GLOBAL MARINE INSURANCE PREMIUMS

AND THE MARITIME INDUSTRY

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GLOBAL MARINE INSURANCE PREMIUMS

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DECLARATION OF ORIGINALITY

I, Hatice Selin Oguz, certify that

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- this thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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ABSTRACT

Global Marine Insurance Premiums and the Maritime Industry

Maritime transportation and insurance have always been very important two industries for the developments in trade. Many studies have been conducted to analyze the relationship between these industries and global economic indicators. Results obtained from these researches supported the strong connection between the global economic indicators and these two industries. Both maritime and insurance industries are found to follow a cyclical pattern with recurrent upward and downward movements. Many different hypotheses exist about the reason for these cycles. With this background, this thesis aims to reveal cyclical movements in global marine insurance premiums and maritime freight markets, then analyze the relationship between them.

With this purpose, three hypotheses, which suggest that maritime freight markets follow a cyclical pattern, marine insurance premiums follow a cyclical pattern and these cycles are positively synchronized, are structured. To test these hypotheses, global marine hull insurance premiums, Baltic Dry Index values, and world merchant fleet volume data for 23 years between 1996 and 2018 is employed.

The findings of the study support the cyclical movements in both industries. Cycles in marine insurance and maritime freight markets are found to be in a positive relationship. Unit hull insurance premium cycles have matched BDI cycles with a lag of years. Both hull insurance premiums and BDI showed a common cycle length of 16 years.

ÖZET

Küresel Deniz Sigortası Primleri ve Denizcilik Endüstrisi

Deniz taşımacılığı ve sigorta, ticaretteki gelişmeler açısından her zaman iki önemli sektör olmuştur. Bu endüstriler ve küresel ekonomik göstergeler arasındaki ilişkiyi analiz etmek için birçok araştırma yapılmıştır. Araştırma sonuçları küresel ekonomik göstergeler ve bu iki endüstri arasındaki güçlü bağları destekler yöndedir. Hem denizcilik hem de sigorta endüstrilerinin tekrarlayan yukarı ve aşağı yönde hareketlerle döngüsel hareket ettiği görülmüştür. Bu döngülere neden olan faktörlerle ilgili birçok farklı hipotez vardır. Bu bağlamda, bu tez küresel deniz sigortası primleri ve deniz taşımacılığı piyasalarındaki döngüsel hareketleri ortaya çıkarmayı ve aralarındaki ilişkiyi analiz etmeyi amaçlamaktadır.

Bu amaçla denizcilik navlun piyasalarında döngüsel hareketlerin varlığı, küresel deniz sigortası primlerinde döngüsel hareketlerin varlığı ve bu döngüsel hareketlerin birbirleri ile pozitif senkronizasyonda olduğunu savunan üç adet hipotez kurulmuştur. Hipotezleri test etmek amacıyla 1996-2018 yılları arasında 23 yıllık küresel tekne sigortası primleri, 'Baltic Dry Index' değerleri ve dünya ticaret filosu hacmi verileri kullanılmıştır.

Analiz sonuçları her iki endüstride de döngüsel hareketler bulunduğu desteklemektedir. Deniz sigortası ve deniz taşımacılığı piyasalarındaki döngüler arasında pozitif bir ilişki olduğu bulunmuştur. Birim tekne sigortası prim döngüleri ile BDI döngüleri, aralarında bir gecikme olacak şekilde eşleşmiştir. İki seri için de 16 yıllık bir ortak döngü gözlemlenmiştir.

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ABBREVIATIONS

BDI	Baltic Dry Index
BFI	Baltic Freight Index
CEFOR	Central Union of Marine Underwriters
DNV	Det Norske Veritas
DWT	Deadweight tonnage
FDD	Freight, Demurrage and Defence
H&M	Hull and Machinery
IMF	International Monetary Fund
IUMI	International Union of Marine Insurance
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MIA	Marine Insurance Act
NBER	National Bureau of Economic Research
OECD	The Organisation for Economic Co-operation and Development
P&I	Protection and Indemnity
RO-PAX	Roll-On-Roll-Off-Passenger
RO-RO	Roll-On-Roll-Off
UNCTAD	United Nations Conference on Trade and Development

CHAPTER 1

INTRODUCTION

Waterways have been the most efficient way to carry goods in high volume since the beginning of the trade. In ancient times, various floating vehicles were being used for transportation of the goods through the rivers and coastal waters. With the development of the civilizations, increasing efficiency of production and surplus of products brought the need for trade in larger quantities and transportation in larger volumes between the longer distances. Therefore, along with the industrial revolution, the first steamship can be considered as a milestone in international trade and the beginning of modern maritime economics. Today, seaborne trade covers more than 90% of total global trade (Ducruet, Cuyala, & Hosni, 2018).

Insurance is another essential business for global trade which is being practiced since the first samples of modern trade. The first insurance policy in history is known to be written by Genovese merchants in the 14th century on the marine section. Then, Lloyds of London dominated the marine insurance market and has been the most important body for both marine and other types of insurance since it was founded in the 18th century.

Shipping is among the three most finance-intensive industries worldwide, needing by rough estimation, about 80 billion dollars per year for financing new buildings alone (Goulielmos & Psifia, 2006). In 2018, the total size of the global shipbuilding market has amounted to approximately 114,3 billion dollars. With a compound annual growth rate of 5.7 percent, it is expected to reach 175,2 billion dollars in 2025 (Scerra, 2020). A vessel is the main asset of a shipping company and an investment tool besides its transportation function. The operators carry the risk from ships' day to day operations and earnings, while the investors carry the risk from changes in the ship’s market value, defaults of the loans and various international regulations. Due to the global nature of the business and mobility of the vessel, maritime markets are exposed to exogenous factors such as political developments, global crises, and international regulations. Besides all modern risk management methods, insurance is still an essential and reliable tool for parties who are exposed to those risks.

The price of the risk in marine insurance is determined by professionals in insurance companies, who have the title of ‘underwriter’. The level of the risk may depend on different factors such as the condition of the vessel, loss record of the client, quality of management, area of navigation, type of the ship and cargo carried, long term carriage contracts and experience level of the managers and seafarers. This factor can be expanded according to any specific situation in the extent of the policy or risk. Underwriters calculate the price considering the probability of the risk to happen, the monetary value of the risk, underwriting results of previous years and the existence of any catastrophic loss in recent years. Another important factor in calculating the price of a policy is the market condition determined by the available capacity and congestion in the market.

In maritime markets, price is determined by supply and demand factors in an unpredictable and volatile manner due to the markets’ exposure to the exogenous factors such as political developments, global crises, and international regulations. Maritime can be dissected under four main markets: new building, second hand (sale and purchase), demolition (scrap) and freight market (Stopford, 2008). The cost of transportation is determined in the freight market, so freight levels are affected first by any disequilibrium in demand and supply factors. Freight levels are reliable indicators of the general condition of the maritime business and useful tool for forecasting. Any movement in freight markets would spill over to the other markets consecutively (Beenstock & Vergottis, 1989a, 1989b).

Any change in the demand for sea transportation without a significant change in the available transportation capacity would affect transportation costs directly. Thus, the appetite of the investors in shipping would increase or decrease depending on the expectation of profitability. Increased or decreased demand by the investors would affect vessel prices in the short term. In the long term, equilibrium would be provided by the change in capacity. These recurrent upward and downward movements cause cycles in maritime markets. Ship's price is an important variable to calculate the monetary value of the total risk, especially for the property policies. So, the fluctuations in maritime freight markets are expected to spill over to the marine insurance prices and cause similar cyclical movements.

Despite the long history of these two important businesses and their importance in global trade, the first academic research in maritime economics does not go far back in history. The academic studies in insurance from an economic perspective are older and in broader scope relatively however, the research on marine insurance is conducted mostly from an insurance technician's or lawyer's perspective. With the aim to contribute the gap in the literature about marine insurance and its relationship with maritime markets, this thesis aims to reveal cyclical movements in maritime freight market and marine insurance prices and analyze the relationship between the movements in these two markets.

The rest of the paper organized as follows; Chapter 2 provides a review of the existing related literature on maritime economics, insurance, and marine insurance.

Chapter 3 explains the motivation behind this research and presents the hypotheses of the study. Chapter 4 explains the fundamentals of the maritime industry, the basics of insurance and marine insurance. Chapter 5 explains the data employed and methods used in the analysis. Chapter 6 includes the results of the statistical analysis. Lastly, Chapter 7 includes the concluding remarks, limitations in the research and suggestions for further research.

CHAPTER 2

LITERATURE REVIEW

“The history of ships, trade and related businesses is global, long and fascinating” (Heaver, 2012, p.16). Although seaways have been a very important component of transportation since the beginning of trade, the roots of academic researches on maritime economics are less than sixty years old. Before the 1960s there were very few academic works on maritime economics (Heaver, 2012). The special challenge about safety at sea and navigation methods directed researchers to work on navigation technologies and the design of the vessels in the first instance. With the globalization and developments in trade, research on maritime economics is encouraged after the 1960s. Also, Heaver (2012) advises “matters dealing with the insurance of ships and cargoes have stayed dominantly within the purview of insurance professionals and lawyers” (p.17). Maritime economists focused mostly on freight market dynamics and their relationship with commodity prices and trade. In the following paragraphs, recent studies on maritime economics, marine insurance, and underwriting cycles will be introduced briefly.

The literature on maritime economics mostly focus on freight markets and shipping finance mostly due to the freight rates’ significance on transport costs, the high volatility and low predictability in the market and consequently, the maritime being an attractive area for investors and access to capital being determinant of competitiveness in a capital-intensive maritime business. The idiosyncratic characteristics of shipping are the derived nature of the demand for shipping services, the non-storable nature of the freight services, the excess volatility and clustering, cyclicality and seasonality associated with freight rates and asset prices, the heightened sensitivity to international supply and demand forces and regulations due to the industry's hyperglobal nature, the fragmented structure of shipping business, and its capital and debt intensity. "These attributes contribute to a challenging investment and capital raising environment and have triggered voluminous academic and professional research alike" (Alexandridis, Kavussanos, Kima, Tsouknidis, & Visvikis, 2018, p.164). The most attractive areas have been the relationship among the maritime markets, the factors affecting freight rate generating processes, cyclical behavior of the markets and effects of global economic developments on the maritime industry.

Beenstock (1985) studied on the interdependence of freight and ship markets and structured a theoretical model. Following two studies by Beenstock and Vergottis (1989a,1989b) applied this theoretical model for dry bulk and tanker markets. Results confirmed that the two most important sectors of the world shipping; freight and ship markets are interdependent, and the developments in one will spill over into the other. Moutzouris and Nomikos (2019) examined the relationship between vessel prices, net earnings and holding period returns in the dry bulk industry. Results show the earnings yield is a reliable indicator of the current condition of the shipping industry and future shipping market conditions. High earnings yield today reflects the current prosperous market conditions but also predicts deterioration in future net earnings and thus, future market conditions. They conclude that ship prices mainly vary due to news about expected market conditions. So, the freight levels and ship values are connected, and vessel values tend to increase in a prosperous freight market environment. Another factor increasing the vessel value is high expectations of prosperity for the future.

Kavussanos (1996) researched the volatility in spot and time charter markets of dry-bulk vessels and concludes that world industrial production and bunker prices have large positive effects on freight rates, while the stock of fleet has negative impacts. Grammenos and Arkoulis (2002) researched the relationship between shipping stock returns and global macro variables such as exchange rates, global inflation, change in oil prices, industrial production growth and laid up tonnage. Results show that oil prices and laid up tonnage are negatively related to shipping stocks whereas the exchange rate variables are positively related. The oil prices show different effects on shipping stock returns and freight rates. “Oil prices represent 47% of the total voyage costs” (Grammenos & Arkoulis, 2002, p.86). So, while it causes an increase in freight rates first, in the long term it reduces the expectation of profitability of the shipping companies. Lastly, Bornozis (2006) explained the demand and supply factors of freight markets. Global economic conditions affect the demand side, while the size and availability of the global fleet affect the supply side. Imbalances between demand and supply have a direct impact on asset values, freight rates, and earnings. Factors presented by Bornozis (2006) are in line with the previous two studies and show that strong industrial development is seen as a source of the increase in the annual growth rate of the demand for dry bulk commodities. Thus, the freight rate environment is positively affected. Whereas, precision in the supply side of new buildings is the signals of strong dry bulk shipping markets in the following years.

Berg-Anreassen (1997) studied the freight rate generating process in the time charter market to explore the relationship between the time charter and spot market freight rates. Results show that time charter rate is impacted by the changes in the comparable spot rate which means also there are interdependencies between the spot and time charter markets. Li et al. (2018) emphasized the importance of describing dynamics and interdependencies among different shipping freight markets to reduce the investor's overall risk by involving in different shipping freight markets. Their analysis using weekly shipping price indices for dry bulk, the dirty and clean tanker, and the container freight markets over the period from 5 January 2002 to 24 March 2018 shows the existence of one-way causality running from dry bulk and the clean tanker freight markets to the dirty tanker and container freight markets respectively. Thus, dry bulk and clean tanker freight rates play a fundamental role in predicting others. It is understood that to comment on the general state of the maritime markets, it is essential to start with conditions of spot dry bulk and clean tanker freight rates that will affect the other freight markets and ship prices eventually.

Goulielmos and Psifia (2006) explain the importance of forecasting shipping cycles for successful investment timing. They used the Rescaled Range Analysis to reveal the duration of shipping cycles for more successful shipping loans that would bring a more stable shipping market. Shipping cycles have been calculated as 4.5 years and 2.5 years from 379 monthly observations of trip dry cargo charter index between 1971 and 2002 and found to be non-periodic. Chiste and Vuuren (2014) investigated cyclical behavior of the shipping market, using Fourier Analysis with the daily data of dry bulk freight earnings between January 1990 – October 2011. Over the 21 years, they have found bimodal cyclicality with a 7-year main cycle and 4-year prominent cycle. Papailias, Thomakos and Liu (2017) investigate cyclical properties of the Baltic Dry Index and form economic models to define cyclical characteristics for accurate forecasting. They define BDI as a variable with heavy economic significance, and they suggest hedging strategies for the participants of the market. Their trigonometric model explains 30% of the annual change in BDI over a period of 271 months between February 1993 and August 2015 with 3,4- and 5-year cycles and shows there is a strong cyclical pattern. All these papers analyzed dry bulk freight market data and found different periods and characteristics of cycles. The reason for the differences may be the analyzed data period and analyzing method, but the common point is the dry bulk freight markets follow cyclical patterns.

The recent research of Su, Wang, Shao, and Tao (2019) investigates the bubbles in shipping freight markets using data between October 1988 – February 2018. The analyzes show four bubbles existed in 2003, 2004, 2007 and 2008. The last bubble is in 2008 whose reason is the 2008 global crisis and the potential explanations for the first three are strong demand (China factor), and the supply capacity, crude oil prices, and US dollar fluctuations.

Besides previously introduced empirical studies, Valentine, Benamara and Hoffmann (2013) expressed the importance of maritime transport system performance for trade competitiveness of the countries, and they reviewed the key developments in the world economy in the last four decades that shaped the maritime trends today. The key developments are listed as; political and geopolitical transformations, trade liberalization, deregulation and greater private sector involvement in the provision of transport infrastructure and services, shocks in the energy market and prices, containerization, use of information and communication technologies, the intensification of world trade and international division of labor, the globalization of manufacturing and distribution processes, greater economic integration and interdependence, emerging of sophisticated logistics services and providers and falling transport costs. The influence of these developments is on the type, volume, and value of the goods. Also, the direction and patterns of the trade flows, technologies used, the logistics costs and structures and global supply chains were affected. The general observation is freight costs have decreased due to the economies of scale, agreements, and technologies such as containerization and fuel efficiency. Gilda (2013) also listed key issues as; a global new design, energy security, oil prices, transport costs, carbon emission cutting from shipping and adapting to climate change impacts, environmental sustainability and corporate social responsibility and maritime piracy and related costs. Paper emphasizes the shift in global trade away from advanced economies towards emerging developing countries, interplay between transport costs, energy security and oil price levels and adapting market strategies according to the ecological and social dimensions. Thus, while assessing the general condition of maritime markets and for successful foreseeing the next step all the factors mentioned need to be considered.

Despite marine insurance constructed the foundations of the modern insurance industry, research on the subject is very limited from a maritime economics perspective. Insurance and law professionals' researches dominate the literature generally. Aydemir (2010) defined terminology and specific features of marine insurance, explained the factors that are important for assessing the risk and pricing strategies in the industry. The most important feature of marine insurance is the global structure of the industry. Almost all policies are subject to globally accepted laws and regulations. Risk sharing and transfer of the risk are more popular in marine insurance compared to the other insurance categories due to the high monetary value of the risk. In the thesis, risk factors are categorized as perils of the seas, perils on the seas, political, war and strike risks. The most important factors to assess risk are listed as age, type, condition, classification society, flag state, navigation area and dimensions of the vessel, the morality of the insured and loss record for the previous several years. Pricing is vital in marine insurance as in all other industries for financial success and sustainability and it is possible with the correct assessment and analysis of the risk. Aydemir (2010) suggested the vessel's age, condition, and value are the fundamentals of pricing in marine insurance.

Li (2017) explains the role of marine insurance in ship finance, combining a financial perspective, an insurance perspective, and a legal perspective. Despite marine insurance is found to be effective in transferring risk to the insurance pool there are still uncoverable risks due to basic rules and commercial unavailability. These risks can be summarized as freight rate risk, operational risk, cyclical risk, ship price risk and regulatory risk. Besides transferring risk, marine insurance may also reduce capital costs, improve the liquidity of shipowners and shipbuilders and provide peace of mind for financiers. Marine insurance is a contract rather than guarantee and this feature makes the policy structure and applicable law and jurisdiction vital for marine insurance professionals.

There is no research on the cyclicality of marine insurance except Nieh and Jiang (2006) to my knowledge, but underwriting cycles in other lines form an important part of the research on insurance business. Researchers mostly focused on the reasons behind the cyclicality in the market, and periods of cycles. Researchers explain the cycles in the insurance business with generally past losses, market imperfections, regulatory and informational lags, past surplus and movements in interest rates.

The capacity constraint theory is developed by Stewart (1984) and Bloom (1987) and suggests that changes in underwriting capacity cause the cycles (as cited in Gron, 1994, p. 112). Lack of capacity is caused by real frictions and imperfections and negatively related to the underwriting margin. Gron (1994) tested this theory and results show that variations in capacity have a significant negative effect on movements in property-casualty insurance profitability and mostly support capacity constraint hypothesis. Unanticipated decreases in capacity cause higher future profitability and prices.

Cummins and Outreville (1987) suggested that cyclical behavior in insurance markets is caused by institutional and regulatory lags and insurer accounting practices. Berger (1988) suggested that profits feedback into surplus with a lag, and that causes cyclicality. Considering the price of insurance is based on the intersection of market supply and demand schedules, it will depend on prior period surplus. Niehaus and Terry (1993) suggested that insurers set premiums equal to the present value of expected future losses. So, in a perfect market price cycle would occur only if the insurer's expected losses were cyclical. They suggest that cyclicality is caused by market imperfections. Lamm-Tennant and Weiss (1997) studied the presence of underwriting cycles and examine the relationship between cycle length and market/institutional features in international markets using data for 12 countries as different from the former studies that analyze only U.S. data. Results show that among all major hypotheses on underwriting cycles, rational expectations/institutional intervention explains many aspects of the underwriting cycle including the length of the cycle.

Grace and Hotchkiss (1995) examines the external links between the general conditions of the economy and fluctuations in the property-liability insurance industry's underwriting performance. The results of the study suggest there is a long-run link between general economic changes and underwriting performance. The demand factor that arises from general economic activity plays an important role in understanding the change in premium levels. For the cycle period, discount rates are significant explanatory variables (Lamm-Tennant & Weiss, 1997).

Chen, Wong, and Lee (1999) examines the presence and causes of the underwriting cycles in five Asian countries. They found cycles in the insurance industries of Singapore, Malaysia, and Japan with periods of 7.78, 12.01 and 13.86 years respectively with the overall industry data. Boyer, Jacquier, and Van Norden (2012) examine the data for U.S. property and casualty insurance market between 1967 - 2004 to check cyclicality and found that the evidence for cyclicality in the property and casualty insurance market could be spurious because of overstatement by standard estimation techniques and amount of data mining and the instability of the parameters. They conclude underwriting data follows time series processes, but cycles do not appear to help speculators or sophisticated underwriters forecast the movements in the market to make a profit.

The most popular hypotheses on insurance pricing and cyclicality are explained above. Nieh and Jiang (2006) have worked on the determinants of underwriting margins of the ocean marine insurance market in the U.S. and found that the best fitting hypothesis for the U.S. ocean marine insurance market is the rational expectations hypothesis explained by Nieahus and Terry (1993). Prices in marine insurance are rational and reflect the expected value of future losses by all available information and cycles are caused by long claims tail and reporting lags. The distinctive characteristics of marine insurance from other lines are explained with differences in coverage, exposure to the risk and regulations. Due to these points, pricing in marine insurance is much more complex than any other insurance lines. Also, the global nature of the business makes capacity constraint theory null for marine insurance considering the diverse markets worldwide.

From existing literature, we understand that both maritime and insurance markets are driven by supply and demand forces and have strong cyclical characteristics. Cycles in the maritime are mainly caused by global macroeconomic conditions. Despite there are various theories on the reasons for underwriting cycles, in marine insurance best fitting theory for cyclicality is financial pricing/rational expectations theory (Nieh & Jiang, 2006).

According to my knowledge, there is no previous research on the cyclicality of marine insurance on a global scale. There is also a gap in the literature on the relationship between the marine insurance and maritime markets. In this thesis, I aim to contribute to these gaps in the literature by analyzing global hull and machinery insurance premiums, Baltic Dry Index values and world merchant fleet volume between the years 1996-2018.

CHAPTER 3

MOTIVATION AND HYPOTHESIS DEVELOPMENT

The main motivation behind this thesis was to investigate the relationship between maritime freight markets and marine insurance premium levels. There is plenty of research conducted before about maritime freight markets and their relationship with the global economic variables. However, researches on marine insurance from an economic perspective are very few and there is no previous study on the relationship between maritime and marine insurance markets as to my knowledge.

The annual reports provided by Central Union of Marine Underwriters (CEFOR) were comprehensive resources to have initial insight into the marine insurance industry. CEFOR is an organization that was founded by Norwegian and foreign insurance companies that are related to Nordic insurance markets to represent members' common interest in the field of marine insurance. On this purpose, the organization continuously evaluates the market conditions in collaboration with customers, trade associations and other affected parties and provides appropriate statistics to support the activities of its members.

The annual reports on the website of CEFOR include the statistics on the number of vessels insured in Nordic insurance markets, average tonnage, age, and value of these vessels, total paid claims, claim frequency, loss ratio and relevant premium information between 1998-2018. From these reports, the graphic in Figure 1 is obtained with an annual net average premium of a vessel insured in the Nordic marine insurance market between the years 1990-2005. The oldest data on the net average premium per vessel provided in reports belongs to 1990. After 2005, this section is not reported due to the organization's decision as per information from Ms.

Astrid Seltmann from CEFOR. In Figure 1, we can see the cyclical pattern easily and identify a peak in 1993 and a trough in 1999 visually. Unavailability of the underwriting data after 2005 does not allow us to investigate further about cyclicality in Nordic marine insurance markets but available data supports the presence of cyclicality in the marine insurance market.

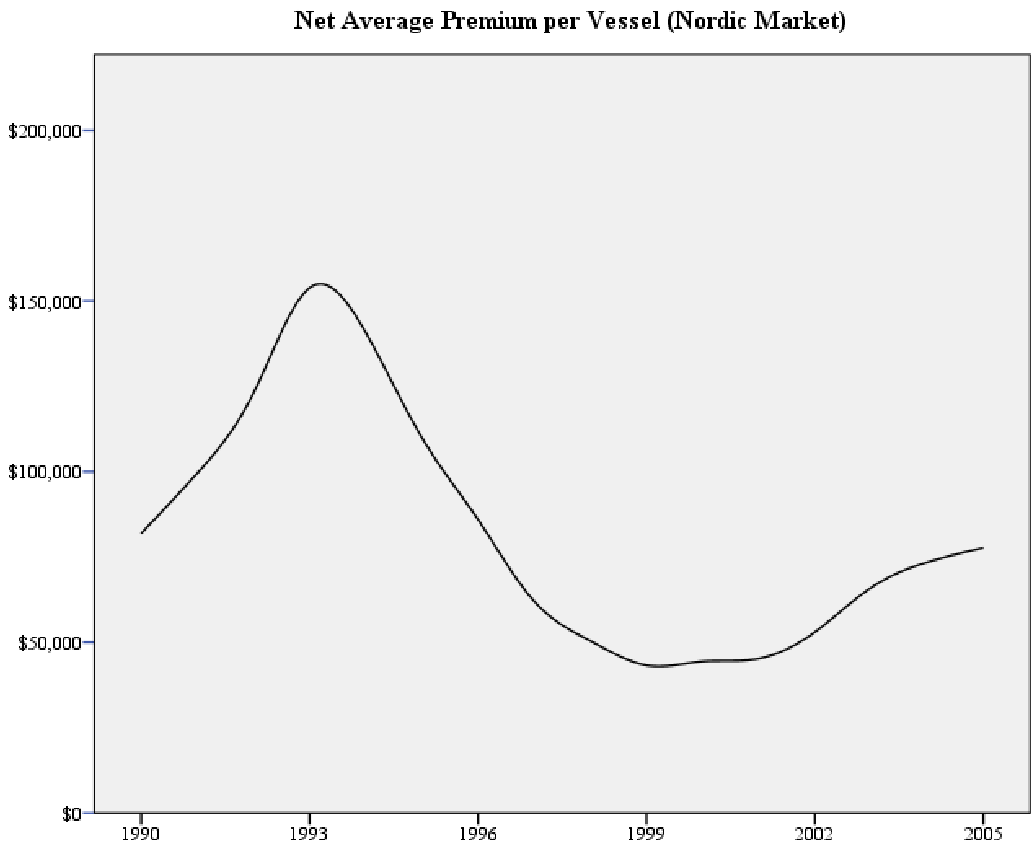

Figure 1 Net average premium per vessel (CEFOR Statistics (n.d.))

International Union of Marine Insurance (IUMI) is another important organization in marine insurance that is run by membership principles as CEFOR. The distinction of IUMI from CEFOR is its focus is on the international marine insurance markets, rather than one specific region. To check the presence of cyclicality in global marine insurance, total written global hull gross premium information from the annual reports of the International Union of Marine Insurance is employed.

Considering underwriting performance is found to be related to general economic conditions (Grace and Hotchkiss, 1995), general conditions of the maritime industry is expected to affect the marine insurance industry directly. Pricing in marine insurance mainly depends on the vessel's age, condition, and value (Aydemir, 2010). So, the changes in vessel values affect insurance prices.

The connection between global macroeconomic conditions, shipping markets, and marine insurance markets can be structured as; increased demand for transportation without any significant change in the fleet capacity causes an increase in maritime freight markets. Prosperous freight markets would attract investors and increase demand for vessels. Vessel prices increase due to increased demand and insurance prices go up as the monetary value of the main assets at risk.

Below, a list of hypotheses constructed with the aim of analysis in this thesis is represented.

H1 Maritime freight markets follow a cyclical pattern.

H2 Marine insurance premiums follow a cyclical pattern.

H3 Maritime freight cycles and marine insurance premium cycles are positively synchronized.

CHAPTER 4

CONTEXT

4.1 Overview of maritime transportation

4.1.1 Trade and sea transportation

Since the first known sea trade route in Mesopotamia, sea transportation has been the optimum way to carry goods in high volumes between continental landmasses. From prehistoric times, human beings have been living along coastlines, rivers, or lakes have used various watercraft for the transportation of their goods, as the waterways provided natural corridors that could be used for the transportation of larger quantities without complex engineering activities (Heidbrink, 2012). The history of shipping which has started with these various watercraft in sheltered coastal waters has continued its journey in open seas with rowing and sailing ships, steamships, faster diesel engine vessels and still evolving with today's modern green ship projects.

"Maritime transportation is one of the oldest forms of interaction across the Earth, and still supports more than 90% of international trade volumes nowadays" (Ducruet et. al, 2018, p. 342). The milestone of modern shipping is the industrial revolution like most of the industries today. Foundations of globalization have been laid by the geographical discoveries by converting random sea adventures to regular sea routes and start a cultural and material exchange between the continents. After the invention of steam engines, voyages became faster and with the iron hull, the ship's safety was added. Another result of the industrial revolution was the surplus of products caused by mass production, and a need arose for exchanging these products.

Thus, maritime transportation becomes a reliable solution for the transportation need of international trade and fostering international trade relationships.

Two main types of shipping dominated the market at the beginning of the twentieth century and modern shipping; liner and tramp. Practically, all liner companies started with the passenger trades which was the first big business that speed and regularity mattered (Miller, 2012). In the following years, regular trade routes have been added to liner shipping services while raw materials such as coal, iron ore or grains were carried by the tramp market. Increased demand for transportation accelerated the developments in shipping. From another point of view, the availability of fast and reliable transportation fostered long-distance trade.

After the invention of diesel engines and the building of screwed, iron hull ships another important invention was from Malcon McLean. The introduction of containers in the second half of the 1950s marked a major innovation in transportation: the standard container (referred to within the industry as “the box”) improved efficiency by allowing automation in cargo handling, connecting sea transport with intermodal inland transport, and reducing spoilage/pilferage on and off the ship (Cosar & Demir, 2018). In the beginning, few of shipping professionals were convinced that it is a good idea because of the special requirements and appliances needed on ships for carrying containers. Containers started to be carried onboard general cargo vessels with special lashing systems in the first instance, then specialized container vessels spread through. Today, containerization is accepted as a turning point for global trade and sea transportation.

With the popularity of containers in the industry, old-fashioned general cargo ships left their place to specialized vessels. Today, the main types of ships in the industry are dry bulk carriers, tankers, container vessels and specialized vessels such as forest product carriers, Ro-Ro/Ro-Pax vessels, LNG/LPG carriers, refrigerated cargo carriers, offshore supply vessels, and ice breakers. Liner passenger vessels are also changed with regional ferries and cruise vessels that are mainly being used for pleasure trips.

From a country's trade competitiveness perspective, the efficient access to affordable, reliable, and cost-effective transport systems remains an imperative challenge to be addressed in many developing countries (Valentine et. al, 2013). Therefore, developments in shipping bring the need for an improvement in port organizations as well, to allocate the goods unloaded at the port to the production sites or final receivers. The ports have been linked with railroads first, then intermodal transportation has become essential in trade. Ports have been the hubs for shipping professionals and traders with their intermediary function. Increased volume in transportation brings the need for storage and added warehousing to the functions of the port. Along with containerization, automation in ports has improved the handling performance significantly and increased the reliability with removing human errors. Today, ports are the gateways to massive industrial regions and indispensable intermediaries for international trade.

Trading thus dovetailed with ports and shipping to build out the world maritime systems. Ports provided docking, handling, coordinating and information centers, and processed mass movements inland and overseas. Shipping companies offered transport, speed, regularity, and organization that lowered rates and magnified trade. Trading companies added commercial know-how, conduits for exchange, and promoted the production and distribution of commodities and migrant labor. Each sector thoroughly interlocked with the other (Miller, 2012).

4.1.2 Marine industry

The marine industry consists of many branches such as transportation, energy, fishing, and tourism. The annual turnover of the marine industry in 2004 was over $1 trillion (Stopford, 2008). “Although these figures contain many estimates, they make a useful starting point because they put the business into context and provide a reminder of the other businesses with which shipping shares the oceans” (Stopford, 2008, p.48). This number includes the activities of vessel operations, marine engineering and shipyards, offshore oil & gas facilities, minerals, and renewable energy facilities, fishing and fish processing activities, tourism, and other services.

Vessel operations can be defined simply as maritime transportation or shipping. Shipping markets can be characterized as capital intensive, cyclical, volatile, seasonal, and exposed to the international business environment (Kavussanos and Visvikis, 2006). The shipping industry has different players in its structure; shipowners, shippers, traders, brokers, shipbuilders, international, national and regional regulators, investors, and bankers. The responsibility of the carriage of good changes between them regularly during the transportation process. “The international maritime transportation industry facilitates between 80% and 90% of global commodity trade in volume terms and contributes significantly to the welfare and development of nations adding around $380 billion a year via freight rates alone to the global economy” (Alexandridis et al., 2018, p.164).

Martin Stopford (2008) divides shipping into four main markets; new building, freight, second-hand and demolition. An investor who decided to invest in shipping gives an order for a newbuilt in the newbuilding market. After delivery of the ship, she is operated in the freight market to earn money and take the fruits of investment back. When it is time to quit from the industry or shipowner believes the timing is good to sell the asset, the ship is sold in the second-hand market. Finally, when she completed her lifespan in the industry, the demolition market is where the ships are scrapped.

Each player of shipping has different roles in different markets and all the markets and players are linked by cashflow in the industry. The direction in the market is determined by the combination of cash flow and market sentiment (Stopford, 2008). Figure 2 shows a summary of how these four markets operate, who are the players of each market, and it visualizes cashflow between them.

Maritime transport is produced globally, with maritime goods and services purchased in different countries. “Shipping businesses are no longer the domain of rich countries, but many developing countries have benefited from liberalized markets and found niches where they can participate in parts of the supply chain of maritime transport services” (Valentine et al., 2013, p. 237). Mobility of the main asset, ship, brings flexibility in trading region, investment, and the applicable jurisdiction. Because of the international nature of the shipping business and the mobility of assets, they are globally competitive and very close to the perfect competition model described by classical economists (Stopford, 2008).

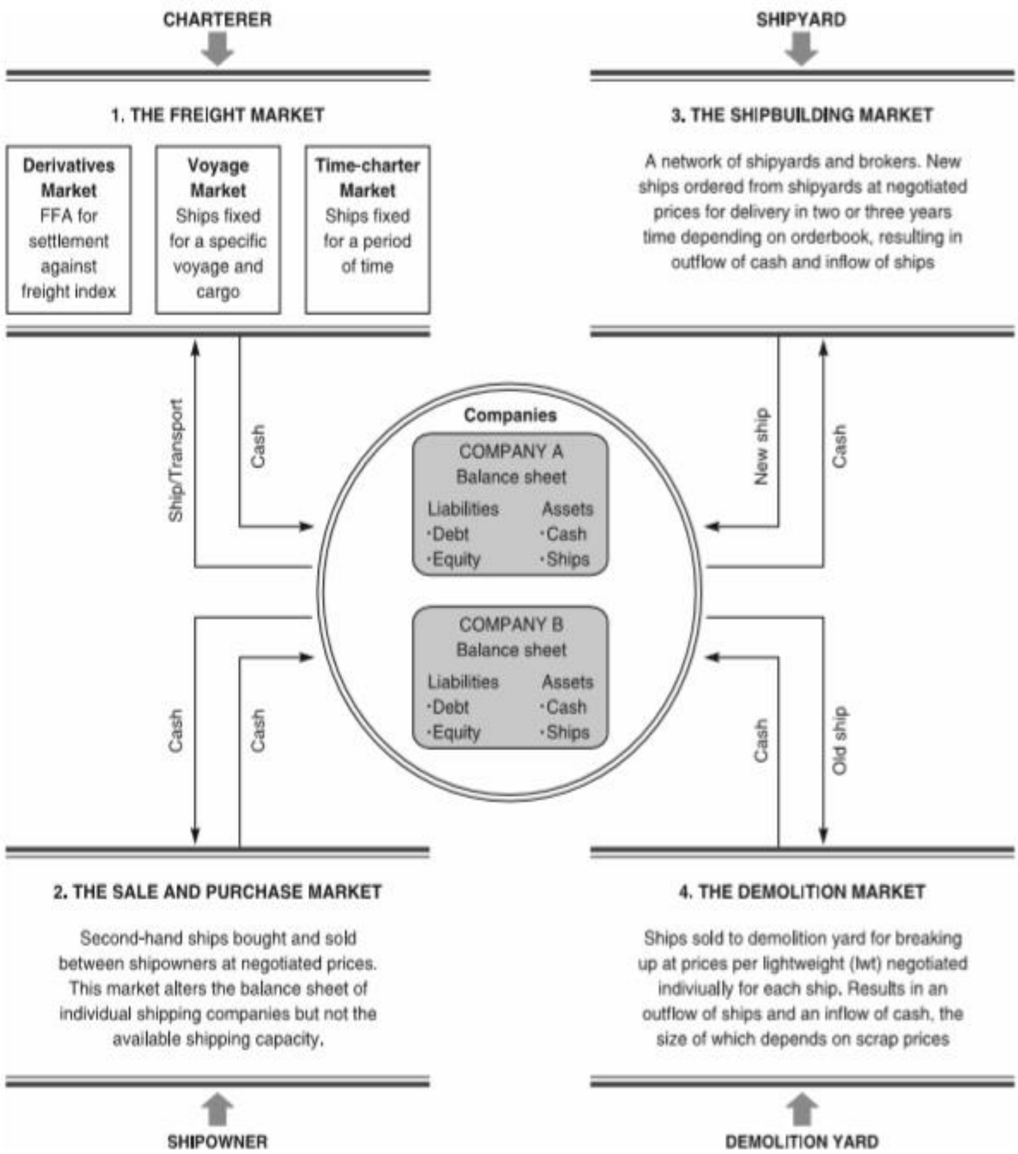

Figure 2 Cashflow between four maritime markets (Stopford, 2008)

The freight market is divided into 3 main sectors by the type of charter contract; voyage charter market, time charter market and bareboat or demise charter market. In voyage charters, the contract is made for a specific voyage and freight rate can be defined for a whole voyage (lump sum) or per cargo quantity (per metric tons). Time charters are made for the use of ships by the charterer in a specific period. Lastly, bareboat or demise charter the vessel is operated by charterer as a shipowner.

Time charter means stability for the business and generally preferable from a shipowner/operator perspective in low freight periods due to high competition. Voyage charter means the owner/manager must compete with others in every voyage with the freight rates. In a good market, it is paying but always risky. Bareboat charterers are generally for ship’s life span and usually, specialized contracts are signed. Also, each sub-market is separated according to the cargo and ship type. All these separate sections behave differently in the short term, but they are in continuous interaction, and the general trend is prevailing in the long term.

“Freight rates are determined in a bargaining game between the owner and the charterer over a given equilibrium rate, which is usually the latest one available to both players” (Karakitsos & Varnavides, 2014, p.37). Knowledge of market conditions and the flow of information are essentials for that bargaining game. Hence, regular market reports are published, commonly by brokers, for specific cargo/vessel type and region/route. The biggest portion is on the dry bulk and tanker charters in the market. But still, a significantly growing market exists for liner and specialized vessels. It is very common in specialized and liner market that operators time charter the vessels for short and long terms according to the density of the business.

Voyage freight rates are commonly reported in USD per metric tonne for the specific voyage to cover all transportation costs, and time charter rates are for a round voyage, 6 months, 12 months, or 3 years. The average rates of the fixed voyages are reported by brokers each week. The freight rate statistics are used for dry cargo commodities, while in the tanker market a more complex standard, 'The Worldscale Index' is adopted. The Worldscale Index shows the estimated cost of conveying oil cargo with a standard size of a tanker on a given route. Charter negotiations are made generally as a percent of this rate. Worldscale Index concept appeared during World War II and after the war it is adopted by players of the tanker market. The latest revision was in 1989 and the name changed as 'New Worldscale'. It is published by two non-profit making organizations based in London and New York annually in a book.

The maritime industry is known for its conservative nature and there have not been many changes in the main principles for the last several centuries. But, to adapt to modern financial environments, the creation of a freight derivatives market is a radical change in the industry. The function of the freight derivatives market to arrange contracts settled against the future value of the freight index market at a specific time. A derivatives contract is a legally binding agreement in which two parties agree to compensate each other, with the compensation depending on the outcome of a future event. These contracts are used to hedge risk by compensating the cost of a large adverse movement in the variable being hedged (Stopford, 2008). The freight derivatives market stands for shipowners and charterers to share their risk for any future movements in the freight rates.

The freight derivatives market appeared first in 1985 with the publication of Baltic Freight Index (BFI) by the Baltic Exchange. "The Baltic Exchange is a London-based exchange that provides real-time maritime shipping information to traders for settling physical and derivative shipping contracts" (Chen J., 2019). History of the Baltic Exchange started in a coffee house in London in 1744. In the early years of modern shipping, people were meeting there to trade. Then, membership and rules have been constructed and Baltic Exchange becomes an independent source of information in the maritime market.

In November 1999, the name of BFI has been changed as Baltic Exchange Dry Index (BDI). The index is calculated by taking into consideration the rates of Capesize (125 000 – 220 000 deadweight tonnage (DWT)), Panamax (60 000 – 80 000 DWT) and Supramax (50 000 – 60 000 DWT) ships. Members of the Baltic Exchange contact the people from the industry to collect daily freight rates of the dry bulk vessels across different sea routes and after certain calculations, the average rate is published daily.

Today, BDI is an economic indicator for global trade as it is mainly showing the unit cost to transport goods from A to B. It is a basic and reliable market source and simply driven by supply and demand forces. It is almost impossible to manipulate the BDI due to physical contract requirements and the ships being the main factor in supply. To build a ship and put it into service takes several years and it is too costly to keep the vessel empty for manipulation purposes.

4.1.4 Cyclicality in the maritime industry

Cyclicality is the recurrent upwards and downwards movements in economic activity over a period. Cyclical movements can be observed from the production output levels, stock market indices or profitability, depending on the nature of an industry. The period of these cycles may differ from a couple of months to a couple of decades. Each completed cycle consists of four main stages; trough, recovery, peak, and collapse. Fluctuations during the year usually depend on the season and if one cycle is completed in a year, it is called a seasonal cycle. Seasonal cycles are common in shipping, especially for the carriage of edible/perishable goods due to harvest timing.

Movements in economic activity in the long term are generally driven by technical, economic, social, political, or regional developments. Despite it is hard to observe, provided that enough data is available, analyzing long-term movements is very convenient. Short time cycles are easier to recognize compared to long term cycles, generally driven by supply and demand levels and optimizes the efficiency of the market.

“The demand for seaborne transport is a direct derivative of global trade and thus industry cash flows in shipping are tightly linked to the business cycle” (Drobetz, Menzel, & Schröder, 2016, p.130). Shipping has always been a cyclical industry because of its dependency to supply and demand levels. When trade activities get increased in a stabilized way, demand for transportation increases. The prosperous shipping industry attracts more investors and ships in the market increase gradually. An increase in the supply brings competition and lowers transportation rates in the market. Sometimes, shipowners run their ships even for a loss. When the market gets harder with the increased number of ships, it is easier for strong shipowner companies to compensate their loss from their earnings in earlier prosperous periods. But the weaker ones need to give up at a point when the loss is intolerable. So, cycles behave as a mechanism to push inefficient companies out of market and to balance supply and demand.

Even these fluctuations seem like regular periodic movements, the duration of the periods may change depending on the decision by investors. The average time for delivering a new ordered ship is around 3 years. If shipowners decide to invest in a trough stage with the expectation of high profits, this will increase the capacity and supply, so the cycle duration may extend, and recovery period may postpone. The shipping cycle depends very much on people's decisions and crowd psychology as well.

4.2 Overview of marine insurance

4.2.1 Introduction to risk and insurance

Risk means the probability of the occurrence of an undesirable event or any unexpected result of an occurrence. This undesirable event may be the loss of physical property or any financial loss because of an unexpected event. The cause of the loss is named as peril and any condition that may increase the chance of loss is called the hazard in risk management terminology. The risk sources can be categorized as personal, property, liability and financial, and the management process needs to be shaped according to the source and specifications of the exposed risk. The main stages of the risk management process are identification, assessment of the risk, potential treatment in case of occurrence, creating a management plan and implementation of the plan.

There are many financial solutions to spread the risk, but the most effective and important way is insurance. Insurance can be defined as one party's agreement to compensate another party's loss in return for a certain amount of money which is called the premium. The agreement between the insurer and the insured is called the policy. An insurance policy is a reimbursement contract between the parties rather than a guarantee by the insurer to the insured. Insured must comply with contract terms and conditions to get reimbursed after the loss occurred.

A risk must carry certain specifications to be covered by an insurance policy. For example, if the risk is unique or not large enough to create difficulty for the holder, probably the cost of insurance would exceed the value of the insured and it becomes unnecessary to buy a policy. Also, the loss must be definite, the occurrence of the loss must be accidental or fortuitous, and calculation of the loss must be possible.

There are 7 basic principles of insurance; indemnity, utmost good faith, subrogation, contribution, insurable interest, proximate cause, and loss minimization. Insurance is a reimbursement contract, and the assured cannot make any profit from an insurance policy after a loss occurred. Indemnity means that assured is in the same financial position before the occurrence of loss by virtue of the insurance policy.

Both parties subject to an insurance contract need to act in good faith and disclose the accurate information on the condition to each other as the primary principle of the contract. All material facts about the risk need to be presented by the insured during the proposal and the insurer needs to disclose terms and conditions accordingly. The misrepresentation or non-presentation may be intentionally or unintentionally. If it is intentional, it is considered a fraudulent act otherwise, it is a breach of the general duty.

The insurance company has the right to compensate for the loss in the name of the insurer from another party. Subrogation means the transfer of ownership rights to another person and it is applied in the insurance contracts. The insurer can only recover the money it paid to the insured and the costs to acquire this money. Any excess gain needs to be transferred to the insured.

The insured can recover the loss only once despite there are other policies for the same subject against the same peril. This contribution condition is to restrain any profit-making from the insurance. If there is more than one policy purchased by the same insured for the same subject and against the same peril, each insurer’s responsibility for the loss will be proportionate to their share on the risk.

There should be an insurable interest to be able to purchase an insurance policy and this interest should provide a financial benefit to the insured and would create harm if it is lost. In some branches such as fire insurance, insurable interest must be present at the time of purchasing policy and at the time of occurrence of loss, while in other types of policies it is enough for the insurable interest to exist only at the time of loss.

An incident may have more than one cause and sometimes the loss may escalate with the chain reaction. During the proposal, insurers quote their offer with the policy conditions, and an insurer can see there the covered and uncovered clauses. If not all the causes are covered under the policy, the proximate cause needs to be found out. This situation may lead to a dispute between the insured and insurer, and the duty to prove that the cause of the incident is covered, proximate cause, belongs to the insured.

Lastly, the final principle is loss minimization which puts the responsibility on the insured to ensure all precautions are taken to minimize the loss on the subject property.

4.2.2 Marine insurance

Definition of the marine insurance is made in the Marine Insurance Act 1906 as "A contract of marine insurance is a contract whereby the insurer undertakes to indemnify the assured, in the manner and to the extent thereby agreed, against marine losses, that is to say, the losses incident to marine adventure." Marine is a branch of insurance that covers the risks of persons who are interested in a marine adventure due to 'perils of the seas'. A marine insurance contract is a tool for minimizing financial uncertainty and protects against any possible undesirable event. It compensates any of the ship or cargo interests' losses incidental to marine adventure. Any person who participates in a marine adventure, such as owners of the cargo or ship, a person who lent money for the cargo or ship, agents, carriers, etc. may be subject to a marine insurance policy.

A ship or any moveable object exposed to marine perils is an insurable property. Additionally, any benefit from the marine adventure is deemed to be an insurable interest such as the earning of the freight, any lender's or mortgagee's interest, wages of the seafarers, etc. The only provision for compensation is the assured must have an interest in the marine adventure at the time of the loss. If the assured is not an insurable interest as per MIA 1906 or the contract is made "interest or no interest", "without further interest than the policy itself or benefit or salvage to the insurer", the contract deemed to be a gaming or wagering as per MIA 1906 and is void.

Marine Insurance has been a ground for all parties to share the risk of a marine adventure since early modern times as being the first type of contract of indemnity. Existence of such an opportunity to share the risk, parties were more enthusiastic about long-distance voyages and thus the long-distance trade was encouraged. Like the maritime transportation, the insurance industry was an important factor in the development of trade and globalization. It still serves for similar purposes as, without a possibility of sharing the risk of maritime transportation, the losses would be much more destructive for all parties.

Marine insurance can be explained simply under two main categories; property and liability. Property policies cover the physical loss to an asset, while liability policies cover the loss of any other third party during the transportation of cargo by sea. A 'hull and machinery' policy covers the vessel against any marine perils such as rough weather, collision, grounding, negligence of the master or officers/crew, fire or violent theft except the ordinary action of the weather/sea and ordinary wear and tear. Another important cover for shipowners is 'protection and indemnity' that covers the loss to any third party caused by vessel operations. Protection and indemnity covers are usually provided by mutual clubs instead of traditional insurers/underwriters. There are thirteen mutual clubs who can offer shipowners membership against a fee named 'call' instead of premium. The earnings and loss of the club are shared between members. Clubs may pay the money back to the members after a successful underwriting year or have the right to announce supplementary calls for all members if the calls are insufficient for the year. In addition to shipowners, also charterers who are in the position of disponent owner need Protection and Indemnity (P&I) cover.

In addition to these two main categories, there are also several other policy types for the insured's special needs such as war risks, kidnap and ransom, increased value, builder's risk, yacht, open cargo, freight, cargo, defense (FDD) or professional indemnity. MIA 1906 expresses that every lawful marine adventure can be subject to a marine insurance contract. Marine insurance may be extended to inland waters or land, provided that the risk is incidental to any sea voyage or analogous to marine risk. For example, the ship during the building or launching process needs to be insured with a marine policy. The scope of the policy may change according to the situation of the vessel and/or position in a transportation contract.

4.2.3 History of the marine insurance

Marine insurance is known as the first contract of indemnity whose origins date back to the 12th century. The first known type of marine insurance was 'bottomry' that can be explained as the mortgage of a ship. A lender advanced the money for the sea voyage and if the vessel and goods are lost during the voyage, the lender lost the money. But, after vessel and goods safely arrive in the port, the lender receives a defined amount of premium in addition to the money lent. The geographic origins of marine insurance are still unclear. Considering the marine contracts are highly related to the commercial relationships of the nations, it is believed that the ancient Phoenicians, Greeks, and Romans first used the type of contract to secure themselves against marine risks.

The first legislation about marine insurance was the Elizabeth Act of 1601 in London explained as 'an act concerning matters of assurances amongst merchants. With the Act, also Court of Insurance has been established. Before 1666, the place of the contracts was private offices of bankers in the United Kingdom. After that date, various coffee houses are established for this purpose and they were the meeting points of the merchants, shipowners and other marine people. 'Lloyd's Coffee House' established first in Tower Street in the late 1680s by Edward Lloyd. In 1771, a committee was elected to represent Underwriters in Lloyd's Coffee House and regulate the payment of subscription. In 1871, via Lloyd's Act, it has become a structured organization that continues the activity.

After the 1601 Act, a couple of revisions have been adopted in 1745, 1788, and 1795 which have tightened the rules of making policy. In 1894, 'Marine Insurance Codification Bill' was presented by Lord Herschell in the House of Lords which is the base of MIA 1906, which is still widely accepted as the main legislation for modern marine insurance. The latest revision to the Marine Insurance Act has been brought in 1963.

Before 1884, only two underwriting companies other than Lloyd's of London could issue marine insurance policies. After this date, starting with the incorporation of the Institute of London Underwriters (ILU) a great expansion has occurred in the marine market and each institution needs its own clauses. There was one common application, Ship and Goods form which is created in the 17th century. In 1883, UK Underwriting Community decided to establish and adopt a common wording for marine policies. In 1888, Institute Time Clauses has been published for the first time. Because of changes in trade conditions revised versions have been issued in 1952, 1959,1969, 1970, 1983 and 1995. Over those years, Institute Time Clauses have been a common practice internationally and in 2002 got the new title of 'International Hull Clauses'. The latest version of International Hull Clauses has been published in 2003.

The second major market for marine insurance is the Nordic market which has its own legislation and clauses under Nordic Plan 2013, version 2019. The first standardized rules for Nordic Market were 'Norwegian Marine Insurance Plan' and it has been prepared in 1871 with the supports of Det Norske Veritas, the national classification society of Norway. CEFOR - The Nordic Association of Marine Insurers has been established in 1911 under the name of The Central Union of Marine Underwriters which changed in 2009 as The Nordic Association of Marine Underwriters. In 2001, Det Norske Veritas (DNV) transferred its intellectual property rights on the Plan to CEFOR. In 2010, shipowners' associations of Nordic countries signed an agreement with CEFOR to develop the Nordic Marine Insurance Plan. The Nordic Plan has been approved and came into operation in 2013. As per the agreement, the plan needs to be updated every three years and currently the latest version 2019 is available.

CHAPTER 5

METHOD

5.1 Data

In this thesis, to check the cyclical characteristics of the marine insurance industry and analyze its relationship with maritime freight markets, annual mean of monthly Baltic Dry Index (BDI_t) values, annual data of world merchant fleet volume in ‘dwt’ (F_t) and annual total produced global hull premium (HP_t) for 23 years, between 1996 and 2018 is employed. Total written global hull insurance premiums are provided by IUMI in their annual reports. To reach the average unit hull premium per dwt (P_t), total hull premium values are divided by world merchant fleet volumes. Baltic Dry Index is chosen as representative of maritime freight markets as it is a reliable market source, considered as an economic indicator for global trade and it plays a fundamental role to assess the condition of the maritime market and predict developments in other freight markets. BDI data was available monthly, and it is converted to annual data by calculating the arithmetic mean of monthly data for each year. World merchant fleet volume is provided by the United Nations Conference on Trade and Development (UNCTAD) website under the statistics section. $HP_{t,}$, BDI_t, and F_t data series are shown in the graphics in Figure 3, Figure 4 and Figure 5 respectively.

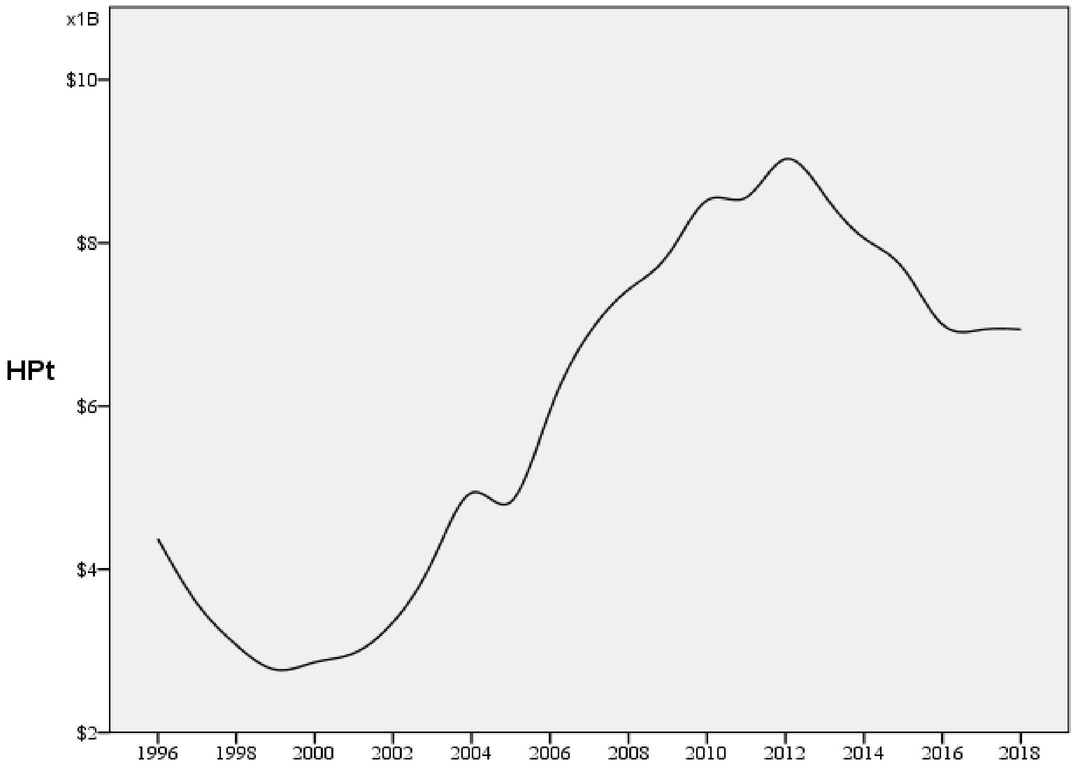

Figure 3 Annual total produced global hull premium (IUMI member statistics. (n.d.))

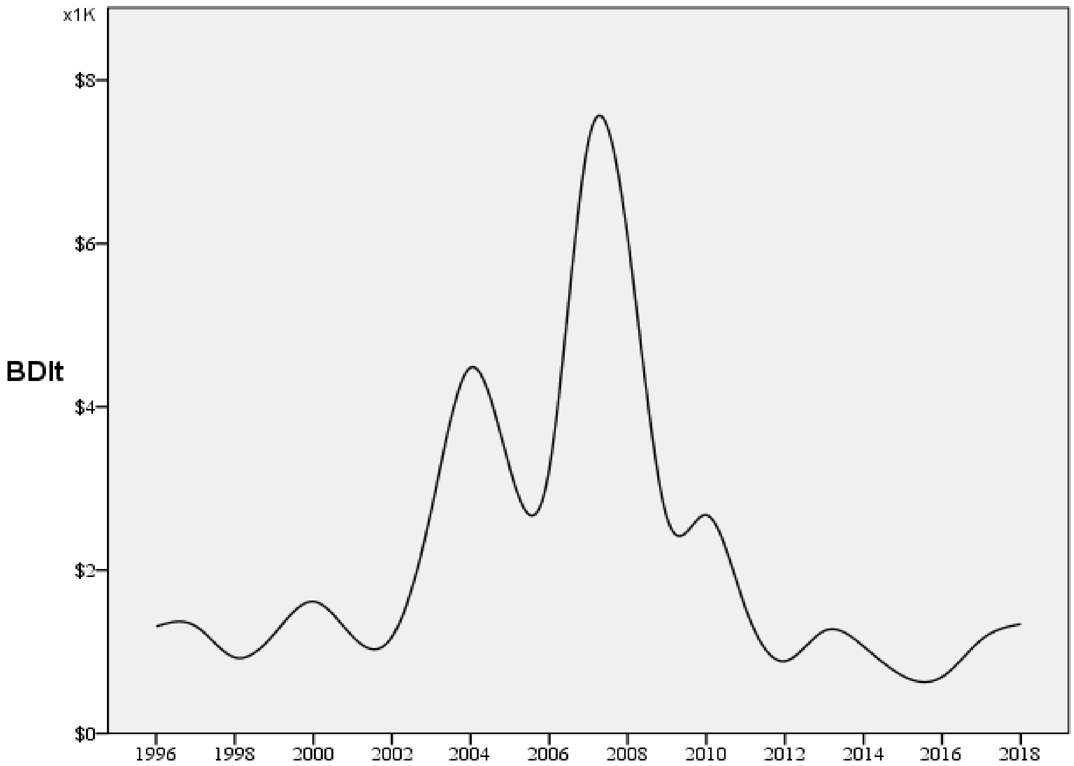

Figure 4 Baltic Dry Index (Baltic Exchange: Baltic Dry Index (.BADI:Exchange),2019)

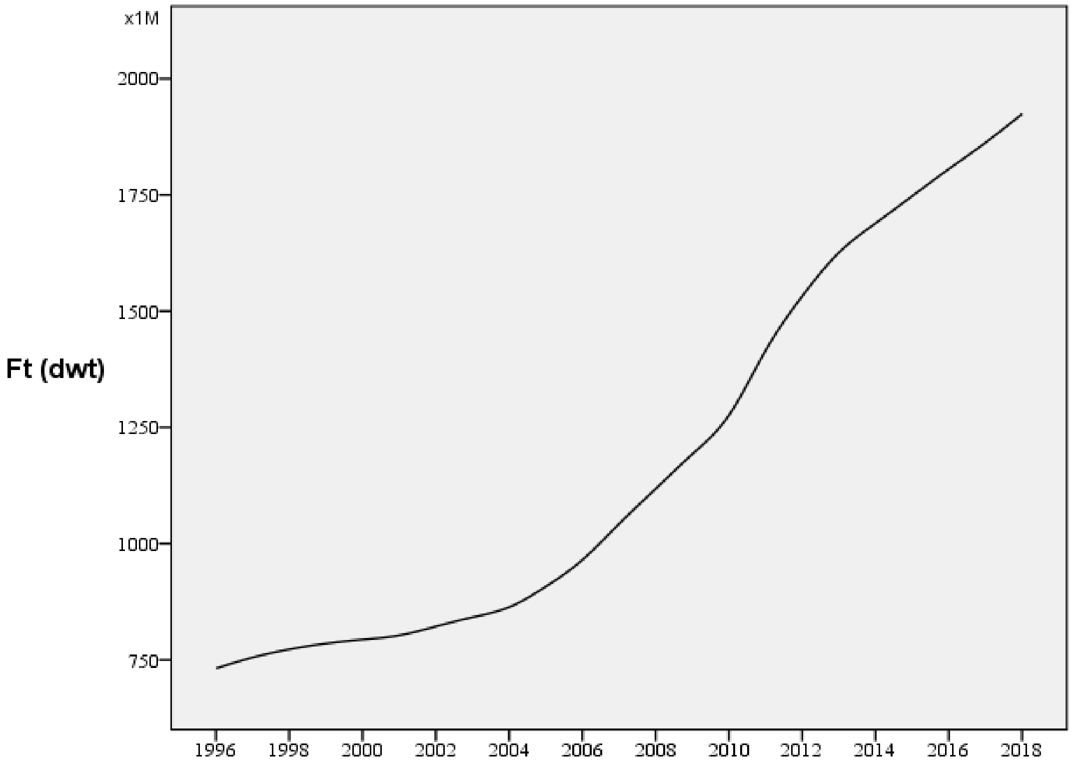

Figure 5 World merchant fleet volume in million dwts (UNCTADSTAT. (n.d.))

5.2 Identification of turning points

The most basic and popular way of determining a cycle in a time series is to detect turning points in its sample-path. This procedure first introduced by Burns and Mitchell (1946) and adopted by many institutions such as International Monetary Fund (IMF), National Bureau of Economic Research (NBER) and The Organisation for Economic Co-operation and Development (OECD) (as cited in Harding and Pagan, 2008, p. 1). Harding and Pagan (2008) define this procedure basically as 'peaks are local maxima and troughs are local minima in a series Y_t'.

The detection and description of any cycle are accomplished by first isolating turning points in the series, after which those dates are used to mark off periods of expansions and contractions (Harding & Pagan, 2002). To visualize a peak or trough at a time *t* conditions below explained in Harding and Pagan (2001) can be tested. If the observations is higher(lower) than other values in a symmetric window of k observations to the left and right, it is a peak (trough).

Peak:

$y_t > y_s$ for $t - k < s < t$ and $t + k > s > t$

Trough: (1)

$y_t < y_s$ for $t - k < s < t$ and $t + k > s > t$

5.3 Trigonometric regression

An alternative way of determining cycles is to consider time series Y_t as a trigonometric function which composed of periodic components represented by sine and cosine waves (Harding & Pagan, 2008).

Papailias et al. (2017) employed this model in their forecasting exercise on BDI and applied the periods as 3,4, and 5 years. After the application of two models one of which contains only cosine waves and other is a combination of cosine and sine waves, they found out the composite model demonstrated below, fits better.

Following the same formula where the λ_j indicates the frequency, the cyclical components of a time series can be investigated according to its fitting level in the different frequencies.

$$Y_t = \alpha + \sum_{j=1}^{m}\{\beta_j \cos(2\pi\lambda_j t) + \gamma_j \sin(2\pi\lambda_j t)\} + \varepsilon_t \quad t = 1,\dots, T, \quad (2)$$

5.4 Testing the synchronization

Comparing different cyclical time series and having an idea of whether they may be related is possible using the two basic statistics related to phases of cycles; duration and amplitude, which describes the period of the phase in a cycle and the difference between trough and peak respectively. When we detect these two measures which are perpendicular to each other on a graphic, hypotenuse becomes the path followed by the variable. (Harding and Pagan, 2008) Another important point to understand is whether the two cycles are in the same phases at an exact point of the time which shows the synchronicity of cycles.

Synchronization may answer whether the cycles are affected by the same developments and what is the effect of these developments on the cycles. To check the synchronization of two cyclical series, it is useful to convert time series data into binary indicators S_t first, following the researches of Burns and Mitchell (1946) and Harding and Pagan (2006). After determining turning points, the cycle is divided into phases of contraction and expansion by those points. The phase started by a peak is identified as contraction until the next trough. While the one started by a trough until the next peak is expansion. The specific series show which phase occurs at a specific time; S_t=1 in expansion and S_t=0 in contraction periods.

SPPS (strong perfect positive synchronization) is the situation that two random variables S_{X_t} and S_{Y_t} are identical. SNS (strong non-synchronization) is the situation that two random variables S_{X_t} and S_{Y_t} move independently of each other. Following Harding and Pagan (2006), below moment conditions for binary data of two cycles are applied to check unconditional and conditional densities.

SPPS (i): $\mathrm{E}(S_{Y_t}) - \mathrm{E}(S_{X_t}) = 0$ (3)

SPPS (ii): $\mathrm{E}(S_{X_t}) - \mathrm{E}(S_{X_t}S_{Y_t}) = 0$ (4)

SNS: $\mathrm{E}(S_{X_t}S_{Y_t}) - \mathrm{E}(S_{X_t})\mathrm{E}(S_{Y_t}) = 0$ (5)

The unconditional density of the two series is checked by applying (3) and conditional density is checked by applying (4). If both (3) and (4) are confirmed, the two series are perfectly synchronized. Rejecting (3) and/or (4) leads us to reject the strong perfect positive synchronization between the two cycles. If (5) is confirmed in the same instance, it can be said that the series are strongly non-synchronized. Rejecting all three hypotheses shows that cycles are neither perfectly synchronized nor non-synchronized but synchronized with a lesser degree than perfect. In the latter situation, interpreting the components of the correlation coefficient of the series would be useful to check co-movement. (Harding & Pagan, 2006).

$$\rho_S = \frac{\Pr(S_{X_t}=1, S_{Y_t}=1) - [\Pr(S_{X_t}=1)\Pr(S_{Y_t}=1)]}{\sqrt{\Pr(S_{X_t}=1)\Pr(S_{X_t}=0)}\sqrt{\Pr(S_{Y_t}=1)\Pr(S_{Y_t}=0)}} \quad (6)$$

Harding and Pagan (2006) explain how strong perfect positive synchronization and strongly non synchronization explained in equations (3), (4) and (5) can be based on the following test statistics:

SPPS (i): $\hat{\mu}_{S_X}$- $\hat{\mu}_{S_Y}$

SPPS (ii): $\hat{\rho}_S$- 1

SNS: $\hat{\rho}_S$

Another way of measuring the synchronization of cycles to check what fraction of time the cycles are in the same phase. Harding and Pagan (2006) apply below the concordance index formula for this purpose.

$$\hat{I} \ = \frac{1}{T}\left\{\sum_{t=1}^{T} S_{X_t} S_{Y_t} + \sum_{t=1}^{T} (1 - S_{X_t})(1 - S_{Y_t})\right\} \tag{7}$$

The concordance index has a maximum value of unity when $S_{X_t} = S_{Y_t}$ and a minimum value of zero when $S_{X_t} = (1 - S_{Y_t})$. This corresponds that concordance index $\hat{I}$=1 if series are in strong perfect positive synchronization and$\hat{I}$=0 if series are strong perfect negative synchronization. If the correlation between the two series is 0, then the concordance index becomes equal to 0,5 which means strong non-synchronicity between two series. In other words, the concordance index shows us the percentage of the time that cycles are in the same phase. The result of the formula may be misleading in the instance that $\rho_S = 0$, so first looking at the correlation between the two series is essential.

CHAPTER 6

DATA ANALYSIS AND RESULTS

6.1 Descriptive statistics

Descriptive statistics for our data is presented in Table 1. P_t is the unit Hull Premium in US dollars which is calculated by dividing total global written hull premium amount by total global fleet volume in dwts. BDI_t is the annual mean of monthly Baltic Dry Index values in US dollars. The mean value of P_t is USD 5,03 per dtw while it is USD 2162,12 for BDI_t through years 1996-2018. P_t has changed USD 3,15 per dwt and BDI_t is changed USD 6559,42. Results of all statistics are given in Table 1. The scatter plot of P_t against BDI_t is shown in Figure 6. Skewness values indicate that P_t is more symmetrical than BDI_t with a value of 0,09. A positive value of the skewness in BDI_t indicates the right tail of the distribution is larger than the left tail. Kurtosis values indicate that P_t (-1,5) has lighter tails than normally distributed data, while BDI_t (2,9) has heavier tails. So, with skewness and kurtosis values that differ from zero, it is understood that neither of the datasets is normally distributed. BDI_t has more significant peaks than P_t, while P_t is more symmetrical than BDI_t. The visual expression of both datasets together can be seen in Figure 7.

Table 1. Descriptive Statistics P_t- BDI_t

		P_t	BDI_t
Range		\$3.15	\$6,559.420
Minimum		\$3.53	\$692.830
Maximum		\$6.68	\$7,252.250
Mean		\$5.0348	\$2,162.11986
Skewness		.094	1.816
	Std. Error	.481	.481
Kurtosis		-1.542	2.935
	Std. Error	.935	.935

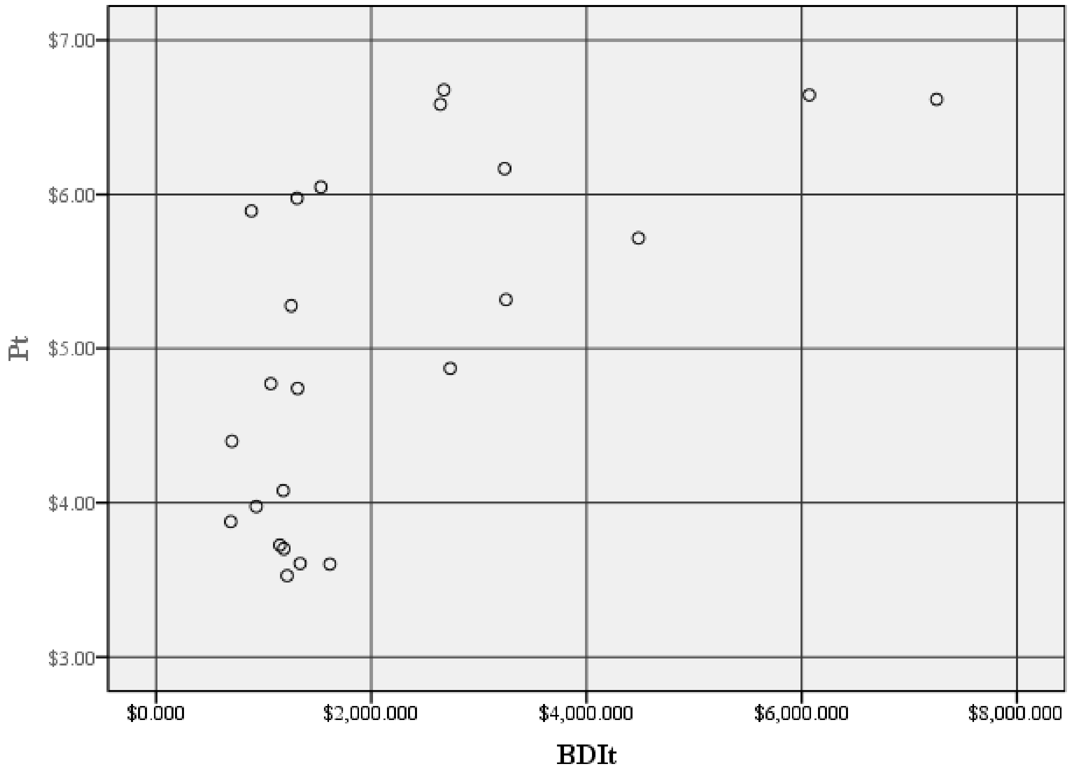

Figure 6 Scatter plot P_t - BDI_t

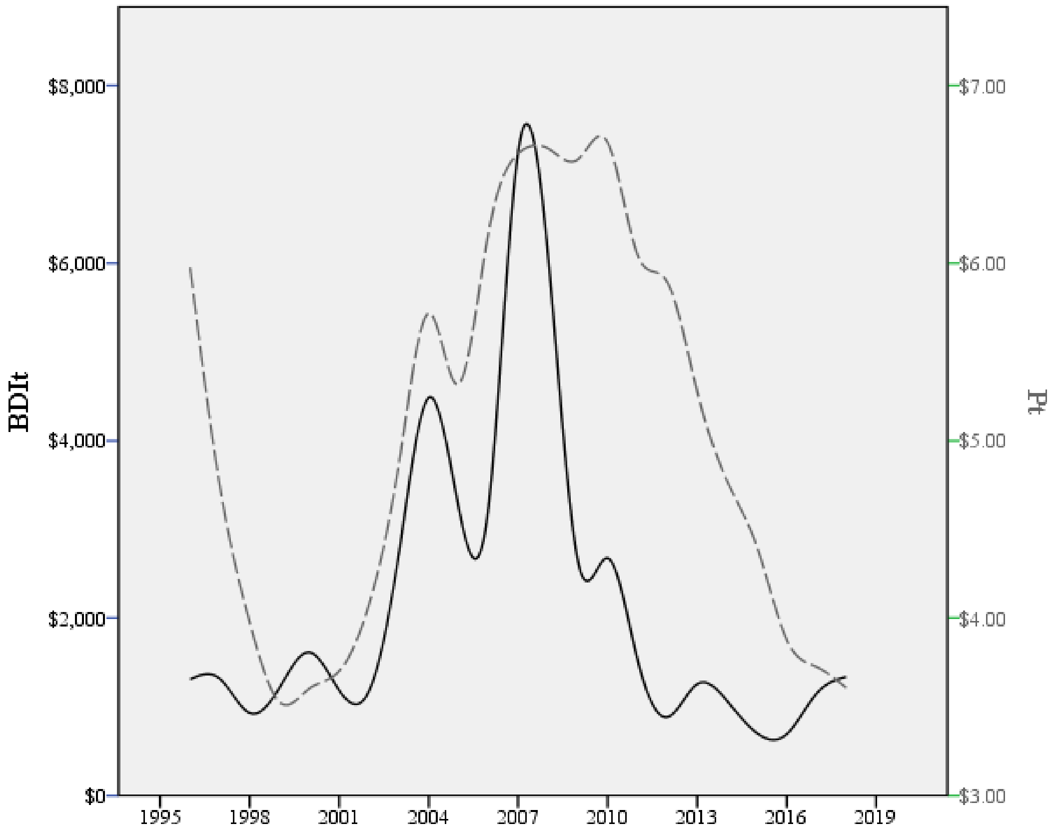

Figure 7 P_t - BDI_t values among the years 1996-2018

Despite both time series are not normally distributed, referring to previous similar studies Pearson's correlation is used as the best fitting method to measure the relationship degree of the two series. (Chistè & Van Vuuren, 2014; Harding & Pagan, 2006; Papailias et al., 2017) Correlation analysis results are given in Table 2. The result shows there is a significant positive correlation between BDI_t and P_t series.

Table 2. Correlation Between P_t - BDI_t

		BDI_t
	ρ	.637**
P_t	Sig. (2-tailed)	.001
	N	23

**. Correlation is significant at the 0.01 level (2-tailed).

6.2 Identification of turning points

Formula (1) is applied to identify turning points in the data series to check cyclicality. Harding and Pagan (2002) took 'k' as 2 to analyze quarterly data in their paper. However, the cyclical pattern in the annual data used in this research gave clearer results with a symmetric window size of k equal to 5. Turning points in both series are shown in Table 3.

Application of (1) revealed one peak and two troughs for BDI_t and two peaks and two troughs for P_t within the period between 1996 and 2018. The first trough in BDI_t is one year before the first trough in P_t and peak in BDI_t is three years before the peak in P_t. Second troughs have two years difference, which makes the average difference two years in turning points through the period. The proximity of the turning points gives signals of a positive relationship between two series and a lag is observable in P_t.

Table 3. Turning Points of BDI_t and P_t Between 1996 and 2018

	Peak	Trough	Peak	Trough
P_t	1996	1999	2010	2018
BDI_t	-	1998	2007	2016

Only one clear completed cycle is found in both series during the period. For unit hull premium, there are two cycles however, the non-existence of the data before 1996, makes it difficult to consider as a completed cycle. But, the existence of peak and trough points indicates the signals of cyclicality in BDI_t and P_t.

Despite it is hard to comment on the features of the cycles with this information in hand, detecting turning points is useful to construct a trigonometric model for both series to find out cycle periods and to test synchronicity and comment on the relationship between the cycles.

With the aim of further analysis of the relationship between BDI_t and P_t, cross-correlation is applied for 1-7 years to check possible lag between them and results in Table 4 and Figure 8 show the highest correlation coefficient is found for 2 years lag in P_t. Also, 1 and 3-years lag in P_t resulted in relatively high and significant correlation coefficients, but negative 2-years is considered as the lag between the series with the highest correlation coefficient.

Table 4. Cross-Correlation Table P_t- BDI_t

Lag	ρ	Std. Error
-7	-.126	.250
-6	.111	.243
-5	.338	.236
-4	.534	.229
-3	.700	.224
-2	.755	.218
-1	.712	.213
0	.637	.209
1	.413	.213
2	.099	.218
3	-.088	.224
4	-.285	.229
5	-.545	.236
6	-.651	.243
7	-.614	.250

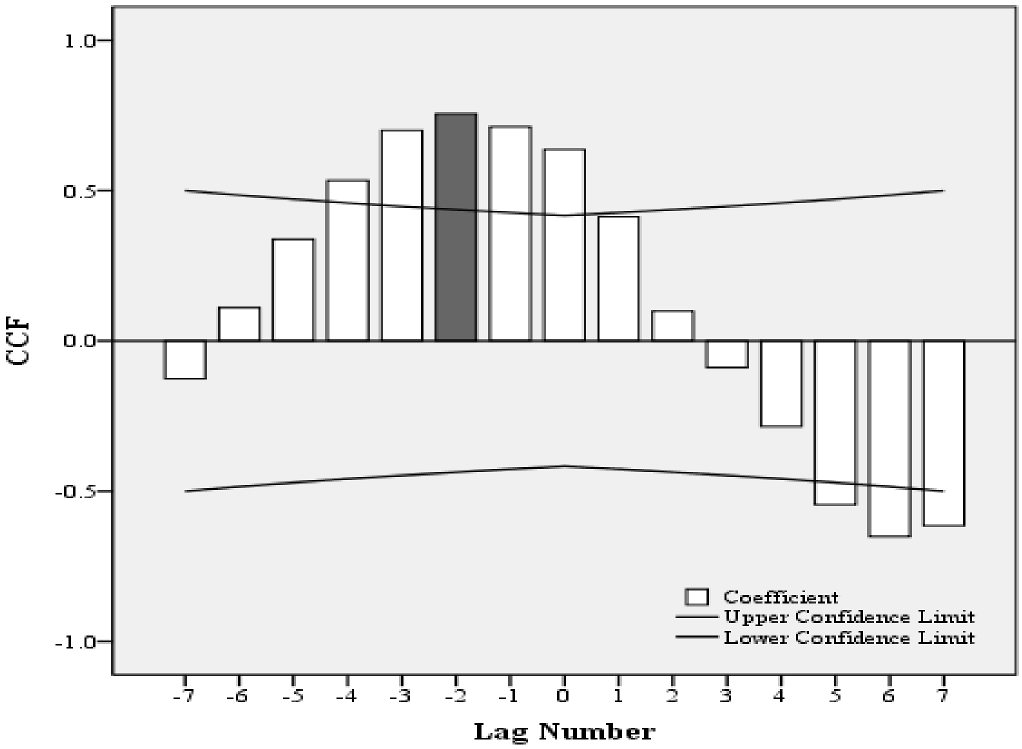

Figure 8 Cross correlation function graphic P_t - BDI_t

6.3 Trigonometric regression

A trigonometric model is constructed following the formula (2) from Harding and Pagan (2008) and Papailias et al. (2017). λ_j indicates the frequency of the cycle in the formula. Cosine waves are indicated with the letter 'W' and Sine waves are indicated with the letter 'Z'. 2-year lag in P_t is considered for application of the model as per cross-correlation results. After testing the model with various frequencies (λ_j) for both data series, the common period is found as 16 years and the application of the formula gives significant results for both series. Fitting into a trigonometric method is another proof for cyclicality in both series. In addition to the previous section, the cyclicality in maritime freight markets and marine insurance premiums as suggested by H1 and H2 are confirmed with the trigonometric regression as well.

$$Y_{BDI_t} = \alpha + \beta \cos\left(\frac{2\pi}{16} * t\right) + \gamma \sin\left(\frac{2\pi}{16} * t\right)\} + \varepsilon_t$$

$$Y_{BDI_t} = 2612.382 - 225.106 \cos\left(\frac{2\pi}{16} * t\right) - 2059.944 \sin\left(\frac{2\pi}{16} * t\right) + \varepsilon_t$$

$$Y_{P_t} = \alpha + \beta \cos\left(\frac{2\pi}{16} * t\right) + \gamma \sin\left(\frac{2\pi}{16} * t\right)\} + \varepsilon_t$$

$$Y_{P_t} = 5.319 + 1.519 \cos\left(\frac{2\pi}{16} * t\right) - 0.321 \sin\left(\frac{2\pi}{16} * t\right) + \varepsilon_t$$

68% of the variation in BDI_t values are explained by the trigonometric model where the duration is considered as a 16 years period. Despite W (cosine) wave is not a significant variable for the model, Z (sine) wave is significant, and this shows a 16-year cycle inside the aggregate data. The visual expression of the model fit is shown in Figure 9. Detailed analysis results are shown in Table 5, Table 6 and Table 7.

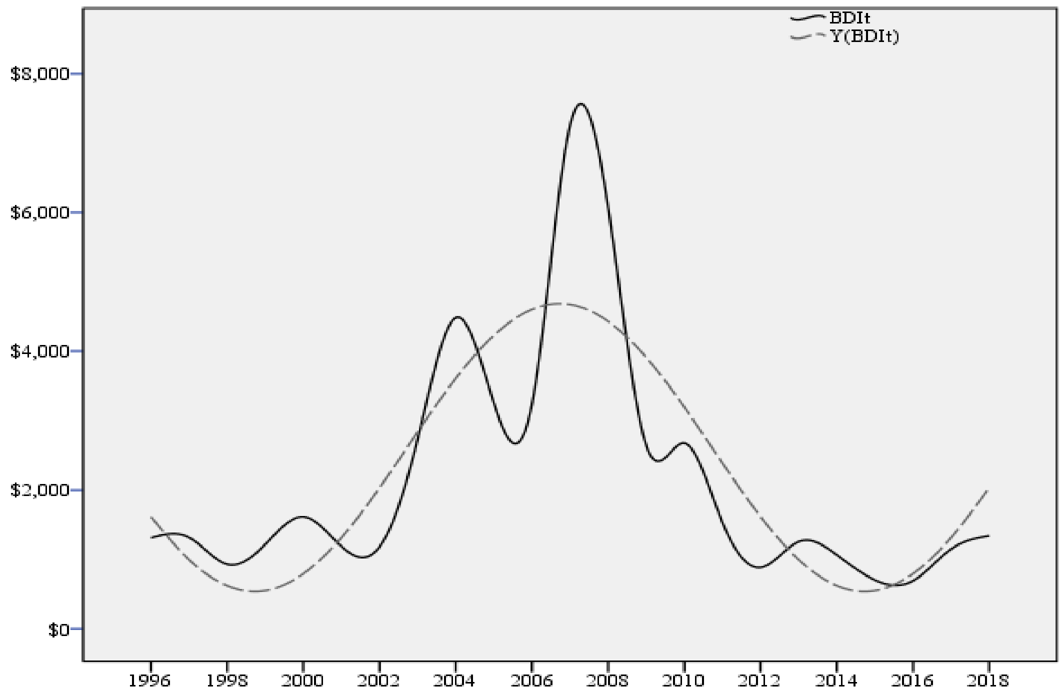

Figure 9 BDI_t - Y_{BDI_t} trigonometric model fit

Table 5. Trigonometric Model Summary Y_{BDI_t}

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{BDI_t}	.843	.711	.682	$975.206782	.711	24.613**	2	20	.000

Table 6. Trigonometric Model Y_{BDI_t} Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	2612.382	213.348		12.245**	.000					
W16	-225.106	294.036	-.092	-.766	.453	-.092	-.169	-.092	1.000	1.000
Z16	-2059.944	295.366	-.838	-6.974**	.000	-.838	-.842	-.838	1.000	1.000

Table 7. Trigonometric Model Y_{BDI_t} ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	46814913.389	2	23407456.695	24.613**	.000[b]
Residual	19020565.336	20	951028.267		
Total	65835478.726	22			

The model is applied with a 2-year lag in trigonometric functions considering the findings in the previous section with the application of cross-correlation (Table 4, Figure 8). Values are explained by 92% with the trigonometric model of 16 years period. Both W (cosine) wave and Z (sine) waves are significant. The visual expression of the model fit is shown in Figure 10. Numerical analysis results are shown in Table 8, Table 9 and Table 10. The results of the P_t trigonometric regression show that both BDI_t and P_t data series have a 16-year cycle within the total data set.

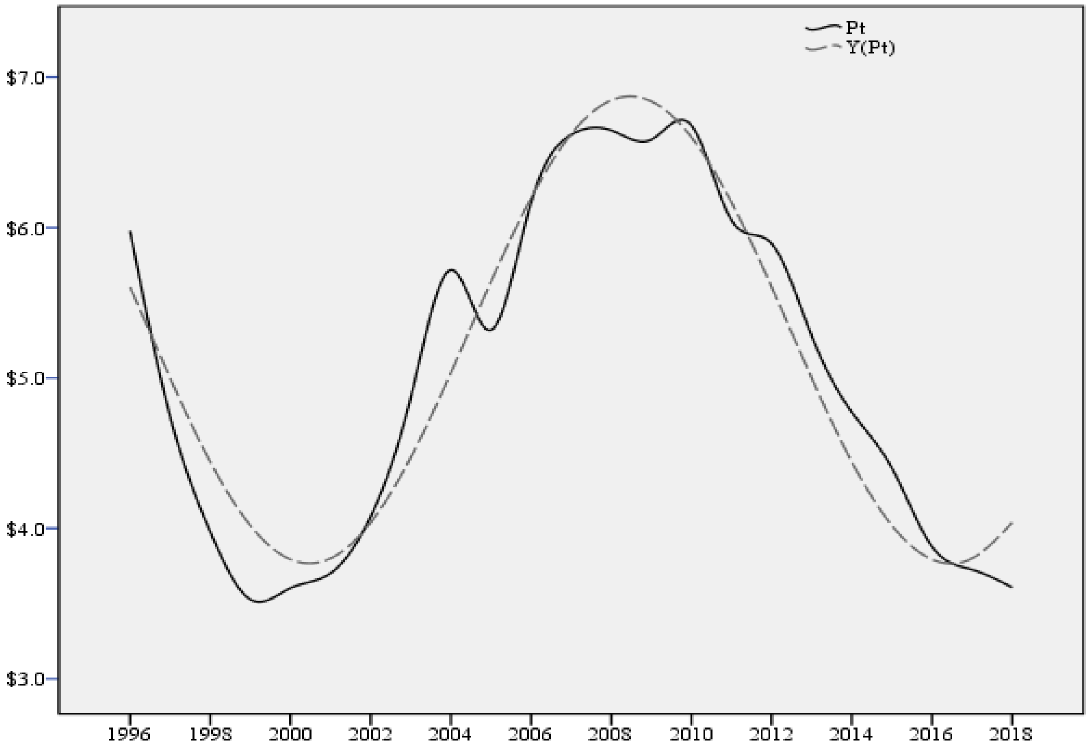

Figure 10 P_t - Y_{P_t} trigonometric model fit.

Table 8. Trigonometric Model Summary Y_{P_t}

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.961	.924	.916	$0.33022	.924	120.852**	2	20	.000

Table 9. Trigonometric Model Y_{P_t} Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	5.319	.072		73.630**	.000					
W16	1.519	.100	.941	15.226**	.000	.940	.959	.941	1.000	1.000
Z16	-.321	.100	-.199	-3.212**	.004	-.194	-.583	-.199	1.000	1.000

Table 10. Trigonometric Model Y_{P_t} ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	26.357	2	13.178	120.852**	.000[b]
Residual	2.181	20	.109		
Total	28.537	22			

6.4 Testing synchronization

The duration of the common cycle in P_t and BDI_t has been found as 16 years by trigonometric regression results. Despite the duration of cycles are the same, when the amplitude is checked a significant difference exists. P_t values increase about two times over the period, while BDI_t increases more than 10 times. So, BDI_t has more inclined hypotenuse than P_t over the same period.

After checking these statistics, to apply synchronization test by formulas (3), (4) and (5) cyclical time series are converted into binary indicators S_{BDI_t} and S_{P_t}. The synchronization test is applied both for real-time data and the data that P_t has 2 year-lag and significance tests are applied. First, it is applied for S_{BDI_t} and $S_{P_{t+2}}$ as per results of cross-correlation (Table 4, Figure 8) and the same calculations are done between data series without any lag, S_{BDI_t} and S_{P_t}.

Table 11 shows correlation results for both applications. The correlation between the S_{BDI_t} and S_{P_t} is not significant while the correlation between S_{BDI_t} and $S_{P_{t+2}}$ is significant.

Table 12 shows the results of the synchronization test for S_{BDI_t} and $S_{P_{t+2}}$. As per calculations and test statistics, SPPS(i) and SPPS (ii) cannot be rejected for the series S_{BDI_t} and $S_{P_{t+2}}$ with significant test results, but SNS is rejected. Significance of correlation coefficient between S_{BDI_t} and $S_{P_{t+2}}$shows there is positive synchronization between two series. (Table 11) Also, the test results confirms the strong perfect positive synchronization between the two series. The concordance index ($\hat{I}$) (7) shows that S_{BDI_t} and $S_{P_{t+2}}$are in the same phase %90 of the time. (Table 12)

Table 13 includes the results of the synchronization test for S_{BDI_t} and S_{P_t}. As per test results, SPPS (i) and SNS cannot be rejected, while SPPS(ii) is rejected. Together with the non-significant correlation coefficient and concordance index ($\hat{I}$) (7) value which is lower than 70%, analysis results confirms that there is a strong non-synchronization between the special series, S_{BDI_t} and S_{P_t} (Table 11 and 13).

Analysis results reject Hypothesis 3 which suggests the positive synchronization of S_{BDI_t} and S_{P_t}, however significant positive synchronization between S_{BDI_t} and $S_{P_{t+2}}$is found and the 2-year lag between special series is supported with findings.

Table 11. Correlations S_{BDI_t} - $S_{P_{t2}}$, S_{BDI_t} - S_{P_t}

		$S_{P_{t+2}}$	S_{P_t}
S_{BDI_t}	ρ	.826**	.394
	Sig. (2-tailed)	.000	.063
	N	21	23

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 12. Synchronization Test of S_{BDI_t} - $S_{P_{t+2}}$

SPPS(i)			SPPS(ii)		SNS	
$\hat{\mu}_{S_X}$- $\hat{\mu}_{S_Y}$	-0.0952381		$\hat{\rho}_S$- 1= -0.1742772		$\hat{\rho}_S$= 0.826	
			standard	robust (HAC adjusted)	standard	robust (HAC adjusted)
t	-0.60578	*t*	-1.35	-1.42	6.38	6.69
		s.e	0.1294	0.1235	0.1294	0.1235
p-value	0.5481	*p* value	0.1939	0.1705	0.0000040	0.0000021
Concordance Index ($\hat{I}$) = .90476						

Table 13. Synchronization Test of S_{BDI_t}- S_{P_t}

SPPS(i)			SPPS(ii)		SNS	
$\hat{\mu}_{S_X}$- $\hat{\mu}_{S_Y}$	0.04348		$\hat{\rho}_S$- 1= =-0.6061		$\hat{\rho}_S$= 0.394	
			standard	robust (HAC adjusted)	standard	robust (HAC adjusted)
t	-0.28868	*t*	-3.021239	-2.86974	0.3939	6.69
		s.e	0.2006	0.2112	0.2006	0.2112
p-value	0.7742	*p* value	0.006498	0.009171	0.06289	0.07617
Concordance Index ($\hat{I}$) = .69565						

6.5 Forecasting models

Previous analysis results (Table 4, Figure 8) which shows a significant correlation between the series for from 1 to 3-years lag in P_t lead me to construct six forecasting models to predict *P* values depending on earlier *BDI* variables. First, simple linear regression models are constructed with BDI_{t-1}, BDI_{t-2}, and BDI_{t-3} consecutively, then a multiple linear model is constructed with all previous 3-years' BDI values, then the most significant simple linear model which is found with BDI_{t-2} values is combined with trigonometric regression model and lastly, multiple linear model is combined with the trigonometric regression model. The best-fitting model with an adjusted R^2 of 93% is found as the combination of the trigonometric regression and multiple linear regression. A summary of the forecasting models and the trigonometric model for comparison can be found in Table 14. Also, detailed analysis results are presented in the following sub-sections.

Table 14. List of Forecasting Models

Model	R^2	R^2 adj.	Significance F
1. $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$	0.530626	0.507158	0.000121
2. $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$	0.609894	0.589362	0.000029
3. $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$	0.563987	0.539764	0.000136
4. $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$	0.796321	0.758131	0.000009
5. $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$	0.949789	0.931857	0.000000
6. $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j BDI_{t-2} + \varepsilon_t$	0.931684	0.919628	0.000000
$Y_{P_t} = 5.319 + 1.519 \cos\left(\frac{2\pi}{16} * t\right) - 0.321 \sin(\frac{2\pi}{16} * t) + \varepsilon_t$	0.923578	0.915935	0.000000

6.5.1 Regression analysis results of $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$ is shown in Figure 11. Detailed regression analysis results are given in Table 15, 16 and 17.

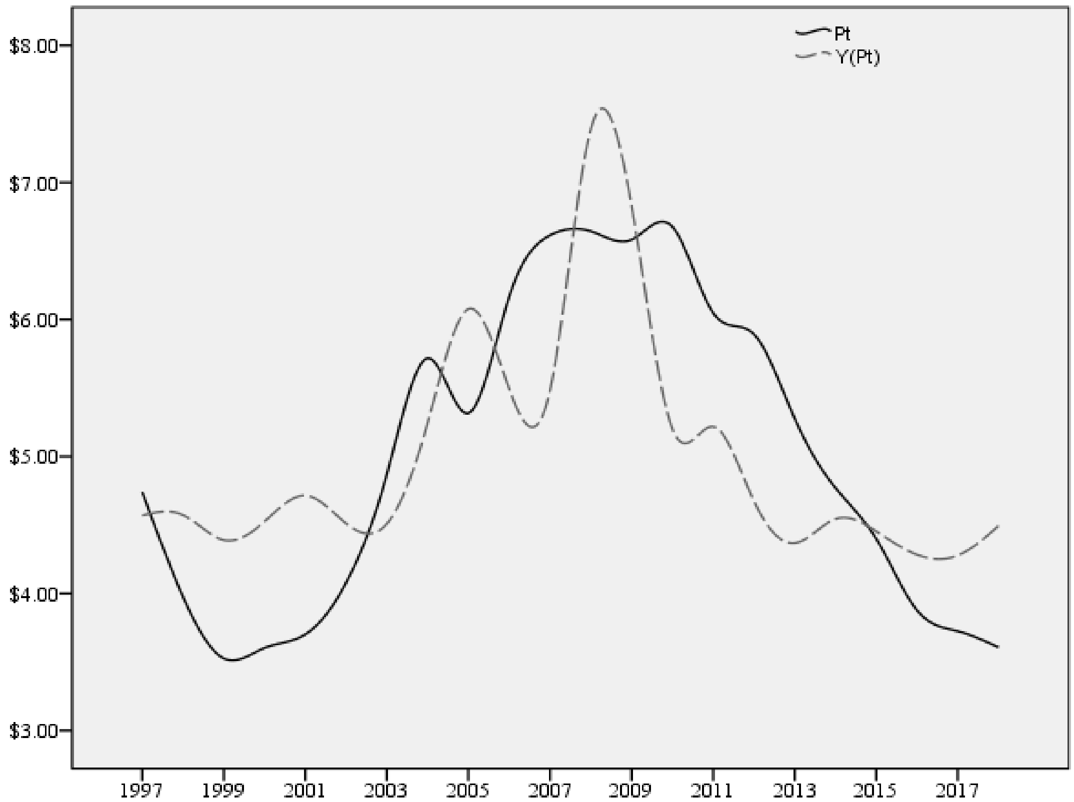

Figure 11 Forecasting model fit of $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$

Table 15. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	14.651	1	14.651	22.610**	.000
Residual	12.960	20	.648		
Total	27.611	21			

Table 16. Forecasting Model Summary $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.728	.531	.507	$0.80499	.531	22.610**	1	20	.000

Table 17. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-1} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.949	.279		14.176	.000**					
BDI_{t-1}	.000	.000	.728	4.755	.000**	.728	.728	.728	1.000	1.000

6.5.2 Regression analysis results of $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$ is shown in Figure 12. Detailed regression analysis results are given in Table 18, Table 19 and Table 20.

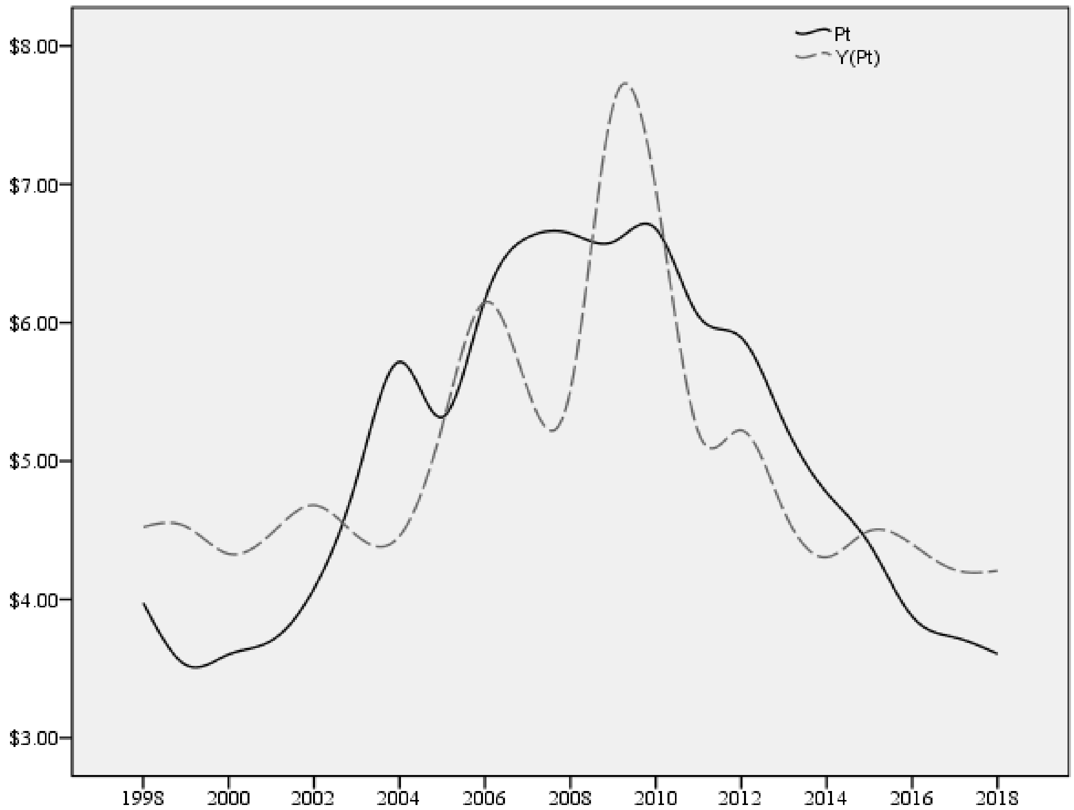

Figure 12 Forecasting model fit of $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$

Table 18. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$ ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	16.800	1	16.800	29.705**	.000
Residual	10.746	19	.566		
Total	27.546	20			

Table 19. Forecasting Model Summary $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.781	.610	.589	$0.75204	.610	29.705**	1	19	.000

Table 20. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-2} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.851	.268		14.386	.000**					
BDI_{t-2}	.001	.000	.781	5.450	.000**	.781	.781	.781	1.000	1.000

6.5.3 Regression analysis results of $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$ is shown in Figure 13. Detailed regression analysis results are given in Table 21, Table 22 and Table 23.

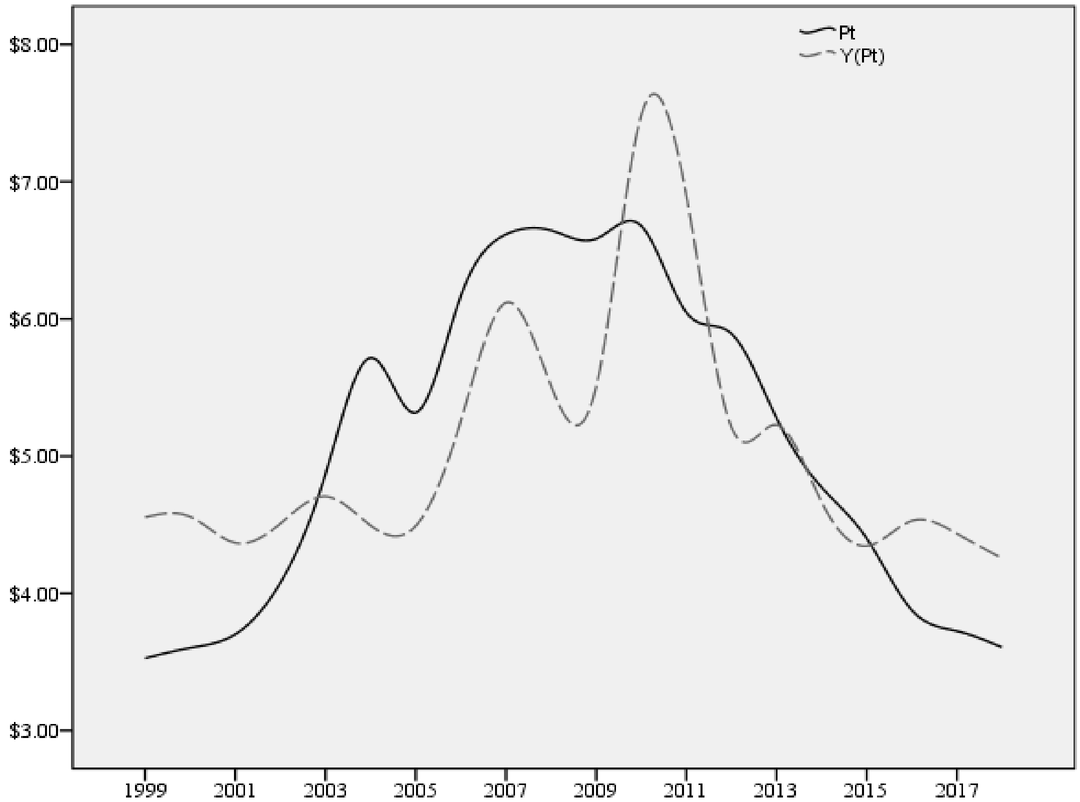

Figure 13 Forecasting model fit of $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$

Table 21. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$ ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	14.910	1	14.910	23.283**	.000
Residual	11.527	18	.640		
Total	26.436	19			

Table 22. Forecasting Model Summary $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.751	.564	.540	$0.80023	.564	23.283**	1	18	.000

Table 23. Forecasting Model $Y_{P_t} = \alpha + \gamma BDI_{t-3} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.909	.297		13.140	.000**					
BDI_{t-3}	.000	.000	.751	4.825	.000**	.751	.751	.751	1.000	1.000

6.5.4 Regression analysis results of $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ is shown in Figure 14. Detailed regression analysis results are given in Table 24, Table 25 and Table 26.

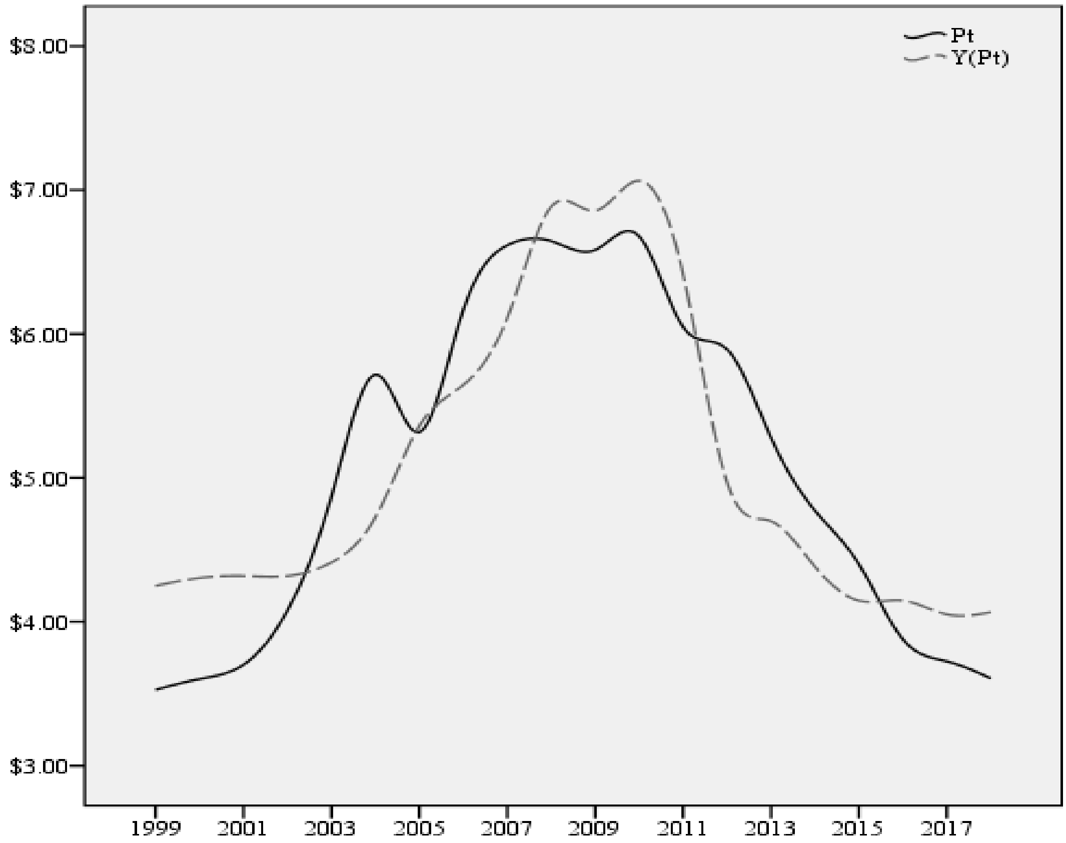

Figure 14 Forecasting model fit of $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

Table 24. Forecasting Model $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	21.052	3	7.017	20.852**	.000
Residual	5.385	16	.337		
Total	26.436	19			

Table 25. Forecasting Model Summary $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.892	.796	.758	.58011	.796	20.852**	3	16	.000

Table 26. Forecasting Model $Y_{P_t} = \alpha + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.446	.242		14.235	.000**					
BDI_{t-1}	.000	.000	.451	2.838	.012*	.724	.579	.320	.504	1.986
BDI_{t-2}	8.153E-005	.000	.126	.620	.544	.778	.153	.070	.309	3.239
BDI_{t-3}	.000	.000	.495	3.122	.007**	.751	.615	.352	.508	1.970

6.5.5 Regression analysis results of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ is shown in Figure 15. Detailed regression analysis results are given in Table 27, Table 28 and Table 29.

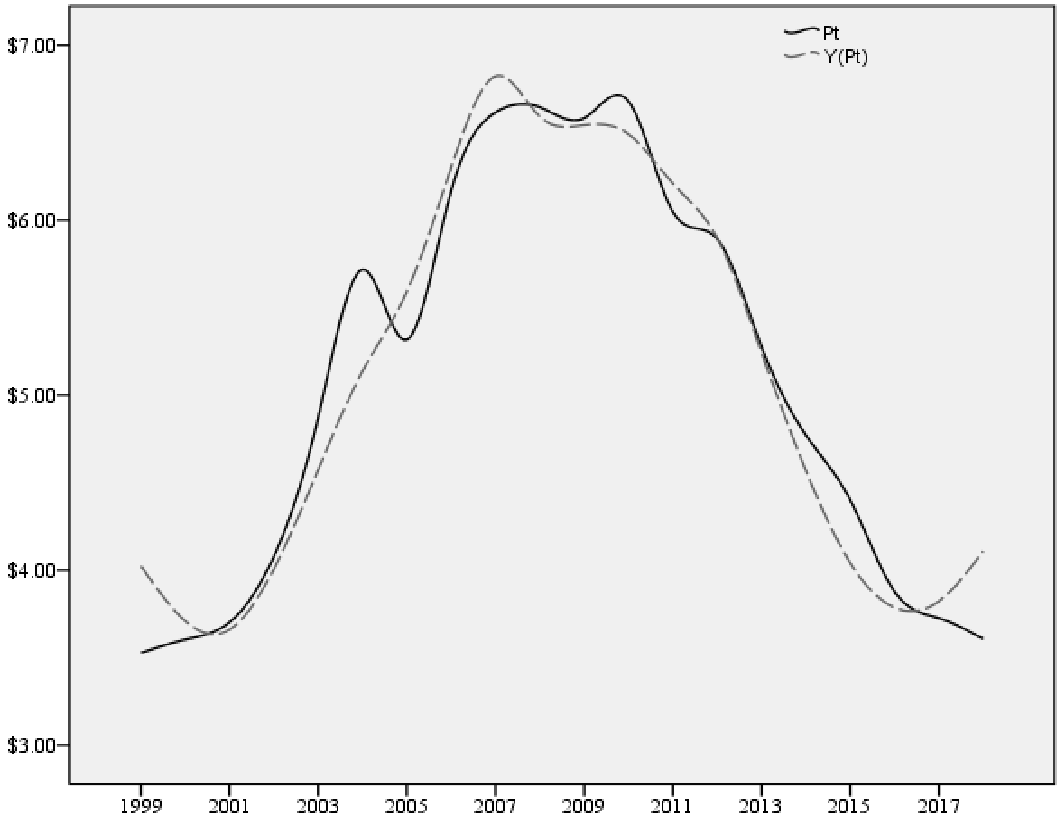

Figure 15 Forecasting model fit of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

Table 27. Forecasting Model $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	25.109	5	5.022	52.965**	.000
Residual	1.327	14	.095		
Total	26.436	19			

Table 28. Forecasting Model Summary $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.975	.950	.932	.30792	.950	52.965**	5	14	.000

Table 29. Forecasting Model $Y_{P_t} = \alpha + \beta cos\left(\frac{2\pi}{16} * t\right) + \gamma sin\left(\frac{2\pi}{16} * t\right) + \sum_{j=1}^{3} \gamma_j BDI_{t-j} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	6.116	.432		14.168	.000**					
BDI_{t-1}	.000	.000	-.241	-1.762	.100	.724	-.426	-.106	.192	5.206
BDI_{t-2}	-5.856E-005	.000	-.090	-.801	.437	.778	-.209	-.048	.281	3.556
BDI_{t-3}	-8.148E-005	.000	-.124	-.926	.370	.751	-.240	-.055	.199	5.019
W16	2.056	.321	1.300	6.414	.000**	.953	.864	.384	.087	11.459
Z16	-.426	.130	-.245	-3.280	.005**	-.200	-.659	-.196	.641	1.560

6.5.6 Regression analysis results of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j * BDI_{t-2} + \varepsilon_t$

The visual expression of the fitness level of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j * BDI_{t-2} + \varepsilon_t$ is shown in Figure 16. Detailed regression analysis results are given in Table 30, Table 31 and Table 32.

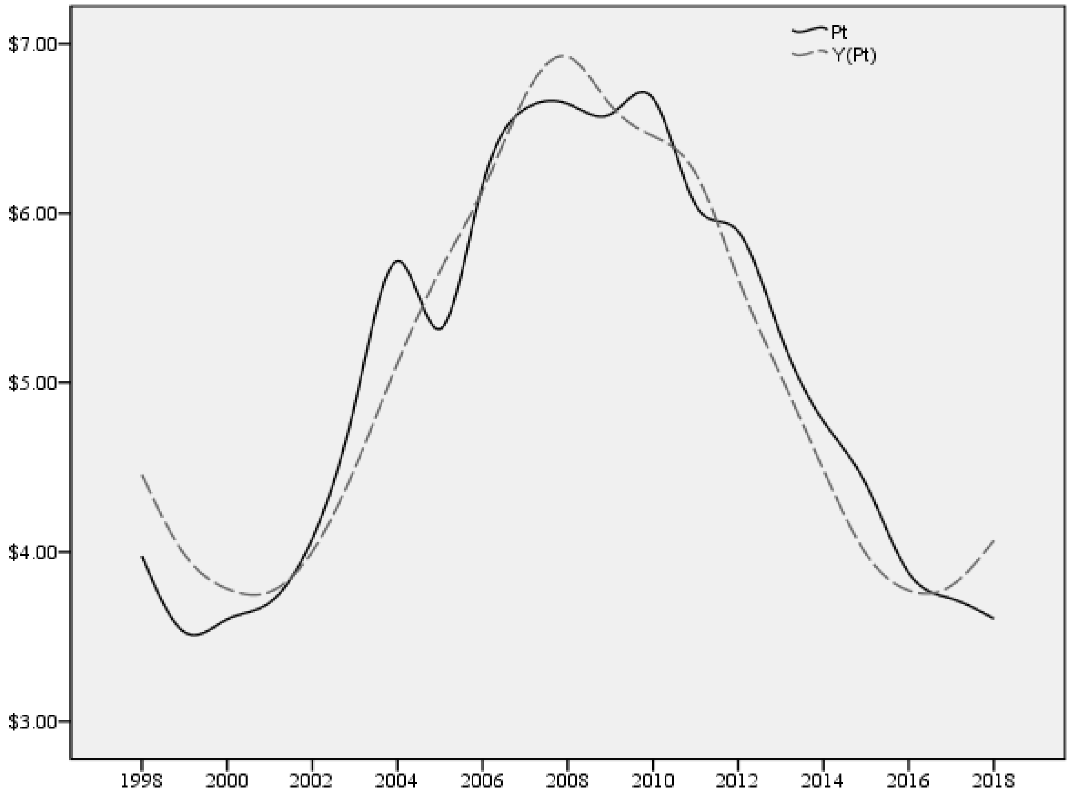

Figure 16 Forecasting model fit of $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j * BDI_{t-2} + \varepsilon_t$

Table 30. Forecasting Model $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j * BDI_{t-2} + \varepsilon_t$ ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	25.664	3	8.555	77.281**	.000
Residual	1.882	17	.111		
Total	27.546	20			

Table 31. Forecasting Model Summary $Y_{P_t} = \alpha + \beta cos(\frac{2\pi}{16} * t) + \gamma sin(\frac{2\pi}{16} * t) + \gamma_j * BDI_{t-2} + \varepsilon_t$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
Y_{P_t}	.965	.932	.920	$0.33271	.932	77.281**	3	17	.000

Table 32. Forecasting Model $Y_{P_t} = \alpha + \beta cos\left(\frac{2\pi}{16} * t\right) + \gamma sin\left(\frac{2\pi}{16} * t\right) + \gamma_j * BDI_{t-2} + \varepsilon_t$ Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	5.498	.219		25.069	.000**					
BDI	-7.042E-005	.000	-.107	-.908	.377	.781	-.215	-.058	.288	3.477
cos16l2	1.647	.188	1.022	8.757	.000**	.944	.905	.555	.295	3.391
sin16l2	-.352	.111	-.207	-3.177	.006**	-.245	-.610	-.201	.949	1.054

CHAPTER 7

CONCLUSION

The main purpose of this research was to investigate the existence of cyclicality in marine insurance and maritime freight markets and to explain the relationship between these cycles. For this purpose, the annual reports from IUMI and the annual mean of the Baltic Dry Index monthly data are employed to analyze.

The existence of cycles in marine insurance and maritime freight markets are first checked by detecting turning points in the data series. The peaks and troughs in both data series gave the signals of cyclicality in both series and allow us to study the features of cycles further. The proximity of the turning points in data series and the %64 correlation coefficient gave signals of a positive relationship with a 1 to 3-year lag between them. Cross-correlation analysis demonstrated the highest correlation coefficient is found when a two-year lag is applied to P_t. Another method to check cyclicality and detect the length of the cycles in two markets was trigonometric regression. The 2-year lag was considered for P_t series during the regression. The application of trigonometric regression analysis showed that there is a common 16-year main cycle in both series with significant results. The existence of a common cycle supported the positive relationship between the series.

To further analyze the relationship between two series, a synchronization test is applied. Test results for S_{BDI_t} and S_{P_t} are found to be strongly not synchronized and the non-significant correlation coefficient between the binary series rejected H3 which suggests the positive synchronicity between two series. However, the synchronization test results of S_{BDI_t} and $S_{P_{t+2}}$ confirmed the strong perfect positive synchronization between the series and concordance index value demonstrate two series are in the same phase for 90% of the total period of our data. Concordance index was found as 69% only for S_{BDI_t}- S_{P_t}. Hypothesis 3 is rejected while the 2-year lag between the series is confirmed again with synchronization test results.

In addition to the trigonometric models which revealed the common 16-year cycle in BDI_t and P_t series, also six forecasting models are constructed to estimate Pt values from the BDI values of previous years. First, simple linear models with previous 3 years' BDI values are constructed, then a multiple linear regression is carried out with the combination of these simple linear regression models. Lastly, the multiple regression model and best fitting simple regression model, which is constructed by BDI_{t-2} are combined with the trigonometric model consecutively. All models are found significant and the best fitting model is found with the combination of multiple linear regression and trigonometric regression with a fitness level of 95%.

Despite the long and fascinating history of both maritime and marine insurance businesses, there is no previous study about the cyclicality of global marine insurance to reveal common cycles and explain the relationship of the maritime freight markets and marine hull insurance market as to my knowledge. With this thesis, I explained the relationship between those two markets and construct a forecasting model which would be beneficial for industry professionals.

Changes in the maritime and marine insurance markets may contain significant importance for the professionals and key players in the maritime industry such as shipowners, charterers, insurers, and brokers. Besides, traders may indirectly be affected by the situation in these two markets, due to the reflection of changes in transportation costs on the price of the goods and raw materials. Forecasting models developed in this research may be useful for these parties to assess the current situation of the market better, predict future developments, and take decisions accordingly. Shipping is considered as a capital-intensive industry. Therefore, budget planning is vital for maintaining or improving competency in the market. With this purpose, forecasting models would be useful for a shipowner to calculate an approximate amount of insurance spending and plan a more accurate budget for the following years. Insurers, on the other hand, can make more accurate forecasting on the marine insurance market by looking at the current movements in the freight market and take position accordingly. Charterers, brokers, and traders can make better forecasting and expect market changes considering insurance prices as well. All in all, developed forecasting models can be a significant tool for better competency opportunities to the maritime market players in their market via its outcomes.

The most important restriction for this study was limited timespan of underwriting data which was not available before 1996. Unavailability of monthly or quarterly data in marine insurance due to the nature of the business restrained me to analyze/reveal any seasonal or sub-cycles in addition to main cycles in data series. Also, any regional analysis is avoided because of the global nature and mobility of the maritime business.

For further research, the relationship of hull insurance prices with the condition of the other maritime markets; newbuilding, sale and purchase, and demolition can be analyzed. To enlarge the research area, marine cargo insurance premiums and/or P&I calls can be included in the research. Considering the unavailability of historical data before 1996, repeating this study in the future with further available data would be beneficial to reconfirm the results.

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