Exploring Price Formation in the Global Ship Demolition Market

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ABSTRACT

The Ship Demolition market has been at the focus of research regarding mainly the environmental soundness of recycling and the labor safety conditions. The economic aspect of the ship demolition market impinges upon price formation. We consider the importance of the ship recycling industry in the context of the global production of steel and from the side of the world's largest ship recycling markets, Bangladesh, India, China, Pakistan, and Turkey, who are the largest importers of steel in the world. Specifically, the steel retrieved by the ship recycling industry, globally, covers 1.5% of the needs of the global steel industry. Hence, the steel industry is essential for the ship recycling industry. This observation sheds light from a different point of view on the determination of the ship demolition prices. Further, in periods where the freight rates are high, ship-owners are reluctant in selling their ships for demolition, reducing the supply of ship scrap;

therefore, the prices offered by ship recyclers should be higher, albeit they never exceed the price of the imported steel.

Using monthly time series data between 2004-2014 we develop ECMs (Error Correction Models) in three distinct but interrelated ship demolition markets, the tanker market, the product market and the dry bulk. In all three cases we find that the scrap value primarily leads together with the Chinese growth rate, the exchange rate and an index reflecting ship profitability. We show that these four determinants jointly provide the signal for price formation in the ship demolition market.

JEL CODES:R40,R49

1. Introduction

Ship Recycling practices have been placed recently at the focus of attention by regulators, policy makers, and businesses involved. This development is largely attributable to social,environmental as well as economic aspects. Regarding the economic aspect,studies have been conducted mostly for the determinants of the supply side in demolition markets. However,the factors that determine the prices of the ship recycling industry are not only the determinants of supply,such as freight rates, the age of the ship, and the cost of operating an old ship,buy also internal demand for steel and hence scrap, the demand growth and the exchange rates of the developing countries in which demolition takes place.

Collecting monthly data from Clarksons data base,GMS,and Bloomberg during the 2004-2013 sample period, we examine potential determinants of the price in the ship demolition market for three segments:the dry bulk,the tanker and the product. The contribution of our paper is that we provide the interested parties with a quantifiable perspective for price formation in the ship recycling industry. We argue that scrap prices, the exchange rate and the china factor form strong signals for price formation in the ship recycling industry. The remainder of the paper is organized as follows. Section 2 contains a brief general review of the literature, while Section 3 presents our sample and methodology. Section 4 presents our main empirical findings. Section 5 concludes.

2. Literature Review

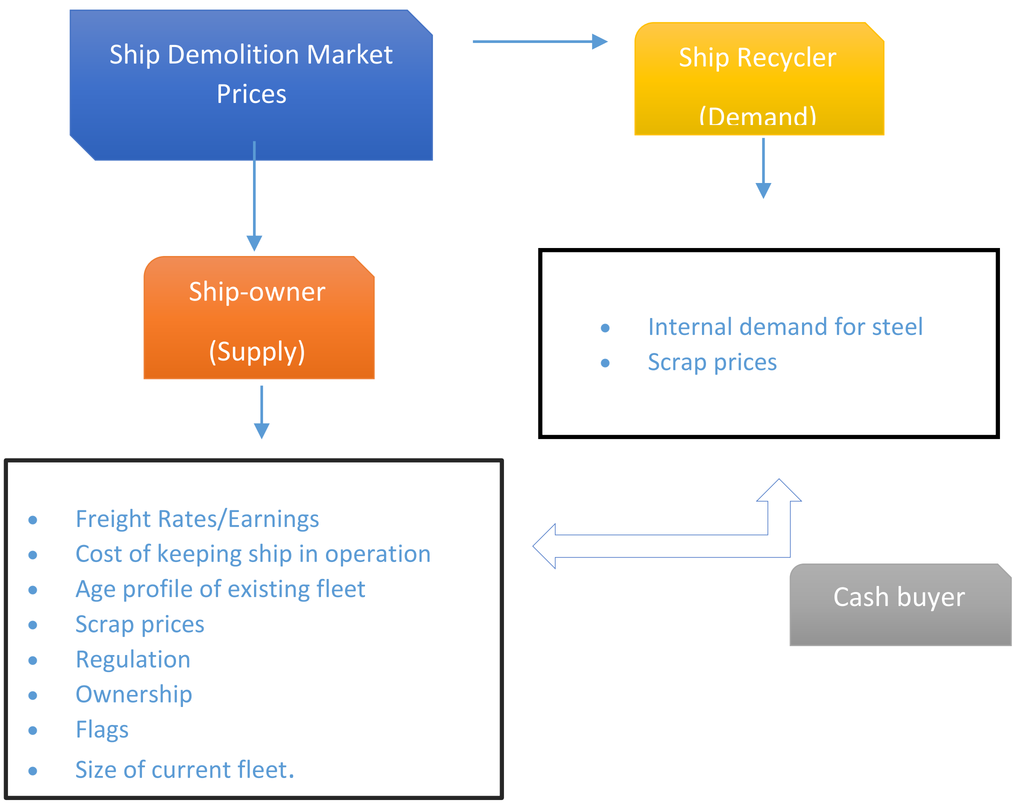
The analysis of the Ship Demolition market has focused primarily on the environmental soundness of recycling and the labor safety conditions. Scholars have been writing extensively on the procedures of dismantling in order to address the topics discussed in the Hong Kong International Convention (HKIC) so that ships, when recycled, do not pose any unnecessary risk to human health and safety or to the environment. Specifically **Demaria (2010)** focuses on the "toxic waste management" and argues that the ship demolition market is characterized by an "ecological distribution conflict". By this, it is meant that the scrap-waste flows from the developed countries towards the developing creating an uneven distribution of benefits (profits) and costs (bad labor conditions and environmental pollution). That is to say, ship-owners and shipbreakers gather the profits by externalizing the costs to the developing countries, such as India, Bangladesh, China, and Pakistan, where the demolition markets are located. The Lawrence Summers' Principle supports this uneven flow of waste towards the LCDs as the cost of dumping toxic waste is minimized due to very low wages. On the same line, **Mikelis (2013)** presents the factors which ship-owners should take into consideration in order to distinguish between acceptable and unacceptable yards, before the implementation of the HKIC standards. Such factors are the training of the work-force, protection equipment, the process of disposing of hazardous materials, sanitary facilities, the safety of the equipment used etc.

An important aspect regarding the Ship Demolition market is the economic one. Specifically, whether the prices are determined by the dynamics of demand and supply or by the scrap prices, and which factors actually determine demand and supply. **Knapp et al (2008)** investigates the probability of a vessel to be scrapped by creating a binary logistic model. The variables used to construct this model are based on economic data, such as earnings, second hand prices, and new building prices; on demolition data, such as location and price; on changes in ship particulars, such as ownership, flag, classification society, on ship safety inspection data, such as ISM audits, flag state inspections and vetting inspections; and finally causality data to reflect historic safety performance (p.3). It was created a distinct model for each ship demolition market (India, Bangladesh, China, Turkey and Pakistan) and the results showed: the ship's age and scrap prices coefficient are positive and significant with respect to the probability of being scrapped. The earnings' coefficient is negative and significant showing an indirect relationship. Regarding ownership the results were of different patterns; for unknown ownership there a positive effect with India, China and Pakistan, whereas for owners from developing nations there is great probability for ships to be scrapped in Pakistan. As to the flags the model showed a positive or negative effect toward each country. Moreover, **Mikelis (2007)** presented some statistical data which showed that recycling markets are cyclical in nature; that the average age of the ships, being recycled, has increased; and that these two facts might be explained by the increasing freight rates. So, Mikelis supposed a direct relationship between freight markets and recycling prices due to the similarity of the two time series.

However, he does not exclude the effect of the local demand for scrap to the determination of recycling prices. Additionally, Mikelis (2007) mentioned the price differentials in the major demolition markets due to differences in labor and environmental costs, and in internal demand for steel. Also, by the time the HKIC is implemented two markets will be created; one that satisfies the requirement of the convention and one that does not. So an economic model should be developed in order to be able to forecast the movements of supply and demand under the Convention. Regarding the connection between steel and scrap prices, and hence their function in the determination of recycling prices, **Xiarchos (2005)** proposed a model in order to examine the connection between primary and secondary (recycled) markets. Specifically, she studied the linkages between steel and scrap prices and found a bidirectional relationship along with a transmission of volatility. In other words, the variability of prices in the primary and secondary market are not uncorrelated and that the variability in the one is carried on the other, and vice versa. Overall, both Mikelis (2007) and Xiarchos (2005) detected the important role of scrap prices in the shape of the ship demolition market prices. Hence, a study regarding the scrap prices and how they are formed is very important in the research for the ship demolition market. Furthermore, **Mikelis (2013)**, in a recent paper put forward the importance of the ship recycling industry in the global production of steel and for the economies of the world's largest ship recycling markets, Bangladesh, India, China, Pakistan, and Turkey, who are the largest importers of steel in the world; whereas Europe and USA are the largest exporters. Specifically, he observed that the steel retrieved by ship recycling industry, globally, covers 1.5% of the needs of the global steel making industry. Hence, the steel industry is essential for the ship recycling industry, whereas the opposite is not true. These conclusions might give an insight in the determination of the ship demolition prices. For instance, in periods when the freight rates are high, ship-owners are reluctant in selling their ships for demolition, reducing the supply of ship scrap; therefore, the prices offered by ship recyclers should be higher, but should not exceed the price of the imported steel. Also **Buxton (1991)** supported that the ship-owner decides on whether to dismantle the ship or not according to the freight market conditions and to the recycling market offers.

Overall, the research regarding the factors that form the prices of the ship recycling industry needs to take into consideration not only the determinants of demand, such as freight rates, the average age of the ship, the cost of keeping an old ship, and supply, such as the supply of scrap ships and the internal demand for steel; actually the interested parties, i.e. ship-owners, ship recyclers, cash buyers, and the researchers should also take into consideration the steel-scrap prices, how they are related with the ship demolition market and how these prices are shaped. As a result by monitoring the scrap more accurate inferences could be made about the ship recycle industry.

This Graph below presents in a nutshell that the Demolition Prices, which are of major interest for the three parties involved in the demolition market (Ship Recyclers, Ship-owners, and Cash buyers), are determined by the demand and supply as shown in the Graph; however we shall be exploring the possibility that the equilibrium price achieved through the interaction of demand and supply is not the signal to which the three parties respond. The signal is the scrap prices to which demand and supply respond, and thereafter the price is formed, i.e. the equilibrium price is the result to this signal.



3. Data description and empirical methodology

3.1. Data Description

We collected monthly data from Clarksons' data base, GMS, and Bloomberg during the 2004-2013 sample period, for three shipping segments in the demolition market: the dry bulk, the product and the tanker. The Table that follows presents the definition of variables used.

TABLE 1

Data description

LTAV	logarithm of average china & india demolition prices for crude tankers
LSCRAP	logarithm of average eu and us scrap export prices
LCHINA	logarithm of Chinese growth rate
LDOLARYUAN	logarithm of the exchange rate dollar yuan
LCLARKS	logarithm of Clarksons profitability index
LPROD	logarithm of average china & india demolition prices for product tankers
LBULK	logarithm of average china & india demolition prices for dry bulk

TABLE 2

Descriptive Statistics

	LTAV	LBULK	LPROD	LCHINA	LCLARKS	LDYUAN	LSCRAP
Mean	5.966186	5.886207	5.950125	2.335586	9.959596	1.952388	5.768816
Median	5.988624	5.903490	5.968382	2.317596	9.965497	1.921325	5.746986
Maximum	6.486542	6.396461	6.472829	2.650421	11.10125	2.112635	6.476588
Minimum	5.500578	5.322604	5.417951	2.034706	8.693329	1.813195	5.090678
Std. Dev.	0.209392	0.219866	0.211370	0.167343	0.625462	0.097263	0.278752

3.2. Methodology

We use the General to Specific modeling (GETS). This method enables us to start with and then to simplifie a general congruent model, which effectively explains the empirical data within a theoretical context. Actually, GETS implements the theory of reduction in an empirical framework.

Specifically, this approach, which is also called "LSE" (London School of Economics approach), is about seizing the general model which adequately explains the important characteristics of the empirical dataset and then we reduce the general model by eliminating statistically insignificant variables, by testing the validity of the reductions in each stage in order to guarantee congruence at the final model. GETS allows, through the creation of computer algorithms by Hoover and Perez, automatic modeling. Such algorithms make sure that the general model is congruent, that the eliminated variables satisfy the simplification criteria and that the final model is also congruent. This is done by checking up to 10 different simplification paths; it chooses the model which variance-dominates the others in order to avoid choosing the wrong route.

Since the data generation process (DGP) is an unknown high-dimensional distribution, there are some variables which are of interest to the researcher and some are not. Hence the goal is to determine the value of these parameters in order to test for theories, do forecasting, etc. and reduce the DGP in order to obtain the effective model. However, the problem about reduction is whether information is lost about the parameters of interest. These reductions lead from the original DGP to the local DGP. The empirical model of these parameters should fit the local DGP; if not a more parsimonious representation is required.

Initially we test our variables for unit root by the ADF test and then once we establish that they are all integrated of the same order we perform johansen cointegration test (results will be supplied upon request) and using the GETS methodology we start from a general model with 12 lags in.

4. Empirical Results

TABLE 3

Tanker Demolition Price Determinants

Dependent Variable: D (LTAV)

Variable	Coefficient
C	-0.4468 (0.3322)
LSCRAP-LSCRAP(-2)	0.4190 (0.0327)***
LCHINA-LCHINA(-1)	1.7517 (0.4683)***
LDOLLARYUAN-LDOLLARYUAN(-4)	-1.1750 (0.5108)**
LCLARKS-LCLARKS(-6)	-0.0404 (0.0124)***
LTAV(-1)-LTAV(-2)	0.4755 (0.1013)***
LTAV(-1)-LTAV(-3)	-0.3111 (0.0616)***
LTAV(-1)	-0.5503 (0.0625)***
LSCRAP(-2)	0.5339 (0.0607)***
LCHINA(-1)	0.0938 (0.0601)
LDOLLARYUAN(-4)	0.5431 (0.1553)***
LCLARKS(-6)	-0.0651 (0.0158)***

R squared=0.8120 J-B=1.8706, p (value) =0.392,

LM=1.020, p (value) =0.6003,

WHITE=84.74, p (value) =0.2304

DIAGRAM I

Within Sample Forecast of Tanker Demolition Price

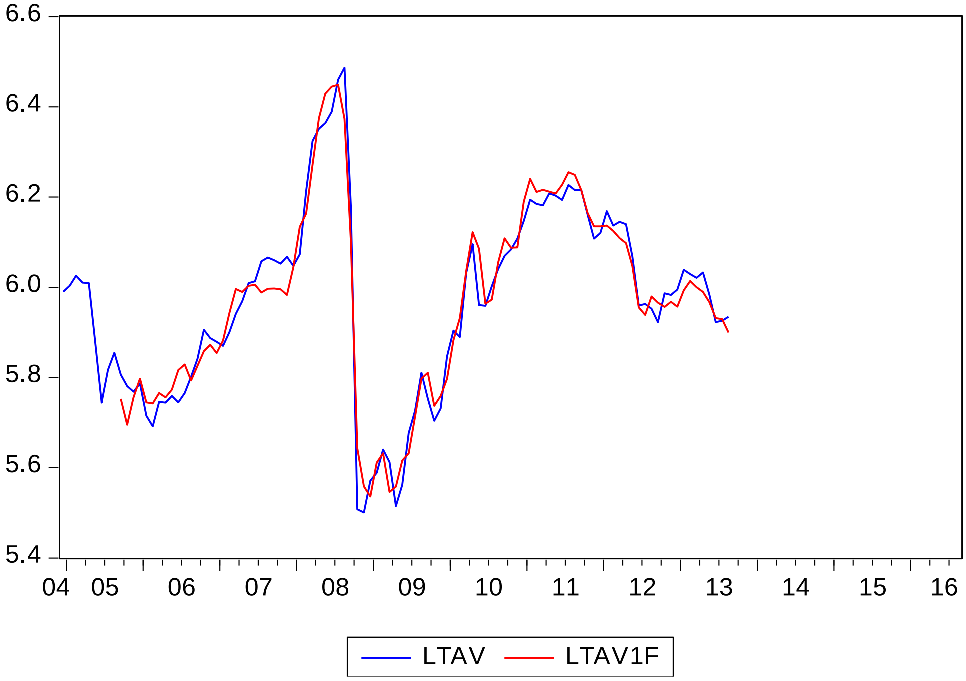


TABLE 4

Product Demolition Price Determinants

Dependent Variable: D (LPROD)

Variable	Coefficient
C	0.3684 (0.4401)
LSCRAP-LSCRAP(-1)	0.0974 (0.0456)***
LSCRAP-LSCRAP(-9)	0.0473 (0.0217)***
LDOLLARYUAN-LDOLLARYUAN(-4)	-1.4309 (0.4834)**
LCLARKS-LCLARKS(-6)	-0.0286 (0.0124)***
LCHINA-LCHINA(-1)	1.3815 (0.4372)***
LPROD(-1)-LPROD(-3)	-0.3068 (0.0442)***
LSCRAP(-1)	0.3728 (0.0416)***
LCHINA(-1)	0.1289 (0.0617)***
LPROD(-2)	-0.4558 (0.0340)
LDOLLARYUAN(-4)	0.2047 (0.1857)
LCLARKS(-6)	-0.0533 (0.0156)***

R squared=0.8126   J-B=4.5168, p (value) =0.1045,

LM=4.428, p (value) =0.1092,

WHITE=90.01, p (value) =0.13

DIAGRAM II

Within Sample Forecast of Product Demolition Price

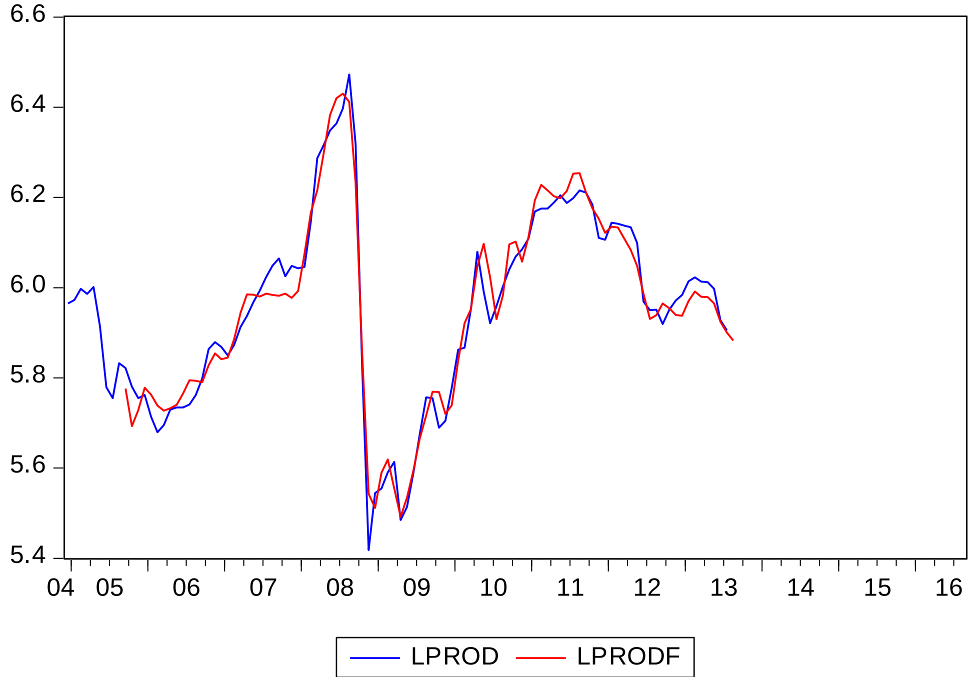


TABLE 5

Dry Bulk Demolition Price Determinants

Dependent Variable: D (LBULK)

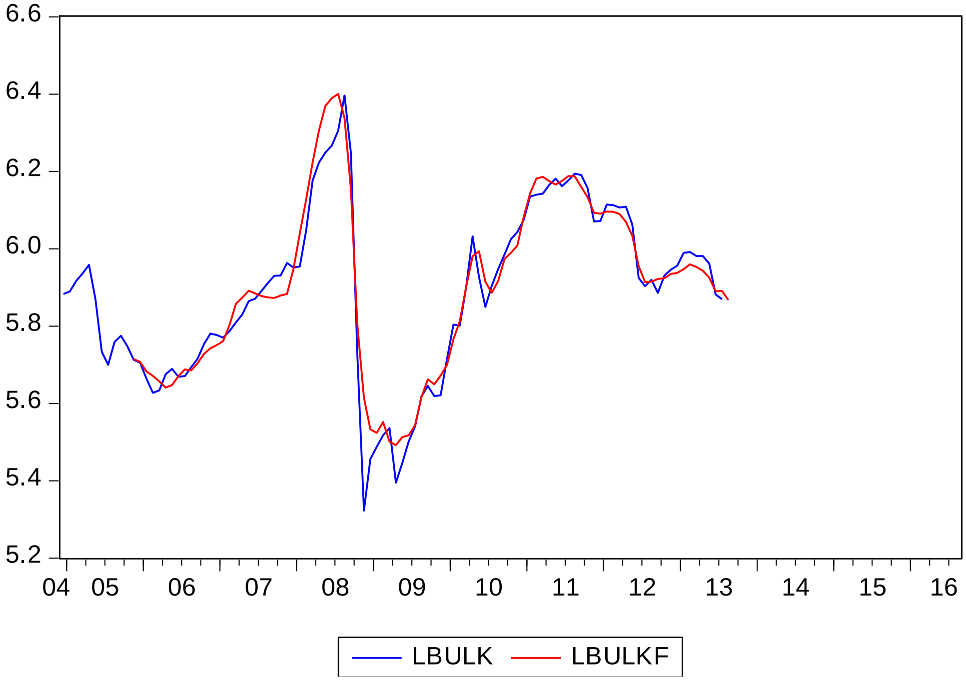
Variable	Coefficient
C	1.2388 (0.2966)***
LSCRAP-LSCRAP(-1)	0.1937 (0.0283)***
LDOLLARYUAN-LDOLLARYUAN(-4)	-0.8978 (0.3690)***
LCLARKS(-1)-LCLARKS(-2)	-0.0270 (0.0107)***
LBULK(-1)	-0.3180 (0.0322)***
LSCRAP(-1)	0.1784 (0.0262)***
LCHINA(-9)	0.1584 (0.0471)***
LDOLLARYUAN(-4)	-0.2965 (0.1217)***
LCLARKS(-6)	-0.0194 (0.0089)***
LCHINA-LCHINA(-11)	0.2140 (0.0553)***
VARIANCE	**EQUATION**
C	0.0001 (0.0001)
e_{t-1}^2	0.4648 (0.2028)***
h_{t-1}^2	0.4975 (0.1857)***

R squared=0.7114 J-B=1.3102, p (value) =0.5193,

ARCH=0.2703, p (value) =0.6031,

DIAGRAM III

Within Sample Forecast of Dry Bulk Demolition Price



5. Conclusion

The demand side in the price formation of the ship demolition industry matters because it helps the stakeholders, ship-owners, cash buyers and ship recyclers to form expectations about the direction of change in the ship demolition price. Our empirical investigation has shown that a primary determinant of demolition prices is the average export prices of scrap in the U.S and Europe,as they affect the internal demand for scrap in the developing countries,where demolition takes place.However,further research could be conducted in order to study a model which takes into consideration demand growth,exchange rates,or tank average earnings. Moreover,research could be conducted for other markets like India and Turkey, to have a global view for the formation of prices.Hence,not only the economic literature for the shipping industry will be enriched,but also ship-brokers and ship-owners will be able to make accurate strategic decisions in regards to ship demolition transactions. Overall,this research has been conducted in order to see from a different perspective the formation of ship demolition markets and encourage further investigation to reach conclusive results.

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