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Non-Operational Predictive Indicators of Piracy: Identifying Potential Outbreaks

M.R. Brooks, R. Pelot, J.W. Reuchlin & S. Rezaee

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Marine Affairs Program, Dalhousie University

Marine Affairs PROGRAM

DALHOUSIE UNIVERSITY *Inspiring Minds*

Rowe Management Building, Suite 2127
6100 University Avenue PO BOX 15000
Halifax, NS B3H 4R2 Canada

phone 902.494.3555
fax 902.494.1001
marine.affairs@dal.ca

Dalhousie Marine Piracy Project

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TABLE OF CONTENTS

1. Executive Summary 1
2. Introduction 4
3. Literature Review 5
4. Process Overview 7
5. Piracy Event Database 9
6. Potential Piracy Indicators 12
   6.1 Length of coastline 18
   6.2 Human Development Index 19
   6.3 Gross National Income per capita 19
   6.4 Corruption Perception Index 20
   6.5 Failed States Index 21
   6.6 Environmental and socio-economic impacts of overfishing 22
7. Piracy Indicator Models 25
8. Discussion 30
Bibliography 33
Appendix 1 Countries included in analyses (2000 – 2011 data) 38
Appendix 2 Correlation matrix of included variables 39

Figures

Figure 1 Piracy indicator model development process 7
Figure 2 Simplified piracy profit model 13
Figure 3 Percentage of piracy attacks originating from piracy outbreak countries 25
Figure 4 Graphs comparing the variables' values of countries with (Y=1) and without (Y=0) piracy outbreaks 26
Figure 5 Map of piracy outbreak countries and countries with increased risk of outbreaks 31

Tables

Table 1 Illustrative measures for predicting piracy outbreaks 12
Table 2 Considered variables per key aspect of the piracy profit model 14
Table 3 Percentage of coastal countries for which data is available per selected variables and period 16
Table 4 Percentage of countries for which average variable values for the

period 2005 - 2010 are available 17

Table 5 Example of cut-off values for 4 variables 27

Table 6 Selected binary logistic regression piracy indicator model for all countries..... 27

Table 7 Selected binary logistic regression piracy indicator model for countries

with at least 1 piracy attack 28

1. Executive Summary

Funded by the TK Foundation in 2011, the Dalhousie Marine Piracy Project (DMPP) is undertaking an integrated and interdisciplinary approach to examining the problem of global contemporary piracy and its impact on global shipping and coastal communities. The development of a piracy indicator model is part of this project.

The purpose of the model is to determine what factors help distinguish between countries that are the origin of a piracy outbreak versus those that are not. By establishing factors that help determine this distinction, policy-makers and analysts can pay special attention to states where factors point to an outbreak of piracy. The right confluence of factors could signal that conditions are ripe for an outbreak. If an outbreak does not occur in such countries, the relation of outbreaks to the selected factors is presumably not strong enough and/or other factors which are not in the developed models are affecting the outcome.

In order to determine which countries are the origins of piracy outbreaks, data on piracy events were gathered. Dr. Bridget Coggins of Dartmouth College provided the piracy data which she had already compiled from the detailed annual records of the International Maritime Bureau's (IMB) Piracy Reporting Centre (PRC) for her own research. The database consists of all reported piracy events during the period 2000–2011. Each of the event records contains a large number of details, often coded, including: the type of event; the level of violence used; and the country of origin of the pirate attack. Based on the details included in the piracy event database, only those events were included in the analysis that constituted an actual piracy attack and not a case of petty theft or sighting of a suspicious vessel.

To distinguish between countries that have experienced a piracy outbreak and those that have not, we define a piracy outbreak based on two criteria: (1) consistency: in at least eight of the 12 years included in the piracy database one or more piracy events must have been reported; and (2) scale: the total number of reported piracy events originating from a country must be at least 20 events over that time period. Using these criteria, 14 countries are considered to be the origin of a piracy outbreak in the period 2000–2011: Somalia; Indonesia; Nigeria; Bangladesh; Philippines; India; Peru; Vietnam; Brazil; Guinea; Venezuela; Côte d'Ivoire; Ecuador; and Ghana.

An assumption we made to select the factors to be tested as potential piracy indicators is that piracy is primarily an economic act. This assumption is supported by numerous sources and therefore the selection of factors begins with those that may influence the profitability of piracy. A simplified piracy profit model was developed as a tool to structure the selection process. The selection process was further developed by selecting factors that: (1) are objective, defined and measured statistics; (2) are accessible/available from credible sources; and (3) provide sufficient data coverage (temporal scope covering the same period as the piracy data used, and geographical scope covering at least all key piracy countries and preferably all coastal countries).

Both the temporal and geographic scopes of many of the considered data were very limited. Consequently, the number of factors that could be included in the analysis is limited and only the average values for the period 2005 – 2010 are considered. The selected factors are: the length of the coastline; the Human Development Index (HDI); the Gross National Income (GNI) per capita; the Corruption Perception Index (CPI); the Failed States Index (FSI), including the 12 indicators used to compile the FSI; and the environmental and socio-economic impacts of overfishing. The data quality of these factors was considered sufficient for 99 coastal countries and these countries were used to develop the two piracy indicator models in this report.

The analyses performed as part of this research show that piracy outbreaks only occur in relatively poor countries, with high corruption rates, scoring low on the HDI, ranking high on the FSI, and faced with medium to severe socio-economic impacts of overfishing. However, there are many countries in the world that have the same characteristics, but have not experienced a piracy outbreak.

In order to determine a statistical relationship between the selected factors and piracy outbreaks, two binary logistic regression models have been developed. Both these models show that "Human flight and brain drain" (HFBD), one of the 12 indicators from which the FSI is compiled, has a statistically significant relationship with piracy outbreaks and therefore could be considered an indicator for such outbreaks. High levels of HFBD often coincide with irregular immigration facilitated by organized crime. Associated criminal organisations that are already using vessels to transport immigrants can arguably easily expand business activities to piracy, providing a possible explanation for the statistical link between piracy and HFBD. Another

potential reason why relatively high levels of HFBD might lead to an increased risk of piracy outbreaks is because the outflow of human capital, especially entrepreneurs, hampers private sector development, employment opportunities and the number of successful people in legal businesses that could serve as role models for a younger generation. The downward spiral associated with high levels of outflow of human capital lessens the economic prospects for people that do not leave the country and increases the attractiveness of participating in the often lucrative piracy business. Alternatively, high HFBD and piracy outbreaks might both arise from a more fundamental issue, such as deteriorating government stability.

The models developed in this report are only partially successful in finding strong indicators for piracy outbreaks. In order to create stronger models, the quality of economic, social and governance data needs to be improved. Potentially important factors, such as the levels of organized crime, navy and coast guard capabilities, fish catch per unit of effort or vessel traffic information could not be included as a result of a lack of adequate data. The statistics on piracy attacks also need to be improved to develop stronger predictive models. If Choong's assessment of under-reporting (Torchia, 2009) is correct, and at least 50% of all piracy attacks are not reported, this increases the likelihood that we could not develop future statistical models that accurately reflect reality. This issue should be addressed by lowering reporting barriers.

This research has provided an indication of countries that are at a higher risk of becoming an origin of a piracy outbreak. Future research could compare these countries with countries that actually experienced a piracy outbreak. Such a comparison can focus on fewer countries than this report and therefore could take both local and regional specific factors into consideration. The resulting insights would, together with the findings presented in this report, facilitate the development of measures to prevent piracy outbreaks from occurring or to mitigate potential impacts.

2. Introduction

Piracy is one of the oldest crimes in the world, waxing and waning historically throughout various geographic regions. Although the actors, motives, tactics and targets involved differ substantially across regions, the majority of responses to piracy have focused on the sea rather than on land. Yet, "pirates are not fish; they don't live in the sea they live in the cities... [they live on land!]" (Hirsi, 2011, p. 22). Failure to sufficiently address the root causes of piracy has been a major limitation to previous and current efforts to effectively address the problem.

Funded by the TK Foundation in 2011, the Dalhousie Marine Piracy Project (DMPP) is undertaking an integrated and interdisciplinary approach to examining the problem of global contemporary piracy and its impact on shipping and coastal communities. The development of a piracy indicator model is part of this project.

The goal of developing the model is to explore what factors might be indicators that piracy outbreaks could originate in a particular country. This research encompasses social, economic and governance factors on a country level. The results are intended to contribute to ongoing discussions by governmental and non-governmental organizations as well as researchers about the causes of, and potential solutions to, piracy. This research does not consider the relevance of operational aspects of shipping in relation to piracy, such as the speed of a vessel, whether there are armed security personnel on board and the like. Those aspects are seen as contributing or suppressing factors and not potential outbreak indicators.

The paper presents the research that was conducted to determine whether the current publicly available data includes potential piracy outbreak indicators. The literature review in Section 3 illustrates what quantitative modelling of piracy has already been undertaken, in order to build on previous findings and minimize the risk of repetition. The development of the piracy indicator model is explained in Section 4, while Section 5 presents the piracy event database used to develop the piracy indicator model. Section 6 describes the selection process of potential piracy indicators, resulting in the selected variables. Section 7 presents the quantitative analyses undertaken and the two resulting piracy indicator models. In the final Section, the research findings are discussed and recommendations for further studies are made.

3. Literature Review

This research draws from numerous sources throughout all the steps of developing the piracy indicator model. Many authors have incorporated quantitative analysis in their research on piracy. Most of that research focuses on the economic impacts of piracy in the Gulf of Aden and Indian Ocean. For example, Bendall (2010) estimates the impacts of piracy on a Very Large Crude Carrier and a container vessel if they are forced to reroute as a result of piracy. The paper shows the substantial costs that shipowners are faced with, either as a result of rerouting or increased insurance premiums. Martinez-Zarzoso and Bensassi (2011) take a broader perspective and model the impacts of piracy on trade costs and volumes between Europe and Asia. Fu et al. (2010) estimate the economic welfare loss caused by decreased shipping activities between Europe and Asia as a result of piracy.

Though there are numerous articles that assess the impacts of piracy, there are relatively few that take a quantitative approach to determine the causes. Coggins (2012) provides an analysis of both the details of piracy attacks and the locations across the world in the period 2000–2009. She does not attempt to perform statistical analysis on the analysed piracy data, but does mention that the data could yield "models capable of forecasting attacks or identifying piracy-prone regions" (p. 615). Moreto and Caplan (2010) show how country and regional factors can be used to determine high-risk piracy areas. They assume that the Failed States Index (FSI) developed by the Fund for Peace could be used as a piracy indicator, particularly in the vicinity of maritime chokepoints. Nincic (2008) shows that in the period 2005–2007 the vast majority of the attacks in Africa occurred in countries that could be regarded as 'failed states' according to the FSI. Her statistical analysis results were "modestly encouraging" and showed a significant relation between one of the FSI indicators (state within a state) and the number of piracy attacks in Africa in the period 2005–2007.

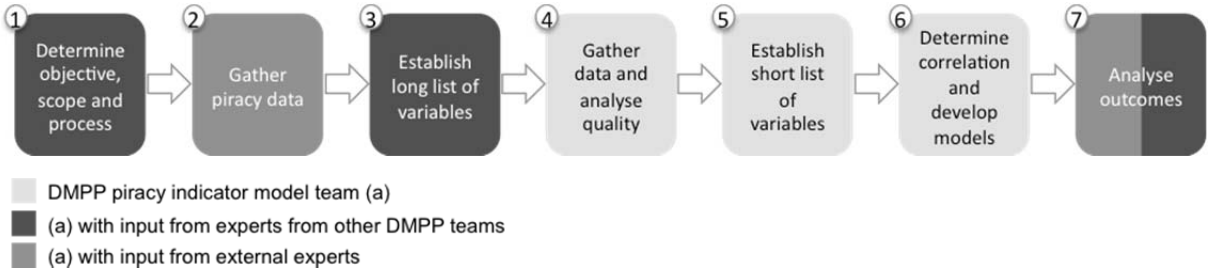
As no attempt, to the authors' knowledge, has yet been made to develop a piracy indicator model from a global perspective, additional literature was reviewed to determine what variables have been mentioned as potential piracy indicators. Particularly valuable sources were Liss (2007, 2011) for her insights into piracy in Asia, Bawumia and Sumaila (2010) for their observations about the relation between piracy and fisheries, and Raidt and Smith (2010) for their background information regarding piracy on the west coast of Africa. Numerous other sources have been

drawn on for this research, including many news articles, reports by governmental organizations such as the UN, non-governmental organizations such as the One Earth Foundation and private companies such a Geopolicity. This research also relied strongly on the work undertaken by Whitman et al. (2012) as part of the DMPP.

4. Process Overview

In order to develop a model that would identify leading indicators of piracy, that is, that can serve to foreshadow an outbreak of piracy in a country or region; the study adopted the approach shown in Figure 1.

Figure 1 Piracy indicator model development process



1. Determine the objectives, scope and process to develop the piracy indicator model and ensure alignment with the overall DMPP objectives based on input from DMPP research directors;
2. Construct a database with reported piracy attacks and categorize them based on gravity of incidents and location, with input from external experts as needed;
3. Develop a long list of potential indicators, based on a literature review and the research performed during the course of the DMPP project;
4. Gather the data and analyse it based on data quality criteria;
5. Establish a short list of those variables for which data exist that meet the criteria and that are potential indicators;
6. Determine the correlation between the indicator variables and the incidents of piracy outbreaks;
7. Analyse results to identify relationships and develop a list of variables that could be significant indicators of piracy outbreaks, with input from external experts and experts from other DMPP teams.

The focus of this report is on the output of the process[1] and not on the process itself. All steps were relevant for the development of the current model, but some provided input for subsequent stages, while others provided final results. Step 2 provided the necessary piracy data to be used as

[1] A description of the model development process can be found in the progress reports submitted as part of the overall DMPP project

output of the model and Step 5 provided the list of variables included in the analyses. Both of these steps are presented in Section 2 of this report. Steps 6 and 7 consisted of the analysis and results.

The purpose of the model is to determine what factors help distinguish between countries that have a piracy outbreak versus those that do not. If we can establish factors that help with this distinction, then policy-makers and analysts can pay special attention to states where the factors point to an outbreak, even though there has not been one yet. The right confluence of factors could signal that conditions are ripe for an outbreak. If an outbreak does not occur in such countries, then it presumes that the correlation of outbreaks with the selected variables is not strong enough and/or that other factors, which are not in our model, are affecting the outcome.

With that in mind, our approach was to develop a model with the following basic structure:

$Y = f(X_1, X_2, X_3, \ldots X_N)$.

Each X represents one measurable independent variable (an indicator such as the level of poverty or corruption in the pirates' country of origin). Y represents whether a piracy outbreak occurs in a country or not (0-1 variable). The equation denotes that Y is a function of the independent indicators (X) in order to identify indicators that correlate with piracy outbreaks.

The development of a piracy indicator model required making numerous assumptions relating to both the inputs to the models and the thresholds used to classify pirate states. These assumptions are based on contemporary piracy literature, guidelines for statistical models and the interpretation of the authors. Thus the validity of the model is somewhat limited by these suppositions, but the process and results are intended to facilitate discussions on piracy causes and solutions.

5. Piracy Event Database

The second step in developing the piracy indicator model was to gather data on piracy events. Dr. Bridget Coggins of Dartmouth College (hereafter referred to as Coggins) had already compiled a piracy event database from the detailed annual records of the International Maritime Bureau's (IMB) Piracy Reporting Centre (PRC) for her research. This database is also used for this research with consent of Coggins. Therefore the definition of piracy used by the IMB/PRC is applicable to this research:

> An act of boarding or attempting to board any ship with the apparent intent to commit theft or any other crime and with the apparent intent or capability to use force in the furtherance of that act (IMB/PRC, 2009 p. 3).

The database consists of all reported piracy events during the period 2000–2011, each event record composed of a large number of details, often coded, for each attack, including:

- The type of event;
- The level of violence used;
- The country of origin of the pirate attack.

Each piracy event has been coded as either: a suspicious vessel (0); an attempted attack (1); or a successful attack (2). An event coded as successful indicates that the pirates commandeered the ship, but does not indicate that the attack led to a successful kidnap and ransom incident, since not every event involves these elements. For the purpose of this research only those piracy events coded 1 or 2 were used, in order to focus on actual piracy events.

Each event is also classified according to the intensity of the violence used by the pirates: no reported violence (0); armed attack with threats but without physical violence (1); armed attack with physical violence but without deaths (2); and armed attack with physical violence and one or more deaths (3). The piracy events used to develop the piracy indicator model only included the piracy events that were coded 1, 2 or 3, so as to exclude cases of low impact theft, where a ship is boarded, part of the ship's stores is stolen and the culprits try to leave the ship undetected. The levels of violence are used as an indicator of the gravity of the piracy incidents. Ideally, this

would be combined with, for example, the economic impact and duration of the incidents, but that information is not available.

In most cases, the IMB/PRC reports the country of origin of the pirate attack based on the report filed by the victimized vessel. The reporting format used by the IMB/PRC does not ask what the nationality of the pirates was, but it does ask what language they spoke and what the country nearest to the attack was. This creates uncertainty regarding the reported nationality of the pirates and therefore the following adjustments were made in an attempt to further improve the data quality on the origin of the pirates (the number of attacks affected by these adjustments is shown in brackets):

- Somalia: based on the literature, for example Geopolicity's (2011) report, the attacks attributed to Tanzania (31), Yemen (17), Madagascar (5), Mozambique (5), Djibouti (3), Eritrea (3), Kenya (3), Oman (3), Saudi Arabia (2) and Sudan (2) have all been added to the total of Somalia;
- Malaysia (144) and Singapore (25): Based on the description of piracy in Asia by Liss (2007), the attacks attributed to these countries are most likely undertaken by pirates from Indonesia, Thailand and the Philippines. The attacks in Singapore and Malaysia have been added to the totals of Indonesia, Thailand and the Philippines in proportion to the relative number of other attacks in those countries;
- Nigeria: Nincic (2009), Neethling (2011) and many news articles (Sahara Reporters, 2011, Reuters, 2011) show that attacks of Nigerian pirates are spreading throughout the Gulf of Guinea, thus the attacks attributed to Benin (16), Cameroon (28) and Togo (5) have all been added to the total for Nigeria.

The data of the IMB/PRC have been used because this data provides statistics on piracy attacks from across the world and this ensures consistent coding across countries. The data are based on direct reports from victimized, or nearly victimized, vessels to the IMB/PRC. The advantage of the direct reporting is that political pressure or lack of state capacity does not influence the data (Coggins, 2012). Unfortunately, the data quality is far from perfect as a result of under-reporting. One of the reasons mentioned is that the IMB/PRC, a specialised division of the International Chamber of Commerce (ICC), focus on the interests of the global trading industry. Vessels not

involved in international trade will therefore be less familiar with the IMB/PRC and less likely to report a piracy attack (Coggins, 2012). A second reason mentioned for under-reporting is that reporting piracy incidents is done in English; non-English speaking victims are therefore unlikely to report an attack (Coggins, 2012). The third and fourth reasons for under-reporting are that captains do not want to run the risk of costly delays as a result of an investigation by the authorities (Vaknin, 2011) or because they fear insurance premium increases (Pallett, 2009). Fear of revenge by pirates is a fifth reason for not reporting an attack while a sixth reason is that many fishers have been attacked when fishing illegally and do not want to run the risk of prosecution (Liss, 2007). Noel Choong, head of IMB's reporting centre in Kuala Lumpur, has estimated that more than 50% of pirate attacks are not reported (Torchia, 2009).

6. Potential Piracy Indicators

The third step undertaken was to establish the long list of variables that would be considered as inputs to the model. At a meeting of all DMPP team members, brainstorming based on a literature review generated a long list of over 40 variables, indexes and topics. These were based on the research performed in the different modules of the DMPP project and included social, economic, governance and operational topics. It was realized early in the process that the long list would ultimately be shortened due to issues such as data access, data quality and data variability. The purpose was not to generate new data but to use existing data and identify which data would be useful as indicators of future piracy activities. The team examined five types of possible indicators. Table 1 indicates the initial categorization of measures considered and provides some illustrative measures that were considered by the various DMPP research teams. Considerable effort was undertaken to understand the composition of available multi-factor indexes as well.

Table 1 Illustrative measures for predicting piracy outbreaks

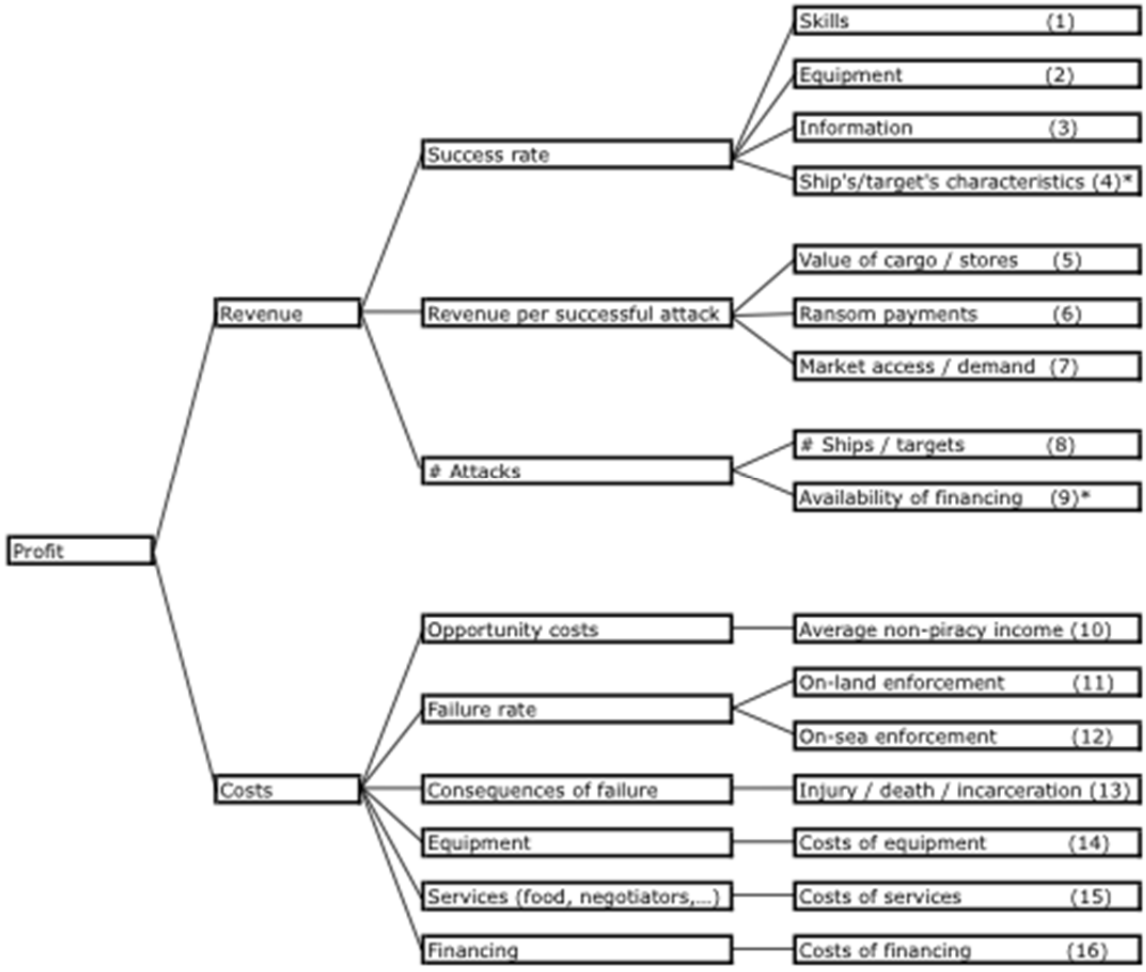
Type	Illustrative measures
Economic	Informal banking practices incorporated into the economy; shipping density of the region
Social	Hofstede's cultural dimensions (power distance, uncertainty avoidance, etc.); clan structure/family style; homicide rates
Socio-economic	Health of the fisheries; existence of minimum wage; child labour rates
Political/Governance	Incidence of civil war; security expenditure; effectiveness of the courts (prosecution and sentencing backlog); naval strength
Other	Mobile phone usage; Internet usage

To try to overcome time and data constraints, in developing the long list the DMPP team hypothesized that most pirates are economically motivated and that piracy is an economic act. Support for this hypothesis is found in the work of Liss (2007), which shows that pirates in Southeast Asia pursue economic gain. Articles on piracy in Latin America and the Caribbean, for example by El Nacional (2010) and Knews (2011), also show that financial gain is the key motivation for pirates in that region. Piracy on the east and west coasts of Africa is said to originate in grievances related to environmental exploitation. Although this could be one of the initial drivers, the act of piracy itself is, in most cases, clearly aimed to generate economic profit (i.e. holding ships for ransom or stealing valuable cargo). According to Geopolicity (2011, p. 10):

> Pirates who have not been press-ganged into being pirates would appear to be the very essence of rational profit maximizing entrepreneurs described in neo-classical economics. Expected profits determine decisions based on the information available. The supply of pirates, therefore, is closely related to the expected benefits of being a pirate and the associated risk-adjusted costs of being a pirate.

Hence, the selection of variables to include in the piracy indicator model begins with those that may influence the profitability of piracy. Therefore, a simplified piracy profit model was developed as a tool to structure thought, as shown in Figure 2.

Figure 2 Simplified piracy profit model



Note: * items 4 and 9 in this figure are excluded from Table 2 because shipping data were unavailable (4) and so was international financial data (9)

The profit that pirates can make depends on their expected revenues and costs. The number of attacks, the success rate of the attacks and the revenue per successful attack determine total revenue. The costs depend on the pirates' opportunity costs (i.e. the average income could they generate if they were not pirates), the failure rates of attacks, the economic consequences of a failed attack, and the costs of services, equipment and financing necessary for an attack.

Table 2 shows which key variables could influence this piracy profit model. The input is based on a review of the literature on piracy and the work done by the DMPP's socio-economic team (Whitman et al, 2012). The third column in Table 1 shows which variables were considered as piracy indicators. This Section explains which variables were selected for the purpose of developing the piracy indicator model, delving more deeply into defining the variables and the sources of data used in the research.

Table 2 Considered variables per key aspect of the piracy profit model

Aspect	Explanation	Considered variables
Skills & equipment (1,2)	One of the skills needed for piracy attacks is nautical experience. The literature makes mention of the fact that pirates at times force fishers to assist in piracy attacks, for example in Somalia (Sumaila, 2010) and Nigeria (Ochai, 2011). Apart from being forced directly by pirates to assist in their acts, the effects of overfishing on the local economic situation often does not leave many alternatives for, especially artisanal, fishers than to enter into illegal acts themselves (Termansen, 2011). For example, Liss (2011) notes that the perpetrators of attacks in Southeast Asia are at times "unemployed or desperate fishers who have the nautical skills needed to navigate and participate in the attack" (p.113)	- Environmental and socio-economic impacts of overfishing - Number of artisanal fishers and number of fishing vessels.
	Another skill, which is often mentioned in the literature, is the ability to organize a piracy attack, including holding the ship and seafarers for ransom, selling stolen cargo, obtaining financing and arms, etc. In several regions, piracy has become a component of larger, transnational, organized crime networks that are active in oil bunkering and trafficking in cocaine, children, counterfeit medicines, and cigarettes across the region (United Nations Security Council, 2012).	- (Organized) crime levels - Illegal firearms trade
Information (3)	An important aspect of contemporary piracy often mentioned in the literature is the availability of information. Pirates in East and West Africa often have detailed information on the vessels they attack, including information on the cargo, crew, routing and defence measures. For example, in Nigeria captains of attacked vessels were convinced pirates were being guided to their targets by corrupt port and customs officials (Murphy, 2011). Somali pirates are also thought to be provided with information from corrupt port officials in Kenya and Yemen who monitor AIS (Automatic Identification System) ship tracking information (Gilpin, 2009; Maouche, 2011).	- Level of perceived corruption

Aspect	Explanation	Considered variables
Market access and demand (7)	In order for pirates to profit from stealing cargo or items from crewmembers, they have to be able to sell their loot. In Nigeria, for example, the pirates require and obtain 'forged' official documents to import stolen oil into the country (Raidt & Smith, 2010). In Southeast Asia, tugs are frequently targeted by pirates and sold on the second-hand market after they have been repainted and renamed (ReCAAP, 2011), again requiring falsified documents.	- Level of perceived corruption - Size of black/grey market
Value of ransom, vessels, cargo/stores (5,6)	The average value of the vessel, the cargo and the stores onboard strongly determine the revenue pirates are able to generate. For example, it is not surprising that the highest ransom amount paid in 2011 was paid for the Irene SL, a Very Large Crude Carrier (Oceans Beyond Piracy, 2011a).	- Average value of vessels, cargo and stores - Average ransom payments
Availability of targets (8)	In order for pirates to launch successful attacks, there must be vessels in a certain area that can serve as targets. Therefore, the location of maritime shipping routes and maritime 'bottlenecks' are believed to be important factors in relation to piracy (Moreto and Caplan, 2010). Piracy attacks in the Malacca Straits and Gulf of Aden support this notion. Other aspects that influence the success of an attack are the operational aspects of the vessels in a certain region. These aspects can influence the likeliness that a vessel becomes a piracy target. For example, in 2011, there were no vessels hijacked that were travelling at 18 knots or faster (Oceans Beyond Piracy, 2011a).	- Number of ships within certain distance from coast - Speed and freeboard of all ships, security guards onboard, etc.
Average non-piracy income (10)	Frequently mentioned cause of piracy is poverty. Piracy is said to often originate in poor isolated coastal communities in which the population has little economic prospective (Liss, 2007; Raidt & Smith, 2010). Not only income, but also the level of education and health in a country is said to be related to piracy, i.e. low levels of human development can further push people towards getting involved in piracy (Onuoha, 2012)	- Gross National Income per capita (GNI) - GINI index - Human Development Index
Governance (legislation and terrestrial/ maritime enforce-ment) (11, 12)	A first step for a country to effectively reduce the risk of piracy is to make sure that it is clearly defined as a crime in its national legislation. For example, the UN stresses the importance of adequate national legislation as an element for ensuring that suspected pirates are effectively brought to justice (UN Security Council, 2011). A more frequently mentioned aspect in the literature is the importance of the capacity of a country to enforce its legislation in its Exclusive Economic Zone (EEZ). Several authors mention that piracy can thrive in weak or failed states that cannot secure their coastlines or EEZs (Nincic, 2008; Sumaila, 2010). The characteristics of the coastline (i.e. length and coves) can further complicate law enforcement operations (Reuters, 2011).	- Failed State Index (FSI) - Length of coastline - Implementation of anti-piracy legislation - Military expenditure (incl. navy and coast guard) - Size of police force

Aspect	Explanation	Considered variables
Injury / death / incarcera-tion (13)	The risks of injury, death or imprisonment are expected to be a consideration by pirates. However, Geopolicity (2011) estimates that the risk adjusted cost of death, injury, or imprisonment, based on foregone opportunity, ranges from $1,666 to $3,333 for Somali pirates, which is far below the expected gain. The risk of dying during an attack is a significant threat for Somali pirates, as an estimated seven percent of pirates drown or are killed at sea annually (Oceans Beyond Piracy, 2011b).	- Average number of (fatally) injured pirates - Number of imprisoned pirates
Costs of equipment, services and financing (14-16)	Apart from the costs of the actual piracy attack itself, the profits of pirates are also influenced, in the case of Somali pirates, by the costs of negotiators and spokesmen, accountants and financiers, logistics coordinators and caterers, and an extensive financing/money laundering network (Lennox, 2008). The financiers of Somali piracy attacks are estimated to receive some 50% of the revenue of an attack (Atallah, 2011).	- Costs to launch a piracy attack - Costs of support services to piracy - Financing costs

Before gathering data on relevant variables, criteria for assessing the quality of the data were established. The main criteria are: (1) they were objective, defined and measured statistics; (2) they were accessible/available from credible sources; and (3) they provided sufficient data coverage (temporal scope covering the same period as the piracy data used, and geographical scope covering at least all key piracy countries and preferably all coastal countries).

Table 3 provides an overview of all the indicators for which reliable data were found. It also shows that data coverage is a critical limitation, particularly as the FSI and Impacts of Overfishing were not reported before 2005.

Table 3 Percentage of coastal countries for which data is available per selected variables and period

Indicator (Number in Table 2)	Source	Data coverage for	
		2000-04	2005-10
Length of coastline (11, 12)	CIA fact book (2012)	100%	100%
Gross National Income per capita based on purchasing power parity (PPP) (10)	World Bank (2012)	88%	88%
Human Development Index (HDI) (10)	UNDP (2012)	84%	86%
Military expenditure / GDP (11, 12)	World Bank (2012)	69%	66%
Corruption Perception Index (3, 7)	Transparency International	56%	83%
Police / 100,000 inhabitants (11, 12)	UNODC (2012)	26%	25%
GINI index (10)	World Bank (2012)	21%	17%
Failed States Index (FSI) (11, 12)	Fund for Peace (2012)	0%	74%
Socio-economic impacts of overfishing (1, 2)	UNEP (2006)	0%	12%

Based on the findings shown in Table 3, it is clear that the coverage of data on a yearly basis and for all coastal countries is limited. By only selecting the period 2005–2010, data availability is somewhat improved, but still not enough to be able to develop a robust model. Further analysis of the available data for the period 2005–2010 showed that there was little annual change in the values of the variables. This means that by taking the average value of the variables in that period, the loss of information would be minimal and the model could be developed with a relatively complete database.

Table 4 shows, for each variable, the percentage of coastal countries for which the value of the variable is provided for at least one year in the 2005–2010 period. It also shows the total number of countries for which an average value is available. It is apparent that using the average values does not provide 100% data coverage for all variables. The countries for which data are missing differ by variable, which means that when multiple variables are selected, the number of countries for which data are available for all cumulatively selected variables can diminish considerably (as shown in the fourth column). The fifth column shows the percentage of countries that experienced a piracy outbreak for which the value of the variable is provided for at least one year in the same period. The last column shows the total number of countries that experienced a piracy outbreak that could be used for developing the model if the variable is included.

Table 4 Percentage of countries for which average variable values for the period 2005 - 2010 are available

Variables	% coastal countries	No. coastal countries	'Add effect' *	% piracy outbreak countries **	No. piracy outbreak countries
Coastline	100%	158	158	100%	14
HDI	91%	143	143	93%	13[2]
GNI/capita	90%	142	141	93%	13[1]
Corruption	89%	141	135	100%	14
FSI	85%	134	126	100%	14
Overfishing impacts	72%	114	99	100%	14
Military	72%	114	88	86%	12

[2] The HDI and GNI per capita for Somalia were not included in the UNDP and World Bank databases. Hastings (2009) included an estimate for the HDI and GDP per capita of Somalia in his report for UNESCAP. These estimates were used as a basis for the HDI and GNI value for Somalia used for the purpose of this study.

Variables	% coastal countries	No. coastal countries	'Add effect' *	% piracy outbreak countries **	No. piracy outbreak countries
expenditure					
GINI index	42%	67	54	93%	14
Police size	41%	64	26	50%	7

* The effect of adding the variable to the preceding ones on the total number of countries that can be included in the analysis (i.e. those countries for which data are available for all selected variables to date).

** For the purpose of this research, a country is classified as a "piracy outbreak country" if more than 20 piracy events originated from that country (undertaken by their nationals) in the period 2000–2011 and piracy events were report in at least 8 of the 12 years (further explained in Section 3).

Based on the results shown in Table 4, it was decided to exclude the following variables: military expenditure per GDP; number of police employees per 100,000 inhabitants; and the GINI index. The data quality for these variables is too low in terms of geographical scope, so including these variables would mean either a strong reduction in the total number of coastal countries, or of piracy outbreak countries, that could be used to develop the models. As a result of the selected variables, 99 coastal countries can be used to develop piracy indicator models. These 99 countries are included in Appendix 1, which also lists the number of attacks per country in the period 2000 – 2011. The selected variables are:

- The length of the coastline
- The Human Development Index
- Gross National Income per capita
- Corruption Perception Index
- Failed States Index
- Environmental and socio-economic impacts of overfishing

6.1 Length of Coastline

The length of the coastline influences the level of resources needed to enforce legislation. Also, the chance that there are parts of a country's coastline suitable for piracy is expected to increase with the length of the coastline.

'The World Factbook' (CIA, 2012) was used as the source for the length of the coastlines of the countries included in the analyses.

6.2 Human Development Index

A more holistic method of analyzing countries, and perhaps also more relevant in relation to piracy, is to look at the general level of human development. The UNDP argues that human development can be assessed based on the levels of health, education and living standards in a country. The UNDP has developed the Human Development Index (HDI), which captures the level of human development in a single value between 0 and 1 (UNDP, 2012). The HDI is calculated based on data from several international data agencies and other data sources and the underlying variables of the HDI are:

- Health: life expectancy at birth
- Education: Mean years of school and expected years of schooling
- Living standards: GNI per capita

No value was provided for Somalia, because of a lack of data sources. Because of the importance of this country in relation to analyzing piracy it was decided to use an estimate. Hastings (2009) included in his report for UNESCAP an estimate for the HDI of Somalia. Based on this estimate an HDI value was included for Somalia.

6.3 Gross National Income per capita

As explained in Table 2, the average income of a country might be related to maritime piracy in that country. A low average income could mean that people are looking for opportunities to generate additional income and piracy could be one of those. A low average income also means that the opportunity costs and risks of piracy are relatively low. Pirates do not miss out on significant income by being involved in piracy and the gains strongly outweigh the financial risks.

The gross national income (GNI) data used for the purpose of developing a piracy indicator model is obtained from the World Development Indicators of the World Bank. The variable used is the GNI per capita based on purchasing power parity (PPP). PPP GNI is gross national income (GNI) converted to international dollars using purchasing power parity rates. Thus an international dollar has the same purchasing power over GNI as a U.S. dollar has in the United States. GNI is the sum of value added by all resident producers plus any product taxes (less

subsidies) not included in the valuation of output. It also includes the net receipts of primary income (compensation of employees and property income) from abroad (World Bank, 2012a)

The World Bank works together with a large number of governmental, non-governmental and private organizations to obtain its statistics. It has also set up the International Comparison Program (ICP), which is a global statistical initiative to collect internationally comparable price levels. Purchasing power parities (PPPs) are computed based on the collected data. This enables the comparison of standards of living across countries (World Bank, 2012b).

Information on the GNI per capita was not provided for Somalia. The assumption was made that the GNI of Somalia would be the lowest of all countries. In case GNI would become an important part of the piracy indicator model, the influence of this assumption would be further tested.

6.4 Corruption Perception Index

Corruption is mentioned in the literature as contributing to piracy for several reasons, as discussed in Table 2. Examples include officials providing information to pirates, providing documents to import and sell stolen cargo and accepting financial gains from piracy.

For the purpose of this research the data on corruption provided by Transparency International (TI) is used to determine the statistical relationship between piracy and corruption. In 1995, Transparency International first published its Corruption Perception Index (CPI). This index is a composite index, a combination of polls, drawing on corruption-related data collected by a variety of institutions, and ranks countries based on how corrupt their public sector is perceived to be. The CPI reflects the views of observers from around the world, including experts living and working in the countries evaluated. All these sources publish a ranking of countries that is related to their perceived corruption levels. TI determines a single score for all countries that are included and ranked in at least 3 of the sources (TI, 2011). A score of 0 means that a country is perceived as highly corrupt and a score of 100 means that a country is perceived as very ‘clean’ (TI, 2012).

6.5 Failed States Index

As was expressed in Table 2, the literature suggests that weak and failed states are more susceptible to maritime piracy. For this reason it is important to determine whether there is in fact a statistical relationship between being a failed state and the presence of piracy.

For the purpose of developing a piracy indictor model, the Failed States Index (FSI) was included in the statistical analyses. The FSI is produced by the Fund for Peace (FfP) group since 2005 and is a tool that "makes political risk assessment and early warning of conflict accessible to policy-makers and the public at large."

The FSI ranks nations based on their levels of stability and the pressures they face. The Index is based on the Conflict Assessment Software Tool (CAST), which analyzes millions of documents each year using specialized search terms that flag relevant items. This analysis is then converted using an algorithm into a score representing the significance of each of the various pressures for a given country. Twelve key political, social and economic indicators and over 100 sub-indicators determine the relevance of the information items. These indicators have been determined over the course of several years by experts.

Each of the 12 indicators is scored on a 1 to 10 scale with 1 being the most stable and 10 being the most at-risk for collapse and violence. The total score per country is the sum of the scores of the twelve key indicators, which are:

1. Demographic Pressures: Pressures on the population such as disease and natural disasters make it difficult for the government to protect its citizens, or demonstrates a lack of capacity or will to do so.
2. Refugees and Internally Displaced Persons (IDPs): Pressures associated with population displacement. This strains public services and has the potential to pose a security threat.
3. Uneven Economic Development: When there are ethnic, religious, or regional disparities, governments tend to be uneven in their commitment to the social contract.
4. Group Grievance: When tension and violence exist between groups, the state's ability to provide security is undermined and fear and further violence may ensue.

5. Human Flight and Brain Drain: When there is little opportunity, people emmigrate, leaving a vacuum of human capital. Those with resources also often leave before, or just as, conflict erupts.
6. Poverty and Economic Decline: Poverty and economic decline strain the ability of the state to provide for its citizens if they cannot provide for themselves and can create friction between the "haves" and the "have nots".
7. State Legitimacy: Corruption and a lack of representativeness in the government directly undermine the social contract.
8. Public Services: The provision of health, education, and sanitation services, among others, are key roles of the state.
9. Human Rights and Rule of Law: When human rights are violated or unevenly protected, the state is failing in its ultimate responsibility.
10. Security Apparatus: The security apparatus should have a monopoly on the use of legitimate force. The social contract is weakened between government and citizens where this is influenced by the existence of competing groups (e.g. private militia).
11. Factionalized Elites: When local and national leaders engage in deadlock and brinksmanship for political gain, this undermines the social contract.
12. External Intervention: When the state fails to meet its international or domestic obligations, external actors may intervene to provide services or to manipulate internal affairs (FfP, 2011).

6.6 Environmental and Socio-economic Impacts of Overfishing

Table 1 provides information on why looking at fisheries could be important in order to better understand piracy. Fishers are frequently part of piracy attacks and a lack of sustainable fish stocks could be one of the causes that push fishers towards illegal activities. Unfortunately reliable statistical data on the number of (artisanal) fishers and the number of vessels that they use per country is not available. However, information on the socio-economic impacts of overfishing across the world is available through UNEP's Global International Water Assessment (GIWA, 2006). Part of the assessment was to evaluate the severity of trans-boundary ecological and societal impacts in international waters on a regional scale. One of the concerns assessed in GIWA was 'Overfishing and other threats to aquatic resources'. Though GIWA did not include

detailed quantitative information on the environmental and the resulting socio-economic impacts, it does provide normative impact information. This information can be used to determine whether overfishing and other threats to aquatic resources that cause severe impacts are more prone to piratical activities.

The methodology used to establish the environmental and socio-economic impacts of overfishing was based on a bottom-up approach involving 1500 scientists and administrative and managerial experts, who were organised into regional teams. These teams were multidisciplinary and included representatives from each country in the regions. The geographic boundaries of the GIWA regions in most cases consist of large drainage basins and their adjacent marine areas. The marine areas often correspond with those of Large Marine Ecosystems. The GIWA final report provided information on overfishing for 38 regions (some of which included sub-regions). These 38 regions provided information on 114 coastal countries.

As part of the GIWA process the experts assessed the environmental impacts based on quantitative and qualitative criteria. The topics included in the environmental impact assessment were:

- Overexploitation
- Excessive by-catch and discards
- Destructive fishing practices
- Decreased viability of stock through pollution and disease impact on biological and genetic diversity

After establishing to what extent these environmental impacts occurred, the experts assessed to what degree they led to socio-economic impacts. The experts took multiple potential impacts into consideration, which were grouped into:

- Economic impacts: The degree, frequency and duration of the impact on the quantity and quality of the output, and costs of operation of the key economic and public service sectors;
- Human health impacts: The degree of severity, frequency and duration of health impacts and the approximate number and types of people affected;

- Other social and community impacts: The frequency and degree to which community life is affected, and the number, size and principal characteristics (e.g. presence of vulnerable groups) of the affected communities.

The experts assessed the magnitude of the environmental and socio-economic impacts for each region. They based their assessment on their own knowledge and the available information obtained from a wide range of sources. In order to increase the comparability of the results, the impacts were evaluated using a standardised scoring system involving a four-point scale:

0. No impact reported
1. Slight impact
2. Moderate impact
3. Severe impact

The assessment resulted in one score for each of the four impact types (environmental, economic, health and social). These scores were based on the weighted average scores of each underlying impact. In addition, the expected impact by 2020 was also assessed based on the scenario that the experts found most likely. The scores for the four impact types and the expected future impacts were averaged into one overall score per region.

For the purpose of this research, all coastal countries located within one of the GIWA regions were assigned the overall score of that region and this one value was taken as the average for the period 2005–2010. Some countries were located within more than one region and in those cases the score of the worst performing region was assigned to the specific countries. The reasoning behind this decision is that just having a part of the coast severely affected by overfishing could potentially be sufficient for piracy to occur in those countries.

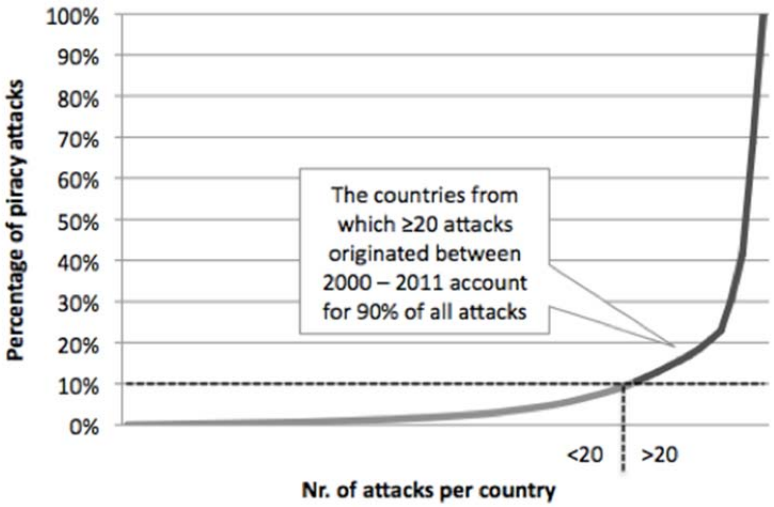
7. Piracy Indicator Models

This part of the report presents the different quantitative analyses that were undertaken to develop piracy indicator models. As briefly indicated in the introduction, two models were developed. The first model compares countries that have experienced piracy outbreaks with those that have not. The second model is constrained to those countries from which piracy attacks have originated, comparing those with low levels of piracy to those that have experienced a major piracy outbreak in recent years.

In order to distinguish between countries that have experienced a piracy outbreak and those that have not, what constitutes a piracy outbreak needs to be determined. For the purpose of this research two criteria were established: (1) consistency: in at least eight of the 12 years included in the piracy database one or more piracy events must have been reported; (2) scale: the total number of reported piracy events originating from a country must be at least 20 events. Using these criteria results in 14 countries that experienced a piracy outbreak in the period 2000–2011. These are Somalia, Indonesia, Nigeria, Bangladesh, Philippines, India, Peru, Vietnam, Brazil, Guinea, Venezuela, Côte d'Ivoire, Ecuador and Ghana.

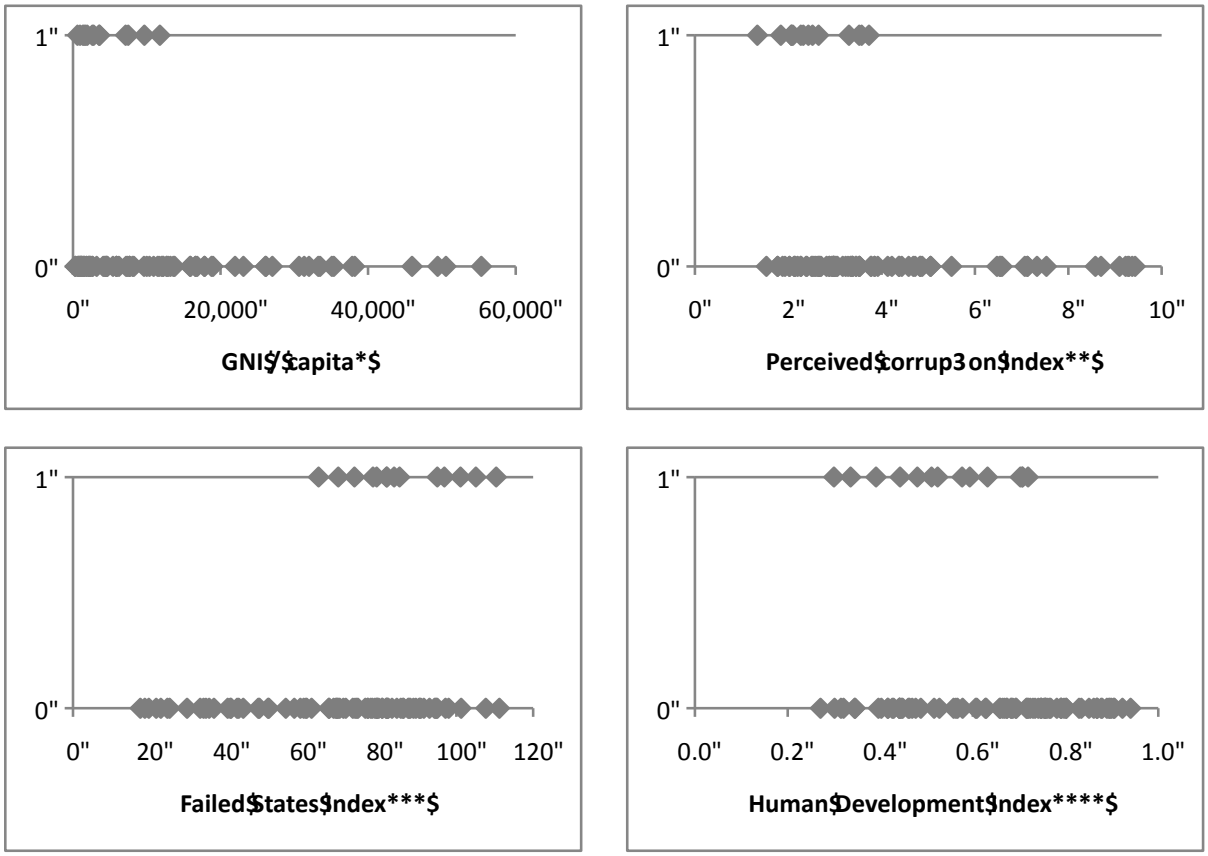
Together, these countries represent over 90% of all reported piracy attacks in the period 2000–2011 as shown in Figure 3.

Figure 3 Percentage of piracy attacks originating from piracy outbreak countries



Plotting potential indicator variables against piracy outbreaks provides an initial indication of possible relationships. Figure 4 plots the GNI per capita, corruption index, FSI and HDI and for countries that have experienced a piracy outbreak in recent years (Y=1) with those that have not (Y=0).

Figure 4 Graphs comparing the variables' values of countries with (Y=1) and without (Y=0) piracy outbreaks



* GNI per capita converted to international dollars using purchasing power parity rates
** 1 being the highest perceived level of corruption and 10 being the lowest level
*** Sum of the scores of 12 FSI conflict assessment indicators. Scores vary between 1 and 10, 1 being the most stable and 10 being the most at-risk for collapse and violence
**** 0 being the lowest level of human development and 1 being the highest level

The graphs suggest that thresholds (or cut-off points) can be set for each of the shown variables, beyond which piracy outbreaks begin to occur indicated by the dashed vertical line). Considering only the countries beyond the cut-off point (i.e. the cut-off group), allows us to reduce the number of countries under consideration in the analysis. Table 5 shows the cut-off point for each

of the variables in Figure 4, along with the number of countries in the cut-off group that did not experience a piracy outbreak in recent years (referred to as non-outbreak countries).

Table 5 Example of cut-off values for 4 variables

Variable	Cut-off value	Minimum or maximum value	No. countries in database	No. countries in cut-off group
GNI / capita	11,765	Maximum	99	63
Corruption	3.7	Maximum	99	63
FSI	64.1	Minimum	99	69
HDI	0.7	Maximum	99	60

Table 5 shows that using cut-off points could substantially reduce the number of countries and therefore could be used to increase the focus on certain groups of countries. However, they do not provide proof of statistically significant piracy outbreak indicators.

In order to find statistical evidence of piracy outbreak indicators, several binary logistic regression models were tested. Though this is a coarse method, it is regarded as the most appropriate one given that the dependent variable (piracy outbreak vs. no piracy outbreak) is dichotomous. Because there is strong correlation between many the included variables (see Appendix 2), collinearity has been taken into account when selecting the different combinations of variables to be tested. The selection of the strongest models was based on the chi-square test, their p-values and misclassification rates of piracy outbreaks.

Including all 99 coastal countries for which the data quality is considered to be sufficient, the resulting model shown in Table 6.

Table 6 Selected binary logistic regression piracy indicator model for all countries

Independent variables	Beta	Standard Error	p-level
Coastline	0.00008	0.00004	0.03893
Human flight & brain drain (HFBD)	1.02067	0.3245	0.00166
Intercept	-9.04764		

Chi-square: 22.31208
Degrees of Freedom: 2
p-level: 0.00001

The probability (p) that a country could be faced with a piracy outbreak (Y=1) can therefore be expressed as:

$$p(Y=1) = \frac{e^{(-9.04764+1.02067\,HFBD+0.00008*Coastline)}}{1+e^{(-9.04764+1.02067\,HFBD+0.00008*Coastline)}}$$

Although our model performs better than the Null model (i.e. whereby none of the independent variables are significantly related to the dependent variable), only 14% of the countries that have been the origin of a piracy outbreak in recent years are classified as such by the model. When making the assumption that a piracy outbreak will only originate from those countries that have already been the origin of at least one reported piracy event in the 2000-2011 period, a model can be developed that has a much lower misclassification rate of piracy outbreaks.

When including only the 48 countries that have been the origin of at least one piracy event in recent years and for which the data quality is considered to be sufficient (see Appendix 1 for the list of countries), the resulting model shown in Table 7.

Table 7 Selected binary logistic regression piracy indicator model for countries with at least 1 piracy attack

Independent variables	Beta	Standard Error	p-level
Human flight & brain drain (HFBD)	0.98068	0.35956	0.00638
Intercept	-7.61664		

Chi-square: 11.37145
Degrees of Freedom: 1
p-level: 0.00075

The probability (p) that a country becomes the origin of a piracy outbreak (Y=1) if it already has been the origin of at least one piracy event in recent years, can therefore be expressed as:

This model classifies six of the 14 countries correctly as the origin of piracy outbreaks and is a significant improvement over the previous model. The countries that are at a higher risk (p (Y=1) >25%) of seeing piracy outbreaks originate from within their borders are: Guatemala; Mexico; Liberia; Guinea-Bissau; Papua New Guinea; Democratic Republic of Congo; Trinidad and Tobago; Haiti; Sierra Leone; Sri Lanka; Colombia and the Dominican Republic.

GNI per capita, corruption levels, the FSI and HDI all show a significant relationship with piracy, but statistically they are relatively weak indicators of piracy outbreaks. In both models, the level of "human flight and brain drain" (HFBD), which is one of the 12 indicators of the FSI, is the strongest indicator for a piracy outbreak. This means that countries that suffer from "brain drain" and also an "economic drain" of people leaving in search of better economic perspectives or out of fear of persecution or repression have a higher chance of piracy.

There could be several reasons for the relationship between HFBD and piracy outbreaks. First of all, a high number of people leaving their country will increase the likelihood of irregular immigration patterns, which are often associated with organized crime (UNODC, 2006). For example, in the case of Somalia, human trafficking and piracy are closely connected (Beerdhige, 2012). This means that the presence of organized crime involved in human trafficking could spread to, or facilitate, other activities such as piracy.

Secondly, a high level of HFBD means that the human capital needed to contribute to the development of a country diminishes. This often includes entrepreneurs taking their skills and investments abroad and consequently the development of a more dynamic private sector is stifled (Ndulu, 2004). Employment opportunities are reduced and a lack of positive role models of successful people in legal businesses occurs. Young, unemployed men are attracted to the apparent economic success of piracy gangs (Nincic, 2009). The downward spiral that high levels of HFBD create results in little hope for better economic and social circumstances for those left behind. The relative economic and social security of piracy gangs provides an attractive alternative.

Note that a relationship between a piracy increase and a corresponding HFBD increase does not imply causation, as both could be simultaneously driven by other factors. However, the observations in our study provide good grounds for further investigation into this phenomenon.

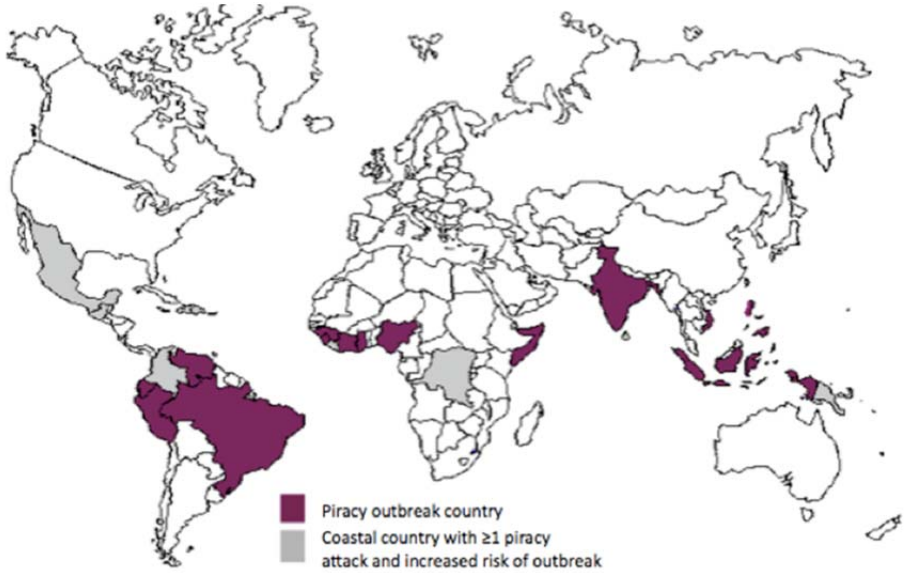
8. Discussion

The analyses performed as part of this research show that piracy outbreaks only occur in relatively poor countries, with high corruption rates, that score low on the HDI, are ranked high on the FSI, and are faced with medium to severe socio-economic impacts of overfishing. However, there are many countries in the world that have the same characteristics, but have not experienced a piracy outbreak. One variable that does appear to have a relatively strong influence on the risk of a country becoming the origin of a piracy outbreak is "Human flight and brain drain (HFBD)". This is one of the 12 variables from which the FSI is compiled. High levels of HFBD often coincide with irregular immigration facilitated by organized crime. The associated criminal organisations could expand their business activities to piracy, thus explaining the statistical link between piracy and HFBD.

Another potential reason why relatively high levels of HFBD might lead to an increased risk of piracy outbreaks is because the outflow of human capital, especially entrepreneurs, hampers private sector development, employment opportunities and the number of successful people in legal businesses that could serve as role models for a younger generation.

The downward spiral associated with high levels of outflow of human capital minimizes the economic prospects for people that do not leave the country and increases the attractiveness to participate in the, often lucrative, piracy business. The countries shown in purple (dark) in Figure 5 have already experienced a piracy outbreak in the period 2000–2011. The countries shown in grey have experienced low levels of piracy in the same period, but their levels of HFBD suggest that they are at risk of piracy outbreaks.

Figure 5 Map of piracy outbreak countries and countries with increased risk of outbreaks



As already noted, the countries that are at a higher risk (p (Y=1) >25%) of seeing piracy outbreaks originate from within their borders (indicated in gray on Figure 5) are: Guatemala; Mexico; Liberia; Guinea-Bissau; Papua New Guinea; Democratic Republic of Congo; Trinidad and Tobago; Haiti; Sierra Leone; Sri Lanka; Colombia and the Dominican Republic.

Of those 'piracy countries' in Figure 5, Brazil is an interesting case, because the number of reported piracy attacks indicate that it did suffer from a piracy outbreak in recent years, but the model outcomes do not indicate that Brazil is at risk of a piracy outbreak. This could be the result of a discrepancy between the national average values of the indicators and the actual situation in remote areas in the country. For example, Frecon (2011) notes that people in remote coastal areas characterized by poverty and isolation from the state are particularly exposed to the effects of overfishing and environmental degradation, which increases the risk of piracy occurring. A country that experiences relatively strong economic growth in its cities could improve its national statistics, while local, rural circumstances still pose breeding grounds for piracy. The case of Brazil therefore shows that a local approach could be equally or even more important than a national approach when analyzing piracy. However, it could also mean that the reported attacks are actually committed by perpetrators from other countries in the region, as piracy incidents may wash into the 'country next door'.

The models developed in this report are only partially successful in finding strong indicators for piracy outbreaks. In order to create stronger models, the quality of economic, social and governance data needs to be improved. Potentially important variables, such as the levels of organized crime, navy and coast guard capabilities, fish catch per unit of effort or vessel traffic information could not be included as a result of lack of data quality. The statistics on piracy attacks also need to be improved to develop stronger models. If Choong's assessment of under-reporting (Torchia, 2009) is correct, and at least 50% of all attacks are not reported, this raises the concern that the statistics do not accurately reflect the reality. This issue should be addressed by lowering reporting barriers.

This research has provided an indication of countries that are at a higher risk of becoming an origin of a piracy outbreak. Future research could compare these countries with countries that actually experienced a piracy outbreak. Such a comparison can focus on fewer countries than this report and therefore could take both local and regional specifics into consideration. The resulting insights would, together with the findings presented in this report, facilitate the development of measures to prevent piracy outbreaks from occurring or mitigate potential impacts.

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Appendix 1 Countries included in analyses (2000 – 2011 data)

Countries	# piracy attacks	Piracy outbreak (y/n)	Countries	# piracy attacks	Piracy outbreak (y/n)
Belize	0	n	Bulgaria	0	n
Turkey	0	n	Algeria	1	n
Tunisia	0	n	China	1	n
Syrian Arab Republic	0	n	Congo, Rep.	1	n
Namibia	0	n	Costa Rica	1	n
Nicaragua	0	n	El Salvador	1	n
Cape Verde	0	n	France	1	n
Equatorial Guinea	0	n	Gambia, The	1	n
Kenya	0	n	Georgia	1	n
Madagascar	0	n	Greece	1	n
Cameroon	0	n	Guatemala	1	n
Tanzania	0	n	Libya	1	n
Yemen, Rep.	0	n	Mexico	1	n
Comoros	0	n	Panama	1	n
Togo	0	n	South Africa	1	n
Benin	0	n	Liberia	2	n
Djibouti	0	n	Mauritania	2	n
Sudan	0	n	Morocco	2	n
Eritrea	0	n	Guinea-Bissau	3	n
Mozambique	0	n	Papua New Guinea	3	n
Mauritius	0	n	United States	3	n
Brunei Darussalam	0	n	Congo, Dem. Rep.	4	n
Saudi Arabia	0	n	Egypt, Arab Rep.	4	n
Malaysia	0	n	Myanmar	4	n
Grenada	0	n	Trinidad and Tobago	5	n
Russian Federation	0	n	Angola	6	n
Albania	0	n	Gabon	8	n
Lebanon	0	n	Haiti	8	n
Norway	0	n	Senegal	8	n
Australia	0	n	Sierra Leone	9	n
New Zealand	0	n	Sri Lanka	9	n
Sweden	0	n	Jamaica	12	n
Iceland	0	n	Thailand	15	n
Japan	0	n	Colombia	17	n
Denmark	0	n	Dominican Republic	19	n
Finland	0	n	Ghana	21	y
Italy	0	n	Ecuador	25	y
Slovenia	0	n	Cote D'Ivoire	27	y
Spain	0	n	Venezuela, RB	30	y
Singapore	0	n	Brazil	32	y
Estonia	0	n	Guinea	32	y
Poland	0	n	Vietnam	34	y
Lithuania	0	n	Peru	38	y
Latvia	0	n	India	55	y
Chile	0	n	Philippines	55	y
Barbados	0	n	Bangladesh	186	y
Croatia	0	n	Nigeria	263	y
Argentina	0	n	Indonesia	655	y
Romania	0	n	Somalia	761	y
Uruguay	0	n			

Appendix 2 Correlation matrix of included variables

Variable	Pearson's	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t
Coastline (a)	Correlation	1.																			
	p-value																				
	H0 (5%)																				
GNI per capita (b)	Correlation	0.275	1																		
	p-value	0.006																			
	H0 (5%)	reject																			
CPI (c)	Correlation	0.198	0.821	1																	
	p-value	0.050	0.000																		
	H0 (5%)	reject	reject																		
Overfishing impacts (d)	Correlation	0.220	-0.204	-0.242	1																
	p-value	0.029	0.043	0.016																	
	H0 (5%)	reject	reject	reject																	
FSI (e)	Correlation	-0.225	-0.801	-0.900	0.224	1															
	p-value	0.025	0.000	0.000	0.026																
	H0 (5%)	reject	reject	reject	reject																
Demographic pressure (f)	Correlation	-0.189	-0.810	-0.876	0.218	0.938	1														
	p-value	0.061	0.000	0.000	0.031	0.000															
	H0 (5%)	accept	reject	reject	reject	rejected															
Refugees & IDPs (g)	Correlation	-0.133	-0.620	-0.691	0.192	0.841	0.779	1													
	p-value	0.190	0.000	0.000	0.056	0.000	0.000														
	H0 (5%)	accept	reject	reject	accept	rejected	rejected														
Group grievance (h)	Correlation	-0.120	-0.594	-0.735	0.188	0.866	0.786	0.783	1												
	p-value	0.238	0.000	0.000	0.062	0.000	0.000	0.000													
	H0 (5%)	accept	reject	reject	accept	rejected	rejected	rejected													
Human flight & brain drain (i)	Correlation	-0.248	-0.775	-0.790	0.215	0.840	0.777	0.610	0.628	1											
	p-value	0.013	0.000	0.000	0.032	0.000	0.000	0.000	0.000												
	H0 (5%)	reject	reject	reject	reject	rejected	rejected	rejected	rejected												
Uneven economic development (j)	Correlation	-0.181	-0.738	-0.849	0.153	0.885	0.863	0.719	0.799	0.769	1										
	p-value	0.073	0.000	0.000	0.132	0.000	0.000	0.000	0.000	0.000											
	H0 (5%)	accept	reject	reject	accept	rejected	rejected	rejected	rejected	rejected											
Poverty & economic decline (k)	Correlation	-0.300	-0.774	-0.724	0.120	0.776	0.732	0.597	0.530	0.728	0.577	1									
	p-value	0.003	0.000	0.000	0.235	0.000	0.000	0.000	0.000	0.000	0.000										
	H0 (5%)	reject	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected										
Legitimacy of state (l)	Correlation	-0.226	-0.723	-0.881	0.242	0.954	0.867	0.765	0.813	0.784	0.844	0.674	1								
	p-value	0.025	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000	0.000	0.000									
	H0 (5%)	reject	reject	reject	reject	rejected	rejected	rejected	rejected	rejected	rejected	rejected									
Public services (m)	Correlation	-0.279	-0.860	-0.880	0.177	0.916	0.921	0.689	0.685	0.805	0.812	0.821	0.844	1							
	p-value	0.005	0.000	0.000	0.080	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000								
	H0 (5%)	reject	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected								
Human rights (n)	Correlation	-0.132	-0.659	-0.829	0.189	0.926	0.860	0.771	0.830	0.695	0.821	0.614	0.932	0.818	1						
	p-value	0.191	0.000	0.000	0.061	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000							
	H0 (5%)	accept	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected							
Security apparatus (o)	Correlation	-0.185	-0.705	-0.838	0.223	0.951	0.855	0.772	0.867	0.752	0.839	0.664	0.923	0.835	0.900	1					
	p-value	0.068	0.000	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000						
	H0 (5%)	accept	reject	reject	reject	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected						

Variable	Pearson's	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*
Factionalized elite (p)	Correlation	-0.157	-0.642	-0.799	0.226	0.935	0.838	0.794	0.870	0.712	0.810	0.625	0.923	0.783	0.900	0.926	1				
	p-value	0.121	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000					
	H0 (5%)	accept	reject	reject	reject	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected					
External intervention (q)	Correlation	-0.273	-0.716	-0.750	0.235	0.863	0.780	0.702	0.657	0.760	0.634	0.798	0.794	0.807	0.724	0.805	0.768	1			
	p-value	0.006	0.000	0.000	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
	H0 (5%)	reject	reject	reject	reject	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected				
HDI (r)	Correlation	0.274	0.801	0.749	-0.126	-0.818	-0.846	-0.653	-0.579	-0.693	-0.671	-0.839	-0.727	-0.906	-0.719	-0.713	-0.682	-0.756	1		
	p-value	0.006	0.000	0.000	0.214	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
	H0 (5%)	reject	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected			
LifeExpectancy (s)	Correlation	0.234	0.644	0.651	-0.143	-0.696	-0.745	-0.564	-0.458	-0.582	-0.609	-0.671	-0.616	-0.812	-0.615	-0.592	-0.573	-0.637	0.901	1	
	p-value	0.020	0.000	0.000	0.158	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
	H0 (5%)	reject	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected		
Literacy (t)	Correlation	0.284	0.611	0.558	0.025	-0.628	-0.645	-0.497	-0.435	-0.509	-0.487	-0.718	-0.551	-0.727	-0.561	-0.529	-0.503	-0.587	0.875	0.769	1
	p-value	0.004	0.000	0.000	0.806	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	H0 (5%)	reject	reject	reject	accept	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	rejected	

Sample size 99

Critical value (5%) 1.98472

All "rejected" relations are statistically significant correlated