**No. 117/21, 7–19**
**ISSN 2657-6988 (online)**
**ISSN 2657-5841 (printed)**
**DOI: 10.26408/117.01**

**Submitted: 15.12.2020**
**Accepted: 06.02.2021**
**Published: 31.03.2021**

# HIERARCHICAL MODELLING OF VOLATILITY SPILLOVERS IN SHIP DEMOLITION MARKETS

**Abdullah AÇIK**

Dokuz Eylül University, Maritime Faculty, Department of Maritime Business Administration, Buca, İzmir, Turkey, ORCID: 0000-0003-4542-9831,
e-mail: abdullah.acik@deu.edu.tr

**Abstract:** The offered demolition prices are as important as the freight rates in the market in shipowners' decisions to send their ships for demolition. This study aims to determine the most affected and the most affecting countries in the ship demolition market by examining the hierarchical price movements among the prices offered for demolition in major centres around the world. In this direction, integrated causality in variance, Interpretative Structural Modeling (ISM) and MICMAC (Matrices d'Impacts cross-multiplication appliqúe a classmate) analysis are used. According to the obtained results, the price dependence on Turkey is the lowest, while the price dependence in Bangladesh is the highest. Volatility in the market is spreading to other markets from Turkey. These results are thought to be useful in understanding price behaviour in the ship demolition industry, which is a relatively small market.

**Keywords:** ship demolition, price behaviour, volatility spillover, hierarchic structure.

## 1. INTRODUCTION

Approximately 90% of the world's trade is transported by sea in terms of tonnage [Rodrigue 2013]. In this respect, maritime transport plays a very important role in the global economy [Wilmsmeier 2014]. Maritime markets basically consist of four sub-markets. These markets are: the freight market, where transportation activities are carried out; the new building market, where new ships are built; the sale & purchase market, where second-hand ships are traded; the demolition market, where old ships are scrapped and brought back into the economy [Stopford 2009].

The freight market can be defined as the main market among these markets. Developments in other markets are generally shaped according to the situation in the freight market. For example, when freight rates increase, second-hand ship values may also increase, as current earnings and future earning opportunities increase [Açık and Başer 2018a], or new building prices may also increase as demand for new ships increases. When freight drop, old ships with high operating costs are either laid up or sent to demolition [Taylor 1974]. The operation of ships requires very high costs, and many cannot meet these costs in depressed market conditions where the demand for ships is tight.

The ship demolition market, where the ships are scrapped, has a balancing role in the general market. Since ship supply is inelastic in the short run [Koopmans 1939], the ships ordered may take a long time to enter the market. In this case, when the freight rates get too high, there is a big increase in the amount of new ship orders. It is unclear what the market will be like when these orders are delivered after about two years [Başer and Açık 2018]. In the future, if the rate of increase in demand stays far behind the rate of increase in supply, the freight rates will plummet since there has been an excess supply in the market. In this case, ships that are old and obsolete compared to others cannot cover their operational expenses and are sent for scrapping [Buxton 1991]. As the supply in the market decreases, freight rates tend to rise again, and the market is balanced. Moreover, the fleet becomes renewed and has low operational costs due to the decrease in the average ages of the ships [Randers and Göluke 2007].

In addition to the freight rates, another factor influencing the decision to send ships for scrapping is the demolition prices. This is because ship owners make decisions by comparing the income they will earn by operating their ships with the income they will receive when they send their ships for scrapping. Higher demolition prices may be more attractive to ship owners and may influence their decisions. Since ship scrapping activities are carried out in a small number of countries around the world, there is a possibility that prices may be affected by each other. This interaction was tested in a previous study with significant results [Açık and Başer 2019]. It has also been found that prices do not move randomly and are dependent on their historical values [Açık and Başer 2018b]. However, some centres may be more dominant than others, and some may be more dependent on the interaction between prices. It may be useful to demonstrate this hierarchical structure (if any) in the market and examine it from a wider perspective. In this respect, we aimed to obtain a hierarchical structure by using a methodologically integrated approach in this study. For this reason, we used the causality in variance analysis and Interpretive Structural Modeling (ISM) methods in an integrated manner. The results we have obtained offer an original approach to addressing the issue, as well as presenting the hierarchical structure in the market. According to the results we have obtained, it has been revealed for the first time in literature that there is a hierarchical structure in the volatility and information spillover in the tanker ship demolition market.

In the second section of our study, the general situation in the demolition market and the studies in academic literature about the market are evaluated. The methods used in the research are introduced in the third section. After analysing our dataset used in the integrated model in the fourth section, our analysis results are presented in the fifth section. The general evaluations of the findings are then made in the last section.

## 2. INDUSTRY OVERVIEW AND LITERATURE REVIEW

Ship demolition activities are carried out intensively by a small number of countries around the world. The main reason for its concentration in these countries over time is the low labour cost and regional demand for steel [Stopford 2009]. In addition, since these countries are developing countries, the sector is also seen as a workforce area that contributes to economic development [Saraf et al. 2010]. Figure 1 shows the tonnage of ships scrapped by countries between 2014–2018 and the share they received from the demolition sector around the world. Recently, Bangladesh stood out as the most active country in this sector with a share of 45%. China, on the other hand, has decreased its share in the sector over time due to its protectionist policies.

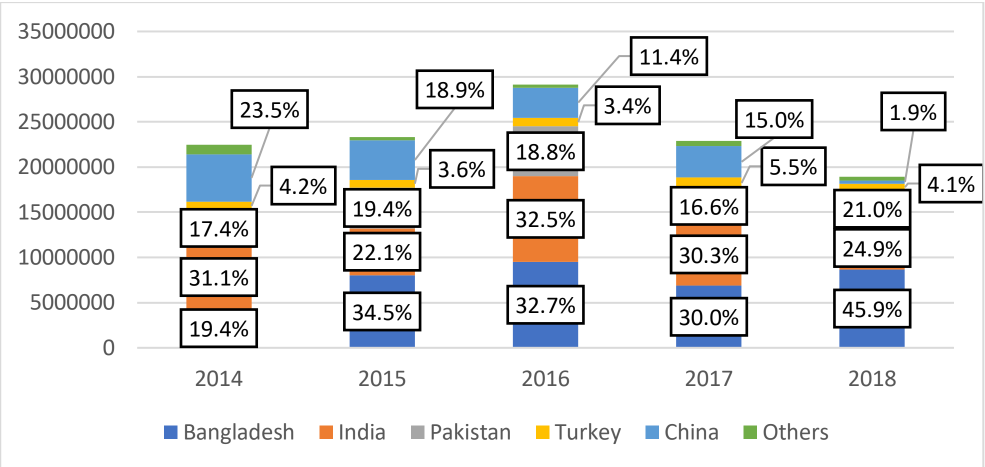


**Fig. 1.** Total demolition tonnage and share of major countries

*Source: [UNCTAD 2020].*

The demolition market has a multidimensional network of relationships. For this reason, it is intertwined not only with developments on the maritime side but also with factors such as the steel industry, the construction sector, environmental policies and macroeconomic indicators. Due to the preferences in these factors, the demolition sector continues its activities intensely in a small number of countries. The relationship between the shipping market and the demolition industry is very strong. Vessels on the market have different operating cost structures, as the age and size of a ship are important factors affecting the total costs per unit [Stopford 2009]. As the age of a ship increases, the fuel consumption will be higher, because its technology is old [Harwood 2008]. Insurance costs will also be higher as the risk increases. In addition, maintenance and repair costs will be higher than newer ships [Alizadeh and Nomikos 2009]. In this respect, freight levels are of vital importance for ships on the market. Ships that cannot carry out their operational activities under current freight conditions are laid up or sent for demolition. Theoretically, there is a negative relationship between freight rates and the tonnage of ships going for demolition.

This relationship has been empirically tested by Açık and Başer [2017], and the negative relationship between variables has been confirmed. Although freight rates in the market are the most influential factor in shipowners' decisions to send their ship for demolition, this alone is not effective. In addition, the scrap values of the ships are also effective. Sometimes high scrap prices can affect shipowners' decisions to send their shipd to demolition even though freight rates have not fallen to a very lethal level. This relationship has been empirically tested and confirmed by Knapp, Kumar and Remijn [2008] and Yin and Fan [2018].

Apart from the sea part of the demolition market, the developments in the markets it deals with after the ships are scrapped are also important. Recycled scrap from demolition is mainly used in the steel industry. Therefore, developments in the steel market and the change in demand are reflected in demolition prices. Developments in the general scrap market can also be influential, because ship scrap accounts for a relatively small share in the global scrap market. This has also been empirically tested and confirmed by Kagkarakis, Merikas and Merika [2016] and Tunç and Açık [2019]. Due to this close relationship, ship demolition prices can also affect construction costs, as investigated by Açık and Baran [2019]. However, this effect may be due to its close relationship with the steel market rather than the direct effect of the ship demolition price.

The demolition market may also have a relationship with macroeconomic factors. For example, the global economic growth rate may also affect the demolition market, as it affects the demand for shipping and steel. Interest rates can also be effective, as they affect the costs of purchasing new or second-hand ships. Increasing interest rates can cause a decrease in the number of ships going for scrapping, as it makes it difficult to purchase ships due to the increase in capital costs. Shipowners may prefer to use their existing ship for a longer period. This relationship has been empirically tested by Açık, Kesiktas and Başer [2020], and findings have been obtained in this direction.

Of course, there are many different factors that affect tanker demolition prices. These factors are mainly related to situations that affect the demolition of tanker ships. This may be related to the cargo and the profitability of the transportation activities in tanker transportation. For example, if the demand for oil decreases, the demand for tanker transportation may decrease, and the old ships are sent for demolition because of a decrease in freight rates. In this respect, there may be an information flow from oil prices to freight and, hence, demolition prices. In addition, fuel costs can be considered as one of the other important factors, as they affect the profitability of tanker ships. In this framework, in the study applied by Sun, Haralambides and Liu [2019] in terms of information flow in the tanker market, volatility spillovers from crude oil and bunker prices to tanker freight rates are determined. However, since we only wanted to model the hierarchical structure between prices in the demolition market, we ignored other variables that have a probable impact on demolition prices in this study, as our model is not suitable when including more variables.

As can be seen, studies in literature have examined the relationships from different angles. However, prices in a sector concentrated in a few countries are likely to be affected by each other, such as the demolition industry, as there may be competition between them, and this can affect pricing strategies. This situation may prevent the prices from moving randomly [Açık and Başer 2018b].

An empirical study in this direction has been carried out by Açık and Başer [2019], and the results of the research showed that demolition prices in Turkey and Pakistan were effective in terms of influencing the prices of other countries. However, only finding a result such as whether there is an effect from A to B or not is insufficient to see the big picture. Some centres in the market may be more dominant in overpricing than others. The volatility and information here can spread to other countries by following a hierarchical path. In this respect, we aimed to reveal the hierarchical price distribution in the demolition market by using causality in variance and ISM modelling in this study. We tried to contribute to ship demolition literature by testing the contribution of this method to see the big picture.

## 3. METHODOLOGY

We used an integrated version of the causality analysis and ISM method in this study. We applied our analysis by using the results obtained from the causality analysis as input in the ISM method.

The causality in variance test can be considered as an adaptation of the method developed by Granger [1969] for the variances of the variables. If the current and past variance of a variable contributes to explaining the current and future variance of the other variable, a causality relationship can be mentioned between them. This method makes it especially possible to determine the pass-through between financial markets [Koseoglu and Çevik 2013] and the volatility spillover between them [Bayat, Nazlioglu and Kayhan 2015]. It also makes it possible to identify the flow of information between markets, because variance is a concept related to the evaluation of new arriving information [Cheung and Ng 1996]. This method has been developed over time, and the version used in this study was proposed by Hafner and Herwartz [2006]. Researchers have tackled small sample problems using the LM approach. In this method, the series must be stationary [Nazlioglu, Erdem and Soytas 2016].

Interpretive Structural Modeling (ISM) is a method that makes it possible to reveal the direction and structure of the relationships between the elements of systems in complex structures [Sage 1977]. In this method, the priorities and hierarchical structure in the system are revealed [Yudatama, Hidayanto and Nazief

2018] by using the dependencies and driving forces between the elements [Luthra, Garg and Haleem 2015].

It makes it possible to see the big picture by revealing this network of relations on the macro scale when it is not sufficient to define the relationship between the elements only [Chuang et al. 2013]. In this method, there are standard procedures to be followed. As a result of these analyses, an ISM model and MICMAC (Matrices d'Impacts cross-multiplication appliqúe a classmate) chart showing a hierarchical structure are obtained.

The methodology used in our study consists of causality in variance, which is a pure econometric method, and ISM analysis, which has a wider range of applications in many areas. The advantage of causality testing is that it is easy to apply. It can also present important findings in terms of analysing information flow and risk transmission in financial markets. The disadvantage is that it can only be used to model bidirectional causality between two variables. In this case, the effects of other variables cannot be included in the model. The main reason for choosing this method in information flow analysis is its availability and easy applicability by the authors. In addition, since other factors affecting the demolition prices are not taken into account, it may not be appropriate to apply analysis with linear methods. This method, which detects volatility spillovers in a nonlinear way, gives us an advantage in this regard.

On the other hand, the ISM model is a successful method in revealing the relationships between factors in a large system, as well as the hierarchical structure of these relationships. In a market with very few players, such as the ship demolition market, there is likely to be an interaction between prices. To reveal this possible effect hierarchically constitutes the main motivation of our research. Examining the causality between prices alone is insufficient to form the big picture, as some centres may be more dominant and have more influence than others. In the next section, the data set used in our research is examined.

## 4. DATA

In the study, the tanker demolition prices of Bangladesh, India, Pakistan and Turkey were used. There is also general ship demolition price, but we used tanker ship demolition prices due to the availability of data. Since China has been reducing its ship scrapping activities recently, up-to-date price data for that country is not available, and therefore China was not included in the analysis. The dataset consists of 377 weekly observations and covers the period between 8.01.2013 and 31.03.2020.

Descriptive statistics of the data used in the study are presented in Table 1. The unit of variables is the offered scrap value in US dollars per ltd (light displacement) for wet ships (tankers). When the average value is taken as the basis, the prices offered by all countries except Turkey seem to be high and close to each other.

**Table 1.** Descriptive statistics of the variables

| | BANGLADESH | INDIA | PAKISTAN | TURKEY |
|---|---|---|---|---|
| Mean | 391.9 | 391.7 | 391.6 | 260.3 |
| Median | 410.0 | 405.0 | 410.0 | 270.0 |
| Maximum | 485.0 | 485.0 | 490.0 | 350.0 |
| Minimum | 245.0 | 250.0 | 250.0 | 160.0 |
| Std. Dev. | 58.21 | 59.53 | 57.83 | 50.26 |
| Skewness | -0.652 | -0.631 | -0.59 | -0.29 |
| Kurtosis | 2.396 | 2.29 | 2.36 | 2.06 |
| Jarque-Bera | 32.43 | 32.90 | 28.69 | 19.13 |
| Probability | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 377 | 377 | 377 | 377 |

*Source: [Athenian Shipbrokers 2020].*

Series are converted to return series to be used in causality analysis by using $ln\ (Demo_t)\text{-}ln\ (Demo_{t-1})$. Thus, the stationary condition required by the method is also provided.

The skewness and kurtosis values of the return series can provide information about the effects of the shocks they are exposed to in the period under consideration. High kurtosis values and negative skewness values indicate that negative shocks are more effective in all variables in the covered period. The distributions of the series are also not normal, and this situation can be interpreted as a nonlinearity in their structures.

**Table 2.** Descriptive statistics of the return variables

| | R BANGLADESH | R INDIA | R PAKISTAN | R TURKEY |
|---|---|---|---|---|
| Mean | -0.000 | -0.000 | -0.000 | -0.001 |
| Median | 0.000 | 0.000 | 0.000 | 0.000 |
| Maximum | 0.115 | 0.075 | 1.360 | 0.126 |
| Minimum | -0.123 | -0.119 | -1.410 | -0.214 |
| Std. Dev. | 0.022 | 0.019 | 0.103 | 0.031 |
| Skewness | -0.67 | -0.734 | -0.685 | -1.54 |
| Kurtosis | 9.30 | 7.42 | 173.0 | 13.20 |
| Jarque-Bera | 649.9 | 340 | 455180.0 | 1780 |
| Probability | 0.00 | 0.00 | 0.00 | 0.00 |
| Observations | 376 | 376 | 376 | 376 |

*Source: [Athenian Shipbrokers 2020].*

Figure 2 shows the movements of variables over time. It can be said that there is a very high correlation between prices. The likely reason for this is that the market is small, and few countries specialise in demolition work.

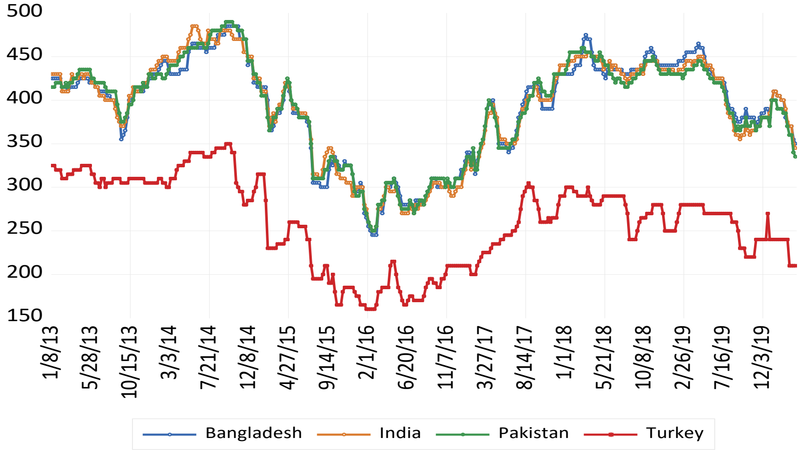


**Fig. 2.** Graphical display of the variables

*Source: [Athenian Shipbrokers 2020].*

## 5. RESULTS

In order for the results of the causality in variance tests to be used as input in the ISM method, the relationships should be presented as a matrix. The results of mutual analysis between scrap centres are presented in Table 3. According to the results, there are significant causalities from the prices of India, Pakistan and Turkey to the price of Bangladesh. There is also significant causality from the price of Turkey to the price of India.

**Table 3.** Causality in variance results

| | | To | | | |
|---|---|---|---|---|---|
| | | **Bangladesh** | **India** | **Pakistan** | **Turkey** |
| **From** | **Bangladesh** | x | 3.10 [0.21] | 0.76 [0.68] | 1.52 [0.46] |
| | **India** | 5.30 [0.07]* | x | 2.57 [0.27] | 2.16 [0.33] |
| | **Pakistan** | 6.30 [0.04]* | 2.01 [0.36] | x | 2.41 [0.29] |
| | **Turkey** | 21.20 [0.00]* | 16.97 [0.00]* | 0.69 [0.70] | x |

Probabilities in [], *Null of non-causality hypothesis is rejected.

In the MICMAC analysis, countries are grouped into four clusters. Although the groups are not clear for some countries, they are clear to Turkey and Bangladesh. Turkey is positioned in the Independent group, because dependence is low, and influence power is high. On the other hand, Bangladesh is in the Dependent group, because it has a high dependence and low driver power. India can be said to be in the Linkage group, because both characteristics are in the middle.

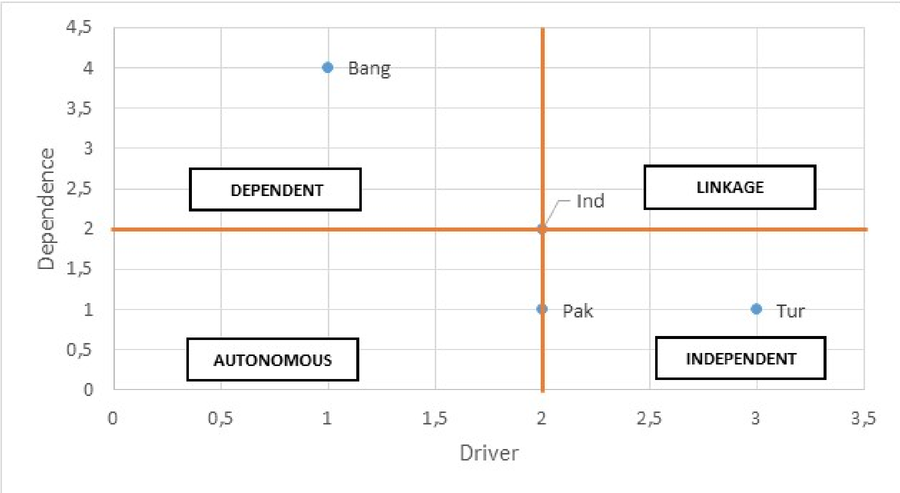


**Fig. 3.** MICMAC analysis

The formed ISM model is presented in Figure 4. Turkey is located at the bottom of the model, because the dependence is the lowest, and the influence power is the highest.

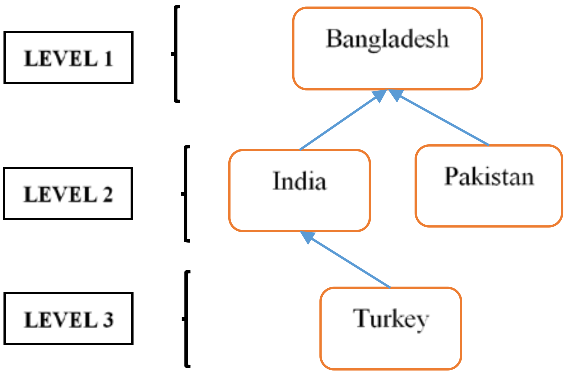


**Fig. 4.** ISM model

The source of the volatility of the market and the information flow according to the results obtained from this model is Turkey. Information spillover of prices in Turkey is spread over India and Bangladesh. Bangladesh prices are also affected by volatility spillovers in Pakistan. In this respect, Bangladesh prices stand out as the most dependent prices. This situation can be interpreted for Bangladesh as monitoring its competitors and planning their pricing strategies accordingly. Thus, the highest amount of demolition was done in Bangladesh in 2018, followed by India [UNCTAD 2020].

This situation can be interpreted the pricing strategy being planned according to competitors in order to get ahead of them and that they are successful in attracting most of the tonnage. This result also supports the findings that demolition prices do not move randomly and are dependent on historical values [Açık and Başer 2018b]. Of course, these findings only address the interaction between prices.

The interactions of demolition prices with each other are discussed, and this can be considered as a complementary study of the work done by Açık and Başer [2019]. Therefore, moving the subject to a hierarchical concept can be regarded as the originality of the study. Using methods where other factors affecting demolition prices can be included in the model may be more comprehensive in understanding the overall market behaviour, as demolition prices are directly affected by the steel industry [Kagkarakis, Merikas and Merika 2016; Tunç and Açık 2019] and the freight market [Knapp, Kumar and Remijn 2008; Açık and Başer 2017; Yin and Fan 2018] as well. There is a deep need in literature to develop models that can include all these factors.

## 6. CONCLUSIONS

In this study, we aimed to integrate a previously empirically tested and verified relationship with another model. Our reason for doing this was to reveal the possible hierarchical relationship between them, rather than just closing the issue by saying that there is a relationship from A to B or not. Since the number of countries operating intensively in the ship demolition sector is small, it is likely that there is an interaction between their prices. They may be watching the prices of other countries while developing their pricing strategy, or the effect of pricing in a country on shipowners' decisions may follow a hierarchical path. The ISM model showed that the driving force of the volatility in prices is the highest in Turkey, and the volatilities spread to other countries. We also found that prices in Bangladesh are dependent on the volatilities in prices in all other countries. Prices in India and Pakistan are at Level 2 and are in a linkage position. As can be seen from the MICMAC analysis, while prices in Bangladesh are positioned in the Dependent cluster, prices in Turkey are positioned in the Independent cluster. It can be said that India is positioned in the Linkage cluster, and Pakistan is more or less positioned in the Autonomous cluster. These results showed that prices in Turkey had an effect on the volatility of demolition prices of wet (tanker) ships. It is also interesting that the hierarchical structure of the relationships in the ISM model shows a parallelism with the distance of countries to Turkey. While Bangladesh is the farthest country from this country, other countries are closer.

The results obtained show that there is a hierarchical structure among the demolition prices of the countries. This research does not include analyses that can determine the reasons for this hierarchical structure. However, some important implications can be presented for the three groups closely related to the ship demolition industry.

These three groups can be defined as ship demolition centres, ship owners and scrap steel customers. These results may suggest to ship demolition centres that they should be more careful in their pricing strategies, as they present a hierarchical structure in the volatility and information spillover of their prices. By offering some advantages and services other than price, the competitive advantage of the other centres due to price can also be prevented.

For ship owners, this can contribute to the selection of a demolition centre. Due to the price movements in the dominant centres, possible price changes in the dependent centres can be predicted, and maximum benefit can be obtained from the scrapping of a ship by making a final voyage arrangement to a suitable destination before the delivery of the ship. The less time the ship is idle during delivery, the lower the last voyage cost for the shipowner.

Decisions to make long-term or short-term agreements can be made for scrap customers based on price information from dominant centres. Thus, important information may be provided in reducing the risks arising from indeterminacy against price fluctuations. Of course, the information suggested for these three groups has been handled with a theoretical approach. In order to obtain a more practical approach, the results obtained can be supported by different methods.

In further studies, the hierarchical structure of dry (general) ship demolition prices, which is another kind of scrapping activity, can also be modelled. Whether the two markets are parallel to each other and what the reasons may be for the differences (if any) can be examined. In addition, by including China in the analysis, a bigger picture of past markets can be drawn with modelling until the period when the prices of the country can be reached. Finally, the volatility spillovers between prices can be tested with a time-varying approach, as the direction and significance of the interaction between variables may change according to market conditions over time. The largest limitation of the study is related to the data available. If a more comprehensive dataset can be reached, the results would be more consistent.

## REFERENCES


Açık, A., Baran, E., 2019, *The Reflection of Ship Demolition Prices to Construction Costs in Turkey*, Marine Science and Technology Bulletin, vol. 8, no. 1, pp. 23–29.

Açık, A., Başer, S.Ö., 2017, *The Relationship Between Freight Revenues and Vessel Disposal Decisions*, Ekonomi, Politika & Finans Araştırmaları Dergisi, vol. 2, no. 2, pp. 96–112.

Açık, A., Başer, S.Ö., 2018a, *The Impact of Freight Rates on the Second-Hand Ship Price Bubbles: An Application on the Panamax Market*, İzmir International Congress on Economics and Administrative Sciences, pp. 629–643, İzmir, Turkey.

Açık, A., Başer, S.Ö., 2018b, *Market Efficiency in Ship Demolition Prices*, International Conference on Empirical Economics and Social Sciences, pp. 780–792, Bandırma, Turkey.

Açık, A., Başer, S.Ö., 2019, *Price Volatility Spillover in Ship Demolition Markets*, Optimum: Journal of Economics & Management Sciences, vol. 6, no. 2, pp. 311–322.

Açık, A., Kesiktaş, H.H.İ., Başer, S.Ö., 2020, *Role of Interest Rates on Fleet Capacity Adjustment Decisions of Shipowners*, Ekonomi Politika ve Finans Araştırmaları Dergisi, vol. 5, no, 1, pp. 66–80.

Alizadeh, A., Nomikos, N., 2009, *Shipping Derivatives and Risk Management*, Macmillian, London.

Başer, S.Ö., Açık, A., 2018, *The Response of Shipbuilding Activities to Freight Rate*s, Uluslararası İktisadi ve İdari Bilimler Dergisi, vol. 4, no. 1, pp. 120–136.

Bayat, T., Nazlioglu, S., Kayhan, S., 2015, *Exchange Rate and Oil Price Interactions in Transition Economies: Czech Republic, Hungary and Poland*, Panoeconomicus, vol. 62, no. 3, pp. 267–285.

Buxton, I.L., 1991, *The Market for Ship Demolition*, Maritime Policy & Management, vol. 18, no. 2, pp. 105–112.

Cheung, Y.W., Ng, L.K., 1996, *A Causality-In-Variance Test and Its Application to Financial Market Prices*, Journal of Econometrics, vol. 72, no. 1–2, pp. 33–48.

Chuang, H.M., Lin, C.K., Chen, D.R., Chen, Y.S., 2013, *Evolving MCDM Applications Using Hybrid Expert-Based ISM and DEMATEL Models: An Example of Sustainable Ecotourism*, The Scientific World Journal, pp. 1–18.

Granger, C.W., 1969, *Investigating Causal Relations by Econometric Models and Cross-Spectral Methods*, Econometrica: Journal of the Econometric Society, vol. 37, no. 3, pp. 424–438.

Hafner, C.M., Herwartz, H., 2006, *A Lagrange Multiplier Test for Causality in Variance*, Economics Letters, vol. 93, no. 1, pp. 137–141.

Harwood, S., 2008, *Shipping Finance (3rd Ed)*, Euromoney Books, London.

Kagkarakis, N.D., Merikas, A.G., Merika, A., 2016, *Modelling and Forecasting the Demolition Market in Shipping*, Maritime Policy Management, vol. 43, no. 8, pp. 1021–1035.

Knapp, S., Kumar, S.N., Remijn, A.B., 2008, *Econometric Analysis of the Ship Demolition Market*, Maritime Policy&Management, vol. 32, no. 6, pp. 1023–1036.

Koopmans, T.C., 1939, *Tanker Freight Rates and Tankship Building: An Analysis of Cyclical Fluctuations*, De Erven F. Bohn nv.

Koseoglu, S.D., Cevik, E.I., 2013, *Testing for Causality in Mean and Variance Between the Stock Market and the Foreign Exchange Market: An Application to the Major Central and Eastern European Countries*, Finance a Uver, vol. 63, no. 1, pp. 65–86.

Luthra, S., Garg, D., Haleem, A., 2015, *An Analysis of Interactions Among Critical Success Factors to Implement Green Supply Chain Management Towards Sustainability: An Indian Perspective*, Resources Policy, vol. 46, pp. 37–50.

Nazlioglu, S., Erdem, C., Soytas, U., 2013, *Volatility Spillover Between Oil and Agricultural Commodity Markets*, Energy Economics, vol. 36, pp. 658–665.

Nazlioglu, S., Gormuş, A., Soytas, U., 2016, *Oil Prices and Real Estate Investment Trusts (REITs): Gradual-Shift Causality and Volatility Transmission Analysis*, Energy Economics, vol. 60, pp. 168–175.

Nouira R., Amor T.H., Rault C., 2019, *Oil Price Fluctuations and Exchange Rate Dynamics in the MENA Region: Evidence from Non-Causality-In-Variance and Asymmetric Non-Causality Tests*, Quarterly Review of Economics and Finance, vol. 73, pp. 159–171.

Randers, J., Göluke, U., 2007, *Forecasting Turning Points in Shipping Freight Rates: Lessons from 30 Years of Practical Effort*, System Dynamics Review, vol. 23, no. 2-3, pp. 253–284.

Rodrigue, J.P., 2013, *Transport and Globalization*, [in:] Rodrigue, J.P., Notteboom, T., Shaw, J. (eds.), *The SAGE Handbook of Transport Studies*, pp. 17–30, Sage, London.

Sage, A.P., 1977, *Interpretive Structural Modeling: Methodology for Large-scale Systems*, McGraw-Hill, New York.

Saraf, M., Stuer-Lauridsen, F., Dyoulgerov, M., Bloch, R., Wingfield, S., Watkinson, R., 2010, *Ship Breaking and Recycling Industry in Bangladesh and Pakistan*, The World Bank Washington.

Stopford, M., 2009, *Maritime Economics*, Routledge, London – New York.

Sun, X., Haralambides, H., Liu, H., 2019, *Dynamic Spillover Effects Among Derivative Markets in Tanker Shipping*, Transportation Research Part E, vol. 122, pp. 384–409.

Taylor, A.J., 1974, *The Dynamics of Supply and Demand in Shipping*, Dynamica, vol. 2, no. 2, pp. 62–71.

Tunç, M., Açik, A., 2019, *The Impact of Steel Price on Ship Demolition Prices: Evidence from Heterogeneous Panel of Developing Countries*, Sosyoekonomi, vol. 27, no. 42, pp. 227–240.

Wilmsmeier, G., 2014, *International Maritime Transport Costs: Market Structures and Network Configurations*, Ashgate, UK.

Yin, J., Fan, L., 2018, Survival Analysis of the World Ship Demolition Market, Transport Policy, vol. 63, pp. 141–156.

Yudatama, U.K.Y., Hidayanto, A.N., Nazief, B.A.A., 2018, *Approach Using Interpretive Structural Model (ISM) to Determine Key Sub-Factors at Factors: Benefits, Risk Reductions, Opportunities and Obstacles in Awareness IT Governance*, Journal of Theoretical and Applied Information Technology, vol. 96, no. 16, pp. 5537–5549.

Internet sources

Athenian Shipbrokers S.A., 2020, *Demolition Prices by Country*, https://www.atheniansa.gr/ (20.04.2020).

UNCTAD, 2020, *Ship Scrapping by Country of Demolition*, https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=89492 (08.10.2020).