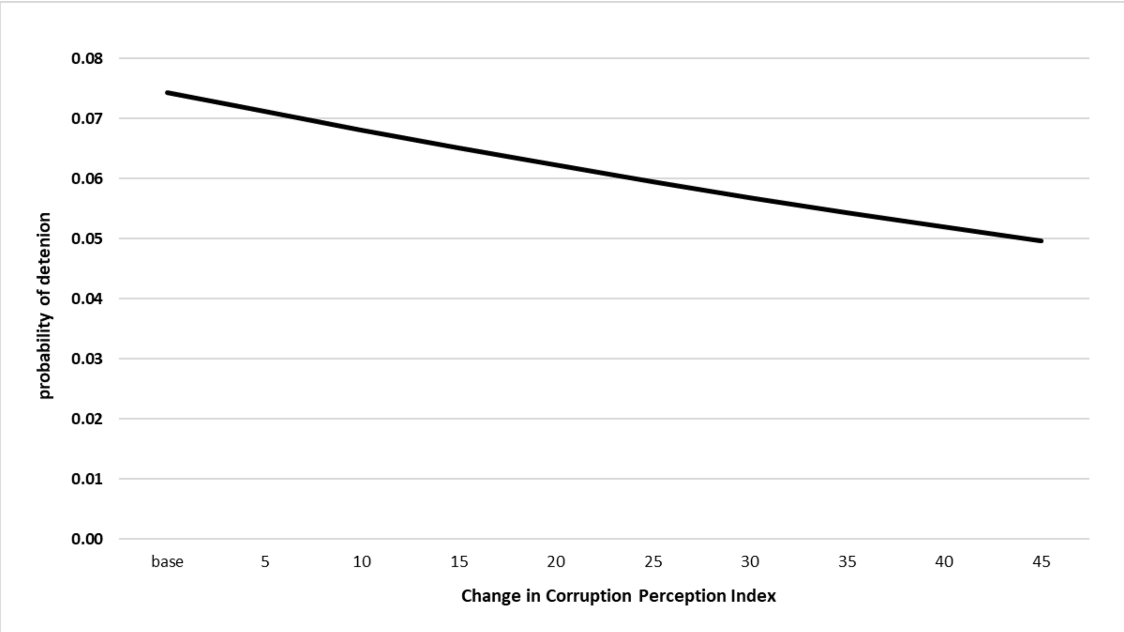
Table 3: Coefficients of interest for visualization (logit model step 3)

Parameter of interest for visualization	DV	Nr var	Coefficient	Prob	
CPI port state	detention	199	-0.00956	0.00000	*
CPI beneficial owner	TLVS	108	-0.00016	0.94390	ns
CPI flag	TLVSS	134	-0.00955	0.00000	*
	TLVS	69	-0.00043	0.83020	ns

*Note: * significant at 1% level, ** significant at 5% level, - ns = not significant, DV =- dependent variable*

The results confirm the negative relationship of CPI for port states towards the probability of detention and a negative relationship of CPI for flag states towards the probability of incident (TLVSS). The relationship could not be confirmed for flag or beneficial ownership location for the probability of incident (TLVS) which is most likely due to confounding and also confirms that a multi-step approach is needed to test for the underlying relationship. As a result, only significant coefficients from Table 3 are visualized in Figures 3 and 4. For the effects that could not be obtained from the logit model, the direction of the correlation can be seen from the scatter plots in Figure 2. The increase in the CPI values is shown on the x-axis and the estimated probabilities are plotted on the y-axis respectively.

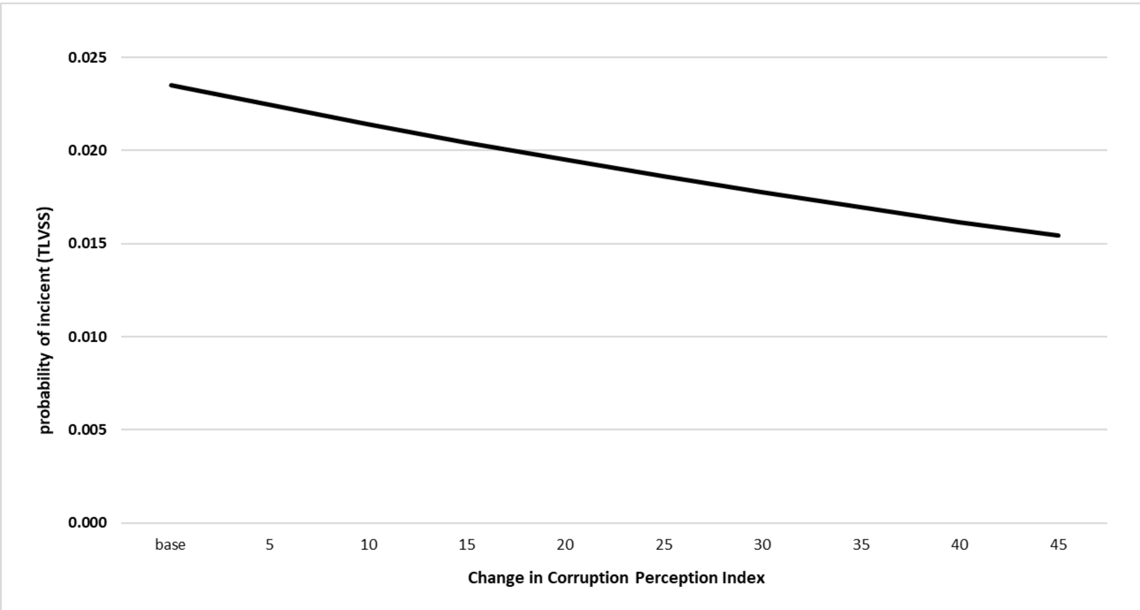
Figure 3: Effect of CPI towards probability of detention



To create Figures 3 and 4, a typical vessel is chosen, and the base probability is estimated given the various input parameters. Assuming no corruption, this forms the base probability. Keeping all other variables fixed and only changing CPI from 0 to 40 and coefficients from Table 3, the respective probabilities are estimated and visualized in the graphs. The basic ship specific input parameters for the two Figures are as follows:

- *dry bulk carrier of 5 years and 38,927 GRT*
- *the vessel is registered in Liberia with classification society Lloyds Register*
- *the vessel changed flag and class once within the last 3 years*
- *the vessel was built in China with main engine builder from Italy and main engine designer (Cummins)*
- *the vessel is managed by a DoC company located in a middle-income country and is owned an owner located in a low-income country*
- *average monthly earnings over the last 6 months prior to the event of interest are as by the SIN of Clarkson for dry bulk carriers*
- *the vessel had one less serious incident in the last 365 days and 2 deficiencies were found during PSC inspections over the last 365 days*

Figure 4: Effect of CPI flag towards probability of incident (TLVSS)



4. Discussions and policy implications

While corruption is known to exist in the maritime industry and has been brought to the attention at IMO via the FAL Committee, the effect has not been quantified or visualized in the manner this analysis has and draws further attention to possible policy implications. Furthermore, sustainable development goal 16 (SDG) specifically relates to the fight against corruption (Hutter, 2018), in particular SDG 16.5 (reduce corruption and bribery in all their forms), SDG 16.6 (develop effective, accountable, and transparent institutions at all levels, SDG 16.10 (ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements). Given the results presented here, some policy implications and challenges are discussed in this section based on the three key findings:

– ***Finding 1 related to H1:*** *Port states with higher perceived corruption are less likely to detain vessels as ship owners try to avoid detention, pay off briberies and treat those as part of operating costs.*

- ***Finding 2 related to H2 and H3:*** *Flag states or ship owners located in countries associated with higher perceived corruption are more likely to have incidents (TLVS) as the operating environment might facilitate substandard shipping and weaker enforcement of international conventions. Corruption also influences ship owners operating costs and can enhance economic hardship that influences reduced safety qualities of vessels as investigated and confirmed by Bijwaard et al (2009).*
- ***Finding 3:*** *The results also highlight a degree of underreporting of serious incidents of flag states with higher perceived corruption.*

Accountability frameworks are not well established and harmonized across UN Organizations (JIU, 2011) which was also recognized by the United Nations General Assembly (Resolution 64/259). Based on a comparative analysis by the JIU (JIU,2011), a recommendation was made to IMO to develop a stand-alone accountability framework which relates to both Member States and Secretariat (JIU, 2011) as part of the political covenant of the Organization. The accountability framework should refer to 17 benchmarks and 43 tools including provisions for anti-corruption and anti-fraud. Latest development at IMO via the FAL Committee however highlight the importance to address corruption and the need to develop guidance to enforce anti-corruption practices.

In the absence of IMO's own accountability framework, the relevant recommended benchmarks of the JIU related to corruption could be integrated into IMO's IMSAS (Mandatory Member States Audit Scheme at IMO). IMSAS is based on mandatory provisions in particular the provisions of the III Code (IMO, 2015). The consolidated IMSAS report on findings does not go into detail with respect to the areas of root causes that contribute to the lack of effective implementation of requirements (IMO, 2018).

It is worth noting that existing policy processes within the PSC MoU's were not established to tackle or account for the impact of corruption in the PSC space or flag state implementation in general. IMO in its remit can provide guidance to Member States on PSC procedures as is done with the implementation of the *Code of good conduct* (IMO, 2019b) as part of existing training. The Code encompasses three fundamental principles against which all actions of port state control officers are judged: integrity, professionalism and transparency and specifically refers to the freedom from corruption influences or motives, openness, and accountability.

While the development of a new targeting factor is outside the scope of this analysis (see Knapp and Heij, 2020 for improved targeting using statistical models), CPI values could be included into targeting routines for detention, but it is not recommended to do so. The effect can easily be confounded with other factors. Only one maritime administration (Australia) so far uses statistical models to target vessels for port state control inspection. It would be challenging to convince PSC MoU's to agree on using quantitative methods to improve their targeting besides including a factor that accounts for CPI given the political sensitivities associated with allegations of corruption and the slowness of the process of updating targeting routines in general. A better approach would be to try to enforce the *Good code of conduct* by enhanced training and to include measures within IMSAS as well as work via the FAL Committee to establish a GISIS module that enables transparent reporting of corruption.

Perhaps an improvement in transparency of PSC inspection data might assist with the detection of corruption and provide better means to provide the necessary proof for ship owners. GISIS does not allow reporting by members of the public. The channel currently is from the owner company to the flag State and activation of appeal procedure within the PSC regime. It may be that company report directly to the PSC regimes but that does not happen often. GISIS could be amended to include a reporting capability that allows ship owners or companies to report directly to IMO and the flag state either via a standalone module on corruption or via the already existing module for Port State Control. The improvement of

GISIS would also assist IMSAS auditors to prepare for an audit as well as increasing transparency in line with SDG 16.

Concerning finding 3 related to the possible degree of underreporting by flag states, the relevant policy implication would be to make the reporting of serious incidents to GISIS mandatory. Currently, only the reporting of very serious incidents is mandatory (IMO, 2014) by electronic means to GISIS. Increased reporting will also help with pre-emptive risk management and could also include less serious incidents.

5. Conclusions and future research

This manuscript investigates the relationship of the CPI index towards the probability of detention and incident (TLVSS and TLVS) from several dimensions. A multi-step approach is used in order to enhance interpretation of the effect of interest that can otherwise become confounded with the effect of other factors that influence safety qualities of a vessel. The findings confirm the hypotheses and demonstrate that the effect of corruption is present.

Since corruption can potentially increase incident risk and create burden to ship owners and operators who integrate the cost of corruption into their operating costs, the findings should not be ignored by policy makers and the findings support industry efforts and efforts at IMO to establish accountability frameworks and enhance transparency in line with SDG 16.

Relevant policy implications could be to strengthen the fight against corruption via IMSAS or the FAL Committee in general and specifically by strengthening training and enforcement of the *Code of Good Conduct* for Port State Control Inspectors. To enhance transparency, GISIS could be adjusted to include an option to report corruption directly by ship owners and operators to IMO and flag states. In order to decrease underreporting of incidents, mandatory reporting of serious incidents should be included into GISIS.

Future research in this area would be to quantify the effect of corruption in monetary terms – that is to translate the effect towards the probability of detention or incident into potential incident costs due to the effect on corruption. This will provide policy makers with an estimate on the magnitude of the effect of corruption on damages related to potential incidents.

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Appendix A: Model statistics binary logistics regression (step 1)

Model Parameter of interest	DV	Total	DV	Rate	Nr var	McFad R-sqrd	Schwarz criteria	HR% overall
Port states	detention	421,518	12,543	0.0298	275	0.1801	0.2280	74.90
Beneficial owner locations	TLVSS	721,767	11,896	0.0165	349	0.1581	0.1480	72.05
	TLVS	721,767	1,736	0.0024	196	0.0838	0.0315	71.22
DoC Company locations	TLVSS	721,767	11,896	0.0165	336	0.1511	0.1436	71.65
	TLVS	721,767	1,738	0.0024	299	0.0998	0.0313	71.54
Flag	TLVSS	721,767	11,896	0.0165	289	0.1539	0.1476	72.26
	TLVS	721,767	1,738	0.0024	150	0.0864	0.0337	71.78

Note: DV = dependent variable, Nr var = Number of variables in model, HR = overall hit rates

Appendix B: Model statistics binary logistics regression (step 3)

Model Parameter of interest	DV	Total	DV	Rate	Nr var	McFad R-sqrd	Schwarz criteria	HR% overall
CPI port States	detention	420,985	12,530	0.0298	199	0.1217	0.2414	74.91
CPI beneficial owner locations	TLVS	354,679	924	0.0026	108	0.0801	0.0372	71.55
CPI flag	TLVSS	398,113	7,505	0.0189	134	0.1337	0.1664	73.81
	TLVS	398,113	1,092	0.0027	69	0.0693	0.0375	68.92

Note: DV = dependent variable, Nr var = Number of variables in model, HR = overall hit rates