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Forecasting bunker prices; A nonstationary, multivariate methodology

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ABSTRACT

This paper suggests a methodological approach for the forecasting of marine fuel prices. The prediction of the bunker prices is of outmost importance for operators, as bunker prices affect heavily the economic planning and financial viability of ventures and determine decisions related to compliance with regulations. A multivariate nonstationary stochastic model available in the literature is being retrieved, after appropriate adjustment and testing. The model belongs to the class of periodically correlated stochastic processes with annual periodic components. The time series are appropriately transformed to become Gaussian, and then are decomposed to deterministic seasonal characteristics (mean value and standard deviation) and a residual time series. The residual part is proved to be stationary and then is modeled as a Vector AutoRegressive Mooving Average (VARMA) process. Finally, using the methodology presented, forecasts of a tetra-variate and an octa-variate time series of bunker prices are produced and are in good agreement with actual values. The obtained results encourages further research and deeper investigation of the driving characters of the multivariate time series of bunker prices.

1. Introduction

The maritime industry is confronted with high risks. Shipowners, ship operators, charterers and related parties are exposed to the fluctuation of vessel (asset) prices, interest rates and currencies, as well as of freight rates and bunker (marine fuel oil) prices. These fluctuations impact on the financial viability of their ventures as they determine their cash flows. There is a pressing demand for further investigations into bunker prices, since almost 80% of the total volume of the international trade is carried by the sea (UNCTAD, 2009, p. 2). As per Stopford (2009, Table 6.1, p. 224), the average bunker costs for a tramp ship is close to 42%; this calculation is based on a price of 300 USD per tonne. For higher prices, such as 600 USD per tonne, this percentage is higher. Furthermore, Notteboom and Vernimmen (2009, p. 334) reports percentages close to 60% of the total cost for containerships, considering the bunker prices of 2008 and 2009, so this percentage is also higher considering the increased bunker prices of the recent years (2011–2013). As bunker expenses constitute a high percentage of the financial exposure, several operational and financial tools have emerged in an attempt to mitigate these risks. A typical operational measure is slow steaming, i.e. the reduction of operating speed that results to a substantial reduction of the consumption (Corbett et al., 2009; Cariou, 2011; Kim et al., 2012; Lindstad et al., 2013; Psaraftis and Kontovas, 2013). A strategic option is the acquisition and operation of new ships; their hulls and engines are technologically more advanced and consume less energy (Duran et al., 2012). It is highlighted that the reduction of energy used for a given transport work implies less CO_2 emissions, thus setting the ship and its operation within the international air emissions regulations of

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MARPOL Annex VI. Briefly stated, MARPOL Annex VI regulates the air emissions from ships, both Green House Gases (GHG) such as CO_2, and nonGHG pollutants such as SO_x. The abatement of CO_2 and SO_x emissions is achieved mainly by increasing the fuel efficiency and by using fuels with low sulfur content; the so-called Low-Sulfur (LS) bunkers, instead of the conventional High-Sulfur (HS) ones (Ma et al., 2012; Yang et al., 2012). There is a substantial price difference between the various types of HS and LS fuels that also dictates some of the operational and compliance decisions of operators (for further analysis see Schinas, 2013). Finally, hedging against bunker price fluctuation constitutes a financial option for mitigating the associated risks. Considering the large amount of money involved in shipping, efficient forecasting of the bunker prices could enhance the financial outcome of the shipping ventures and related hedging strategies.

There are various categories and classifications of fuels. The classification of the International Standard Organization (ISO) protocol ISO 8217(E), as amended in 2005 and 2010, categorizes all fuels on the basis of "distillates" and "residuals". We consider it out of the scope of this work to discuss further issues of viscosity and density here. However, this discussion could interest scientists with a focus on the physical properties of fuels.

In the maritime business there is neither firm nor strict classification, and common practice leads the discussions.

The common classification of marine bunkers is the following (see, e.g., http://en.wikipedia.org/wiki/Fuel_oil, accessed October 1, 2013):

(i) MGO (Marine Gas Oil): It is made by distillate only. It can also be used as home heating oil.
(ii) MDO (Marine Diesel Oil): A blend of heavy gasoil that may contain very small amounts of black refinery feed stocks, but has a low viscosity up to 12 cSt so it does not need to be heated for use in internal combustion engines.
(iii) HFO (Heavy Fuel Oil): High-viscosity residual oil, requiring preheating to 104–127 °C.
(iv) MFO (Marine Fuel Oil): Same as HFO (just another "naming").
(v) IFO (Intermediate Fuel Oil): A blend of gasoil and heavy fuel oil, with less gasoil than marine diesel oil.

These products differ greatly in quality (which affects the operation of the engines of vessels) and the price mainly, and also in storage, service, regulations, etc.

Ships are commonly powered by large diesel engines for navigation, while the secondary electrical power is provided by auxiliary engines which generally use diesel oil. Thus, two different types of fuel are used on board, and, for economic reasons, operators tend to use less expensive fuels with acceptable performance though at a higher environmental (external) cost. The recent international (Marpol Annex VI) and European environmental regulation also determines the content of sulfur, so LS oils contain less than 1.5% instead of the high sulfur HS ones, which contain less than 3.5% per mass sulfur. The main ports for bunkering are: Rotterdam, Houston, Fujairah and Singapore, as well as Gibraltar, Cristobal and Balboa close to Panama Canal navigational corridors. Based on recent data, a picture of the volatile character of the bunker prices is illustrated in Fig. 1.

Fuel prices vary according to type, the products being more expensive the closer they are to the lighter fractions of distillation and therefore have less residual fuel ratio. The price fluctuations are very significant between the different kinds of fuel. The implications of restrictions on sulfur emissions immediately imply an increase in fuel costs. LS-fuel prices are closely correlated to the HS-fuel ones with correlation coefficient R^2 close to 98%, implying that if the future prices of HS-HFO are estimated then the LS-HFO can be also forecasted, so operators can better plan their daily routines and manage their

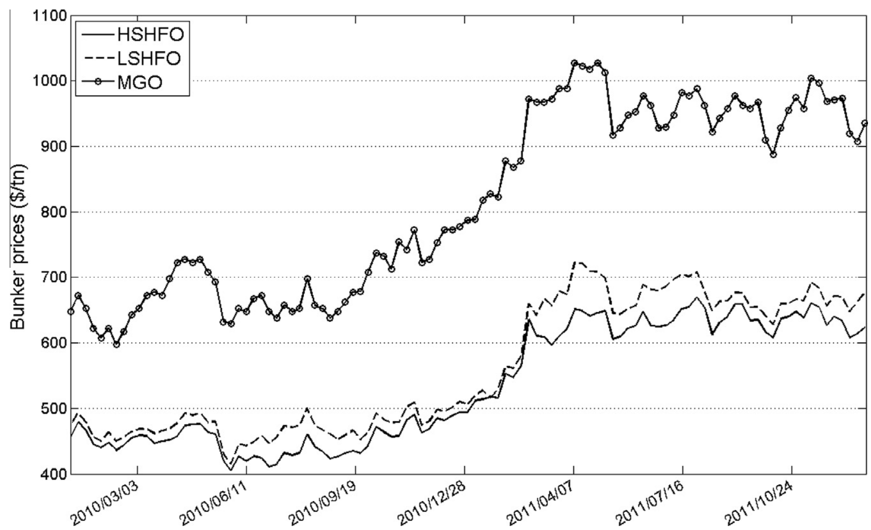

Fig. 1. Example of weekly prices of high sulfur heavy fuel oil (HSHFO), low sulfur heavy fuel oil (LSHFO), and marine gas oil (MGO) in the port of Rotterdam.