7-20-2013

Ransom negotiation with Somali Pirates based on bargaining model

Qiong Xi

SHANGHAI MARITIME UNIVERSITY

WORLD MARITIME UNIVERSITY

Shanghai, China

Ransom Negotiation with Somali Pirates based on Bargaining Model

By

Xi Qiong

China

A research paper submitted to the World Maritime University in partial fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

INTERNATIOANL TRANSPORT AND LOGISTICS

2013

DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

……

Supervised by

Associate Professor Sha Mei

Shanghai Maritime University

ACKNOWLEDGEMENT

Firstly I want to express my profound gratitude to Professor Ma Shuo as the representative of World Maritime University, who provided me with the admission for postgraduate study majoring International Transport and Logistics. Also, I want to thank to Ms. Jiang Zhengfei and Hu Fangfang, who are in charge of this postgraduate program on behalf of Shanghai Maritime University. Their continuous support and timely notification have helped me a lot throughout my study of this program.

Secondly I am grateful to my supervisor associate professor Sha Mei for supporting me in this phase of my paper with her patience and knowledge, making helpful comments on the first draft of this paper. This paper could not have been possibly finished without her academic support.

Thirdly I am deeply thankful to all the professors for sharing their extensive knowledge with me. The wonderful lectures gave me inspiration for my final paper.

Finally, I wish to thank all my classmates who cheerfully encourage me to finish and improve the paper. I would like to express my gratitude to all my classmates for their support and cooperation during my study in the past two years. The errors, idiocies and inconsistencies remain my own.

ABSTRACT

Title of research paper: **Ransom Negotiation with Somali Pirates based on Bargaining Model**

Degree: **Master of Science in International Transport and Logistics**

Somali piracy has been a very serious issue and huge ransom bills paid to Somali pirates are arousing related parties' concern. Although there are many qualitative studies on pirate ransom from the perspective of maritime law, it lacks empirical quantitative study on the application of bargaining model on piracy problem. The ransoms demanded by pirates and paid by shipowners are influenced by various factors. This paper investigates the characteristics of Somali pirates and identifies the empirical determinants of ransom bargaining result. Then this paper builds the dynamic tri-stages alternating-offers bargaining model with one-sided asymmetric information to determine ransom settings. Based on this model, further analysis of factors that affect the bargaining equilibrium outcome is done and corresponding suggestions in shipowner's favor to lower his losses are put forward.

KEYWORDS: Piracy, ransom, bargaining model, Somalia.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

CTL	Constructive Total Loss
IMB	International Maritime Bureau
IMO	International Maritime Organization
K&R Insurance	Kidnap and Ransom Insurance
P&I Club	Protection & Indemnity Club
VLCC	Very Large Crude Carrier

Chapter One: Introduction

1.1 Background

In recent years, the number of global piracy[1] incidents is rising, the behavior of pirates is becoming more abominable and the range of activities is expanding. All these seriously affect the global shipping industry and international trade and production activities. It greatly threatens the safety of life at sea and ships' property, especially in the Gulf of Aden and the waters of the Horn of Africa.

Although the affects of Somalis pirates on the international shipping and what countermeasures should be taken has focused international attention on ransom payments, little empirical work has been done investigating the determinants of ransoms. Since Somali pirates tend to demand sizeable ransoms for the release of captured crews and cargoes, it forces global shipowners, cargo-owners and insurance companies to re-adjust their maritime business strategies.

---

[1] "Piracy" is defined in article 101 of the United Nations Convention on the Law of the Sea as follows:

"Piracy consists of any of the following acts:

(a) any illegal acts of violence or detention, or any act of depredation, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed:
   (i) on the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft;
   (ii) against a ship, aircraft, persons or property in a place outside the jurisdiction of any State;

(b) any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft;

(c) any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b)."

1.2 The Research Problem

Reported ransoms paid to Somali pirates have been rising steadily in the last few years. However, when it comes to ransom payments and negotiation lengths, it differs a lot from shipowner to shipowner. Why can some shipowners pay relatively low ransoms after a few weeks, while others must negotiate in excess of a year to ransom their ships for overwhelming high bills? How do shipowners and Somali pirates bargain when they have asymmetric information available?

In order to answer these questions, this paper mainly explores the following problems:

(1) The characteristics of modem-day piracy and related ransom issues;

(2) Study on piracy and ransom from legal and insurance perspective;

(3) The theoretical determinants of ransom settings according to the characteristics of Somali piracy and ransoms;

(4) The ransom negotiation decision making strategy based on Game Theory, i.e. the dynamic alternating-offers bargaining model with one-sided asymmetric information;

(5) Factors that affect the ransom negotiation result and corresponding countermeasures.

1.3 The Expected Contribution

It is of significant importance to improve the shipping enterprises' capability of risk analysis and risk control in the ransom bargaining process. This not only provides shipping companies with some theoretical guidance for the numerical calculation of ransom offer and counteroffer when it comes to decision making strategy on ransom negotiation, but also gives some practical suggestion what appropriate measures should be taken for

shipowners' ransom payment in dealing with emergency situations. In detail, there are mainly the following contributions:

(1) Theoretical significance：In the existing literature, most scholars did qualitative studies on pirate ransom from the perspective of the legal nature and insurance liability of ransom payment. Yet little economic analysis has been done from shipowners, shippers and insurance companies' point of view. On the other hand, although game theory is widely used, it lacks empirical quantitative study on the application of bargaining model on piracy problem. It is of great theoretical significance to apply bargaining model on pirate ransom.

(2) Practical significance：For the shipowner, the cargo spoils and the ship goes unused. He also suffers hire loss. For the pirates, the captured crew must be fed and the ship guarded. Both sides hope to maximize their own interests (or minimize their losses) in the given conditions. Furthermore, these numerical representations of the bargaining model can be used by shipowner to strategically identify and improve ransom negotiation skills so as to put pressure on Somali pirates' kidnapping and reduce payment amount.

This paper aims to provide some reference to promote the application of bargaining model for shipping enterprises when they are hijacked ships for ransom.

1.4 Research Methodology and Framework

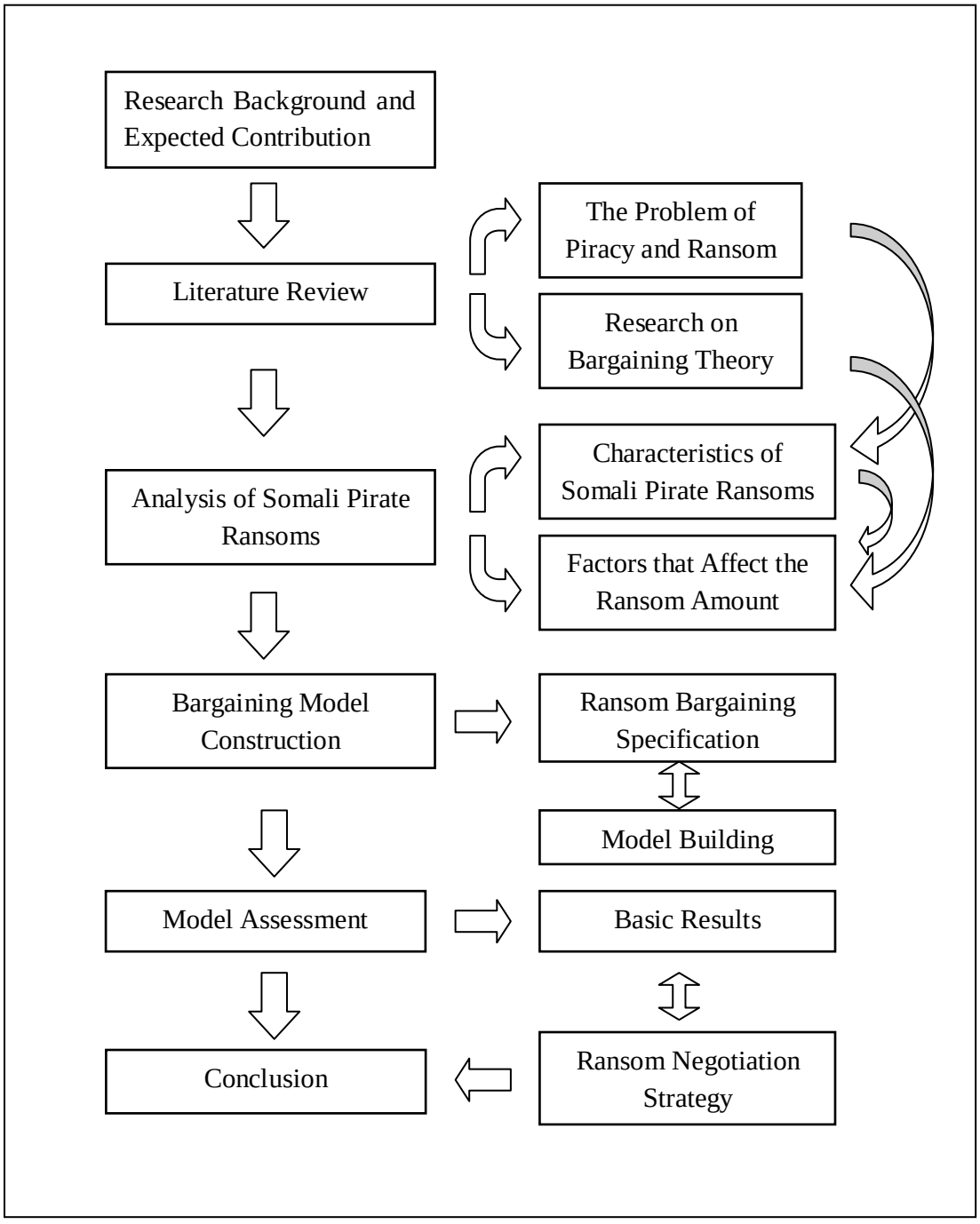
This paper uses the following two methodologies, namely desk research and bargaining model.

The writer starts out with the existing research on pirate ransom from maritime law perspective and then moves to game theory. Then the ransom negotiation problem based

on bargaining model is studied. With the typical tri-stages bargaining model as basic theory, the writer considers the asymmetric information factors, such as different ransom price intervals and various psychological pressure, which shipowners and pirates are faced with in the ransom bargaining process. Next this paper investigates the ransom bargaining model with asymmetric pressure under incomplete information. Finally the model assessment is made considering various factors which affect the ransom bargaining process and result, and suggestions are put forward in shipowners' favor from both shipowners' perspective and pirates' perspective.

This paper is mainly divided into five chapters and the basic framework is as follows:
Chapter 1 is an introduction mainly on the research background and research problem, as well as the expected contribution and research methodology. It serves as a backdrop to the further research on ransom negotiation of this paper. Chapter 2 focuses on the theoretical research on pirate ransom and game theory. It reviews the existing study on ransom from legal and insurance perspective, as well as the current study of bargaining theory and game theory's application in maritime field. Chapter 3 first identifies the geographical characteristics of Somali pirate ransoms, and then analyzes the factors affecting the bargaining process. The writer points out the existing problems that remain to be solved. Chapter 4 uses mathematical modeling to solve the problem of ransom negotiations. Starting out with classical bargaining model and identifying ransom bargaining specification, this paper builds ransom negotiation model and does some basic analysis of both shipowners' and pirates' negotiating behavior. Chapter 5 is the model assessment. The writer explores correlationship between final ransom result and various factors. Then this paper develops corresponding decision-making strategies in shipowners' favor in order to perform appropriate negotiation skills during the ransom negotiating process. In closing, the writer makes a brief summary on this research paper and points out the deficiencies and future research directions.

Figure 1 Research Technology Roadmap



Chapter Two: Literature Review

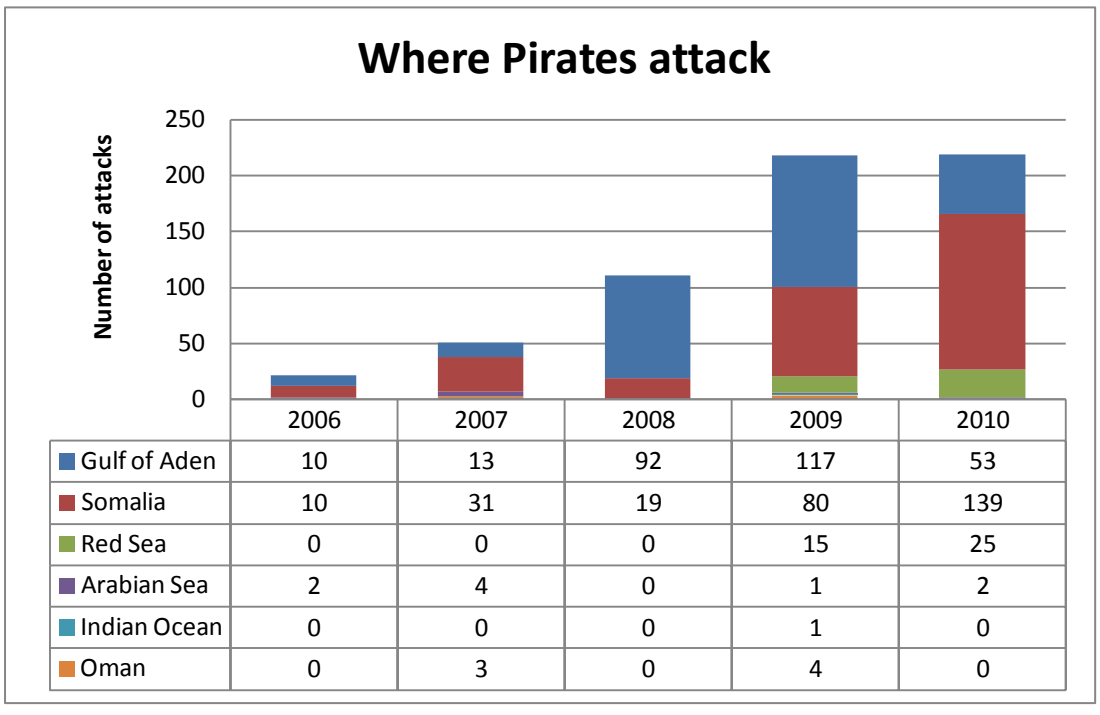
2.1 The Problem of Piracy and Ransom

2.1.1 Research on Piracy Issues

The activity of modern-day pirates does not change greatly compared with historical pirate activity range. It mainly still gathers on the route from Africa to Asia, and near South America and Caribbean.

Where do pirates attack? What do pirates attack? Figure 2 shows statistics on Somali pirate attacks in 2006-2010. Table 1 and Figure 3 show the distribution of global attacks on different ship types in 2010.

Figure 2 Somali pirate attacks, in 2006-2010



	2006	2007	2008	2009	2010
Gulf of Aden	10	13	92	117	53
Somalia	10	31	19	80	139
Red Sea	0	0	0	15	25
Arabian Sea	2	4	0	1	2
Indian Ocean	0	0	0	1	0
Oman	0	3	0	4	0

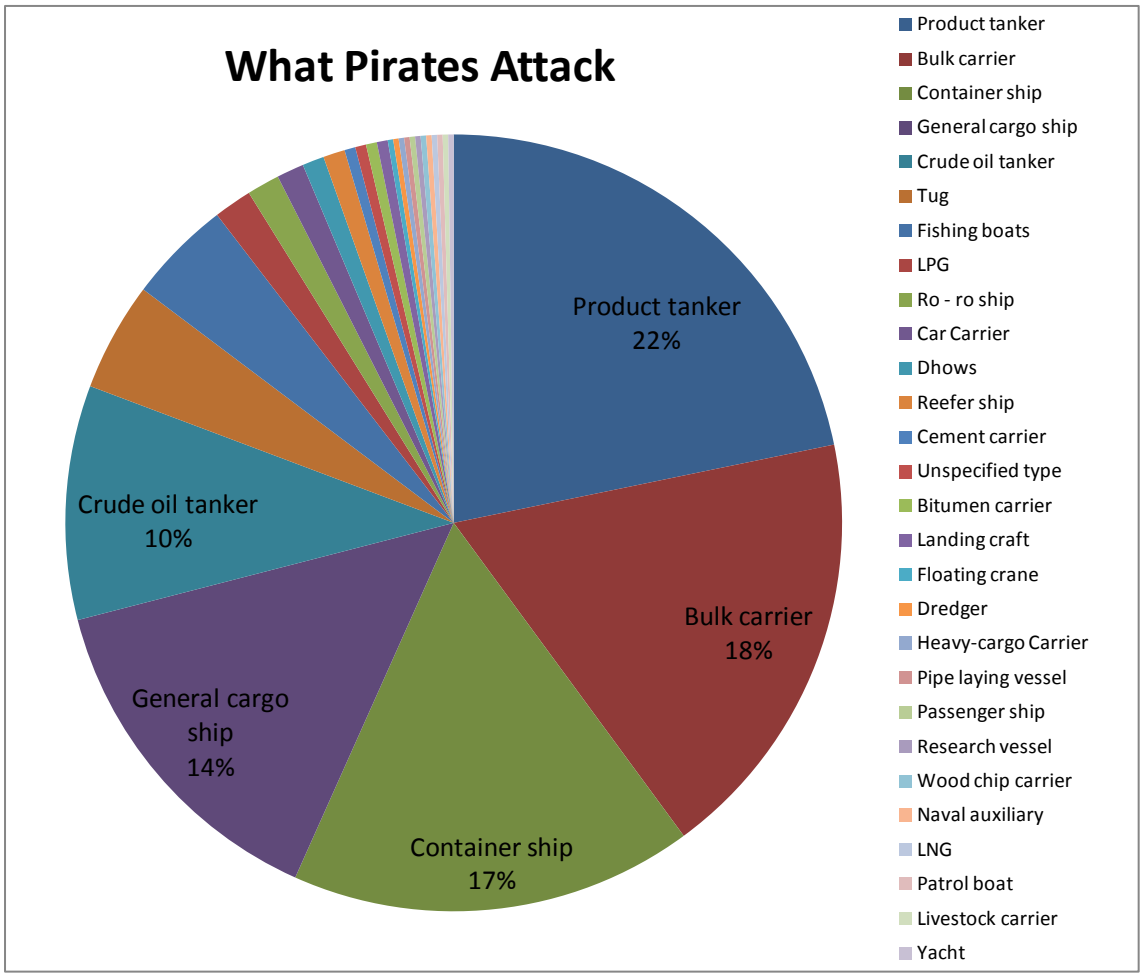
Compared with historical pirate activity range, modern pirate activity range does not change greatly. It mainly still gathers on the route from Africa to Asia, and near South America and Caribbean.

In general, the main activity areas of modern-day pirates range from West African coast, Somali Peninsula, Red Sea and Gulf of Aden, the coast of Bay of Bengal and the entire Southeast Asian waters. Among them, the Southeast Asian waters are the most dangerous areas under pirate attack in the world. With a total of 1567 pirate attacks between 1991 and 2001, it accounted for about 66% of the global maritime piracy.[1] Most of the vicious pirate cases in the world in the past happened here. Figure 1 reveals that pirate attacks near Somalia are getting worse in recent years.

Table 1 Number of global attacks on different ship types in 2010 Unit: ship

Ship Type	No. of attacks	Ship Type	No. of attacks	Ship Type	No. of attacks
Bulk carrier	80	Passenger ship	1	LNG	1
Cement carrier	2	Reefer ship	4	LPG	7
Container ship	74	Research vessel	1	Fishing boats	19
Floating crane	1	Ro - ro ship	6	Tug	20
Dhows	4	Wood chip carrier	1	Patrol boat	1
Dredger	1	Naval auxiliary	1	Car Carrier	5
General cargo ship	63	Bitumen carrier	2	Livestock carrier	1
Heavy-cargo Carrier	1	Landing craft	2	Yacht	1
Pipe laying vessel	1	Product tanker	96	Total	445
Unspecified type	2	Crude oil tanker	43		

Figure 3 Vessels attacked, by type, in 2010 Unit: percent



The above statistics suggest that highjack targets of modern pirates mainly focus on product tanker, bulk carrier, container ship, general cargo ship and crude oil tanker. Once the ship is hijacked, shipowner, shipper and insurance company will suffer significant losses. One of the reasons is that modern ships are more vulnerable under pirate attacks due to automation.[2] These types of ships feature high ship price and cargo value.

Ships and cargoes suffer the mounting pirate threat. According to the International Maritime Bureau (IMB), it was estimated that before 1996 the world suffered an annual loss of about $ 0.3-0.45 billion due to pirate attacks. By 2002, this figure substantially increased to about $ 16-25 billion.[3] Besides, the Pirate Information Center (IMB) located in Malaysia found that the probability of hostage being rescued after the ship was hijacked offshore is less than 10%, while the probability of successful rescuing hostages onshore is more than

90%.[4]

Since piracy problem will still exist in a certain period of time, shipowners will continue to suffer from paying pirate ransoms. Hoping a smooth voyage and goods' arrival on time, shipowners have to pay the ransom in order to minimize their loss and delay. Therefore, it is necessary to study issues related to pirate ransom.

2.1.2 Study on Ransom from Legal and Insurance Perspective

The attacks on commercial shipping vessels by Somali pirates have introduced a business dilemma for ship-owners. Pay it or not? When to pay it? How much should be paid?

The existing literature on pirate ransom mainly focuses on the legal nature of pirate ransom and marine insurance liability.

First of all, English law admits the legitimacy of the ransom. The London insurance market's interest in classifying pirate ransom into general average reveals that under total loss or constructive total loss of the ship and the cargo, the insurance company will have to suffer more indemnity loss. Therefore, the insurance company has no choice but to make this decision from their own interests.[5] Shi Dan suggested that ransom be distinguished according to liability regime and it should be shared between shipowner and cargo-owner according to salved value ratio.[6]

The losses of ransom payment among involved parties vary a lot under different chartering types. We should discuss ransom payment respectively under three circumstances, namely voyage charter, time charter and liner shipping contract. Shipowner, as the owner of big-ticket ship, is not always the top gainer from the ransom payment.[7]

Is it necessary to pay ransom? The author proper thinks that, at present, it still seems

acceptable to pay a ransom. Because the ransom payment is in the purpose of avoiding property damage rather than direct property damage itself. Pirates as a threat, mainly embodied in the following aspects: 1) It is a direct threat to people's life and safety; 2) It causes direct economic loss, such as pirate robbery, theft of goods and delay of the voyage. So, we should not rigidly identify paying ransom to Somali pirates as illegal and neglect the necessity of paying ransom.

However, problem and weakness still exist.

When it comes to studies on Somali piracy, scholars mainly study the problem of anti-piracy on legal basis and discuss its insufficient political aspects. Besides, the existing literature on ransom payment mainly focused on 1) the legal nature of pirate ransom and 2) marine insurance liability from maritime law perspective. What's more, the research methods used in the current studies concerning piracy and ransom are 1) qualitative analysis method and 2) case study method.

From the economic perspective, however, there are little empirical articles on pirate ransom, especially on ransom negotiation. Despite its legal importance, little studies have been done investigating the determinants of ransom negotiations or numerically identify ransom amount.

2.2 Research on Bargaining Theory

2.2.1 Study and Application of Bargaining Theory

The major objects of existing literature on bargaining model are model construction, range, ability (bargaining power), solution, and cost coefficient.

Model construction is widely used in decision making in merger and acquisition negotiations, and in establishing cooperative alliance in supply chain. Bargaining range aims at determining the effective bargaining rang when considering incentive mechanism, risk assessment and so on into account. Bargaining solution discusses corresponding equilibrium point under complete information static game; complete information dynamic game; incomplete information static game and incomplete information dynamic game respectively.[8] Research on bargaining cost coefficients suggests that when the range of bargaining cost coefficients of both sides is decided, rational manufacturers and sellers will choose to cooperate and share the interests in accordance with the bargaining solution and realize "win-win" situation. [9]

When it comes to applications, most bargaining models are applied on regulated markets, ranging from logistics company, power market, high-tech enterprise, investment bank, farming industry to transnational company's horizontal or vertical integration. For example, logistics companies apply bargaining theory to decide the optimal cost input and price setting strategy in promotion problems. Two papers constructed the bargaining game model with incomplete and power consumer, then an integrated market organized by regulated electric utilities is modeled.[10,11]

2.2.2 Application of Game Theory in Maritime Field

In maritime field, major applications of game theory are based on cooperation- competition theory.

In horizontal perspective, it aims to avoid vicious competition among ports whose geographical locations are very close. Meanwhile, it encourages ports to complement each other's advantages and share their resource. Thus, game theory is applied in order to give guidance to port enterprises on how to cooperate with other ports for better development.

Based on the cooperation strategy model, one paper points out the construction of Shanghai international shipping center is a turning point for the ports in Yangtze Delta, transforming from non-cooperative game into cooperative game.[12] Based on the Hotelling model, the port's optimal choice for the service strategy and pricing strategy is modeled.[13]

In vertical perspective, the implementation of game theory aims at enhance cooperation of supply chain's strategic alliance, and scholars try to optimize the logistic and management procedure to shorten receiving, shipping and transit lead time and decrease total logistic cost. Suggestions are made for better coordination between firms like shipping company, port or third-party logistics company who offer services along the service stream in supply chain system. One paper on port logistics enterprise alliance based on Bertrand oligopoly model shows that the differentiation of development strategy is a good choice for port. Under the guidance of port logistics enterprise's strategic alliance, port can meet the challenge; realize healthy competition and sustainable development in an effective way.[14]

From the above, we can see that game theory is widely used in maritime field. And the focus of the above study is based on cooperation-competition game theory. Through a lot of case study by emphasizing on interactive and systematic of game theory, plus considering the characteristics of different ports and shipping companies，analyses are made on the metrics of maritime enterprises countermeasures. Afterwards, suggestions of strategic management are put forward in order to build shipping industry into a healthier environment.

As pirate issue is attracting more attention, research on this topic is worthwhile. While most current literature focuses on cooperation-competition game theory, it belongs to the category of external cooperation for all parties' better development. When it comes to ransom negotiation, however, our target is simply to minimize shipowner side's loss rather than for both parties' (shipowner's and pirate's) interest. Besides, little quantitative study has been done on pirate ransom.

Taking all above into account, we can find that research on ransom negotiation from economic perspective is supplementary to the existing literature and meaningful. Similar to commercial activities, the Somali pirates also obey the laws of economics. They found that hijacking ships for ransom is much more profitable than just looting property. On the other hand, other players involved in the pirate event, such as shipping companies, cargo-owners, insurance companies, private security companies, navies etc., must also face the interests' trade-off. Therefore, ransom negotiation between shipowner and Somali pirate fits the bargaining model well.

Chapter Three: Analysis of Somali Pirate Ransoms

3.1 Characteristics of Somali Piracy and Ransoms

Being a long-standing issue impacting the world, the rampancy of Somali piracy can be attributed to complicated causes regarding both domestic factors and international factors.

There are many factors causing this issue, such as the prolonged internal political instability in Somalia, the economic recession that brought the financial system to the brink of collapse and the extreme destitution of the state for a long time. In addition, the United States and Europe are reluctant to get involved in the internal affairs of Somalia, while African countries cannot afford to help restore domestic stability and economic development in Somalia. It also lacks special international conventions emphasizing on anti-pirate operation, resulting in a very embarrassing situation for international cooperation fighting against piracy.

Furthermore, Somali piracy shows significant geographical characteristics. The peculiar geographical location provides a breeding ground for the rampancy of Somali piracy. Somalia is located in the junction of the Red Sea, Arabian Sea and the Indian Ocean. The complexity of sea condition and terrain, the narrow channel (especially along the Red Sea) and sufficient water branches surrounding the coast are in favor of Somali pirates' quick getaway and hide.

The above factors, to a great extent, encourage the poor people of Somalia to make money by hijacking international ships and taking the crew and the cargo as hostage.

Currently, Somali piracy shows some new characteristics mainly as follows. 1) The timing of

attacks is changing from daytime to all day long. 2) The activity area is extending gradually from 30 nautical miles to more than 1,000 nautical miles. 3) The pirate equipment is upgrading more sophisticated, such as AK-47 rifles, RPG-7shoulder-fired rocket-propelled grenades, grenade launchers, grenades, anti-tank rockets, high-powered fishing boats, hook speedboats, satellite phones and other advanced equipment. 4) The attacking tactic is becoming tricky. For instance, pirate boats tend to hide and blend in with the fishing traffic, catching passing ships off their guard. 5) The pirate organizations are making alliance.

Faced with such pirates and if the ship carries valuable or dangerous goods onboard, modern navy judges that the potential risks posed by fighting piracy may outweighs that of not taking action. The captain will, of course, do everything he could to scare away the attacking pirates. However, if the ship carries chemicals and petroleum, shipowner will remind the captain not to act rashly in case pirates deployed "heavy weapons" for unable to board. Let alone the casualties and the financial losses of the shipping companies.

Despite the risk of being hijacked, the costs substantially increase to take a detour. To illustrate, it takes 12 hours and hundreds of thousands of dollars to voyage between Europe and Asia by Suez Canal and Somali Coast. While facing bad weather conditions, the deviation around the Cape of Good Hope costs an extra sailing distance of 16,000 kilometers and increases the cost up to millions of dollars. Therefore, the number of ships voyaging through the canal still increases from 15,000 in 2003 to more than 20,000 in 2008. So, after trade-off analysis between detouring cost and hijack risk (1/600 ships being hijacked), shipping companies prefer adventure. Of course, the premium of the high-risk routes is accordingly expensive. The K&R insurance surcharged by Lloyds of London's for single voyage is 0.25% of the ship's price. For example, it costs the VLCC Sirius Star $ 380,000 to pay this K&R insurance as the ship's value is $150 million.

Judging from the above, we can suggest that factors affecting the ransom amount cover pirate ransom related costs, ranging from ship and cargo's price, ship hire loss, ransom loss, crew responsibility, legal fees and the cost of emergency response occurring in the

course of kidnapping. Risk assessment and considerations of potential risk evaluation should be taken into consideration as well.

3.2 Factors that Affect the Ransom Amount

How do characteristics of Somali piracy and shipowners' behavior affect the ransom deal?

3.2.1 Humanitarian Reasoning

Pirates kidnap and ransom hostages in different waters worldwide. Compared with most other regions of the world, Somali piracy is unique because its main purpose of kidnapping crew and passengers is to trade the hostages for ransom payments. In other words, Somalia hijack is in the purpose of obtaining ransom income. While the aim of attacking ships sailing in other regions, for instance off the West coast of Africa, is conducted most likely due to political terror and criminal opportunism reasons under a different hijacking purpose.

To illustrate different hijacking purpose in detail, the writer finds that Nigerian pirates act differently from Somali pirates. The former pirates are willing to use violence to attack ships in the delta region so as to steal fuel through pipelines and then sell it illegally in the black market. On the other hand, the motivation of hijacking of Somali pirates is for a better standard of living for themselves.

If we simply reject to pay the ransom, it may induce Somali pirates to seek an alternate means of income generation which is less conducive to safety and peaceful resolution. So, the possible impacts of these alternatives may be making the pirates more reluctant to take care of the onboard hostages.

3.2.2 Economic Reasoning

At present, ransoms may be a reasonable choice for the shipping industry to do business. Shipowners pointed out that compared with simply paying ransoms, the cost of increased insurance premiums and other costs such as time and resources consumed in order to fight back Somali piracy may actually exceed the ransom payment amount. Maintaining armed security is likely to cost the shipowner more than a million dollars per vessel annually in the Somali region, while yet this security cannot completely guarantee to hold back all pirate attacks.

Losses caused by delays are another important aspect of economic concerns. Cargo may suffer a financial loss associated with carriage contract. Onboard crew should be paid their wages even when the ship is detained because of hijacking. [15]

Besides, the related insurance expenses, for instance the Kidnap and Ransom (K&R) Insurance provided by Standard Club and other financial costs of Protection & Indemnity (P&I) Club, will increase due to the higher risk of rapid recovery of the crew and ships. [16]

3.3 Existing Problems that Remains to Be Solved

Since the real-world ransom negotiations are extremely complex, this paper develops a simplified bargaining model (a finite game of alternating offers). It remains to be solved how to establish a reasonable mathematical model based on bargaining theory to quantitatively describe pirate ransom problem. As both sides hope to maximize their own interests (or minimize their losses) in the given conditions, it is a challenging task to establish appropriate indicator system and to choose the most suitable bargaining model for taking large amounts of information into account. Furthermore, it also remains to be solved how to

apply these mathematical representations of the bargaining model by shipowner to make strategic decision and improve ransom negotiation skills in practice so as to put pressure on Somali pirates' kidnapping and reduce shipowners' hijacking losses. This paper builds a dynamic bargaining model with several stages of alternating offers to further study this ransom problem.

Due to asymmetric information and cognitive differences between negotiating parties, each side has asymmetric incentives in the bargaining process. Therefore, we should pay attention to the negotiator's behavior and their influence on the opposite player's interaction. The following factors are likely to have impact on the final negotiations equilibrium result, namely the predetermined price range, turns of offering and counter-offering, diversity of different roles.

In addition, we should simplify some basic concepts such as players, strategies, payoffs, orders and equilibrium. For example: Who is the first mover and has the first-mover advantage? What is the acceptable bargaining price interval for each side? How many turns of offering and counter-offering should be considered? How to evaluate the time value of ship and cargo? How does negotiator's mental status affect their attitude towards discount factor in the bargaining model? All these are lack of existing reference and require further discussion in details.

Chapter Four: Bargaining Model Construction

The ransom negotiation length and the final ransom amount are the bargaining outcome between a pirate gang and a shipowner. In this section the writer develops an alternating-offers bargaining model in order to analyze ransom negotiation process. The writer enhances this model considering the implications of allowing for incomplete information.

4.1. The Alternating-Offers Bargaining Model

4.1.1 The assumptions and basic model

(1) Assume that there are two participants, pirate (seller) and shipowner (buyer), bargain for the final ransom amount.

(2) The acceptable ransom range (the predetermined transaction ransom range) of pirate and shipowner respectively is $[a_1, a_2]$, $[b_1, b_2]$ (a_1 is the minimum reserve ransom of pirate, b_2 is the maximum reserve ransom of shipowner, $a_{1,2} > 0$, $b_{1,2} > 0$. Considering the true condition, let $b_1 < a_1$, $b_2 < a_2$, $b_2 > a_1$), therefore the negotiating interval is $[a_1, b_2]$ (see Figure 4). Here the writer considers the two participants reach an agreement before the deadline rather than the negotiation breaks down.

(3) Set r^f as the ransom price of the successful negotiation, thus $r^f \in [a_1, b_2]$. $r^f - a_1$ is pirates' surplus, $b_2 - p^f$ is shipowner's surplus. For pirates (the seller), r^f is the bigger the better. While for shipowner (the buyer), r^f is the smaller the better.

(4) The ransom negotiation activity is a dynamic process which is simplified into tri-stages. (I.e. the pirates make the initial offer in period t=1, the shipowner makes a counter-offer in period t=2, and the pirates make the final offer in period t=3.)

(5) The transaction goods have time value, thus we introduce the time parameter — the discount rate σ (0≤σ≤1). It can be assigned practical implications, like the bank interest rate, traders' required rate of return and so on. Even the transaction is completed very quickly, the discount rate still counts: The value of perishable fruits and agricultural products will drastically reduces if they are held up. The business opportunity will lose if business intelligence of strategic significance is delayed. The patient is at stake if he is not rescued timely (future value of life is discounted to being infinitesimal). And of course, due to the depreciation of goods and negotiation expenditure, both sides have a loss of payoff. It can be represented by σ. This explains why in practice players make transaction decision in a relatively short period of time -- because they concern about the depreciation of cargo's value.

The psychological state of the negotiator will affect his view of discounted income. Through the ages, numerous cases have proved they are likely to rapidly compromise and accept fewer benefits when the players find themselves in trouble. It is because they cannot effectively and promptly deal with such dilemmas as non-negotiable clauses, qualified ultimatum and unchangeable deadline. Psychology studies shows that time pressure makes communication accuracy reduced in the negotiation and quickly leads players to reach an agreement. This is mainly because the high-stress environment reduces negotiators' systematic information processing motivation and makes them rely more on heuristic clues. Moreover, time pressure will reduce the cognitive motivation of negotiators and lead to their systematic cognitive bias. It induces the negotiator to ignore some important information and misjudgment. All these imply that the negotiation environment and bargaining process can, to some extent, put psychological pressure on negotiators. If negotiators anti-stress capability is poor, it is

very likely that the negotiators will appear urgency, frustration, disappointment, fear and other negative emotions. Their cognitive competence and information processing capability will be badly affected. It may lead to negotiators' misevaluation on the generated benefit, resulting in faster compromise or yield loss.

In general, considering the true condition, it is necessary to ensure: 1) when $0 \le r < \infty$, there exists $d\sigma/dr < 0$; 2) when $R \to \infty$, there exists $\sigma \to 0$; and 3) $0 \le \sigma \le 1$. To simplify our discussion, we select the simplest one among many expressions which meet these requirements: $\sigma=1/(1+r)$ ($0 \le \sigma \le 1$, $0 \le r < \infty$). Apparently σ is inversely proportional to r. In reality, the bargaining process can be regarded as dividing residual value among players concerning goods, technology, capital and information. Thus the bargaining interval can be represented as $[a_1, b_2]$ if there are only two players involved in the game, and the final price is defined as p^f after several rounds of bargaining. Further, in the condition of complete information, namely, $[a_1, a_2]$ and $[b_1, b_2]$ are known to both players, the above negotiation activities can be converted to the classic dividing cake game. The two players strategically negotiate the split ratio "r^f" in the interval [0, 1]. (r^f is the mapping of pf on [0,1]: $r^f = (p^f - a_1)/(b_2 - a_1)$), as shown in Figure 4.

4.1.2 The tri-stages bargaining model

There is tri-stages bargaining model applied to the dividing cake game, as follows: Set player A's initial offer is x_t, thus player B's income is $1-x_t$. (Player B's proposing counter-offer of player A is y_t, thus player B's income is $1-y_t$.) The income at each stage should be discounted to the initial bargaining stage. t = 1, 2, 3. Therefore, we have:

(1) t = 1: Player A quotes the first offer price x_1, leaving $1-x_1$ with player B. If player B accepts, the two players respectively benefits x1 and $1-x_1$. The negotiation terminates. If not, it goes to the next stage — t = 2: Player B counter-offers the price y_2 for player A, leaving $1-y_2$ with himself. If player A accepts, the two players respectively benefits σy_2

and $\sigma(1-y_2)$. The negotiation terminates. If not, it goes to the next stage — t = 3: Player A counter-offers the price x_3, leaving$1-x_3$ with player B. As this is the final stage of the bargaining process, Player B has no choice but to accept. The two players respectively benefits $\sigma^2 y_2$ and $\sigma_2(1-y_2)$, as shown in Figure 5.

(2) According to the reverse deduction, there exists the only sub-game perfect Nash equilibrium point: $x_1=1/(1+\sigma)$. By that analogy, the according results can be deduced for other limited stage ($t<\infty$) bargaining game.

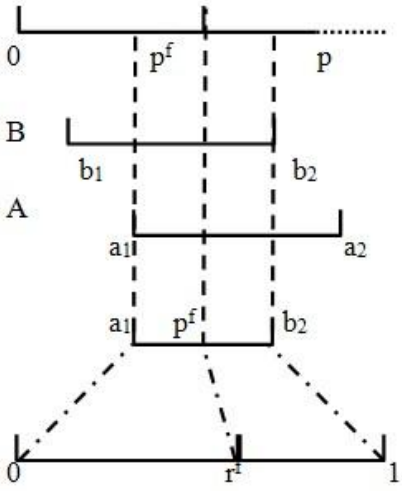


Figure 4 Negotiating price interval

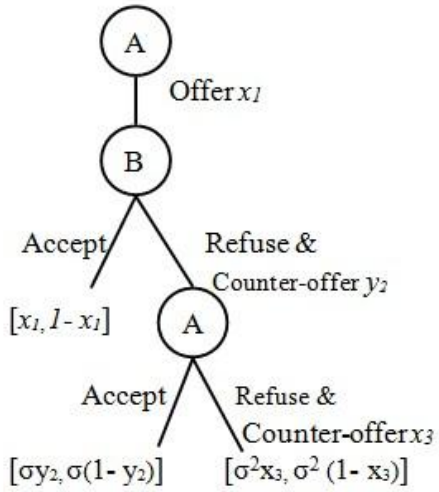


Figure 5 Tri-stages alternating-offers bargaining model

4.2 Ransom Bargaining Specification

Objective features, such as negotiation duration, ship type, ship age and flag-state of the ship, as well as the manning of its crew, are expected to play roles in determining the final ransom amount. [17]

(1) *Time period*: This variable measures the stage of ransom bargaining stage. It

signals the difference between the date of attack and the date of release, here this paper simplify it into three stages, represented by t = 1, 2, 3.

(2) *Ransom amount*：Ransom amount is the size of money demanded or paid by corresponding parties. Here this paper mainly considers three types of ransom amount. Namely, lower bound ransom, upper bound ransom and ransom exactly paid. However, as pirate ransom is a sensitive issue, the ransom amount is not always publicly disclosed, making reliable estimates difficult to obtain. So, this paper refers to some basic concepts mentioned in maritime law field to set up the ransom negotiation intervals. To illustrate, the pirates can obtain the utility α from using the ship as a mother-ship putting the worth of the minimum ransom amount (lower bound) required by pirates at a_1. If the shipowner offers any ransom less than α, the offer is rejected and the negotiation ends. Similarly, the shipowner can get the compensation amount β from an insurance claim for constructive total loss (CTL), which is worth b_1 as the lower bound of shipowner's bargaining interval.

(3) *Ship value*：The hijacked ship, along with its cargo and onboard crew, is considered to worth a particular amount of money. This paper considers the following variables as proxies to evaluate the ship value, represented by *v*.

(3.1) *Ship Age*：The age of a ship is considered to have impact on the value of the ship. The writer calculates the ship age by taking the time difference between the year of construction and the year of capture.

(3.2) *Flag State*：The flag state of a vessel is likely to reveal whether the shipowner is rich or poor. A vessel flying a flag from developed country implies that its owner is rich. On the other hand, a ship flying the well-known "flag of

convenience" indicates its shipowner is probably either located in a poor country or obscures his ownership.

(3.3) *Crew size*：The number of people on board the ship after it has been captured is another factor. It is strongly dependent on ship type, i.e. the more modern and automated the ship is, the fewer crew members onboard the ship. Here this paper excludes those who fled during the hijacking. Generally speaking, the more hostages seized by the pirate gang, the stronger the pirates' bargaining power.

(3.4) *Crew value*：Crew of the nationalities from developed countries will be evaluated more valuable than those of nationalities from underdeveloped countries.

(4) *Pirate hijack costs*：Assume the pirate's hijack cost equals c_0. The pirate's transaction costs may play a role. For instance, their expenses on daily necessity are increasing with each passing day. To simplify the model, this paper set the daily pirate hijack cost as fixed amount. However, in real-world the daily cost keeps changing over time.

4.3 Model Building

This section builds a tri-stage bargaining model to study and analyze the ransom negotiation process. Considering asymmetric pressure and incomplete information, such as psychological stress hypothesis, time-sensitive discount factor and different

negotiating interval, the writer constructs a simplified ransom bargaining model that seeks to extract major influence factors from the complex real-world ransom negotiation.

4.3.1 Bargaining under Asymmetric Pressure and Incomplete Information

In reality, we should take into account the risk of negotiation breakdown. Meanwhile, the negotiating interval $[a_1, b_2]$ is not very clear to both parties (that is why the shipowner always wants to know the pirate's lower bound and pirate wants to know the shipowner's upper bound). To simplify the analysis, we have the following assumptions:

(1) The two parties have different discount rates $\sigma_p \neq \sigma_s$. In addition, we exclude extreme condition: neither the negotiating parties have no patience ($\sigma_{p,s} = 0$) nor do they have infinite patience ($\sigma_{p,s} = 1$).

(2) Both parties have consensus on a_1, b_1, i.e. a_1, b_1 are the common knowledge for both parties. Here, let $a_1 = b_1$. However, pirate does not know shipowner's upper bound of ransom price y. He thinks shipowner's highest reserve price is y^m (v_0 — initial value of the ship and cargo). Shipowner knows his own reserve price is R_{s2} (v — value of the ship, cargo and crew, etc.).

(3) For the sake of argument, let $y^m = b_2^m - a_1$, $y = b_2 - a_1$, then the original negotiation interval $[a_1, b_2]$ is mapped to $[0, y^m]$ for pirate and $[0, y]$ for shipowner, as shown in Figure 6, and Figure 7.

(4) Shipowner is split into two types. A "rich" shipowner can psychologically afford

the ransom y^m raised by pirates, where $y \geq y^m$. While “poor” shipowner cannot actually afford the ransom y^m, where $y < y^m$.

(5) At the beginning of the entire bargaining process, the pirate only knows that the shipowner’s counteroffer is uniformly distributed on $[0, y^m]$. However, pirate is not sure the relationship between y and y^m.

(6) Shipowner knows that pirate regards his counteroffer as following uniform distribution. And he is clear about the relationship between y and y^m.

Last but not least, the players meet the basic assumption of the game theory: both players are seeking the target of increasing the interests and reducing the welfare loss. This paper only considers three stages of the process. Using the reverse deduction method, the analysis of the dynamic equilibrium during the bargaining process is as follows, respectively concerning two types of shipowners:

4.3.2 Tri-stages Ransom Bargaining Structure

4.3.2.1 Bargaining structure for rich shipowner，where $y \geq y^m$

t = 3: At this period, the pirate makes the final offer. The negotiation ends in this stage no matter the offer is accepted or rejected. The shipowner, as a rational person under pressure, will accept any offer the pirate puts forward as long as it belongs to the ransom bargaining interval $(0，y^m]$. As shown in Figure 6 Bargaining structure for rich shipowner，where $y \geq y^m$. Although the shipowner’s upper bound of ransom “y” is not clear to the pirate, the pirate can quote any price belongs to $(0，y^m]$ because he knows this reaction of the shipowner. So, how does pirate make the optimal decision?

As mentioned earlier, the pirate estimates the shipowner's offer be uniformly distributed on $(0, y^m]$.

So the expected return of pirate is: $\max (x_3 p_p + 0 (1 - P_p))$, where x_3 — pirate's offer in the third stage ($0 < x_3 \leq y^m$); P_p — the probability of pirate's offer being accepted by shipowner: $P_p = (y^m - x_3) / y^m$;

Then the optimal choice of pirate at this time is:

$$x_3^* = \text{argmax} [x_3 p_p + 0 (1 - P_p)] \quad (4)$$

The solution is: $x_3^* = y^m / 2$. So in accordance with pirate's offer, the shipowner (buyer) gets the following surplus: $y - (y^m / 2)$. In this period, pirate still does not know y.

t = 2: Because there is asymmetric pressure, the payoff of pirate and shipowner in period t=2 discounted from the last offer (t=3) respectively is: $\sigma_p y^m /2$, and $\sigma_s [y - (y^m /2)]$. It is easy to get that when $y \geq y^m$, shipowner's surplus is more than his payoff discounted from period t=2:

$$y - (\sigma_p y^m /2) > \sigma_s [y - (y^m /2)] \quad (5)$$

At this stage the shipowner makes counter-offer and his initial decision-making behavior y_2^* should satisfy the following condition:

The best-worst quotation: where $y_2^* \geq \sigma_p y^m /2$,

$$y - y_2^* \geq \sigma_s [y - (y^m /2)] \quad (6)$$

The best-worst quotation: where $y_2^* \leq \sigma_p y^m/2$,

$$y - y_2^* \geq \sigma_s [y - (y^m/2)] \quad (7)$$

Formula (6) means that if the offer is accepted by pirate ($y_2^* \geq \sigma_p y^m/2$), shipowner will try to maximize his buyer's surplus; formula (7) means that if the offer is rejected by pirate, shipowner will also try to maximize his surplus. From (5), (6) and (7), we may obtain the following formula:

$$\sigma_p y^m/2 = y_2^* < y - \sigma_s [y - (y^m/2)] \quad (8)$$

Because shipowner knows $y > y^m$, he knows this offer will make him get more surplus. But if the shipowner makes initial offer $\sigma_p y^m/2 = y_2^*$, the pirate will reject shipowner's counter-offer even if he does not know the exact value of y in this period. The reason is that formula (8) has become common knowledge for both parties, and the pirate can easily screen out $y \geq y^m$ because the shipowner will reveal he is rich by making such offer.

In order to reach the equilibrium ransom at this stage, the shipowner will make a counter-offer in this way: He indicates his reserve price is y*, which satisfies: $y^* - (\sigma_p y^m/2) = \sigma_s [y^* - (y^m/2)]$, i.e. $y^* = (\sigma_p - \sigma_s) y^m / [2(1-\sigma_s)]$. It is a deceptive behavior. This is a credible deception if the pirate merely knows incomplete information and he is ensured to gain $\sigma_p y^m/2$ at the same time. Therefore, for pirate, the bargaining interval [0, y*] is complete information, it goes back to equilibrium analysis of Dividing Cake Game. And in this game, shipowner is always able to take advantage because the common knowledge y* is less than his upper bound ransom ($y^* < y$).

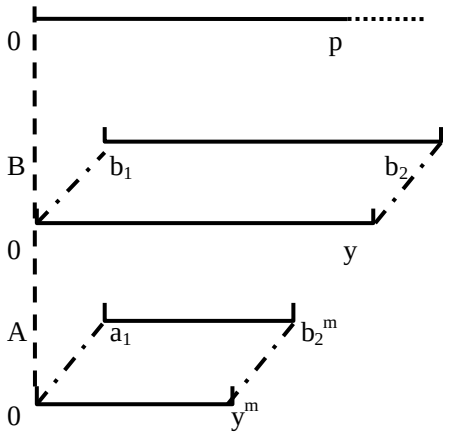


Figure 6 Negotiating interval, where $y \geq y^m$

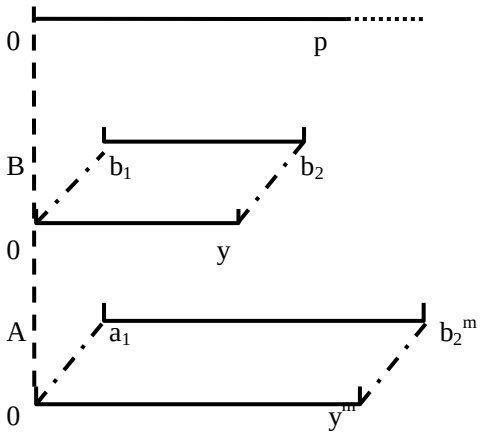


Figure 7 Negotiating interval, where $y < y^m$

t = 1: The payoff of pirate and shipowner in period t=1 discounted from the previous offer (t=2) respectively is: $\sigma_p^2 y^m/2$, $(\sigma_p-\sigma_s)\ \sigma_s\ y^m/[2\ (1-\sigma_s)]$. The pirate makes his first offer maximizing his expected payoff, satisfying the following formula:

$$y-x_1 \geq (\sigma_p-\sigma_s)\ \sigma_s\ y^m/[2\ (1-\sigma_s)]$$

$$x_1 \leq y-(\sigma_p-\sigma_s)\ \sigma_s\ y^m/[2\ (1-\sigma_s)]$$

Because pirate thinks the highest value of y is y^m ($y \geq y^m$), the optimal choice for him is obtained he thinks the upper bound of ransom y^m is reached:

$$x_1^* = y^m-(\sigma_p-\sigma_s)\ \sigma_s\ y^m/[2\ (1-\sigma_s)] = y^m\ \{1-(\sigma_p\sigma_s-\sigma_s^2)/[2(1-\sigma_s)]\ \} \qquad (12)$$

Therefore, the surplus of shipowner is: $y_1 = y-x_1^* = y-y^m\ \{1-(\sigma_p\sigma_s-\sigma_s^2)/[2(1-\sigma_s)]\ \}$.

When pirate is not only aware of $y \geq y^m$ but is also clear about the shipowner's

decision preference, he would not believe the shipowner's counter-offer (i.e. the above counter-offer quoted by shipowner is not credible). Under this circumstances, the pirate will increase y^m by repeating the process in period t = 3 and t = 2 until y= y^m is reached. When $y \geq y^m$ becomes common knowledge, the equilibrium analysis is back to the Cake Dividing Game.

4.3.2.2 Bargaining structure for poor shipowner，where $y < y^m$

t = 3: In this period, as mentioned in Section 4.3.1.1, pirate does not know the value of y. So his strategy for optimal decision-making is to estimate the upper bound of ransom price which can be psychologically accepted by shipowner, and then offer half the price $y^m/2$. (Figure 7 shows the negotiating interval, where $y < y^m$.) Thus, the shipowner's payoff in this period is: $y-(y^m/2)$. Obviously, when $y-(y^m/2) < 0$, the bargaining terminates; when $y-(y^m/2) \geq 0$, shipowner will accept the offer and regard $y-(y^m/2)$ as his maximum surplus at this stage t=3.

t = 2: The payoff of pirate and shipowner in period t=2 discounted from the last offer (t=3) respectively is: $\sigma_p\, y^m/2$ and $\sigma_s[y-(y^m/2)]$. The shipowner makes counter-offer and his initial decision-making behavior y_2^* should satisfy the following condition (9) (10):

The best-worst quotation: where $y_2^* \geq \sigma_p\, y^m/2$,

$$y-y_2^* \geq \sigma_s[y-(y^m/2)] \qquad (9)$$

The best-worst quotation: where $y_2^* \leq \sigma_p\, y^m/2$,

$$y - y_2^* \geq \sigma_s [y - (y^m / 2)] \quad (10)$$

Then, we may obtain the following formula:

$$\sigma_p y^m / 2 = y_2^* < y - \sigma_s [y - (y^m / 2)] \quad (11)$$

Because shipowner knows $y > y^m$, he knows this counter-offer will enable him to obtain more surplus. But if the shipowner makes initial offer $\sigma_p y^m/2 = y_2^*$, as mentioned in Section 4.3.1.1, this counter-offer will be rejected by the pirate even if he does not know the exact value of y at this time. So in order to reach the equilibrium ransom at this stage, the shipowner will indicate that his reserve ransom price is y*, which satisfies: $y^* = (\sigma_p - \sigma_s) y^m / [2(1 - \sigma_s)]$. It can be proofed that $y^* \leq y^m /2$. As mentioned above, the shipowner's initial reserve ransom price y satisfies: $y \geq y^m /2$. Although the exact value of y is not clear to the pirate, the shipowner will reveal his reserve ransom price y by making such offer in this bargaining process. That is, when $y < y^m$, the upper bound of shipowner's ransom price is half the price estimated by pirate: $y^* = y^m / 2$. So the shipowner's optimal game equilibrium choice is: $y^* - y_2^* = (y^m / 2) - (\sigma_p y^m / 2) = (1 - \sigma_p) y^m / 2$.

t = 1: The payoff of pirate and shipowner in period t=1 discounted from the previous offer (t=2) respectively is: $\sigma_p^2 y^m /2$、$(1 - \sigma_p) \sigma_s y^m /2$. The pirate makes the first offer and his decision-making behavior x_1 satisfies:

$$y^m - x_1 = (1 - \sigma_p) \sigma_s y^m /2 \quad (12)$$

So $x_1 = y^m[1 - (\sigma_s - \sigma_p\sigma_s/2)] > y^m /2$, $y_1 = y^m - x_1 = (1 - \sigma_p) \sigma_s y^m/2$ is the game equilibrium choice in this period (t=1). And the bargaining structure for poor shipowner, where y

$< y^m$, is shown in Table 2:

Table 2 Bargaining Game Equilibrium, where $y < y^m$

t	1	2	3
Shipowner	$(1-\sigma_p)\ \sigma_s\ y^m/2$	$(1-\sigma_p)\ y^m/2$ ✓	$y-(\ y^m/2)$
Pirate	$y^m[1-\sigma_s\ (1-\sigma_p/2)]$ ✓	$\sigma_p y^m/2$	$y^m/2$ ✓

Note: ✓ represents this party makes such offer in this period.

Chapter Five: Model Assessment

5.1 Basic Results of the Theoretical Model

The above analysis shows that the ransom bargaining equilibrium outcome is related to the asymmetric information, different roles and psychological attributes of the pirates and shipowner. The implications for the ransom amount from the above bargaining model are summarized as follows:

1) The different roles of the shipowner (buyer) and the pirate (seller) will lead to different payoff. It is because we assume that the final ransom price is the lower the better for the shipowner (buyer). On the contrary, it is the higher the better for the pirate (seller). In addition, it can be found that in the case of asymmetric information, the shipowner and the pirate can obtain corresponding advantage in the bargaining process.(For example, as mentioned in Section 4.3.1.1, the shipowner can make a credible deception by offering y^* rather than y_2^*. As mentioned in Section 4.3.1.2, when $y < y^m$, the pirate has seller's advantage).

2) In Section 4.3.1.1, if the shipowner is greedy, there will be another situation that the shipowner still reports $\sigma_p\, y^m/2 = y_2^*$. After making $y \geq y^m$ become common knowledge, the pirate will repeat the procedure in period t = 3 and t = 2 in oeder to increase y^m until $y = y^m$. Then it becomes back to the Cake Dividing Game. This shows that besides asymmetric information, the psychological characteristics of negotiators affect the final equilibrium outcome as well.

3) In the bargaining game, a rich shipowner, whose upper bound of ransom y is more than the pirate's estimation of the upper bound y^m ($y \geq y^m$), will continuously be suppressed by the pirate in the negotiation process until his final reserve price is reached — such type of shipowner definitely overpays for the ransom. Being a wise shipowner, the basic strategy is "offering half of the price". And this strategy is based on the assumption that shipowner's offer is uniformly distributed on the negotiating interval (see equation (4)). It theoretically proves that the thumb rule of "offering half of the price" has its innate laws of things in practice. Further, if the shipowner's offer is not uniformly distributed, there might be such bargaining strategy as "offering lower than half of the price" or "offering a quarter of the price".

5.1.1 Discount Factor Analysis — σ_p, σ_s

The two parties have different discount rates $\sigma_p \neq \sigma_s$. Assume the psychological pressure of pirate and shipowner are r_p, r_s. If the negotiator is under high pressure, he tends to regard the future value very low discounted into present value. In other words, the discount rate under high pressure is less than the discount rate under low pressure. It means σ is negatively correlated with r. For further analysis, here, we set $\sigma_p = 1/(1+r_p)$, $\sigma_s = 1/(1+ r_s)$.

It is more necessary for a poor shipowner, where $y < y^m$, to find his optimal bargaining strategy since he cannot afford overwhelming ransom. According to the bargaining game equilibrium outcome as shown in Table 4-2, the partial derivatives of x_1 with respect to r_x, r_y are written as:

$$\frac{\partial x_1}{\partial r_p} = \frac{\mathrm{y^m}\sigma_s}{2}\,\frac{-1}{(1+r_p)^2} < 0 \quad , \qquad \frac{\partial x_1}{\partial r_s} = \frac{\mathrm{y^m}(\sigma_p - 1)}{2}\,\frac{-1}{(1+r_s)^2} > 0 \tag{13}$$

The partial derivatives of y_1 with respect to r_x, r_y, similarly, are written as:

$$\frac{\partial y_1}{\partial r_p} = \frac{-\mathrm{y^m}\sigma_s}{2}\,\frac{-1}{(1+r_p)^2} > 0 \quad , \qquad \frac{\partial y_1}{\partial r_s} = \frac{(1-\sigma_p)\mathrm{y^m}}{2}\,\frac{-1}{(1+r_s)^2} < 0 \tag{14}$$

Formula (13) and (14) shows that the ransom amount is:

a) Negatively correlated with his own stress factor;

b) Positively correlated with other player's stress factor;

According to a) and b), we can find that in the case of asymmetric pressure and incomplete information, the greater pressure the negotiator has and the more eager he is to conclude the transaction, the less payoff he will obtain in the end of the negotiation deal.

5.1.2 Lower and Upper Bound Ransom Price Analysis — a_1, b_1, y, y^m

Both the analyses in Section 4.3.1.1 and Section 4.3.1.2 show that the pirate always seizes the initiative in deciding the ultimate payoff, since y^m shows up in the formulas for calculating the bargaining game equilibriums.

For a poor shipowner, where $y < y^m$, the equilibrium of the optimal ransom payoff is $x_1 = (1-\sigma_p)\,\sigma_s\, y^m/2$ and $y_1 = y^m[1-\sigma_s\,(1-\sigma_p/2)]$. And because $0 < \sigma_p < 1$, and $0 < \sigma_s < 1$, it is easy to proof that the partial derivatives of x_1 and y_1 with respect to y^m are written as:

$$\frac{\partial x_1}{\partial \mathrm{y^m}} = 1-\sigma_s(1-\frac{\sigma_p}{2}) > 0 \ , \quad \frac{\partial y_1}{\partial \mathrm{y^m}} = \frac{(1-\sigma_p)\sigma_s}{2} > 0 \qquad (15)$$

Formula (15) shows that the optimal ransom payoff is positively correlated with the pirate's (the seller) estimation of the shipowner's upper bound ransom price y^m. To further analyze factors that affect pirate's estimation of ransom price, y^m is discussed in detail below:

What might be the elements of y^m and y? Pirate's estimation of ransom price involves a wide set of factors. In general, it is closely related to objective estimates of the value of ship and its cargo, and the value of the lives of the crew. Objective estimates, such as ship type, ship-size, ship age (refer to the built year) and flag state of the ship are used by the pirates to evaluate the ship value acceptable by the shipowner. Also the make-up of its crew affects the estimation of crew value. That is to say, pirates tend to recognize that crew from rich countries increase the probability that the shipowner is also located in a rich country, accordingly implying a higher ransom value. For instance, pirates will estimate British hostages to be more valuable than Pakistani equivalents. Besides, the pirate's initial seizure cost c_0 that daily seizure cost c_p that they spend each day for on-board supplies have impact on y^m.

Similarly, we can set v_s as the actual value of the ship, cargo and crew evaluated by shipowner. Let $\tau \in (0, 1)$ be the shipowner's depreciation rate of his ship and cargo as ship depreciates and cargo degrades or perishes, c_p be the shipowner's daily cost as onboard supplies are consumed and hiring income loses.

Here, set $y^m = v_p + c_o + t \times c_p$ and $y = \tau^{t-1} v_s + t \times c_s$,

$$\frac{\partial \mathrm{y}^{\mathrm{m}}}{\partial t} = c_p \ , \qquad \frac{\partial y}{\partial t} = (\mathrm{t}-1)\tau^{\mathrm{t}-2} + c_s > 0$$

According to the above formulas, if we only consider patial derivative of upper bound ransom with respect to time, both y^m and y are positively correlated with negotiation duration. It means the longer the negotiation duration, the higher the ransom amount of the negotiation deal.

When it comes to the lower bound of ransom price a_1, b_1, the minimum ransom is only accepted when it equals to the same utility as the player at least can obtain from other means. From the pirate's perspective, if the negotiation ends, he can utilize the ship as a "mother-ship" in the future, with the value α. Therefore, he must be offered at least what he can obtain from using the ship as a mother-ship. On the other hand, the shipowner is able to recover some losses, say β, through an insurance claim for constructive total loss. The lower bound of ransom prices a_1, b_1 are therefore:

$$a_1 = \alpha, \qquad b_1 = \beta$$

However, as mentioned above in bargaining model construction, in order to simplify the analysis, this paper sets α = β. But in complex real-world, it is scarcely possible that these two parameters are equal.

5.2 Ransom Negotiation Strategy

Based on the formulas put forward in the ransom bargaining model and further analysis in Section 5.1, the shipowner has some practical ways of reducing the welfare loss due to piracy. It is mainly from shipowner's own perspective and from

pirates' perspective.

5.2.1 Suggestions from Shipowner's Perspective

To increase shipowner's discount factor σ_s and depreciation factor τ. As we know, if the shipowner is under lower pressure, he tends to regard the future value relatively high discounted into present value. Therefore, it is beneficial to make ship-owners more "patient" in their negotiations. For example, by governments providing emergency loan guarantees to cover the running cost of the hijack, or compensating ship-owners for loss of hire, while offering significant financial compensation to the crew.

5.2.2 Suggestions from Pirates' Perspective

To reduce pirate's discount factor σ_p and his estimation of the upper bound of shipowner's ransom price y^m. The current approach – sea-based intervention by navies and private security companies – appears to have reduced pirates' success rates and increased their costs.

The pirate's discount factor σ_p can be reduced through increasing his physiological pressure. First, make it less stable for pirate to keep the hijack ship. Pirates have to keep the ships safe from rival gangs as well as local law enforcement initiatives, whether these are local grass-roots or foreign-sponsored regional government campaigns. Second, cut the supply of pirate's daily demand, once on-board supplies have run out, crews and their guards have to be fed and diesel is needed to keep lights and desalination facilities operational. Last, stop the supply of drug. Many

pirates are addicted to the stimulant leaf khat which deteriorates rapidly with time, meaning that reliable supply lines are needed. So government should figure out the supply lines of the drug and stop it.

Conclusion

On average large, modern ships with high-value ship, cargo and crew bring in pirate's higher initial offer of the ransom price. Naval counter-piracy efforts, the adoption of best management practice and private security teams have successfully reduced the incidence of hijackings, but they have not reduced the total income from piracy: pirates have exploited the hijacked ships more intensively over time as success rates dropped and they have had to hunt ever further from the Somali coast.

The ransoms are not perfectly predictable, reflecting unobservable characteristics of the parties in the negotiation such as their respective discount factors, their payoffs for failed negotiations (mother-ship / insurance pay-out) and their ability to sustain a negotiation over time. Expert negotiators exploit this information asymmetry. By sending consistent (cheap talk) signals about his type being a "poor shipowner" rather than a "rich shipowner", the shipowner hopes to negotiate a better outcome. Indeed negotiators are highly paid and well regarded. In addition, the pirates might call in an expert in order to get advice about useful bargaining skills, which makes the negotiation process more complex and unfavorable for the shipowner.

References

[1] Peter Chalk. Threats to The Maritime Environment，Piracy And Terrorism.

[2] John J. Brandon. Protect Asia's Shipping Center for Strategic and International Studies, 2002.

[3][4] Reports on Acts of Piracy and Armed Robbery against Ships in 2007, Annual Report, IMO, 2008.

[5] Li Congrong. Who should Pay Pirate Ransom, China Ship Survey, 2010(2): 92-94.

[6] Shi Dan. Struggle between Shipowner Interests and Cargo-owner Interests from the View of the Dual Nature of Pirate Ransom[J]. Annual of China Maritime Law, 2009, 20(1):73-78.

[7] Fu Tingzhong, Xu Xin. Discussion on Pirate Ransom from Maritime Law Perspective, Annual of China Maritime Law, 2009, 20(1): 68-72.

[8] Zhao Hua, Long Yong, Liu Xiankai. Factors Affecting the Ability of the Enterprise Bargaining in the Skills-based Cooperation [J], Journal of Chongqing University (Natural Science Edition), 2007(3).

[9] LUO Zhiwen, LI Dingti, Jing Hong. Analysis of the Effects of Pricing Power on the Selection of Cooperation Strategies [J] , Systems Engineering—Theory & Practice, 2007(3).

[10] Zou Xiaopyan, Wang Zhengbo. The Bargain Game Model on Electric Power Price in a Bilateral Electricity Market, Journal of Industrial Engineering and Engineering Management, 2005, 19(4)

[11] Wei Jingyuan; Smeers, Y.; Canon, E.; "A bargaining model of regulated markets'

integration with an application to electricity supply market," Energy Management and Power Delivery, 1995. Proceedings of EMPD 95., 1995 International Conference on vol.2, no., pp.510-515 vol.2, 21-23 Nov 1995.

[12] Yu Haibang, Wang Xiaoping. Research on the Relations among Ports in the Yangtze River Delta Based on Co-operation Game Theory [J], China Port, 2010(10).

[13]Wang Tianjiao. Port's optimal strategy choice based on game theory[J], Market Modernization, 2008, (17).

[14] Feng Xuejun, Yan Yixin. Strategy choice of port logistics enterprises in price war[J], Journal of Traffic and Transportation Engineering, 2005, 5(2).

[15] Piracy and Armed Robbery Against Ships in Waters off the Coast of Somalia, Assembly 27th Session, Agenda Item 9, IMO, 20 December 2011.

[16] Xu Miaomiao. K&R: Risk Response to Pirate Ransom--A talk with Alistair Groom, CEO of Standard Club. China Ship Survey, 2012, (9): 36-37.

[17] Olaf J. de Groot, Matthew D. Rablen and Anja Shortland. Barrgh-gaining with Somali Pirates, Economics of Security Working Paper 74, November 2012.