

## The Impact of Steel Price on Ship Demolition Prices: Evidence from Heterogeneous Panel of Developing Countries

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### Çelik Fiyatının Gemi Hurdası Fiyatlarına Etkisi: Gelişmekte Olan Ülkeler Heterojen Panelinden Bulgular

#### Abstract

In this study, the causal relationship between global steel prices and demolition prices in five developing countries (Bangladesh, China, India, Pakistan, and Turkey) that host five main ship scrap centers in the world are examined. The bootstrap panel Granger causality analysis is employed to take heterogeneity and cross-sectional dependence into account. The data set used in this study consists of 289 weekly observations from January 8, 2013 to July 16, 2018. As a result of the study, a collective causality relationship from steel price to demolition prices is determined and individual causality relationships for all countries except Bangladesh are identified.

**Keywords** : Steel Price, Demolition Price, Bootstrap Panel Causality, Developing Countries.

**JEL Classification Codes** : C14, C58, L16.

#### Öz

Bu çalışmada, küresel çelik fiyatlarıyla, gelişmekte olan ve dünyadaki başlıca 5 gemi söküm merkezleri olan Bangladeş, Çin, Hindistan, Pakistan ve Türkiye'deki gemi hurda fiyatları arasındaki nedensellik ilişkisi incelenmektedir. Çalışmada heterojenliği ve yatay kesit bağımlılığını dikkate alan bootstrap Granger panel nedensellik analizi kullanılmaktadır. Çalışmada kullanılan veri seti 8 Ocak 2013 ve 16 Temmuz 2018 tarihleri arasını kapsayan haftalık bazda 289 gözlemden oluşmaktadır. Çalışmanın sonucunda çelik fiyatından hurda fiyatlarına bir bütün olarak nedensellik ilişkisi tespit edilmiştir ve Bangladeş dışındaki tüm ülkelerin hurda fiyatlarına bireysel olarak nedensellik ilişkileri olduğu belirlenmiştir.

**Anahtar Sözcükler** : Çelik Fiyatı, Gemi Hurda Fiyatı, Bootstrap Panel Nedensellik, Gelişmekte Olan Ülkeler.

## 1. Introduction

Maritime markets are generally composed of four sub-markets: shipbuilding market where it is built, freight market where it is operated, sale and purchase market where it is sold or purchased, and demolition market where it is scrapped (Stopford, 2009: 177). All of these sub-markets in which the life of a ship passes through, possess different characteristics and take on important tasks in the maritime market.

The demolition market plays a stabilizing role and affects the entire maritime market (Jugović et al., 2015). The amount of ship in the maritime market is the carrying capacity of the market and represent the supply side. If the amount of ship increases more than demand, capacity becomes abundant in the market and the freight rates fall. The ships that cannot recover their costs due to falling freight rates are sent to demolition. As the amount of ship in the market decreases, freight rates rise again and come back to their equilibrium level. Moreover, when the freight rates are relatively high, newbuilding ships that incur lower operational cost than the old and/or obsolescent ones enter into the market. As the number of ships increases with newbuildings, high freight rates reduce and return to their equilibrium level (Buxton, 1991). There is no fixed time when the ship is scrapped (Evans, 1989), and this time depends on the economic life of a ship. The economic life of a ship depends on the freight rate and the expected freight income in the rest of the technical life of a ship (Strandenés, 2010). The demolition option is considered by the owner if (s)he faces decreasing profitability despite taking cost-cutting measures (Buxton, 1991; Karlis & Polemis, 2016).

In addition to the important role it has undertaken for the maritime market, ship demolition also helps the economic development of countries in which they are located (Sarraf et al., 2010; Mikelis, 2013; Jugović et al., 2015). Since the demolition activity requires less investment and belongs to a labor intensive industry, it is considered to be an important sector for developing economies. On the other hand, ship demolition constitutes important risks in terms of worker's health and safety and the environment.

With the development of environmental awareness in developed countries in the 1970s, ship demolition in Europe and OECD countries has shifted to developing economies where the activities can be carried out at lower costs (Kaya, 2012: 74). Development economics explains this shift with the *hypothesis of the pollution haven under the new colonialism* concept. However, as ship dismantling triggers employment and brings profit, it is seen as an important market in emerging economies.

According to UNCTAD (2018) data, 22,915,519 gross tons of demolition has been completed worldwide. The biggest players in this market are India (30.3%), Bangladesh (30.0%), Pakistan (16.6%), China (15.0%) and Turkey (5.5%). These players offer demolition prices to attract ships that come to their time of scrapping, and these prices are affected by many factors. Steel price is one of the most important factors affecting these prices as the demand for scrap steel is linked to demand for steel (Merikas et al., 2015).

Therefore, identifying this interaction is a very important task for ship-scraping businesses and ship owners.

This study aims to test the effect of international steel prices on demolition prices in five main demolition locations (Bangladesh, China, India, Pakistan, Turkey) in the world by employing bootstrap panel causality analysis. In the literature, the relationship between international scrap prices and ship demolition prices have been investigated and some valuable conclusions have been drawn. However, it is the originality of this study that the dependence among players in this small market of ship scrapping is taken into account and the interaction is also examined individually. The results obtained from our study show that ship demolition countries are heterogeneous and affected by shocks in each other. In addition, when the collective causality relationship is examined, two-way causality relationships are found between steel price and demolition prices. When the individual results are analyzed, it is seen that some countries are affected by steel prices while some others are not. It is also thought that the results will help the stakeholders to understand the price mechanisms, especially those who are engaged in ship demolition or who operate businesses linked to it.

The rest of the study is organized as follows: The relevant literature is reviewed in the second section; the method used in the study is introduced in the third section; the data used in the study and the results obtained from the analysis are presented in the fourth section; and finally, evaluations are made in the last section.

## **2. Literature Review**

There are several econometric studies about the ship demolition market in the literature. While Knapp et al. (2008) examined the probability of a ship to be demolished in five major demolition locations and impact of various factors on that probability, Kagkarakis et al. (2016) studied the relationship between international scrap price and demolition price. Açık & Başer analyzed the relationship between demolition price and the tonnage of ship sent to demolition (2017), the relationship between the demolition price and the freight rate in the market (2018a), market efficiency in ship demolition prices (2018b), and price volatility spillover in ship demolition countries (2019). In their study, Yin and Fan investigated ship demolition decisions of individual shipowners in different market conditions (2018). In addition to these, some studies (Buxton, 1991; Mikelis, 2007; Mikelis, 2013) make evaluations in terms of profiles of demolished ships, steel production by scrapped steel and environmental impacts of demolition activities by using several statistical data related to the market. Moreover, the process of ship sale for demolition has been evaluated in a study as well (Karlis & Polemis, 2016).

Kapp et al. (2008) used a very large data set in their study. They modelled the probability of a ship to be scrapped in one of the five main demolition locations (Bangladesh, China, India, Pakistan, Turkey) in the world by a binary model. The results of their study revealed a negative relationship between the freight earnings of the ships and the probability of being demolished in all locations. In addition, they also found a positive relationship

between ship demolition prices and the probability of being demolished in all of the locations.

The study conducted by Kagkarakis et al. (2016) has overlapping aspects with the present study with some similar objectives. In their study, the authors modelled the ship demolition prices using international scrap steel prices. First, they established VAR equations with stationary variables, and then applied Granger causality and impulse response analyses. According to the causality analysis, they determined a one-way causality from the international scrap steel price to the ship demolition price. According to the impulse response analysis, the ship demolition price reacted positively to a one-unit shock coming from the international scrap price, and the shock has not been neutralized for a long time.

In a study conducted by Açık and Başer (2017), the relationship between the freight rates and the amount of ship sent to demolition was investigated by correlation and regression analyses. As a result of the research, it was determined that there exists a negative significant relationship between the freight revenues and the amount of ship sent to demolition. This is theoretically quite natural, because it becomes more attractive to operate ships when freight revenues increase. Since the freight level in the market allows to make profit despite high operational cost, even the old and rough ships can be used in transportation operations.

In another study by Açık and Başer (2018a), the authors examined the relationship between the freight rates and the Indian demolition prices. The study presented regression and correlation analyses over data that spans from 1999 to 2016. As a result of the study, a significant positive relationship was found between the variables mentioned. Considering the previous study conducted by the authors, increasing freight rates decreases the amount of ships sent to demolition; therefore, scarcity of the ships in the demolition areas increases the prices offered by scrappers. In addition, high freight rates are also indicative of the buoyant economy, which may indicate a high demand for steel. Thus, this high demand may explain rising demolition prices. However, this possible relationship between steel price and scrap price was not supported statistically by the authors. The positive relationship between freight rates and demolition prices was also argued for by Mikelis (2007), although it was not supported by an econometric study.

In another demolition price-related study, Açık and Başer (2018b) tested the validity of the weak form Effective Market Hypothesis (EMH) at prices in five main demolition locations. By applying unit root and BDS tests with distribution statistics, they concluded that demolition prices in all locations are not efficient in the weak form. In other words, demolition prices do not move randomly and can be estimated using historical data. These results are important to support the idea that the demolition market is not independent and is a market affected by other factors. By the same token, our study carried out analyses on the hypothesis that the demolition prices are being affected by the global steel price.

In another recent study, Yin and Fan (2018) examined ship-owners' decision to send their vessels to demolition in different market conditions. As a result of the study, they found

out that the decision to send a ship to scrap differ according to the market conditions. After the 2008 global financial crisis, the freight rates plummeted the depths and therefore the old and obsolete ships, which consume a lot of fuel, have inevitably been sent to demolition. Moreover, the majority of the ships demolished in pre-crisis period belonged to developed countries, while the majority of the ships demolished in post-crisis period belonged to developing countries. Lastly, they calculated the survival distribution function over ship type, nationality of the builder and nationality of the owner.

The most recent study about the ship demolition prices is conducted by Açık and Başer (2019). The authors examined the prices in the five main demolition countries (Bangladesh, China, India, Pakistan, and Turkey) and investigated the volatility spillovers among them using *the causality in variance* method. The authors obtained supportive results for using the method by considering the cross-sectional dependence in the dataset of our study. Volatility spillovers from Turkish demolition prices to all other country prices except China in terms of both general and tanker demolition prices was revealed. These results showed that demolition countries follow each other in price determination, but also support possible linkages among them.

The proportion of steel obtained from ship demolition is very low compared to steel obtained from other scrap sources, and therefore, ship demolition prices have little power to influence general steel prices in the market (Mikelis, 2013). Therefore, the study framework of Kagkarakis et al. (2016) is very robust, as the author examined the one-way causality from international scrap prices to ship scrap prices. However, in this study, rather than examining the individual cases of the prices of ship demolition countries in the world, the situation is examined on the basis of a single price. Our study examines the causality relationship between steel prices and ship scrap prices by adding a different dimension to the framework by taking into account the heterogeneity and possible interdependence of countries due to the existence of small number of ship demolition locations. Because of data limitation, global steel price is proxied by the steel price observed in China in the study. However, since the Chinese economy constitutes a very big proportion of the global economy, it affects the world steel market and has the leading prices for the market. Thus, data limitation for steel price is not hoped to pose an issue (Giuliodori & Rodriguez, 2015).

### **3. Methodology**

Before the application of panel causality test in the study, cross-sectional dependency and slope homogeneity across countries was tested. Then only the types of unit root test and panel causality method were determined in order to investigate causal impact of steel price on demolition prices of the developing countries.

#### **3.1. Testing Cross Section Dependence and Homogeneity**

Cross-section dependence and slope heterogeneity issues must be taken into consideration in panel causality analysis due to the interconnectedness of the global open economy (Chang et al., 2015). The importance of these factors increases considering the fact

that the demolition market evaluated in the present study is small in terms of business volume and number of geographical places. In our study, the Lagrange multiplier (LM) test of Breusch and Pagan (1980), CD LM test of Pesaran (2004), LM adjusted test of Pesaran et al. (2008) was used to test for cross-sectional dependency. LM and LM adjusted tests are more appropriate when the T is much larger than N ( $T > N$ ). If no cross-section dependency was spotted in the variables, first-generation unit root tests were to be applied, otherwise second-generation unit root tests were to be employed. The method recommended by Emirmahmutoglu and Kose (2011) can be used both with and without CD, but if the CD exists, the significances of the test results should be investigated based on the critical values obtained through bootstrap simulations.

### **3.2. Panel Unit Root Test**

The method proposed by Emirmahmutoglu and Kose (2011) embodies a Toda and Yamamoto (1995) process and therefore the series do not have to be stationary, however the maximum degree of integration (dmax) should be known (Umar & Dahalan, 2016). The dmax value is the maximum difference that must be taken for any variable that is subject to the causality test to become stationary.

Bootstrap-IPS test developed by Smith et al. (2004) and Bootstrap-Hadri test were used to determine integration properties of demolition and steel prices based on the results of the cross-sectional dependence and homogeneity tests. The former one is an improved version of the unit root test developed by Im, Pesaran and Shin (2003), and the later one is the improved version of Hadri (2000) stationarity test and used as a confirmatory analysis. Both of the tests take into account the cross-sectional dependence.

### **3.3. Panel Causality Test**

Bootstrap panel Granger causality test proposed by Emirmahmutoglu and Kose (2011) was used in this study in order to examine causal relationship between steel price and demolition prices. In this method, the Fisher (1932) test statistics is used to test the Granger non-causality hypothesis in heterogeneous panels. However, possible cross correlations among the cross-sectional units limit the power and validity of the test due to the limit distribution of Fisher statistics (Xie & Chen, 2014). In order to overcome this problem, Emirmahmutoglu and Kose (2011) used the bootstrap technique in their method for cross-sectional dependent panel datasets. Their method takes into account both cross-sectional dependence and heterogeneity, and therefore reliable and robust causal linkages between variables can be obtained (Doğan & Aslan, 2017).

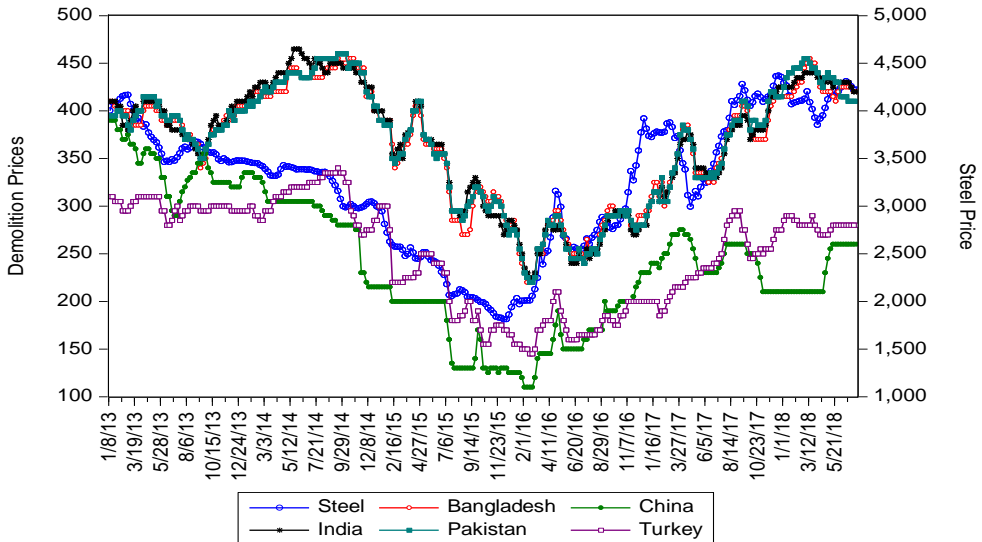
The test procedures were implemented in GAUSS software by using codes developed by Kar et al. (2011) and Menyah et al. (2014). Firstly, the series were converted to logarithmic forms, and homogeneity and cross-sectional dependence tests were implemented in order to determine which unit root and stationarity tests are suitable for the variables. Consequently, suitable unit root and stationarity tests were applied to determine maximum order of integration (dmax) value. Finally, the type of information criterion for

model selection as well as the maximum number of lags and the maximum number of bootstrap simulations for the computation critical values were determined. Finally, the bootstrap panel Granger causality test proposed by Emirmahmutoglu and Kose (2011) was applied. The next section presents the findings obtained from the test.

#### 4. Data and Findings

The data set used in this study consists of 289 weekly observations from January 8, 2013 to July 16, 2018. Demolition prices offered for the demolition of general cargo ships per ltd were obtained from free weekly reports published by Athenian Shipbrokers SA (2018). The price of steel is the price of hot rolled steel in China and obtained from Bloomberg (2018). The steel price used in the study is based on the price realized in China, since the price of the steel in global terms could not be obtained due to data limitations. However, as Giuliadori and Rodriguez (2015) have mentioned, this does not pose an issue since (i) the Chinese economy constitutes a very big proportion of the global economy, (ii) it affects the world steel market and (iii) it has the leading prices for the market.

**Figure: 1**  
**Graphical Display of the Raw Variables**



Source: Athenian Shipbrokers SA, 2018; Bloomberg, 2018.

The data set used in this study is presented in Figure 1. When Figure 1 is examined, it can be said that demolition prices offered by China and Turkey are close to each other. In contrast, Bangladesh, India and Pakistan are forming a separate group by offering close prices to each other. Steel prices are said to be in higher correlation with the demolition prices of the group consisting of China and Turkey. Considering that the steel price used was obtained from the Chinese market, this result is quite natural. Although partially

differentiated, the demolition prices offered by the other tripartite group are parallel to the price of steel in general as well.

Table 1 presents descriptive statistics of the variables used in the study. Along with the price of steel, demolition price data for the 5 main countries dealing with ship demolition activities are presented. In addition to the raw data, descriptive statistics of the data converted to the return series by taking logarithmic differences are also presented. Taking logarithms both facilitates the processability of the data and makes discrete data continuous. Also, it helps to assure better distributional properties (Shahbaz et al., 2017). The reason for the presentation of descriptive statistics of the differenced data is the results obtained from unit root analysis presented in Table 2. It is determined that all of the variables contain unit roots and they become stationary when the first differences are taken.

Table 1 also provides information about the types of news from which the variables are affected. If the Kurtosis value is greater than 3 in the return series, the sign of the Skewness value often refers to the type (positive or negative) of news (shocks) being exposed. Positive ones are news that have a value-increasing effect, and negative ones are news that have a value-decreasing effect. That is, the positive or negative information may vary depending on the type of interest. For instance, value-increasing effect may be a positive situation for steel producers, however it may be a negative situation for steel consumers. With respect to the variables considered in this study, Kurtosis of the steel price is nearly 8 and the Skewness value (0.46) is positive, which indicates that the price of steel is affected more by positive news (shocks) in the period covered. All other demolition prices have high Kurtosis values and all Skewness values are negative. This situation shows that demolition prices are more affected by negative (value-decreasing) news in the covered period. Then, unit root tests were applied to variables as a necessity of the method employed.

**Table: 1**  
**Descriptive Statistics of the Variables**

	STE.	BANG.	CHI.	IND.	PAK.	TUR.	R STE.	R BAN.	R CHI.	R IND.	R PAK.	R TUR.
Mean	3246.0	363.6	240.8	365.6	365.3	250.3	0.000	0.000	-0.001	0.000	0.000	-0.000
Med.	3385.8	380.0	230.0	380.0	385.0	270.0	-0.001	0.000	0.000	0.000	0.000	0.000
Max.	4369.2	455.0	390.0	465.0	460.0	340.0	0.113	0.125	0.194	0.083	0.125	0.125
Min.	1811.2	220.0	110.0	225.0	220.0	145.0	-0.107	-0.100	-0.207	-0.096	-0.095	-0.223
Std.D.	703.4	61.7	71.0	64.7	63.9	54.9	0.02	0.02	0.03	0.02	0.02	0.03
Skew.	-0.37	-0.49	0.05	-0.46	-0.45	-0.34	0.46	-0.06	-0.44	-0.40	-0.20	-1.70
Kurt.	2.10	2.09	2.09	1.99	2.04	1.74	8.13	6.21	13.5	5.84	6.68	13.61
J-B	16.4	21.8	10.0	22.7	20.9	24.5	326.6	124.4	1351.8	105.0	165.0	1491.6
Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obs.	289	289	289	289	289	289	288	288	288	288	288	288

Source: *Athenian Shipbrokers SA, 2018; Bloomberg, 2018.*

Since the causality method developed by Emirmahmutoglu and Kose (2011) follows Toda and Yamamoto (1995) process, the series do not need to be stationary, but the maximum degree of integration must be known. To determine the integration degree, unit root tests should be applied. However, in the selection of the unit root test and the causality analysis, the concepts of cross-sectional dependence and homogeneity are important. For cross-sectional dependency, the Lagrange multiplier (LM) test of Breusch and Pagan (1980), CD LM test of Pesaran (2004), and LM-adjusted test of Pesaran et al. (2008) were used. To



test homogeneity, test of Swamy (1970) was employed. According to the results presented in Table 2, the null of no cross-sectional dependency across countries is rejected, which indicates that a shock occurred in these demolition countries is likely to be transmitted to each other. Based on Swamy results, the null hypothesis of the slope homogeneity is also rejected, which supports the existence of the country-specific heterogeneity. In other words, direction of causalities among the variables may differ across demolition countries. These results provide information about the unit root tests that should be performed and creates evidence about the applicability of the panel causality analysis proposed by Emirmahmutoglu and Kose (2011).

**Table: 2**  
**Results of the Cross-sectional Dependence and Homogeneity Tests**

Test	Statistics	P-value
LM	1873	0.00
LM adj	4067	0.00
LM CD	42.04	0.00
Swamy Shat	2101.69	0.00

Note: \*Null hypothesis is rejected.

Based on the results of the cross-sectional dependence and homogeneity tests, Bootstrap-IPS unit root test developed by Smith et al. (2004) and Bootstrap-Hadri stationarity test were applied to all the series. The results are presented in Table 3. Considering the results of Bootstrap-IPS test, the null of unit root cannot be rejected for the variables at level. According to Bootstrap-Hadri test results, the null of stationarity is rejected at level. Both tests indicate that the unit root problem disappears when the first differences of the variables are taken. This shows that all series are I(1) and thus the maximum degree of integration value (dmax) is 1.

**Table: 3**  
**Unit Root Test Results of the Variables**

	Level				First Difference			
	Ln Demo		Ln Steel		Ln Demo		Ln Steel	
	C	C&T	C	C&T	C	C&T	C	C&T
t-bar statistics	-1.438	-1.194	-1.579	-1.770	-6.793	-6.881	-5.095	-5.298
P-value for t-bar	0.618	0.970	0.468	0.696	0.000 <sup>*</sup>	0.000 <sup>*</sup>	0.029 <sup>*</sup>	0.000 <sup>*</sup>
Panel-Z	24.302	47.337	43.657	150.64	0.305 <sup>‡</sup>	0.553 <sup>‡</sup>	3.210 <sup>‡</sup>	0.524 <sup>‡</sup>
Boot.Cv 10%	2.194	2.563	2.233	3.855	1.544	2.044	2.250	3.227
Boot.Cv 5%	3.896	3.865	3.918	5.175	2.398	2.685	3.831	5.065
Boot.Cv 1%	7.705	8.462	6.010	7.256	3.598	5.685	6.874	6.872

Notes: C refers to Constant, and C&T refers to Constant and Trend; \*Null hypothesis is rejected; ‡Null hypothesis cannot be rejected.

After the maximum degree of integration (dmax) was determined as 1 with the help of the unit root tests, application of the bootstrap panel causality test was started. GAUSS econometrics software and test codes were used in the analysis. Determination of the maximum degree of integration is only one necessity. Some other initial values such as the maximum lag, type of information criterion, and maximum number of bootstraps should also be determined before starting the analysis.

Since the frequency of the data set is weekly, the maximum number of lags was selected as 8. Schwarz was found to be the suitable information criterion to be used for

selecting the best model. Lastly, the maximum bootstrap repetition used to compute stable probability values was determined as 200, and then panel causality test was applied.

The focus of our study is to evaluate the impact steel price has on ship demolition prices rather than the other way around. This is because the ship demolition market has a very small proportion in the entire steel market and is unlikely to affect global steel prices. However, our analysis also presents causality results from demolition prices to steel prices as well. The bidirectional causalities were tested for the price of each ship demolition country, and the results are presented in Table 4. The null hypothesis of the test indicates that there is no significant causal relationship. Since there is a cross-sectional dependence in the sample discussed, Panel Fisher statistics should be compared with bootstrap critical values when interpreting the collective relationship. Accordingly, the nulls of no relationship are rejected both from steel price to demolition prices and from demolition prices to steel price. When individual results are analyzed, causal impacts from steel prices to demolition prices in all countries except Bangladesh are identified. On the other hand, the causal impact of demolition prices to steel price is observed in Pakistan, China and Turkey.

**Table: 4**  
**Bivariate Causality Test Results**

Country	(1) From Steel to Demo			(2) From Demo to Steel		
	Lag	Wald	Prob.	Lag	Wald	Prob.
India	2	6.442	0.040*	2	2.370	0.306
Bangladesh	2	3.173	0.205	2	2.529	0.282
Pakistan	2	6.349	0.042*	2	4.826	0.090*
China	2	20.902	0.000*	2	14.770	0.001*
Turkey	2	17.113	0.000*	2	14.468	0.001*
Panel Fisher		53.979*			38.982*	

Notes: *Bootstrapped CVs for (1): 25.069 (10%), 18.831 (5%), 16.159 (1%); Bootstrapped CVs for (2): 16.018 (10%), 18.652 (5%), 24.601 (1%); \*Null hypothesis is rejected.*

It is seen that the results obtained in the present study are consistent both with the theory and the literature. Our contribution to the literature and originality of our study stems from the use of a method that takes into account the possible cross-sectional dependence and heterogeneity between countries. These are very crucial aspects to be accounted for especially in the ship demolition sector since small number of ship demolishing countries follow each other in price determination strategies in general and the method considers the existence of this interactions (Açık & Başer, 2019). In addition, differentiation of results for some countries is acceptable, as the attraction of ships by demolition countries to their yards depends on various factors such as environmental, political and economic ones independent of the demolition price.

## 5. Conclusion

Although the use of scrap steel in the world is widespread, the ratio of ship scrap steel use is quiet low (Mikelis, 2013). For this reason, the scrap steel prices cannot be determined in the ship demolition market (Açık & Başer, 2018b) and are particularly affected by the developments in the global steel market (Merikas et al., 2015) and the maritime freight market (Knapp et al., 2008; Karlis & Polemis, 2016).

Evaluations about the relationship between ship demolition prices and steel prices have been included theoretically in the literature, however, the number of empirically supported studies is quite low. The closest empirical study to this topic is done by Kagkarakis et al. (2016). In their study, the authors have investigated the causality from global scrapped steel price to the ship scrap prices. The authors identified a one-way Granger causality from global scrap prices to the ship scrap prices. They also pointed out that the prices in the ship demolition market reacts positively to a one-unit shock from global scrap prices and that this positive shock has been embodied for a long time. We have tried to consider the possible differentiation between demolition countries by reducing the issue to a little more individual, as one country may be affected and the other may not from the developments in the steel industry. In addition, while Kagkarakis et al. (2016) examined the global scrap price, we used global steel prices proxied by the steel price realized in China (due to data limitation) and examined the causality from steel price to demolition prices. As the Chinese economy is one of the largest global economies and one of the biggest steelmakers and consumers, taking Chinese steel price as a proxy to world steel price assumes to partially eliminate the weak point of our study.

The heterogeneity and cross-sectional dependence tests we have conducted before the bootstrap panel causality test shows that we were right in our predictions about the market structure and method selection. The determined cross-sectional dependence has also been confirmed by Açık and Başer (2019) in their study where they showed the volatility spillover effect among prices.

The focus of our study is to evaluate the impact steel price has on ship demolition prices as the ship demolition market has a very small proportion in the entire steel market and is unlikely to affect global steel prices. Nevertheless, our analysis also presents causality results from demolition prices to steel prices to enrich the results. The results obtained from our study show that ship demolition countries are heterogeneous and affected by shocks occurred in each other. In addition, when the collective causality relationship is examined, a two-way causality relationship is found between steel price and demolition prices. When the individual results are analyzed, it is seen that there are causality relationships from steel price to demolition prices in all countries except Bangladesh, while there are causality relationships from demolition prices in China, Bangladesh and Turkey to steel prices.

While this study is a first in terms of the method used and the results obtained, it also provides important implications for the stakeholders in the demolition market. Ship owners, who are intended to send their ships to demolition, can predict the possible effects of the changing global steel price on the demolition prices in certain demolition countries. Even if it is claimed that it is very natural for the price of steel to go parallel with the price of demolition, as the ship demolition sector is also affected by the developments in the freight market, the relationship becomes a bit complicated. For instance, when the freight market is depressed, too many ships can be sent to demolition and demolition prices may fall due to the large number of ships, regardless of the steel price.

The lack of a causal relationship from steel price to demolition prices may be due to developments in the freight market. Even if there is an increase in steel price, players in the demolition market may not reflect this to keep their profit margins high, as the amount of ships going to demolition will increase when freight falls excessively (Kapp et al., 2008; Açık & Başer, 2017). They may aim to protect their competitiveness by not reacting immediately to the price increasing news in global steel prices.

However, as shown in our study, the result that only some countries display causality while others do not may be due to political factors, as the demolition sector is considered to be very harmful to the environment. It is even defined as an instance of "garbage imperialism" (Puthucherril, 2010: 1). Therefore, in some regions, the purchase of ships by scrappers for demolition is relatively easy, while in some countries it is more difficult, and this affects the mechanism of the demolition price. Even the fuel cost of ships is so high that ships sent from trade-intensive regions may prefer the nearest demolition country although it offers a lower price, as it may become more attractive due to high transportation cost.

Lastly, since ship demolition is a labor-intensive sector, demolition locations in developing countries may be trying to stabilize their ship purchase prices to some extent in order to increase their profitability. Depending on the developments in the freight market, raising the prices offered for the vessels is insignificant if there are enough vessels for demolition and the operating costs have not increased significantly. For a more detailed analysis on this issue, nonlinear methods that allow to examine the causal relationship considering the lagged values of the variables may be used. From a macroeconomic point of view, as developing countries generally have high inflation rates, negative shocks in global steel prices may cause a decline in the profitability of demolition centers in these countries. However, these countries are able to survive by increasing their profitability by not increasing the demolition prices they offered to vessels against the rising steel prices.

The biggest limitation of our study is related to the availability of the data. Demolition prices are obtained from free weekly reports, and the reports are available since 2013. Further studies may obtain more generalizable results using a wider data set. In addition, the subject can be approached from different angles by methods such as time-varying causality, which detects causality in different periods rather than from a fixed causal relationship. Finally, the results of the study can be diversified by using several basic steel price indicators in the world since demolition countries may react differently to the distinct steel prices.

## References

- Açık, A. & S. Başer (2019), "Price Volatility Spillover in Ship Demolition Markets", *Optimum Ekonomi ve Yönetim Bilimleri Dergisi*, 6(2), 311-322.
- Açık, A. & S.Ö. Başer (2017), "The Relationship Between Freight Revenues and Vessel Disposal Decisions", *Ekonomi, Politika & Finans Araştırmaları Dergisi*, 2(2), 96-112.
- Açık, A. & S.Ö. Başer (2018a), "Navlun Oranlarıyla Gemi Söküm Fiyatları Arasındaki İlişki", *Uluslararası Ticaret ve Ekonomi Araştırmaları Dergisi*, 2(1), 16-32.

- Açık, A. & S.Ö. Başer (2018b), "Market Efficiency in Ship Demolition Prices", in: *International Conference on Empirical Economics and Social Sciences*, Bandırma, Turkey, 780-792.
- Athenian Shipbrokers SA (2018), *Weekly Demolition Reports*, <<http://www.atheniansa.gr/>>, 20.09.2018.
- Bloomberg Data Platform (2018), *China Steel Prices*, <<https://www.bloomberg.com/professional/>>, 18.07.2018.
- Breusch, T.S. & A.R. Pagan (1980), "The Lagrange multiplier test and its applications to model specification in econometrics", *The Review of Economic Studies*, 47(1), 239-253.
- Buxton, I.L. (1991), "The Market for Ship Demolition", *Maritime Policy & Management*, 18(2), 105-112.
- Chang, T. & R. Gupta & R. Inglesi-Lotz & B. Simo-Kengne & D. Smithers & A. Trembling (2015), "Renewable energy and growth: Evidence from heterogeneous panel of G7 countries using Granger causality", *Renewable and Sustainable Energy Reviews*, 52, 1405-1412.
- Dogan, E. & A. Aslan (2017), "Exploring the relationship among CO<sub>2</sub> emissions, real GDP, energy consumption and tourism in the EU and candidate countries: Evidence from panel models robust to heterogeneity and cross-sectional dependence", *Renewable and Sustainable Energy Reviews*, 77, 239-245.
- Emirmahmutoglu, F. & N. Kose (2011), "Testing for Granger causality in heterogeneous mixed panels", *Economic Modelling*, 28(3), 870-876.
- Evans, J. (1989), "Replacement, Obsolescence and Modifications of Ships", *Maritime Policy and Management*, 16(3), 223-231.
- Fisher, R.A. (1932), *Statistical methods for research workers*, (4<sup>th</sup> edition), Edinburgh: Oliverand Boyd.
- Giuliodori, D. & A. Rodriguez (2015), "Analysis of the Stainless-Steel Market in the EU, China and US Using Co-Integration and VECM", *Resources Policy*, 44, 12-24.
- Hadri, K. (2000), "Testing for stationarity in heterogeneous panel data", *The Econometrics Journal*, 3(2), 148-161.
- Im, K.S. & M.H. Pesaran & Y. Shin (2003), "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*, 115(1), 53-74.
- Jugović, A. & N. Komadina & A. Hadžić (2015), "Factors Influencing the Formation of Freight Rates on Maritime Shipping Markets", *Scientific Journal of Maritime Research*, 29, 23-29.
- Kagkarakis, N.D. & A.G. Merikas & A. Merika (2016), "Modelling and Forecasting the Demolition Market in Shipping", *Maritime Policy Management*, 43(8), 1021-1035.
- Kar, M. & S. Nazlioglu & H. Agir (2011), "Financial Development and Economic Growth Nexus in the MENA Countries: Bootstrap Panel Granger Causality Analysis", *Economic Modelling*, 28(1-2), 685-693.
- Karlis, T. & D. Polemis (2016), "Ship Demolition Activity: A Monetary Flow Process Approach", *Scientific Journal of Maritime Research*, 30, 128-132.
- Kaya, Y. (2012), "Basel ve Hong Kong Sözleşmeleri Bağlamında Gemi Söküm Endüstrisi: Çevre, Sağlık ve Güvenlik Odaklı Bir Analiz", *İş, Güç - Endüstri İlişkileri ve İnsan Kaynakları Dergisi*, 14(4), 71-88.
- Knapp, S. & S.N. Kumar & A.B. Remijn (2008), "Econometric Analysis of the Ship Demolition Market", *Maritime Policy&Management*, 32(6), 1023-1036.

- Menyah, K. & S. Nazlioglu & Y. Wolde-Rufael (2014), "Financial Development, Trade Openness and Economic Growth in African Countries: New Insights from a Panel Causality Approach", *Economic Modelling*, 37, 386-394.
- Merikas, A. & A. Merika & A. Sharma (2015), "Exploring Price Formation in the Global Ship Demolition Market", in: *2015 Annual Meetings*.
- Mikelis, N.E. (2007), "A Statistical Overview of Ship Recycling", in: *International Symposium on Maritime Safety, Security and Environmental Protection*, Athens, Greece.
- Mikelis, N.E. (2013), "Ship recycling markets and the impact of the Hong Kong convention", in: *International Conference on Ship Recycling*, Malmo, Sweden.
- Pesaran, M.H. (2004), "General diagnostic tests for cross section dependence in panels", Cambridge: University of Cambridge, *Working Papers in Economics* No. 04350435.
- Pesaran, M.H. & A. Ullah & T. Yamagata (2008), "A bias-adjusted LM test of error cross section independence", *Econometrics Journal*, 11, 105-127.
- Puthucherril, T.G. (2010), *From Shipbreaking to Sustainable Ship Recycling: Evolution of A Legal Regime*, BRILL.
- Saraf, M. & F. Stuer-Lauridsen & M. Dyoulgerov & R. Bloch & S. Wingfield & R. Watkinson (2010), *Ship Breaking and Recycling Industry in Bangladesh and Pakistan*, The World Bank Washington.
- Shahbaz, M. & T.H. Van Hoang & M.K. Mahalik & D. Roubaud (2017), "Energy Consumption, Financial Development and Economic Growth in India: New Evidence from A Nonlinear and Asymmetric Analysis", *Energy Economics*, 63, 199-212.
- Smith, L.V. & S. Leybourne & T.H. Kim & P. Newbold (2004), "More powerful panel data unit root tests with an application to mean reversion in real exchange rates", *Journal of Applied Econometrics*, 19(2), 147-170.
- Stopford, M. (2009), *Maritime Economics (3rd ed.)*, London: Routledge.
- Strandenes, S.P. (2010), "Economics of the markets for ships", in: *The Handbook of Maritime Economics and Business (2nd ed.)*, 217-234.
- Toda, H.Y. & T. Yamamoto (1995), "Statistical inference in Vector Autoregressions with Possibly Integrated Processes", *Journal of Econometrics*, 66, 225-250.
- Umar, M. & J. Dahalan (2016), "An Application of Asymmetric Toda-Yamamoto Causality on Exchange Rate-Inflation Differentials in Emerging Economies", *International Journal of Economics and Financial Issues*, 6(2), 420-426.
- UNCTAD (2018), *Demolition Statistics*, <<https://unctadstat.unctad.org/wds/TableViewer/tableView.aspx?ReportId=89492>>, 18.07.2018.
- Xie, Z. & S.W. Chen (2014), "Untangling the causal relationship between government budget and current account deficits in OECD countries: Evidence from bootstrap panel Granger causality", *International Review of Economics & Finance*, 31, 95-104.
- Yin, J. & L. Fan (2018), "Survival Analysis of the World Ship Demolition Market", *Transport Policy*, 63, 141-156.