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Cyclical fluctuation in dry bulk market caused by non-supply/demand factors

Abstract

The cyclical fluctuation of the dry bulk market is one of the important subjects for the shipping industry. It is commonly believed that the cyclical fluctuation is caused by supply/demand factors. However, if a factor other than supply/demand also causes cyclical fluctuation, that would be very important for more precise market forecasts. This research tries to extract cyclical fluctuations having cycles longer than one year and not caused by supply/demand factors. The method used in this research is (1) eliminating short-term (less than one year) cyclical fluctuations in a spot rates and supply/demand factors through the moving average method, then (2) applying regression analysis to the result to estimate the portion of market fluctuation not derived from supply/demand. We applied this method to the Panamax market between 2009 and 2017, and discovered that there is a cycle lasting about three years. This cycle is roughly consistent with fluctuation of vessel contracts not caused by the shipping market. In addition, the cycle is about twice as long as the lag between a contract and a delivery of a vessel. These suggest that the cycle is related to vessel owners' ordering activity.

Keywords: *(4-6 keywords) drybulk, market, cyclical fluctuation.*

1. Introduction

In recent years, the shipping industry has started to give attention to analysing and/or forecasting shipping markets through statistical methods. For these analyses, industry analysts employ indicators of supply (related to the fleet), demand (related to cargo volume), costs (e.g. bunker prices, crew salaries) and sentiments (e.g., world/Chinese growth rate). Among industry players, both information providers and shipping companies are trying such an approach. The IHS Markit Freight Rate Forecast (IHS Markit, 2018) would be an example

provided by an information provider, and the collaboration between Maersk Tankers and CargoMetrics (Reuters, 2017) be an example provided by a shipping company.

There are various reasons why statistical approaches attract attention from the industry.

First, a general interest in statistical analysis has increased among business people (not limited to the shipping industry) because of a boom in AI and big data.

In addition, maritime database services have improved significantly and analysts can now retrieve more kinds of data items at a higher frequency (e.g., monthly, weekly, or daily) and earlier than before. One of the most significant examples is AIS data, which allow analysts to investigate markets based on almost real-time data.

Finally, dry bulk markets have become more stable than before and the industry's confidence in statistical methods has recovered. During the highly volatile market period around the recent shipping boom and bust, industry people were very sceptical whether statistical approaches could explain the markets.

The statistical approach that industry analysts employ is in line with the traditional understanding of maritime economics: select indicators from among above groups (e.g., supply, demand, costs, and sentiments) and explore them with a time-series model (VAR or more advanced one).

This approach well explains long-term market equilibrium. However, the actual markets often deviate from the equilibrium, and some of deviation is not random. Industry analysts need to explain such deviation and are trying many combinations of indicators and time-series models to explain these deviations, but some deviation remains unexplained.

Therefore, industry analysts are now giving importance to reviewing past achievements in maritime economics, because these knowledges may contain clues for deviations.

Cyclical nature of the market is one of the most important knowledges for this purpose. It is derived from both industry's anecdotal experience and maritime economics texts. Several cyclical fluctuations are known to occur at different frequencies. This paper focuses on a cyclicity that lasts more than one year, and is usually referred to as a "shipping cycle".

This paper also examines cyclicity caused by factors other than supply and demand. There are two reasons. First, within industry analyses supply and demand factors are considered to

be exogenous and investigated separately. Second, if a shipping market mechanism has such a cyclicity, a statistical analysis lacking that element will not obtain a valid result even if supply and demand information in the analysis is valid. And that is the situation industry analysts are facing.

There have been previous studies to break down the fluctuation of time-series into multiple factors and explain the characteristics of those factors. For example, Hylleberg (1992) tries to extract seasonality from a time-series and explain its characteristics. However, to the best of the author's knowledge, there has been no previous study to dissect shipping market fluctuation into supply/demand and non-supply/demand factors and investigate the characteristics of the latter.

The remainder of this paper is structured as follows: Section 2 introduces the preceding studies about cyclicity of shipping markets and effects of factors other than supply/demand on shipping markets. Section 3 presents the approach and data profile. Section 4 presents the result of an analysis that there is a cyclical fluctuation not caused by supply/demand factors. Section 5 presents a hypothesis to explain the cyclicity by how owners handle their orders. The final section concludes this paper.

2. Literature Survey

As noted in the last section, this paper presents two groups of preceding studies. One is about cyclicity of shipping markets. The other is about the effects of factors other than supply and demand on shipping markets.

As for the first group, cyclical nature of shipping markets is one of the most important topics in maritime economics and described in standard textbooks such as Stopford (2009) and Stopford (2010). Stopford (2009) presented a shipping cycle lasting five to 10 years (it describes a cycle lasting seven years as the shipping industry's 'rule of thumb'), based on historical data between the middle of the 16th century and the early 21st century. Stopford (2009) also presents a seasonal cycle and a long cycle lasting 60 years. Shipping cycles are mainly explained through supply and demand factors.

Hampton (1991) presents another approach familiar to shipping industry analysts by explaining shipping cycles through market psychology and sentiment. Two cycles are presented, one lasting three to four years and another continuing for 20 years.

Cyclic natures other than shipping cycles (e.g., lasting one year or less) have been also discussed in previous studies. Kavussanos and Alizadeh (2001) investigated seasonality in the dry bulk market and found there to be no evidence of stochastic seasonality even though a

deterministic one exists. Yin and Shi (2018) researched the nature of seasonality in the container shipping market.

In recent studies, spectral or frequency analysis are employed to find out cycles. For example, Chistè and van Vuuren (2013) used Fourier analysis to extract cycles from BDI and found two distinct cycles (4 years and 7 years). Also, Angelopoulos (2017) applied empirical mode decomposition (EMD) to BDI and found five distinct cycles (11.3-11.6 years, 3.4-5.3 years, 2.9-3.8 years, 1.4-2.3 years and 0.94 years).

For the second group, Glen (2006) provides an excellent overview: it is a survey on the development of econometric modelling techniques for the dry bulk and tanker markets and presents information what kind of factors are used. In general, previous studies regards demand (trade volume, ton mile), supply (size of fleet), and other markets (spot rates, time-charter rates, FFAs, markets of other ship sizes) as the most important factors to determine markets.

Beenstock and Vergottis (1993) present a model showing that freight rates are determined by the proportional difference between demand (ton mile) and supply (active fleet). Demand is considered to be exogenous. The active fleet is determined by an actual (physical) fleet and operational rate, which depends on freight, bunker price, and operating and lay-up costs.

Veenstra (1999) and Adland, Bjerknes, and Herje (2017) also consider the effects of multiple disaggregated trade flows as a determinant of shipping markets.

For other notable factors, Ishizaka, Tezuka, and Ishii (2018) employed a calibrated risk attitude of participants in shipping freight markets.

3. Methodology

This paper focuses on the market of Panamax size bulkers. This is because the Panamax market is the most liquid and competitive among all dry bulk vessel sizes (i.e., Capesize, Panamax, Handysize and Handymax). The markets of Handymax and Handysize are divided into different commodities and therefore less liquid than those of larger vessels. On the other hand, the Capesize market depends almost solely on the iron ore trade, especially between Australia/Brazil and China. Also, a few large mining companies hold large trading shares and therefore have a strong influence on the market. Therefore, the Capesize market is strongly influenced by these few shippers. The Panamax market has two major commodities (i.e., coal and grain) and these markets are integrated. Also, unlike Capesize, there are no players holding a large share.

The examined period starts in December 2008 when the market turmoil caused by the Financial Crisis has passed, and ends in May 2017, when stable data is available at the time of analysis.

The steps to separate the target fluctuation, which is not caused by supply/demand factors and has a cycle longer than 12 months, from the entire fluctuation of the Panamax market are as follows:

[Step 1.] The relationship between spot rates and supply/demand and non-supply/demand factors can be indicated as follows:

$$Y_t = \alpha \times SD_t + NSD_t \quad (1)$$

Where Y_t is the spot rate at time *t*, SD_t is the supply/demand factor at time *t*, α is the regression coefficient of Y_t on SD_t and NSD_t is the non-supply/demand factor at time *t*.

[Step 2.] SD_t is split into two variables based on length of fluctuation; the former SDL_t is a long-term trend with a 12 month or longer cycle. The latter $dSDL_t$ is a fluctuation with a 12 months or shorter cycle and defined as a deviation from SDL_t.

With the same method, NSD_t can be split into $NSDL_t$ and $dNSDL_t$. As a result, equation (1) can be rewritten as below:

$$Y_t = \alpha \times (SDL_t + dSDL_t) + (NSDL_t + dNSDL_t) \quad (2)$$

[Step 3.] 12-month moving averages are calculated both for left- and right-sides of equation (2).

$$ma12(Y_t) = \alpha \times ma12((SDL_t + dSDL_t)) + ma12((NSDL_t + dNSDL_t)) \quad (3)$$

Based on the definition, $ma12(dSDL_t) = ma12(dSDL_t) = 0$. Therefore, they can be eliminated from equation (2) as follows:

$$ma12(Y_t) = \alpha \times ma12(SDL_t) + ma12(NSDL_t) \quad (4)$$

[Step 4.] A regression coefficient α can be obtained from $ma12(Y_t)$ and $ma12(SDL_t)$ and the relationship can be written as equation (5), where η_t is a residual at the time *t*.

$$ma12(Y_t) = \alpha \times ma12(SDL_t) + \eta_t \quad (5)$$

[Step 5.] Based on equation (4) and (5), $ma12(NSDL_t) = \eta_t$ is found. These values are fluctuations not caused by supply and demand factors in cycles over 12 months.

The spot rate used in this paper is Baltic Panamax 4T/C, which is regarded as an industry standard. The value is logarithmic.

The supply/demand factor used in this paper is a ratio of cargo volume to fleet capacity.

Cargo volume is based on customs export statistics retrieved from IHS's online database "Global Trade Atlas". The volume is the total of major commodities from major export countries, listed in table 1:

Table 1 – Major export countries of Panamax cargoes

Commodity	Export Countries
Coking Coal	USA, Australia and Canada
Steam Coal	Australia, South Africa and Indonesia
Wheat	USA, Canada, Russia and Australia
Corn	USA, Argentina, Ukraine and Brazil
Soybean	USA, Brazil and Argentina

Fleet capacity is based on "Panamax Bulkcarrier Fleet Development (in DWT)" retrieved from Clarkson's online database "Shipping Intelligent Network".

In addition to the ratio of cargo volume to fleet capacity, below factors will affect supply and demand conditions:

- Non-operational period of vessels, caused by drydock, lay-up, or congestion
- Transport distance of each cargo (e.g. ton mile)
- Average speed of vessels.

This paper does not include these factors. This is mainly because it is difficult to obtain consistent data over the investigated period. In addition, these factors change gradually and do not heavily affect cyclical fluctuation lasting a few years. However, if this data will become available, it should be included in future studies.

4. Analysis Result

Before starting to investigate the outcome of last section, it should be confirmed whether regression on ma12(SDL_t) to ma12(Y_t) makes sense. As for the stationarity, both ma12(SDL_t) and ma12(Y_t) should have a unit root because of their definition as a moving average. However, the Augmented Dickey-Fuller Test shows that only ma12(Y_t) has a unit root (p-value= 0.2848) but ma12(SDL_t) does not (p-value < 0.01).

The result of linear regression produces a high adjusted R-squared value 0.9445. The result of the Dickey-Fuller Test for the residual is smaller than 2.2e-16, and there is cointegration. Those results suggest ma12(Y_t) has a close relationship with ma12(SDL_t) from a viewpoint of either coefficient of determination or cointegration.

Figure 1 shows how the actual spot rate (ma12(Y_t)) and the estimated spot rate ($\alpha \times$ ma12(SDL_t)) move during the examined period. Both lines decrease almost monotonically and move in a similar way, and often intersect.

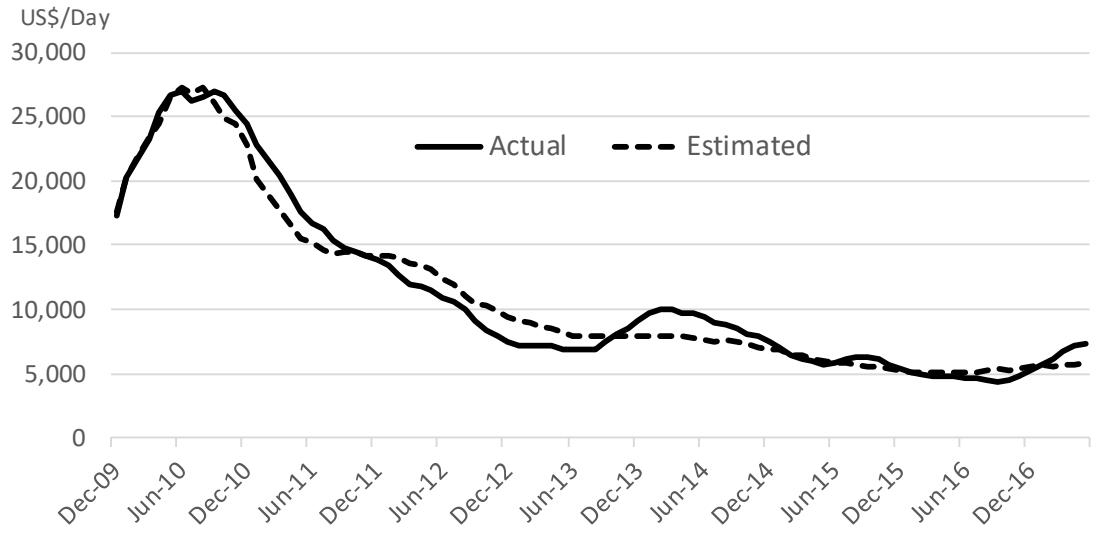

Figure 1 – Actual and estimated spot rates of Panamax

Figure 2 shows the movement of ma12($NSDL_t$), or difference between the actual and estimated spot rates in Figure 1. The amplitude of deviation is about 0.1, which means the actual spot rate is 25 percent higher than the estimated one.

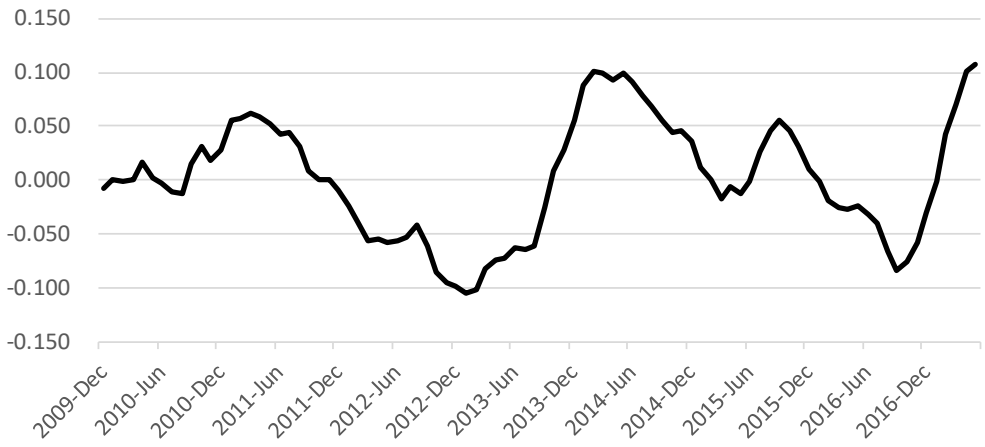

Figure 2 – Movement of ma12(NSDL $_t$)

The shape of the graph in Figure 2 suggests the existence of a cyclical fluctuation lasting three to four years.

Statistical analyses can reveal characteristics of the fluctuation.

First, randomness of increase and decrease in ma12(NSDL $_t$) sequence is tested. A runs test is used for this purpose. The result shows the changes in the sequence are not random (p-value = 0.0004665).

As the changes are confirmed not to be random, the autocorrelation coefficient of ma12(NSDL $_t$) is calculated. The result is as shown in Figure 3.

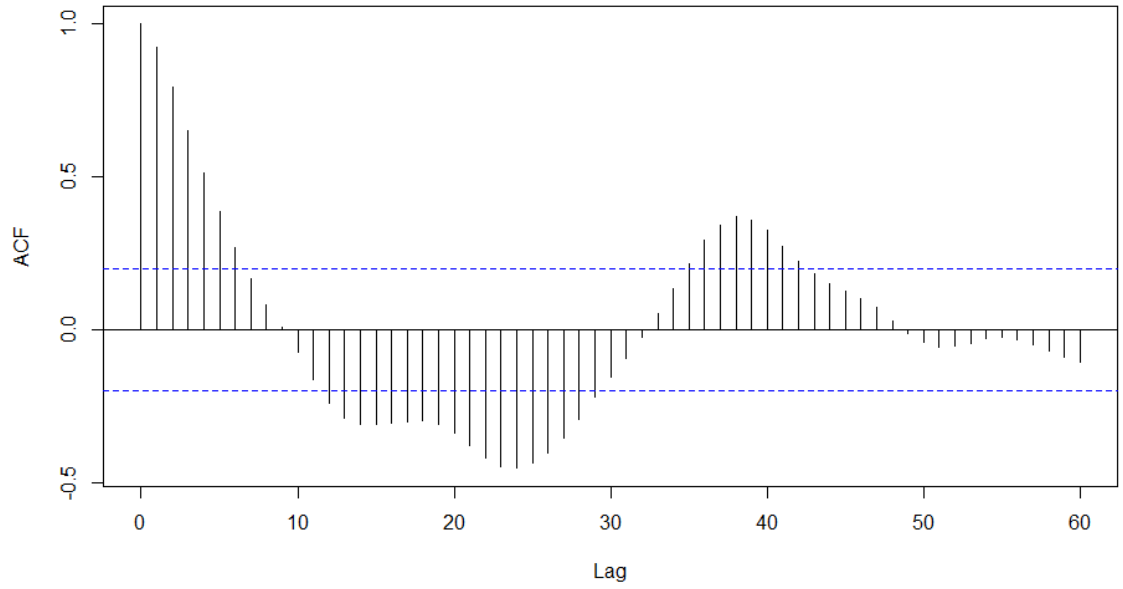

Figure 3 – Correlogram of ma12(NSDL $_t$)

The correlogram shows cyclicity. There is a significant negative autocorrelation with 12 to 29 months ago and the negative peak is 24 months ago. There is a significant positive autocorrelation with 35 to 41 months ago and the positive peak is 38 months ago.

5. Consideration on the length of shipping cycle

As indicated in the previous section, there is a cyclical fluctuation lasting about three years within the difference between actual and estimated (from supply and demand) spot rates. The length is almost same as what Hampton (1991) proposed. In addition, a cycle with this length is identified by spectral or frequency analysis in preceding studies, such as 4 years cycle in Chistè and van Vuuren (2013), and 2.9-3.8 years cycle in Angelopoulos (2017). These cycles may be identical.

To explain this cyclical fluctuation, this paper gives attention to vessel ordering activity. Ordering is usually thought to affect the market after the vessel is delivered. However, this paper tries to propose a hypothesis that ordering affects the market before the delivery by changing sentiment.

Figure 4 shows how ordering and delivery volumes of Panamax vessels changed during the examined period in this paper. Ordering (contract) and delivery volumes are 12 month moving average and based on "Panamax Bulker Contracting (in DWT)" and "Panamax Bulkcarrier Deliveries (in DWT)" retrieved from Clarkson's online database "Shipping Intelligent Network." For reference, 12 month moving average of Baltic Panamax 4T/C is also shown.

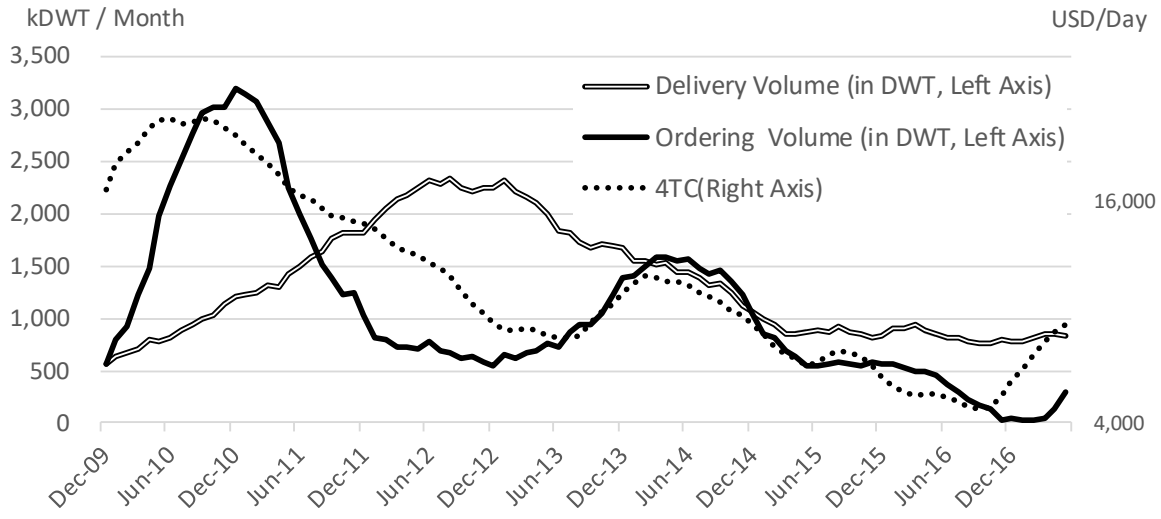

Figure 4 – Monthly ordering and delivery of Panamax vessels

From Figure 4, it is possible to see that an ordering volume changes along with a spot rate. Also, graphs of ordering and delivery have different shapes. This is because deliveries are subject to cancellation and delay due to circumstances of owners or shipyards.

In order to investigate the effect of market sentiment, residuals of a spot rate and ordering volume are calculated in similar way to the section 3. The residuals indicate the market sentiment on ordering activities which is not affected by the shipping market. The result is shown in Figure 5., along with the residuals of a spot rate and supply/demand ratio appeared in Figure 2. From figure 5, it is possible to see a cyclical fluctuation in residuals of a spot rate and ordering volume. Also, the cyclical fluctuation is somewhat similar to the residuals of a spot rate and supply/demand ratio.

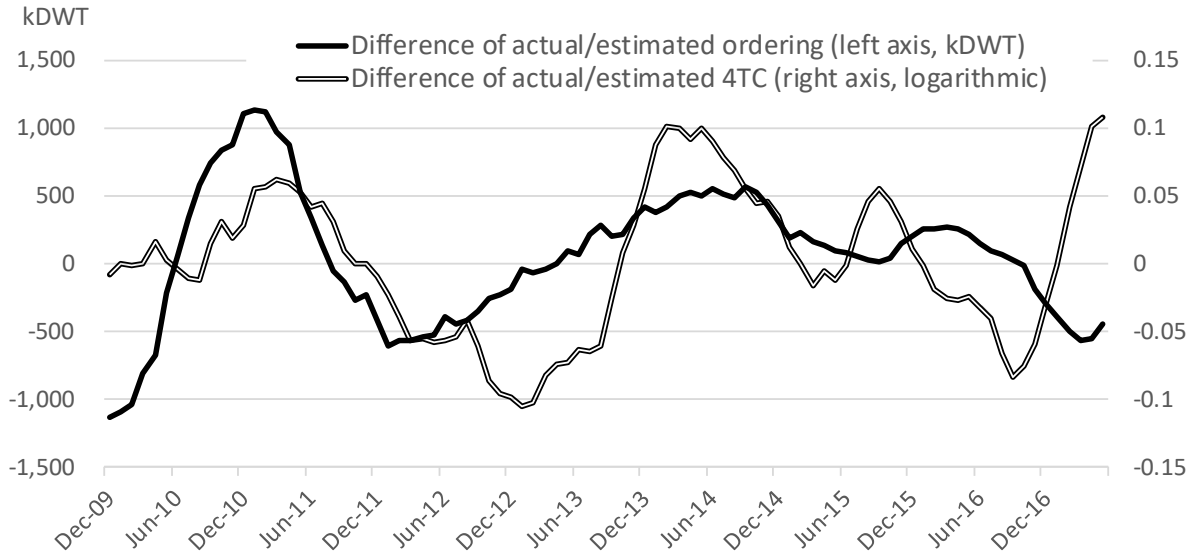

Figure 5 – Residuals of charter rates with supply/demand ratio and contract volume

One possible explanation of this similarity is that unknown factors affect the sentiment in the entire maritime industry, and the sentiment affects the shipping market and ordering activity. Another explanation is that shipping market and ordering activity affect each other and the interaction cause a deviation from estimated values in each market.

This paper tries to explain the possibility of the latter. A hypothesis on why fluctuation of these residuals has similar movement is provided below:

1. When owners' sentiment improves, they start to order vessels. Usually ordering activities are not immediately reported to the market. Therefore, owners cannot understand whether other owners are also ordering vessels at the time of contract.
2. A few months later, information providers (e.g., Clarksons) report these ordering activities, and owners now understand that there are more orders than the market

fundamentals allow, and their sentiment turns negative.
3. Some owners start negotiations for cancellation and delay delivery of their orders. These negotiations worsen sentiment of these owners, and then their negative sentiment spreads to the entire market.
4. When these negotiations finish, the sentiment of owners recovers, and returns to (1).

This hypothesis assumes that this cycle is caused by time lags in information movements affecting the decision making of owners. This implies this cycle may be a special form of Kitchin cycle. The length of Kitchin cycle is about 40 months and similar to this cycle.

6. Conclusion and Further Discussion

This paper examines the existence of cyclic fluctuations having a cycle longer than one year and not caused by supply/demand factors. By means of a 12-month moving average and linear regression, the target fluctuation is found to be around +/- 25 percent deviation from the reference spot rate (estimated from demand and supply) at its peak. The length is 37 months according to the autocorrelation coefficient analysis.

This result reveals that a shipping cycle is (partly) caused by factors other than supply and demand. Previous studies have referred to this point qualitatively but have not investigated quantitatively. This study covers only a limited period of the Panamax market and further studies should extend coverage to other vessel sizes (e.g., Capesize) and periods.

Also, it should be examined in further studies whether more detailed models of spot rates and supply/demand factors produce the same result. This study employs a very simple model, assuming only one-way correlation from supply/demand ratio to spot rate and considering no time lag effects. More detailed formulation may produce a different result.

Another implication of the result is that the fluctuation resembles the deviation of Panamax ordering volumes from estimation by spot rates. This study proposed a hypothesis that these two cycles affect each other through owners' sentiment. In further studies, this hypothesis should be verified in more strict way and compared with other hypotheses.

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