APPLICATION OF FORECASTING IN SHIPPING INDUSTRY

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Abstract

The Product life cycle for a commercial ship is often more than 30 years. The lead-time in designing and manufacturing a ship is often a few years. By the time the ship is built and put into operation, the situation in the market could be very different than when the decision was made to build the ship.

Shipping is a capital intensive business and a good knowledge of ship life cycle and its management is crucial in avoiding losses or making gains. These gains and losses could be substantial. Shipping is often a huge investment which needs to be safeguarded against future trends of supply and demand. To this end, forecasting techniques could help in looking into future and aiding the decision making process.

The research presented in this paper is an attempt to forecast trends in shipping for 11 types of ship design in the last few decades by using conventional and neural networks. In this paper only the results for the bulkers will be presented. The results show that neural networks offer the best results and that it is possible to use information available in the market to complement and improve the reliability of neural network predictions.

Keywords: Shipping, product cycle, forecasting, neural networks.

1. Introduction

Recent statistics, presented in Table below (Clarkson, 2004), show that Bulker fleet has increased from 140.7 million dwt (dead weight tonne) in 1980 to 294.7 million dwt in 2003. This trend is in line with the trend for the total world fleet.

YEAR	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
BULKERS million dwt	140.7	144.5	158.4	171.9	181.0	191.9	197.0	196.4	195.7	197.3	203.4	211.0
YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
BULKERS million dwt	214.2	214.7	219.0	227.4	243.1	253.1	263.8	263.5	266.3	274.9	286.6	294.7

Table 1. Fleet Development - Bulkers

The lead-time in designing and manufacturing a vessel, as well as planning for its management and operation, is normally 18 months. By the time the ship is built and put into operation, the situation in the market could be very different than when the decision was made to build the ship. The supply and demand are not the same for a given design of ship. It can be seen that while the demand for tankers could increase in a given period, the demand for a particular type of a cargo ship could decrease in the same period.

The research included both conventional as well as artificial intelligence methods. The data given in Clarkson (2004) was used to test conventional forecasting techniques as well as an already proven neural network forecasting model (Ziarati, 2003) for 11 different types of vessels but in this paper only results for Bulkers are presented.

The research commenced with what needs to be predicted by looking at types of vessels and what is being transported. The main variables were identified and their effects on demand for products and types of vessels were investigated. The initial work also included searching for sources of data which could be used to analyse trends and in the prediction of demands. An attempt has been made to understand cyclical factors and regional developments (Stopford, 2007) as well as special constraints such as lead-time for provision of products and services as well as designing and building ships.

The research involved two models under construction. One is a conceptual model of the shipping industry and the market as a whole so that all types of variables could be identified. Number of these variables and the amount of data needed could be extracted from elements of this conceptual model. The second model is an analytical one developed to assist in designing experiments, selecting forecasting methods, and developing structures for these methods. Both models have provisions for adding intelligence to forecasting methods which is expected to provide a more accurate and reliable forecasts. However in this paper only the second model is presented.

While several papers and books by various scholars were referenced, since the work of Ziarati (2003) is of most relevance, his thesis was carefully read. Furthermore, rather than re-inventing the wheel a good use was made of how he applied forecasting to his particular area of interest. His experiments were adapted for application in estimating and predicting future demands for a range of vessels. The intention is not to rely primarily on Ziarati (2003) but to apply his neural network model in a new application and also use the method he has developed to identify sudden changes in demand and provide a mechanism for corrective action. Furthermore, work by researchers such as Stopford (2007) is of a particular interest. He has considered many factors effecting sea trade such as growth of Gross Domestic Product at various geographical locations, economic expansions and contractions in these regions, reviewing raw materials and growth of cyclical factors relating to resources such as supply crisis and price hikes. In parallel he has considered ship building cycles and based on these and related data he has predicted demand for the next 50 years in sea trade. Consideration of both approaches is in line with the work of Hanke (1998) who argues that most affective forecaster is able to formulate skilful mix of quantitative forecasting techniques and good judgement and to avoid the extremes of total reliance on either. It is for this reason that the work by Ziarati and Stopford played a role in the research conducted.

2. Forecasting Techniques

Conventional Methods - Three types of conventional methods were used: correlation, regression and time series (moving averages and cyclical corrections). There are many other techniques which in the majority of cases either rely on one of these techniques (or a variation) or a combination of them. There are several other methods such as percentage errors, probability methods, etc. A good account of them is given in Ziarati (2003).

Neural Networks – In the majority of cases there is not sufficient data to predict accurately the future demand for a product or service. To this end, neural network systems have become more popular (Holland, 1975).

The main reason for the popularity and recent prominence of neural networks is that they are basically learning mechanisms and are capable of handling a large amount of data and coming up with reliable outcomes provided the network is carefully constructed, trained and tested. This ability to learn 'seemingly large amount of abstract data and to interrelate different sets of information' makes them ideal tools for forecasting (Ziarati, 2003; Chua and Yang1988).

3. Results and Discussions

The theory of forecasting techniques including how the neural network works is fully described in Ziarati (2003). The purpose of the work presented here is to establish if methods used by Ziarati can be adapted to predict supply and demand for sea transportation of wet and dry cargoes and review the work by Stopford to assess if reliability of forecasts, using market and regional development plans, could be improved.

Correlation

Extracting from Clarkson (2004) the data for Total World Fleet million dwt (x) - capacity and World Seaborne Trade million tonnes (y) - demand and applying the expression given by Ziarati (2003), the following table was obtained.

YEAR	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
Total World Fleet million dwt (x)	565.3	562.1	561.1	570.1	585.5	603.2	615.7	623.6	613.4
World Seaborne Trade million tonnes (y)	3630	3629	3900	4166	4151	4190	4325	4528	4641
YEAR	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
Total World Fleet million dwt (x)	633.8	650.6	665.8	685.1	696.2	706.0	725.4	742.1	762.2
World Seaborne Trade million tonnes (y)	4800	5048	5318	5321	5446	5705	5840	5894	6149

Table 2. Fleet Development

It is interesting to note that correlation coefficient is found to be 0.98 which shows that the World Sea Trade and the Total World Fleet have a linear relationship for the period considered. This is an astonishing result because the two sets of figures are calculated independently and a linear relationship means that demand and capacity are mathematically related.

Forecasting Capacity

Experiments were designed for applying a series of methods such as correlation, regression and time-series as well as neural networks for period 1988-2003 but for brevity only comparison of the results for mid-range 1988-1992 are shown.

Comparisons of forecasting methods

Forecasting Method	Max negative % error	Max positive % error	Average % error
Correlation	0.00%	0.510%	0.50%
Regression	-1.78%	0.26%	-0.45%
Seasonal variations	-1.78%	0.36%	-0.40%
Neural Network	-0.58%	0.78%	0.23%

Table 3. Comparisons of forecasting methods

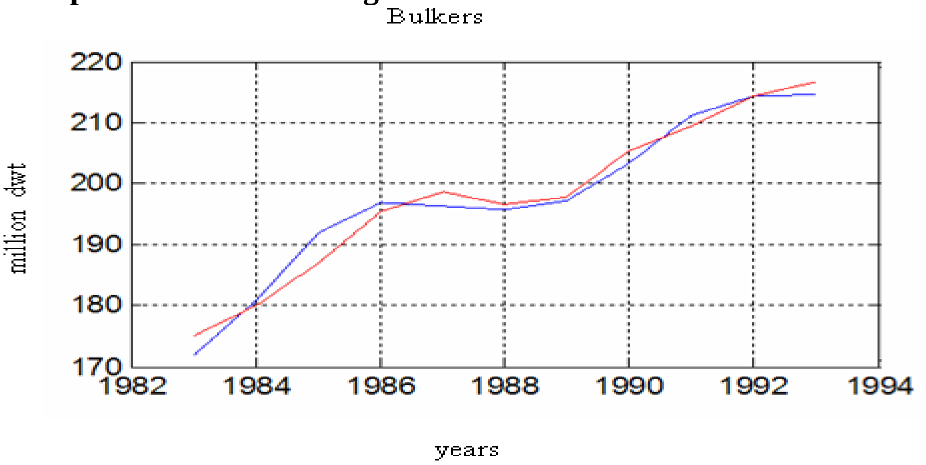

Figure 1. Graphical Presentation of Trends for Bulkers

4. Conclusion

As can be seen from the results given in the table of comparison neural networks produced the least percentage error. To this end, the results show that neural networks is a possible method for consideration for forecasting capacity and demand in shipping. Having established that neural networks produces the best results in a linear range (1988-1994) for Bulkers, similar experiments were designed for all other vessel types. Some vessels had highly non-linear characteristics. Similar graphs to the one shown above were obtained for all other types of vessels and again neural networks produced the best results with good correlation between actual and predicted trends.

The actual and predicted results using neural networks as shown are remarkable. To be able to predict sudden changes Ziarati's (2003) poka yoke method was applied to identify deviation from the predicted trends, and using his correction method, based on Exponential Smoothing, trends were corrected accordingly.

In the figure shown (Stopford, 2007) below, expansion and contraction in various geographical locations could be investigated and estimates of sea trade could be refined. Forecasting millions dwt for various ships or cargoes, requires a knowledge of the past and seaborne trade cycles and this could give an insight into future trends or lead to cause/reason for a given deviation.

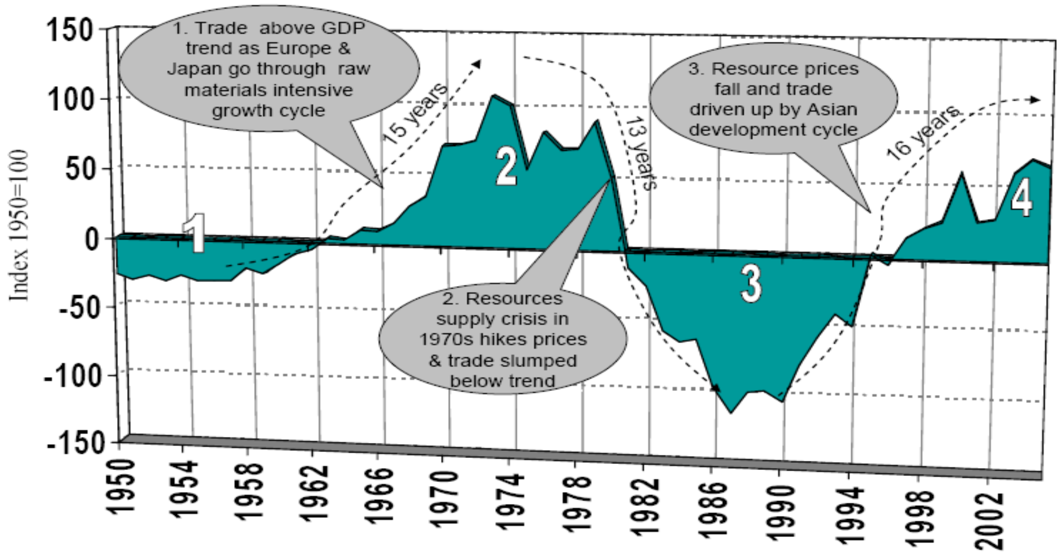

Figure 2. Seaborne Trade Cycles as Deviation from Trend 1950-2005

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