

Forecasting model for dry bulk sea freight

Facilitating Lantmännen to make better procurement decisions

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This article is a summary of a master thesis written at the Division of Engineering Logistics, Department of Industrial Management and Logistics, Faculty of Engineering, Lund university. The master thesis was initiated as a result of an identified need of increased understanding of the sea freight market within Lantmännen's sea freight procurement organization. The main purpose of the thesis was to develop a price prediction model. The model should provide Lantmännen with information that facilitates better decision making when procuring sea freight services. A secondary purpose was to develop a process for the development of price indices and forecasting models. This article presents a background of the problem and describes how the model was created.

Introduction

Lantmännen is one of Nordic's largest companies within food, energy, machinery and agriculture. The company is engaged in business activities throughout the whole value chain: "from field to fork".

For Lantmännen, sea freight is the second most used transportation method after road transport. Lantmännen purchases, approximately, 1300 separate ship freights yearly, with an average load of 1700 ton per ship. On average Lantmännen yearly ships 2.8 million tons, mainly grain and input goods to feedstuff production on dry bulk ships.¹

Lantmännen had identified a need to better understand what is affecting the freight rates, for sea transports, offered to them by shipowners and shipbrokers. In order to help them get an increased understanding, an investigation of how the rates are constructed was needed. This investigation early identified

a fact about the freight rates that came to influence the whole process of the project. This was that the freight rates are built on two main factors: the actual cost that the shipping will inflict on the shipowners and the current market situation. The cost needs to be covered by revenues, in the long-term, to keep the companies from going bankrupt. While the market situation, especially the balance between supply and demand, decides the size of the shipping companies' profit margin. The main explanation for this structure is that dry bulk shipping has a low level of differentiation, and has a tough price competition.² Later in the process the knowledge of this structure lead to the creation of two separate models; one for cost and one for the market situation.

The remaining part of this article will explain the development of the freight rate forecasting model, by discussing the process used and by giving some examples of results.

¹ (Seppä, 2010)

² (van Weele, 2005)

Methodology

The study was conducted with an abductive approach, with an initial focus on broad qualitative data collection followed by a deep quantitative analysis of the collected data.³ Finally, these two steps resulted in the creation of the forecasting model (see Figure 1 for the overall process).

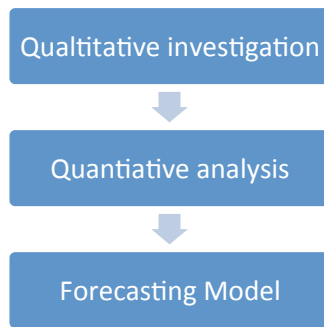


Figure 1: Overall methodology

The qualitative step involved literature research and interviews performed with Lantmännen, shipowners and shipbrokers. The quantitative step contained regression analysis as the foundation of the model building. Later in the quantitative process, accuracy tests of potential models, including both residual and forecasting ability analyses was made.

In this master thesis, the choice was made to create a casual model, or more specifically a multiple regression model. This since the overall focus of this master thesis was to create a forecasting model for the freight rate movements, which requires a quantitative model. Also, there were strong evidences that the freight rates being modeled were dependent on a number of explanatory factors, a characteristic that is captured by a regression model.⁴

Result of data collection

In the data collecting step, industry and expert knowledge about the shipping industry was collected through interviews and literature review. This resulted in a collection of cost, demand and supply factors – for the northern European market of dry bulk sea freight. In the following step of the process these factors were used to create a cost model and a demand & supply model.

Perhaps the most important finding, from the qualitative investigation, was the difference in nature between the two mayor routes used by Lantmännen. Export shipments, where goods leave a Swedish port for a port outside of the Baltic Sea, has a completely different competitive structure than import shipments moving in the opposite direction. The demand for export shipments is normally significantly higher than for import shipments. Hence, the competition for the import shipments is tougher and the freight rates generally lower for the import transportation buyer (e.g. Lantmännen).⁵

The finding of the imbalance between the export and the import goods flow led to the decision to create two separate forecasting models.

Development and design of Forecasting model

The forecasting model was constructed by combining two separate models: the cost model and the market model.

The cost model was constructed based on the result from the qualitative data collection, i.e. by using the cost factors identified in interviews with shipowners and literature review. The model was designed to be able to calculate both fixed and variable costs for any ship and on every route used by Lantmännen. Hence, the profit for each ship, route and time

³ (Holme & Solvang, 1997)

⁴ (Firth, 1977)

⁵ (Shipbroker, 2010)

period could be calculated by subtracting the calculated costs from the stipulated freight rate. The profit for each shipment made by Lantmännen between January 2008 and November 2010 was calculated, and the average profit for each month was compiled to be used as a time series representing the market situation for each time period. Two separate time series were created, one for the export and one for the import flow.

The market model is a regression model constructed to accurately model these monthly average profit time series. The market model was created by finding sensible combinations of the demand and supply factors found in the qualitative investigation (the categories of factors used are summarized in Table 1).

Table 1: Market Factors

Categories for market factors	
Deep sea freights	Grain Price
World Economy Growth	Ore Price
Chinese Import/Export Activity	Coal Price
Mineral Industry	Scrap Metal Price
Wood Industry	Other Commodity Prices
Agriculture Industry	Exchange rates
Construction Industry	Interest rates
Bunker Fuel Price	Inflation rates

The suitable regression models were decided upon by using a combination of mathematical algorithms and logical tests. Where the algorithms were used to find suitable model candidates, based only on their mathematical ability to replicate the market effect.⁶ While the logical tests verified that the models were in line with the theoretical relations between factors and the market situation, found during the qualitative data collection, e.g. increased

⁶ (Makridakis, Wheelwright, & Hyndman, 1998)

commodity prices should have the effect of increasing the freight rates.

The market models had in total nine different indices as underlying components (see Table 2), but only five was used for each individual model.

Table 2: Used Factors for the Market model

Market Model Factors Used
Cocoa Price Index
CRB Metal Spot Price Index
Dow-Jones Commodity Spot Price Index
Euro Area Bond Yield Corporate
Rapeseed Crude Oil Price Index
S&P China Index
S&P Commodity Spot Price Index
STOXX Europe Mining Index
Sweden Bond Yield Corporate
Bunker Oil Price
Euro Repo 3 Month Interest Rate

Besides logical tests, a comprehensive residual analysis was performed on the potential market model candidates, to verify that the assumptions of independent, heteroscedastic and normally distributed residuals were fulfilled. The results of the residual analysis indicated that the stability of the market model could be assured.⁷

When the market model was finalized it was merged together with the cost model to create the final forecasting model that was to be used by Lantmännen. The forecasting model was designed to give both 3 month and 6 month forecasts of the freight rate. The forecasting tool displays both an overall price forecast in percent and a price interval for certain example routes.

Evaluation of Forecasting model

The model was built on the first 28 of total 35 observed months of freight rates. Hence, it was possible to validate the forecasting ability by comparing the values of the model with the

⁷ (Makridakis, Wheelwright, & Hyndman, 1998)

last seven months; from May to November 2010.

Different ways of validating the accuracy of the models were used. The Mean Absolute Percentage Error (MAPE) and the Mean Square Errors (MSE) for the last 7 months were calculated to get a quantitative measurement of the forecasting ability. Also plots were used to be able to review the model's ability to forecast the overall trends of the market.

The overall results from the accuracy tests were that the model showed a good ability to accurately forecast the overall trend of the market. Where the three month forecasts showed a better prediction ability than the six month forecasts, which however was expected because of the doubled prediction horizon.

Even though the model has an overall good prediction ability there are some general limitations that should be kept in mind when using the regression models. One such limitation is that the model was created during the financial crisis, and might hence have less accuracy in the future when the market is more stable. Also, forecasting is based on the assumption of continuity, which assumes that previously observed patterns will continue also in the future.⁸ However, the market conditions and relations in the long-term will most probably change, with the effect of potentially decreasing the accuracy and relevance of the model.

Conclusions

The forecasting model was developed and tested with good results and if Lantmännen uses the model as intended they will acquire new knowledge that will help them make better decisions when purchasing sea freight services. By using the model's forecast of the

freight rate, Lantmännen will be able to create more rational procurement decision strategies.

The second purpose of the master thesis was to develop a process for the creation of forecast models. This purpose was apparently fulfilled since the process used, to structurally develop the model, was successful.

Even though the process developed in this thesis showed good results, it might not be possible to apply to all situations. This since the structure for the model, where freight rates are divided upon costs and a demand and supply effect, was based upon findings about the nature of the dry bulk sea freight market. The process should however be valid for developing price indices for those markets where there generally is a low differentiation in offered products or services.

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⁸ (Makridakis, Wheelwright, & Hyndman, 1998)