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THE IMPACT OF ECONOMIC CYCLES ON THE SHIPS' OPERATING COSTS

UTJECAJ GOSPODARSKIH CIKLUSA NA OPERATIVNE TROŠKOVE BRODOVA

SUMMARY

The maritime market is influenced by economic cycles. These cycles turn the relations in the maritime market upside-down as they cause significant changes in all four segments: the freight market, sales and purchases, shipbuilding and demolition.

The authors analyse the impact of economic cycles on the maritime freight market; more precisely, on the ships' operating costs. The analysis, covering the period from 2000 to 2010, shows the fluctuations in both the structure and the value of the ships' operating costs. The authors use correlation as the statistical method to assess how the fluctuations in the ships' operating costs coincide with the economic cycles and cycles in the maritime market. Correlation is thus applied to evaluate the impact of the global gross domestic products (GDP), crude oil prices and various freight indices to the ships' operating costs as retrieved from the Moore Stephens OpCots data base and indices. At the end of the paper the authors comment on the reliability of the conducted analysis and suggest further research steps regarding this issue.

Key words: **correlation** *of the ships' operating costs and economic cycles, indices of the ships' operating costs, indices of the maritime freight rates, indices of the global economy*

SAŽETAK

Pomorsko tržište djeluje pod utjecajem svjetskih gospodarskih ciklusa. Konjunkturni ciklusi utječu na sva četiri segmenta pomorskog tržišta, tj. tržišta pomorskih prijevoza, tržišta prodaje i kupnje polovnih brodova, tržišta kupnje novih brodova i tržišta brodova na rezalištima.

Autorice u radu analiziraju utjecaj konjunkturnih ciklusa u segmentu tržišta pomorskih prijevoza na operativne troškove brodova. Desetgodišnja analiza operativnih troškova brodova ukazuje na fluktuacije u njihovoj visini i strukturi. Autorice koriste statističku metodu korelacije kojom ocjenjuju utjecaj svjetskih gospodarskih i pomorskih konjunkturnih ciklusa na operativne troškove brodova. Primjenom metode korelacije ocjenjuje se utjecaj globalnog bruto domaćeg proizvoda (BDP), cijene goriva i pomorskih vozarina na fluktuacije operativnih troškova brodova iskazanih u Moore Stephens OpCost bazama podataka i njihovih indeksa. Autorice na kraju rada ocjenjuju pouzdanost izvršene analize i ukazuju na mogućnost daljnjih istraživanja spomenutog problema.

Ključne riječi: korelacija operativnih troškova brodova i konjunkturnih ciklusa, indeksi operativnih troškova brodova, indeksi pomorskih vozarina, indeksi globalnog gospodarstva

1. INTRODUCTION

The maritime market is influenced by economic cycles. This is illustrated by freight rates changes, changes of the new and used ship prices, as well as scrap iron price changes. Ship-operators try to reduce their costs during the time of crisis in order to survive. The most widespread reaction is the ship's speed reduction and thereby the reduction of fuel costs. But although the statement that fuel costs account for a large part of the operating costs is quite common, in theory fuel costs are not considered as operating costs. It would be more accurate to state that the fuel cost is the largest voyage dependent cost that is mostly influenced by the crude oil price and the ship's operating speed.

The ships' operating costs are the on-going expenses connected with day-to-day running of the vessel (excluding fuel, which is included in the voyage costs), together with the allowance for day-to-day repairs and maintenance (but not major dry dockings, which are dealt with separately). The operating costs thus comprise the following five cost categories [adapted from 19, 13]:

- Crew costs that include wages, provisions and other costs like crew changes, crew insurance, social contributions, etc.

- Cost of stores and consumables which include stores of lubricating oils and various consumables, like chemicals, paints, steward stores, etc.

- Cost of repairs and maintenance that include the cost of having various types of spare parts aboard as well as any third party activities that are performed in order to improve or maintain the ship's seaworthiness.

- Insurance costs that include the P&I membership fee and other marine insurance items, like hull and machinery, war risks, drug seizure, etc.

- Administration costs that include annual registration, management fees and sundry expenses like agency fees, communications, bank charges, etc.

Operating costs represent just one segment of the ships' costs. Other costs occurring in maritime transport are periodic maintenance costs (dry-docking for major repairs), capital costs, voyage costs (fuel, port charges and canal dues) and cargo-handling costs (loading, stowing and discharging cargo). The treatment of these costs depends on the ships' exploitation agreement.

In practice, ship-operators attempt to adapt their operating costs to the market situation, although in principle these costs are considered to be fixed. However, operating costs do not depend exclusively on the ship-operator's skills and abilities to follow market changes. For example, past compensation claims, number of ships insured by the same insurance society, sailing zones and above all current ships' market value affect the insurance costs.

The literature review reveals a small number of studies that have covered the issue of adjusting the operating costs to the maritime market situation. This is mainly due to the unavailability of the data on the ships' operating costs - these data have been trade secret of ship-operators; but this has changed with the appearance of Moore Stephens LLP's publication titled OpCost – Benchmarking vessel running costs in 2000. However, it should be noted that Glen et al. developed a continuous time model of the relation between the time charter and spot rates and the operating costs, which is then approximated by a discrete model relating the time charter rate to past values of the spot rate [5]. This model was developed back in 1981 and was later adapted by Veenstra in his book Quantitative Analysis of Shipping Markets, published in 1999.

The shipping industry is an economic system consisting of markets that can be described by economic variables and the relations between them [24]. The aim of this paper is to assess the relationship of the economic cycles and ship operating costs. Due to the limited data availability, the authors have decided to use correlation as an acceptable statistical method. The correlation measures the relationship between two variables X and Y and to what extent the variations in one variable changes with the variations in the other. If standard deviations for the X and Y variables are finite and both of them are non-zero, then it is possible to calculate the correlation coefficient, which is in the case of a linear relationship called the Pearson correlation coefficient, and can have a value between $+1$ and -1. This value is also called the size of correlation.

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}} \qquad (1)$$

Where r is the Pearson correlation coefficient, X_i (Y_i) is the variable value, $\overline{X}$ ($\overline{Y}$) is mean.

2. MARITIME FREIGHT MARKET INDICES

2.1 OpCost Data Base and OpCost Indices by Moore Stephens

Moore Stephens LLP is the eighth largest accounting and consulting firm in London, with 650 partners and staff, while the Moore Stephens International Limited network comprises 638 offices of independent member firms in 98 countries [9].

The running cost information is obtained on a confidential basis from the Moore Stephens' clients, and from ship-owners and managers who voluntarily submit data for inclusion [22].

2.1.1 OpCost Data Base by Moore Stephens

The annual OpCost report is extracted from the database of he actual running costs for almost 2,200 ships. The operating costs are shown for 26 common vessel types and broken down into 12 cost categories, namely crew wages, provisions, crew and medical expenses, lubricating oils, stores, spares, repairs and maintenance, P&I insurance, marine insurance, registration costs, management fees and sundries [13]. The report also includes an analysis of the changes since the previous year and information on dry-docking costs and its duration.

It is possible to see many things from Table 1. For example, the merchant fleet structure and how the fleet changes over time to meet the growing needs of economy and society in the best possible way (this we can see from the ships' average age and size). The larger the sample is (for bulk ships 7.3%, for oil and product tankers 10.4%, for container ships 5.4%), and the closer the average age of the ships in the sample is to the average age of the fleet, the better approximation of the operating costs for the fleet segment. However, Moore Stephens has also developed correcting factors depending on the ships'

Table 1: Interpretation of the size of correlation
Tablica 1: Prikaz veličine korelacije

Correlation	Negative	Positive
None	−0.09 to 0.0	0.0 to 0.09
Small	−0.3 to −0.1	0.1 to 0.3
Medium	−0.5 to −0.3	0.3 to 0.5
Strong	−1.0 to −0.5	0.5 to 1.0

age to better approximate the particular ships' operating costs to the published data.

2.1.2 OpCost Indices by Moore Stephens

To facilitate monitoring the trends in the operating costs Moore Stephen LLP has produced the indices for the three main groups of merchant ships; more precisely for bulk, tanker and container ships, and for each sub-category of the operational costs. The indices for the main ship categories are calculated by weighting the impact of the sub-categories in accordance to the share in the world fleet. A similar approach is used to produce the cost categories indices.

2.2 Baltic, Tanker and Container Indices

The freight market is subject to a wide range of external variables, but it is fundamentally driven by the following factors [21]:

- fleet supply,
- commodity demand,
- seasonal pressures,
- bunker prices,
- choke points, and
- market sentiment.

Freight rates are among the most important indicators of the level of the economic activity in the shipping industry [24], and knowing that the shipping industry carries out around 80% of the world trade in terms of volume; consequently the freight rates provide a good proxy for the global economic activities through various indices.

2.2.1 Baltic Dry Index (BDI)

The Baltic dry index provides an assessment of the price of moving the major raw materials

Table 2: Characteristics of ships included in OpCost 2010
Tablica 2: Karakteristike brodova uključenih u OpCost 2010

Ship type	Sample/ fleet	Avg. age sample / avg. age fleet	Avg. size sample / avg, size fleet [dwt]
Bulker 10-20,000 dwt	23 / 489	Feb 91 / Apr 87	17,760 / 15,765
Handysize bulker	150 / 2,170	May 93 / Aug 91	30,312 / 30,011
Handymax bulker	123 / 1,368	Jul 98 / Nov 96	48,425 / 48,010
Panamax bulker	168 / 1,903	Feb 99 / May 99	66,923 / 67,979
Capesize bulker	72 / 1,446	Aug 98 / Dec 00	147,483/ 157,074
Tanker 5-10,000 dwt	77 / 1,676	Jan 00 – Apr 97	6,906 / 7,004
Product tanker	94 / 1.603	Aug 00/ Jun99	18.068 / 17.195
Handysize product tanker	264 / 1,896	May 01 /Nov 01	43,684 / 43,559
Panamax tanker	88 / 639	Feb 03 / Oct 00	70,022 / 70,878
Aframax tanker	118 / 980	Mar 03 / Aug 02	106,164 / 103,520
Suezmax tanker	79 / 439	Jan 02 / May 02	154,872 / 152,137
VLCC	88 / 534	Dec 01 / Feb 02	304,125 / 300,957
Chemical tanker 15-40,000 dwt	76 / 1,506	Jun 03 / Sep 98	31,796 / 26,799
Chemical tanker 40-50,000 dwt	86 / 988	Nov 02 / Dec 01	45,203 / 45,425
LPG carrier 3-8,000 m³	59 / 383	Nov 97 / Oct 96	4,812 / 4,534 m³
LPG carrier 10-40,000 m³	21 / 158	Mar 98 / May 98	24,210 / 23,145 m³
VLGC	17 / 141	Aug 97 / Jan 01	80,346 / 79,435 m³
Dry cargo 5-25,000 dwt	125 / 4,483	Jan 96 / Oct 89	13,253 / 9,837
Dry cargo 25,000+ dwt	40 / 422	Jul 93 / Jan 93	38,818 / 38,296
Container feedermax	26 / 1,115	Mar 90 / Dec 96	682 / 612 TEU
Container ship*	111 / 1,264	Dec 99 / Oct 99	1,362 / 1,418 TEU
Container main liner	97 / 1,936	Sep 01 / Aug 01	3,469 / 3,697 TEU
Ro-ro	35 / 1,665	May 94 / Apr 96	15,296 / 12,393
Reefer	42 / 715	Jul 89 / Jul 88	426,431 / 348,139 CbFt
Coastal tanker	83 / 4,365	May 98 / May 86	3,841 / 2,541
Coastal dry cargo	29 / 8,044	Jan 95 / Feb 84	3,751 / 2,561

Source: Adopted from [13]
Izvor: Uzeto iz (13)

by sea. Taking in 26 major shipping routes measured on a time charter and voyage basis, the index covers Supramax[1] (9 daily assessments of time charter rates), Panamax (4 daily assessments of time charter rates), Capesize (10 daily assessments including voyage and time charter rates) and Handysize[2] (6 daily assessments of time charter rates), dry bulk carriers hauling a range of commodities including coal, iron ore and grain [2, 4]. Most directly, the index measures the demand for the shipping capacity versus the supply of dry bulk carriers [23], and as such provides a good approximation of global economic activities. BDI continues the established time series of the Baltic Freight Index (BFI) which was introduced in 1985 [3]. BDI is not the only dry bulk index available; however, it seems to be the most comprehensive one. The others mainly cover single segments of dry bulk shipping; for example, the ICAP Supramax and Handymax Index (ship size related), SSY Atlantic and Pacific Capesize Index (region and ship size related), various Axsmarine indices which are also cargo related, or owner related indices like Capital Link's indices (including only the US listed dry bulk companies), etc.

In this paper, the authors have used different types of dry freight indices; namely dry cargo

[1] An original element of the Baltic Dry Indices was a Handysize component – BHI. Subsequently this was replaced by the Baltic Handymax Index – BHMI, which considered larger ships of about 40-45,000 dwt. The BHMI was discontinued at the end of 2005, when it was replaced by the Baltic Supramax Index [17]. The Baltic Supramax Index - BSI (basis 52,000 dwt) was officially launched in January 2006 [14].
[2] The interest in a Handysize component has been revised, and the Baltic Handysize Index - BHSI was launched in May 2006 using trial data. BHSI represents smaller dry bulk ships (basis 28,000 dwt), and it became an "official" index on 1st January 2007 [14].

tramp time-charter and dry cargo tramp-trip charter indices compiled by the Institute of Shipping Economics and Logistics and published in the UNCTAD's Review of Maritime transport.

2.2.2 Baltic Tanker Indices

The Baltic Exchange published the Baltic International Tanker Routes Index (BITR) for the first time on 20th April 1998. Later on, on 1st October 2001, this index was divided into the Baltic Dirty Tanker Index (BDTI) and the Baltic Clean Tanker Index (BCTI). The BDTI covers the maritime trade of crude oil and comprises the daily data on WorldScale and non WorldScale assessments on international dirty tanker routes and a selection of basket and individual Time Charter Equivalents [2] while the BCTI follows the trade of oil products, such as gasoline, diesel, heating oil or kerosene.

2.2.3 Container Indices

There are several indices describing the container maritime market. Maybe the most comprehensive is the Howe Robinson Container Index (HRCI), providing an overview of the global price developments in the charter market for container ships. It includes a total of 14 ship classes in full-container vessels (510 TEU) to the Supramax (4,300 TEU) account. The HRCI accurately measures the demand for container transport and thus the volume of world trade in the present [18]. The Harper Petersen charter index (HARPEX[3]), which tracks weekly container shipping rate changes in the time charter market for eight classes of all-container ships [8] is similar, while the freshly created Drewry World Container Index (WDI), launched on 1st September 2011, reports individual market prices on major east-west container shipping routes; more precisely it analyses the two-way trade in 15 markets. Drewry analysts are generating the index data for the new index from spot rates, while short-term contract rates they collect from market sources, including carriers and intermediaries [6].

Well over 50% of the entire worldwide fleet of container ships is operated from Germany or

by international companies that are mainly under German ownership. This fleet, and also some of the international container ship tonnage, is almost exclusively or to a large extent at least brokered by freight brokers based in Hamburg. That makes Hamburg the world's largest container ship time-charter market. Hamburg brokers control some 75% of all container ship charter tonnage available in the free market [7]. In the analysis, the Liner Freight indices (LFI) are used. This index is an average of the monthly indexes, which are produced by the German Ministry for Transport on the basis of liner freight rates of all ships calling to the ports of Antwerp to Hamburg. It is possible to compile a time series of this index from various issues of the Review of Maritime Transport.

2.3 Bunkerworld Index (BWI)

The Bunkerworld index (BWI) is a weighted daily index made up of 20 key bunkering ports. To obtain a representative geographical spread, the ports were selected by size with reference to their geographical importance. The main grades IFO380, IFO180, MDO and MGO are all included in the spread proportionate to their importance to the bunker market. The BWI is transparent, independently calculated and based on the accurate and highly regarded Bunkerworld Benchmark Prices [1]. However, this index exists for too short a period of time, making any analysis impossible. For this reason the average crude oil prices are used as a proxy for the average bunker prices.

3. THE IMPACT OF ECONOMIC CYCLES ON THE OPERATING COSTS OF SHIPS

Fluctuations in the economic activities are represented by changes in GDP, income and employment. The resulting economic cycles are characterized by expansion or contraction in many sectors of the economy. It is generally impossible to separate the economic activity from trade and as the maritime transport carries around the globe about 80% of all traded goods, it is to be expected that the global economic cycles affect the maritime sector. Freight rates vary considerably depending mainly on the demand arising from economic activities. The sale and purchase market record enor-

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[3] HARPEX index was compiled in 2004, but by using a database of 10,000 records, can be calculated retrospectively back to 1986 [8].

Table 3: The correlation between World GDP and operation costs in main shipping segments in the period from 2000 to 2009

Tablica 3: Korelacija između svjetskog BDP-a i operativnih troškova glavnih segmenata pomorskog prijevoza (brodova) od 2000. do 2010.

	Bulker OpCost	Tanker OpCost	Container OpCost	GDP
Bulker OpCost	1			
Tanker OpCost	0.992828	1		
Container OpCost	0.97684	0.985368	1	
GDP	0.947004	0.966391	0.965172	1

Source: Own calculation, based on [13, 15]
Izvor: Vlastita kalkulacija temeljena na [13, 15]

mous differences in the ships' prices, which results in the changes of the capital costs, depreciation values and finally operating costs of a ship-operator on one side and order books on the other. The fluctuations in economic activities cause huge changes in the scrap iron prices as well as in other services provided by the ship-yards affecting among others also the operation of the ship-operators.

It is possible to see the undeniable linear relationship (correlation coefficient R from Table 2) between the global economy and the operating costs in all the segments of maritime trans-port. The similarity in the behaviour of individual segments of the maritime sector is visible from Figure 1, thus the authors thoroughly analysed only the segment of bulk shipping. This segment is analysed in regard to the time and voyage charter.

Fluctuations in the global economy are more visible on the ship operating costs than on the freight and charter rates. This is because ship-operators take certain measures (like slowing down or laying up the ships) to adjust the supply of their capacities to the market demand, at least for certain periods of time during the time
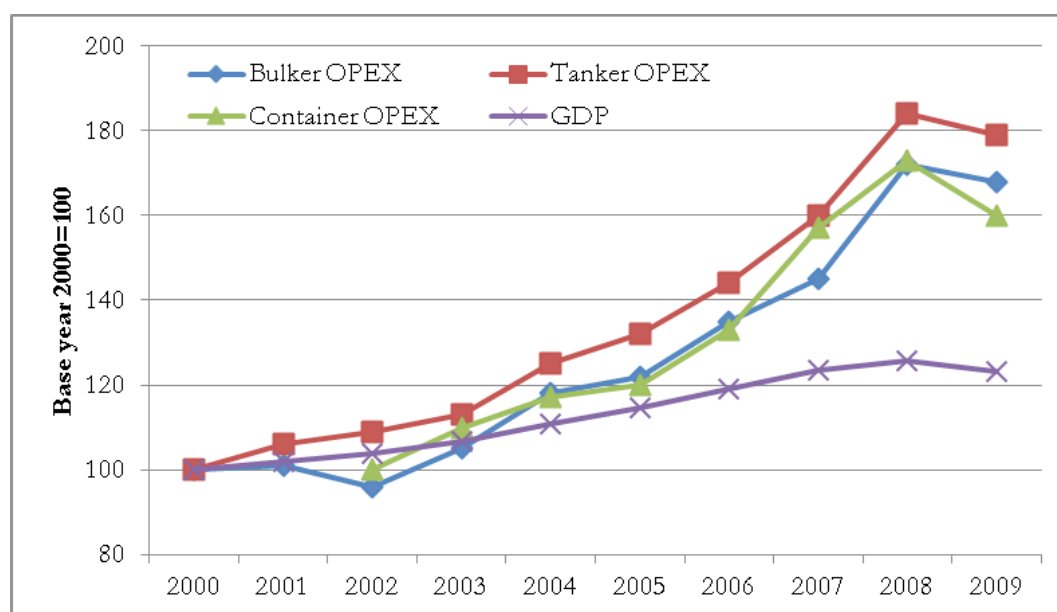

Figure 1: World GDP, freight rates and operation costs in main shipping segments in the period from 2000 to 2009
Slika 1: Svjetski BDP, vozarine i operativni troškovi glavnih segmenata pomorskog prijevoza (brodova) od 2000. do 2009.

Source: [13, 15]
Izvor: [13, 15]

Note: Indices are recalculated to the base year 2003 to easier compare the changes.
Napomena: Indeksi su preračunati prema baznoj 2003. godini kako bi se lakše usporedile promjene

Table 4: The correlation between GDP and freight indices in the period from 2003 to 2009
Tablica 4: Korelacija između BDP-a i indeksa vozarina od 2003. do 2009.

	TC	VC	BDTI	BCTI	LFI	GDP
TC	1					
VC	0.990151	1				
BDTI	0.257847	0.239785	1			
BCTI	0.36315	0.319649	0.915834	1		
LFI	0.059851	0.012152	0.825493	0.76174	1	
GDP	0.542796	0.618755	-0.25776	-0.34113	-0.56578	1

Source: Own calculation, based on [13, 15, 16, 11]
Izvor: Vlastita kalkulacija, temeljena na [13, 15, 16, 11]

Note: TC – time charter rates, VC – voyage charter rates, BDTI – Baltic dirty tanker index, BCTI – Baltic clean tanker index, LFI – liner freight index, GDP – gross domestic product
Napomena: TC – vozarina kod brodova u najmu na određeno vrijeme, VC – vozarina kod brodova u najmu na putovanje, BDTI – Baltik indeks prljavih tankera, BCTI – Baltik indeks čistih tankera, LFI – indeks vozarina kod brodova linijske plovidbe, GDP – bruto domaći proizvod

of crisis, keeping the freight and charter rates up while at the same time already taking some actions to lower the operating costs. The economic downturn causes a drop in asset values, making also the insurance costs fall down. Similar measures may send a false picture of the improving market situation, which is not tied to the economic recovery.

As expected, the dry bulk market, the most competitive maritime market, shows the highest correlation with the global economic activities. A large negative correlation can be seen (Table 4) between the fare rates in .liner (container) shipping since fare rates are based upon the average costs and the lack of cargo increases the fare rate per unit transported.
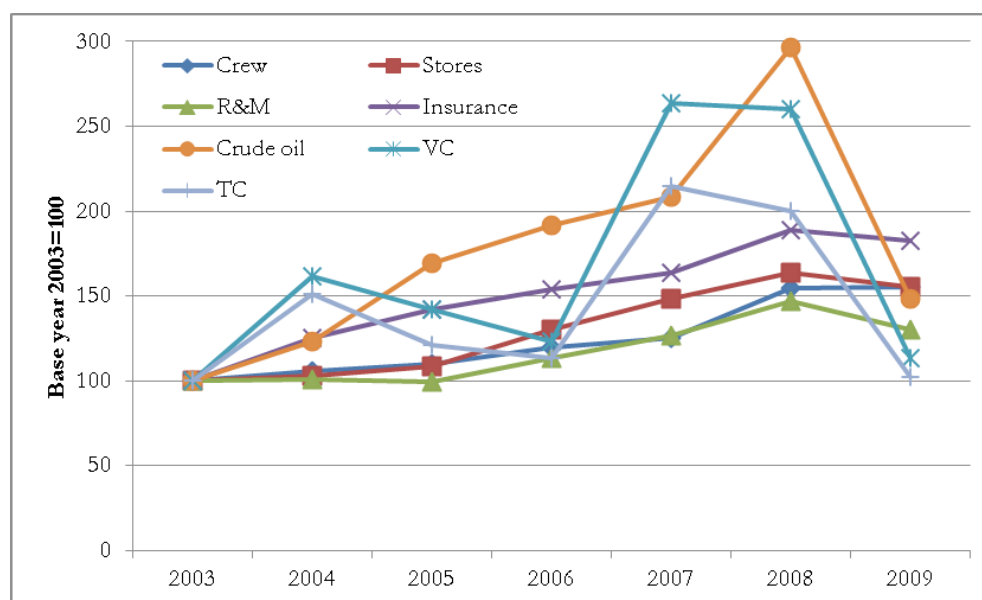

Figure 2: Crude oil prices, freight and operating costs indices for dry bulk shipping for the period from 2003 to 2009
Slika 2: Cijene sirove nafte, indeksi vozarina i operativnih troškova za prijevoz suhog rasutog tereta od 2003. do 2009.

Source: Adapted from [13, 16, 11]
Izvor: Prerađeno iz (13,16,11)

Note: Crude oil at 2008 US$ values; indices are recalculated to the base year 2003 to easier compare the changes
Napomena: sirova nafta po cijeni u US$ iz 2008.; indeksi su preračunati prema baznoj 2003. godini kako bi se lakše usporedile promjene

Table 5: The changes of operating costs in bulk shipping in 2008 and 2009
Tablica 5: Promjene operatinih troškova kod prijevoza rasutog tereta u 2008. i 2009. godini

|	Bulker 10-20.000dwt [%]		Handysize [%]		Handymax [%]		Panamax [%]		Capesize [%]	
	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009
Crew	22.7%	5.3%	26.9%	2.5%	27.5%	3.3%	20.7%	-1.6%	17.9%	-2.4%
Stores	10.3%	-9.3%	12.3%	-5.9%	14.4%	-6.5%	8.9%	-4.2%	5.3%	-2.9%
R&M	17.8%	-9.1%	19.0%	-13.3%	18.2%	-8.5%	6.7%	-10.0%	18.7%	-12.5%
Insurance	5.1%	-1.0%	14.6%	-0.9%	13.8%	-3.2%	13.6%	-5.3%	16.8%	-4.1%
Administration	20.7%	6.1%	23.6%	9.8%	20.3%	-1.7%	12.0%	3.0%	22.5%	8.4%
TOTAL	17.8%	0.0%	21.5%	-0.5%	21.2%	-1.5%	14.6%	-2.8%	16.3%	-2.7%

Source: Own calculation, based on [13]
Izvor: Vlastita kalkulacija temeljena na (13)

3.1 Dry Bulk Shipping

As can be seen from Figure 2, both the time charter and the voyage charter rates dropped significantly in 2009 as a consequence of declining economic activities worldwide. The total operating costs also declined, however at a much lower rate; the value of the operating costs approached the value of freight rates making the survival of many ship-operators difficult.

The operating costs as a whole as well as 3 out of 4 operating costs categories decreased as well, as can be seen from Figures 2 and 3. However, this decrease was not at such a significant pace as the freight rates. Only manning costs recorded a slight increase and gained some share in the cost structure; however this growth was the most modest in the entire analysed period (from 2003 to 2009), and is most probably the consequence of the devaluation of the American dollar. At the same time, the insurance companies slightly lowered the insurance premiums as a result of a collapse in the vessels' values; and regardless of the increased frequency of pirate attacks on some main dry cargo trade routes (the increase from 47 in 2005 to 119 in 2008 and 217 in 2009);
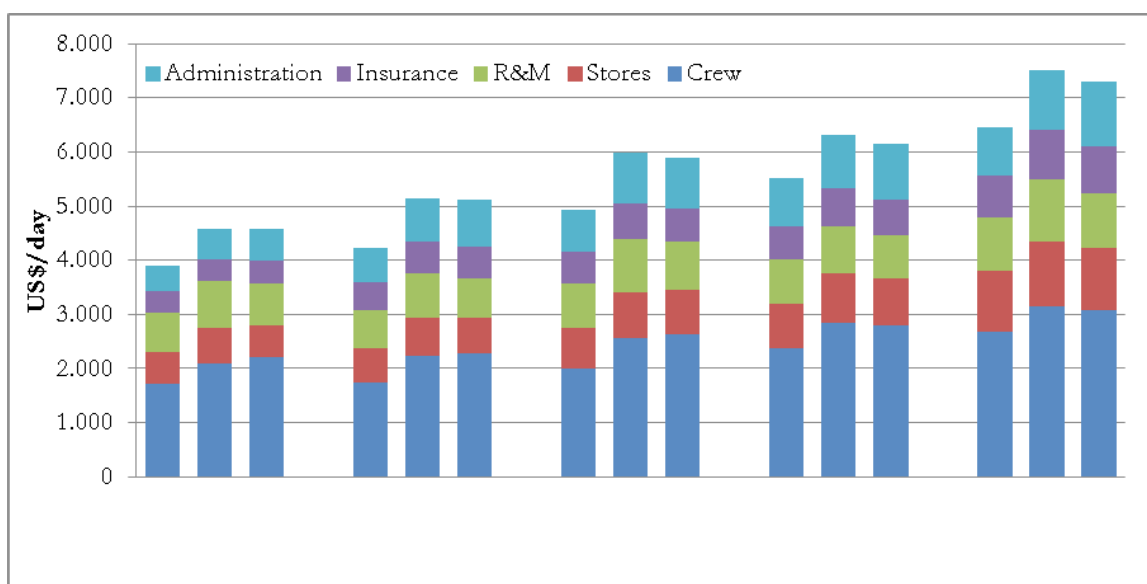
Figure 3: The structure of daily operating costs in dry bulk shipping for 2007, 2008 and 2009
Slika 3: Struktura dnevnih operativnih troškova kod prijevoza rasutog tereta za 2007., 2008. i 2009. godinu

Source: Adapted from [13]
Izvor: Prerađeno iz (13)

Table 6: The correlation between GDP, time charter and operating cost indices in the period from 2003 to 2009

Tablica 6: Korelacija izmeđuBDP-a, najma broda na vrijeme i indeksa operativnih troškova od 2003. do 2009.

	Crew	Stores	R&M	Insurance	TC	GDP
Crew	1					
Stores	0.942105	1				
R&M	0.925832	0.970188	1			
Insurance	0.936251	0.945038	0.891113	1		
TC	0.292304	0.496227	0.565544	0.436313	1	
GDP	0.878947	0.963117	0.900705	0.974086	0.542796	1

Source: Own calculation, based on [13, 15, 16, 11]
Izvor: Vlastita kalkulacija temeljena na (13,15,16,11)

information covering only the Gulf of Aden [20]). Indices are not given for he administration costs, however, these costs were increasing in almost all bulker shipping segments, even during crisis as can be seen from Table 5.

Most dry bulk ship operators have tried to reduce their operating costs by reducing maintenance schedules. This is the part of the operating costs in which the ship-operator has the greatest freedom of choice, and the ability to influence the operating costs in a way that meets the low freight rates. However, these costs also depend on the raw material prices (like zinc, copper and steel prices, as well as coating and painting prices) and these went down in 2009. The question is whether limited resources dedicated to repair and maintenance can later on cause faster deterioration resulting in the increased repair and maintenance costs in the future.

3.1.1 Time Charter

The time charter (TC) gives a charterer the operational control of the ship carrying his cargo, while leaving ownership and management of the vessel in the hands of the ship-owner [19]. This means that the ship-owner still bears all the operating costs, while the charterer pays all voyage expenses.

From Table 6, it is possible to see a medium to large correlation between TC rates and operating costs; as was to be expected, the strongest linear relationship is between the TC rates and the repair and maintenance costs. The weakest relationship is between the TC rates and the

Table 7: The correlation between GDP, voyage charter, operating cost and crude oil indices in the period from 2003 to 2009

Tablica 7: Korelacija između BDP-a, najma broad za putovanje, indeksa operativnih troškova i sirove nafte od 2003. do 2009.

	Crew	Stores	R&M	Insurance	VC	Crude oil	GDP
Crew	1						
Stores	0.942105	1					
R&M	0.925832	0.970188	1				
Insurance	0.936251	0.945038	0.891113	1			
VC	0.383495	0.573931	0.640841	0.522471	1		
Crude oil	0.648113	0.755871	0.806822	0.770672	0.780721	1	
GDP	0.878947	0.963117	0.900705	0.974086	0.618755	0.806652	1

Source: Own calculation, based on [13, 15, 16, 11]
Izvor: Vlastita kalkulacija temljena na (13,15,16,11)

Table 8: The correlation between freight rate, operating cost[4] and crude oil indices in liner/container shipping in the period from 2003 to 2009
Tablica 8: Korelacija između vozarine, opertivnih troškova[*] i indeksa sirove nafte kod prijevoza linijskim/ kontejnerskim brodovima od 2003. do 2009.

	Crew	Stores	R&M	Insurance	Crude oil	LFI	GDP
Crew	1						
Stores	0.907353	1					
R&M	0.871881	0.919261	1				
Insurance	0.032995	0.244909	0.182032	1			
Crude oil	0.724549	0.848567	0.88363	0.598348	1		
LFI	-0.72462	-0.46429	-0.39029	0.570194	-0.08167	1	
GDP	0.941426	0.975068	0.878055	0.217156	0.806089	-0.56635	1

Source: Own calculation, based on [13, 15, 16, 11]
Izvor: vlastita kalkulacija, temeljena na (13,15,16,11)
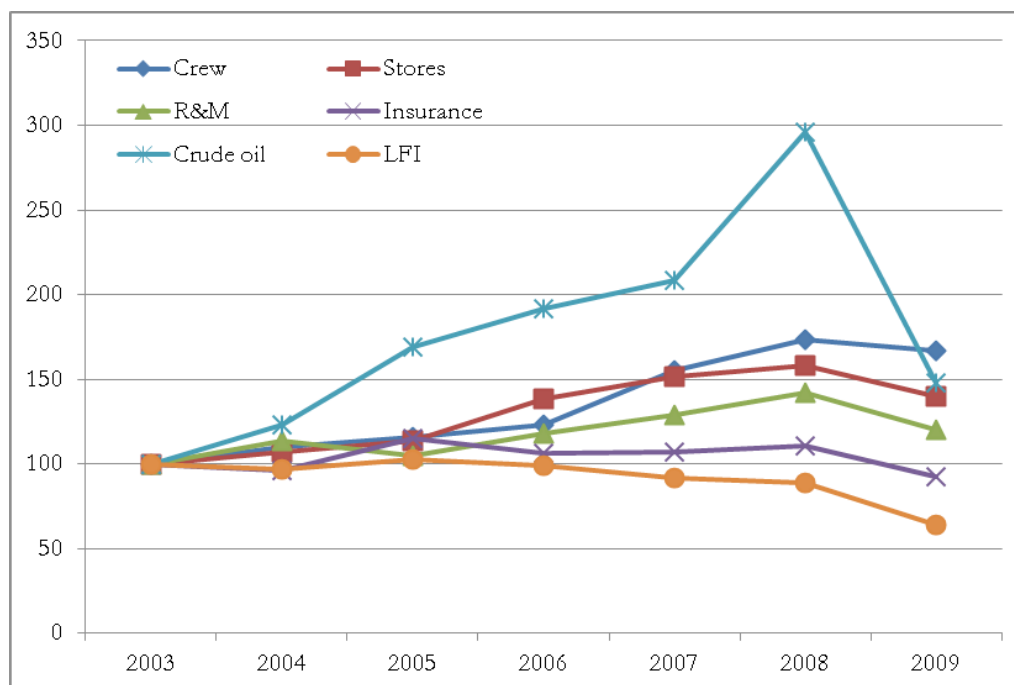
Figure 4: Crude oil prices, liner freight and operating costs indices from 2003-2009
Slika 4: Cijene sirove nafte, indeksi vozarine u linijskoj plovidbi i operativnih troškova od 2003. do 2009.

Source: Adapted from [13, 16, 11]
Izvor: Prerađeno iz (13,16,11)

Note: Crude oil at 2008 US$ values; indices are recalculated to the base year 2003 to easier compare the changes.
Napomena: Cijena sirove nafte po cijeni u US$ iz 2008.; indeksi su preračunati prema baznoj 2003. godini kako bi se lakše usporedile promjene.

manning costs,[4] which is again expected as the flag the ship is flying determines many things re-garding the crew; in addition the International Transport Workers' Federation (ITF) imposes the minimum number of the crew for a certain type of a ship and the minimal wages for the crew. Manning costs are thus more tied to the exchange rates than to the market situation, al-though the latter influences the demand for the crew and therefore their negotiating position.

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[4] It is important to stress that the Stephens Moore OpCost data base does not separately analyse the operating costs of the largest container main liners. Only ships with a capacity of up to 6,000 TEUs are included in the analysis, which can somewhat influence the indices of the entire container shipping segment.
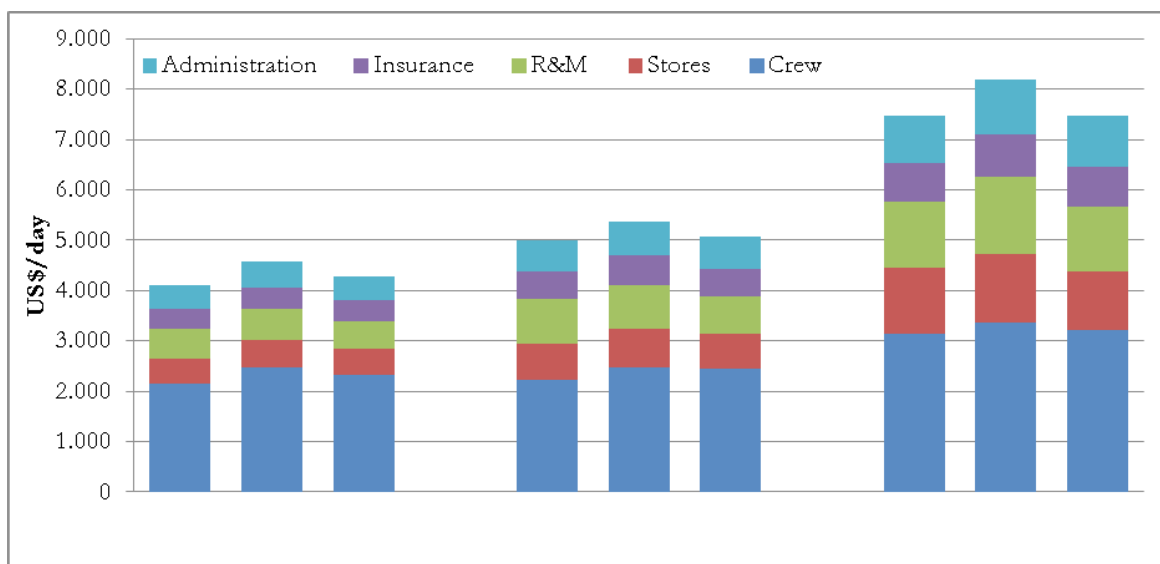
Figure 5: The structure and the changes of daily operating costs in container shipping for 2007, 2008 and 2009
Slika 5: Struktura i promjene dnevnih operativnih troškova kod prijevoza kontejnerskim brodovima za 2007., 2008, i 2009. godinu

Source: Adapted from [13]
Izvor: Prerađeno iz (13)

3.1.2 Voyage Charter

A voyage charter provides transport for a specific cargo from port A to port B for a fixed price per ton [19]. Therefore spot rates typically include all expenses of operating the vessel, from fuel to crew, but exclude costs related to the cargo (e.g., inspection fees) [10].

Perhaps one would expect a negative correlationn between oil prices and operating costs so that the ship-operator could cover all voyage costs despite high bunker prices and low fares. But the fact is, and this can be seen from Figure 3, that the oil prices go up when the economy is booming and decline when the economy is stagnating (R = 0.80 as can be seen from Table 7). The same goes for the fare rates (R=0.78 as can be seen from Table 7). From Table 7 we can see quite a strong linear relationship between fare rates and the operating costs categories.

3.2 Quick Overview of Other Shipping Segments

3.2.1 Liner/Container Shipping

Liner shipping refers to the provision of the services of maritime transport between two or more preordained ports at preordained time intervals and fare rates. The shipping company that operates as a liner operator bears all occurring costs in the provision of the transport service (eight costs categories according to Stopford), which is similar to the voyage charter, but their means of operation vary considerably; cargo is very different resulting in very different ships, and the fare rates in liner shipping are not market dependent, but cost dependent.

The decline in the global economic activity caused a drop in the oil prices and in all categories of the operating costs in container shipping, even in the crew costs. The latter is due to the laying-up of a large number of container vessels and consequently less need for the crew.

There is also a negative correlation between fare rates and the operating costs as well as with the oil price; while the operating costs and oil price were increasing, the fare rates were dropping. The reason for this can be found in the utilization of two concepts: economy of scale and concentration of cargo flows.

During the period of a global economic crisis, all operating costs categories in container shipping declined. The operating costs are generally slightly higher in container shipping than in dry bulk shipping, but the annual changes are less dramatic.

Table 9: The changes of operating costs in container shipping in2008 and 2009
Tablica 9: Promjene operativnih troškova kod prijevoza kontejnerskim brodovima u 2008. i 2009. godini

	Container feedermax		Container ship		Container mainliner	
	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009
Crew	15.0%	-5.2%	12.1%	-1.2%	7.8%	-4.6%
Stores	8.8%	-5.9%	2.2%	-7.2%	2.7%	-14.1%
R&M	6.0%	-14.7%	-1.8%	-17.4%	16.0%	-15.4%
Insurance	7.1%	-1.9%	7.3%	-5.5%	9.6%	-7.3%
Administration	7.2%	-6.3%	13.0%	-7.6%	16.2%	-7.8%
Total	11.3%	-6.4%	7.7%	-5.9%	9.6%	-8.9%

Source: Own calculation, based on [13]
Izvor: Vlastita kalkulacija, temljna na (13)

3.2.2 Tanker Shipping

Tanker shipping provides transportation of liquids in bulk. Major types of tank-ship include oil and product tankers, chemical tankers, and liquefied natural gas carriers. In the analysis only oil and product tankers are included.

The correlation analysis in tanker shipping reveals a strong correlation between BDTI and BCTI, and a minor correlation between freight rates and crude oil price. Freight rates do not significantly influence the operating costs, but the economic situation does.

The freight rate of a tanker charter party is specified in one of the four ways: by a lump sum rate, by rate per ton, by a time charter equivalent rate, or by WorldScale rate. WorldScale is produced on a yearly basis, and currently cov-ers more than 320,000 voyages all over the planet. The freight rate for a given ship and voyage is expressed in percentage of the published rate (it can range from 1 to 1000%) depending on the market situation at the time of fixing. The global economic crisis caused a significant drop in the demand for crude oil and oil products resulting in a severe drop in freight rates.

Crew costs were increasing faster in tanker shipping than in dry bulk or container shipping, while all other categories of operating costs were increasing at a slower pace. The most stagnant category of operating costs in tanker shipping were the insurance costs (taking into account the decreased value of US $ in comparison to other currencies we can assume that these costs actually decreased), probably be-

Table 10: Correlation between GDP, freight rates, operating cost and crude oil price in tanker shipping in the period from 2003 to 2009
Tablica 10: Korelacija između BDP-a, vozarina, operativnih troškova i cijene sirove nafte kod prijevoza tankerima od 2003. do 2009.

	Crew	Stores	R&M	Insurance	Crude oil	BDTI	BCTI	GDP
Crew	1							
Stores	0.876549	1						
R&M	0.868512	0.961293	1					
Insurance	0.93486	0.952024	0.92166	1				
Crude oil	0.663827	0.826441	0.908598	0.792149	1			
BDTI	-0.45602	-0.24965	-0.0846	-0.38603	0.248986	1		
BCTI	-0.47631	-0.2729	-0.06923	-0.39932	0.200891	0.915834	1	
GDP	0.923022	0.978626	0.939599	0.951153	0.806652	-0.25776	-0.34113	1

Source: Own calculation, based on [13, 15, 16, 11]
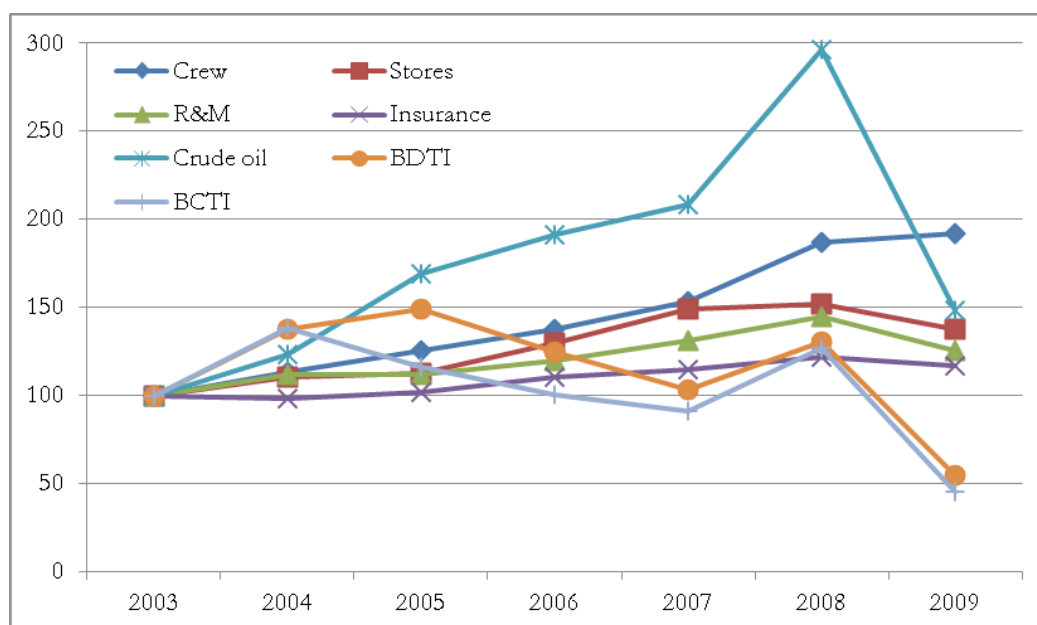*Izvor: Vlastita kalkulacija, temeljena na* (13,15,16,11)

Figure 6: Crude oil prices, tanker freight and operating costs indices from 2003-2009
Slika 6: Cijene sirove nafte, indeks vozarina za prijevoz tankerima i operativnih troškova od 2003. do 2009.

Source: Adapted from [13, 16, 11]
Izvor: Prerađeno iz (13,16,11)

Note: Crude oil at 2008 US$ values; indices are recalculated to the base year 2003 to easier compare the changes.
Napomena: Cijena sirove nafte po cijeni u US$ iz 2008.; indeksi su preračunati prema baznoj 2008. godini kako bi se lakše usporedile godine

cause the trade patterns of oil and petroleum products avoid the most critical points of maritime piracy and the prices of tankers do not fluctuate like in other ship segments. One would expect that this is the result of lower price fluctuations of tanker ships, but that is not the case; the analysis of ship prices (based on data from [15]) and the calculation of standard deviation contradicts this assumption.

Table 11: The changes of operating costs in tanker shipping in 2008 and 2009
Tablica 11: Promjene operativnih troškova kod prijevoza tankerima u 2008. i 2009.godini

	Product Tanker		Handysize product tanker		Panamax tanker		Aframax tanker		Suezmax tanker		VLCC	
	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009	2007-2008	2008-2009
Crew	23.2%	2.8%	21.0%	3.7%	16.1%	0.5%	23.5%	4.4%	29.8%	0.6%	21.0%	3.2%
Stores	-4.6%	-11.9%	1.5%	-6.6%	5.1%	-9.2%	5.4%	-15.4%	-0.4%	-4.6%	12.0%	-7.7%
R&M	12.5%	-14.2%	16.7%	-15.6%	1.4%	-15.9%	16.9%	-10.6%	8.5%	-8.0%	1.3%	-11.6%
Insurance	14.5%	-8.1%	9.4%	-0.9%	2.6%	-6.9%	3.4%	-4.0%	3.4%	0.1%	3.6%	-4.7%
Administration	25.2%	-1.7%	11.9%	-8.0%	17.9%	-4.1%	17.6%	-7.8%	8.1%	5.3%	15.0%	4.9%
Total	17.5%	-3.2%	15.5%	-2.8%	11.1%	-4.6%	17.1%	-2.9%	16.2%	-0.5%	13.0%	-1.5%

Source: Own calculation, based on [13]
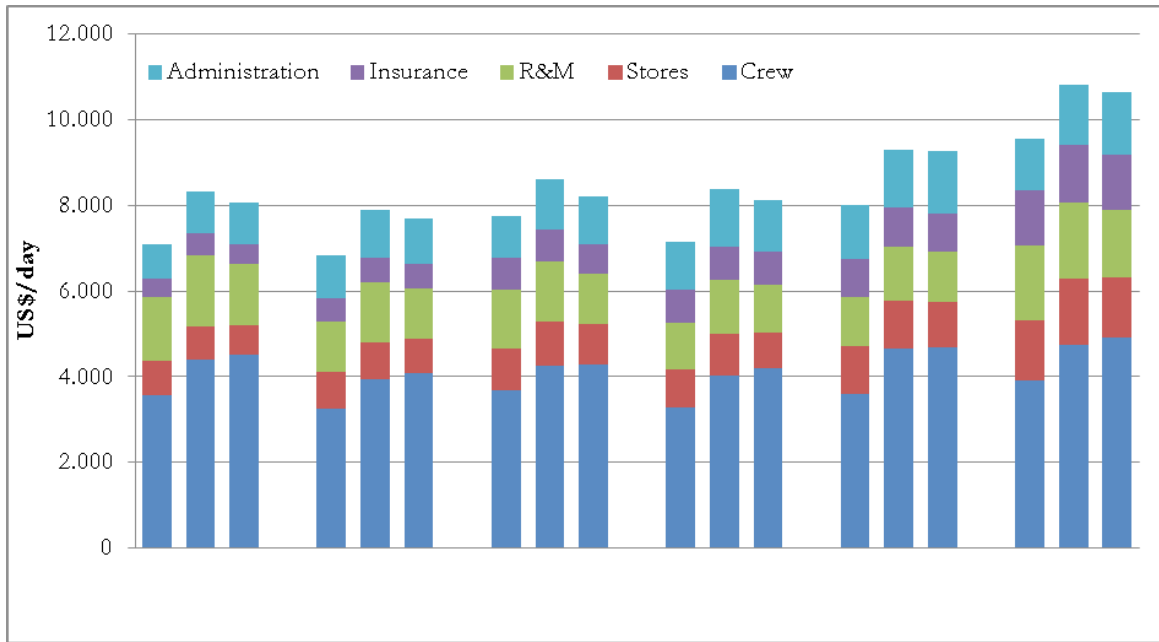*Izvor: Vlastita kalkulacija temeljena na (13)*

Figure 7: The structure and the changes of daily operating costs in tanker shipping for 2007, 2008 and 2009
Slika 7: Struktura i promjene dnevnih operativnih troškova kod prijevoza tankerima za 2007., 2008. i 2009. godinu

Source: Adapted from [13]
Izvor: Prerađeno iz (13)

4. CONCLUSIONS

The last global economic crisis drastically lowered freight rates and the control of the operating costs budgets became an important issue in many shipping companies.

The international accountant and shipping consultant Moore Stephens reported an average fall of 2.0% in the total annual vessel operating costs in 2009 [12]. This was the first drop in the overall ship operating costs since 2002, and was the most visible in the segment of con-
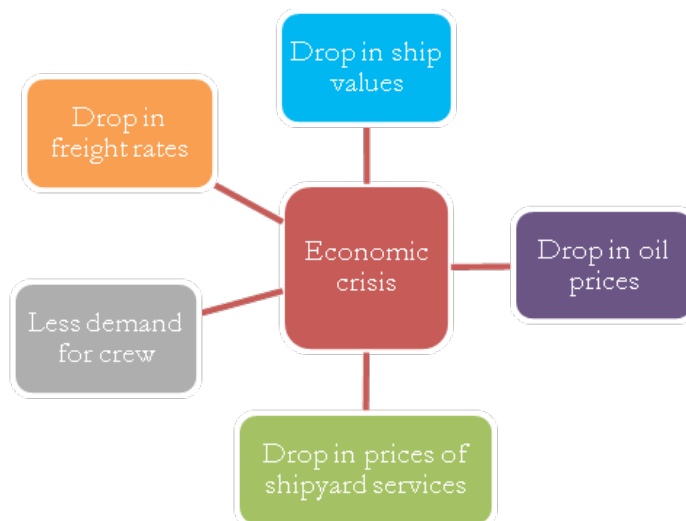

Figure 8: The consequences of economic crisis on the maritime market
Slika 8: Posljedice ekonomske krize na pomorsko tržište odnosno tržište pomorskog prometa

Source: The authors
Izvor: Autori

tainer shipping. Nonetheless, the manning costs increased by 2.2% overall while all other categories of the operating costs decreased; repair and maintenance costs decreased by an average of 11.4%; costs of stores decreased on average by 6.7% and the insurance costs by 1.5% [12, 13]. Ship-operators react to the economic situation by reducing their operating costs in all segments of the maritime freight market, and the economic situation causes a drop in the insurance costs due to the lower value of assets. Ship-operators slow-down, lay-up or even scrap some ships in order to adjust the supplied capacities to the current demand, thus the adaptation of freight rates and charter rates to the economic situation is a bit delayed, which is illustrated by a smaller Pearson correlation.

Notwithstanding the fact that the analysis was done over a very short time series, which was additionally reduced in order to obtain the comparable data (everything was converted to the base year 2003), the obtained correlation coefficients were predictable. Because of the short time series used, it is not possible to state with a high level of certainty that identical coefficients would have been obtained from a longer time series.

The authors have achieved the stated objective of the paper and proved a remarkable correlation between the economic cycles and fluctuations in the ship operating costs in all maritime freight markets. In addition, the influence of the economic cycles on freight and charter rates has been examined. However, there are many indices describing the maritime market, so by applying the same method it could be possible to inspect which indices correlate with the ships' operating costs the most. Future work could also be focused on the prediction of the ship operating costs, but more accurate data and a longer time series would be needed.

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