Using Neural Networks to Forecast Rubber Prices

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Abstract

This paper investigates the performance of two neural networks models in forecasting rubber prices. The three-layer perceptron neural network with nonlinear sigmoid transfer function is employed to establish the relationship between inputs and outputs. Time series data of rubber prices were collected from Rubber Research Institute from 2001 to 2003. Also, a set of time series data of yen currencies exchange rate extracted at the same period has been selected as input data into one model in order to compare the results with the competing model. To compare the forecasting accuracy, root mean squared error (RMSE) and mean absolute percentage error (MAPE) are employed to ascertain whether one model forecasting predicts significantly better than another model. The research findings indicate that the neural networks model that allowed the inclusion of external information or the multivariate time series forecasting model (Model B) performed better than the single time series forecasting model (Model A).Additionally, the possible research directions are also discussed in the paper.

Keywords: Time series, Neural networks, Rubber prices, Back propagation, Sigmoid function.

1. Introduction

Natural rubber is regarded as an important agricultural commodity vital for the manufacturing of a wide variety of products and new materials. The increasing volumes of rubbers are being produced, consumed and exported. Thailand has become one of the world's largest producing and exporting country. Therefore, it is essential to have a potential tool for predicting rubber prices for producers and consumers. The reliable price forecast is desirable for both buying and selling agents. Furthermore, the prediction over time horizon will be beneficial for the Thai government and relevant agencies for making short- and long- term planning policies in this industry.

Traditional short to medium time–series forecasting are generally based on statistical quantitative approaches such as exponential smoothing techniques, Box and Jenkins method and so on [1, 2, 3, 4]. However, there are not many applications of statistical techniques to predict behaviour of rubber prices in Thailand. Supasiripinyo [5] proposed econometric model to study the fluctuation of rubber smoked sheet prices. Recently, Chatchaipun and Atthirawong [6] employed Box and Jenkins and transfer function models to predict rubber smoked sheet prices and compared the accuracy of both models. It was revealed that transfer function model has performed better than Box and Jenkins model.

Although those statistical approaches have been used in almost areas, many still have some limitations. For instances, these models are required human interactions and evaluation during the process. It has been argued that neural networks could overcome these advantages [7, 8, 9]. The neural networks method requires only enough data to create the relationship between input and output time series data. Likewise, it is not necessary to determine the form of a formula into the model.

Moreover, the model itself does not oblige any assumptions about underlying population distributions. Also, it has been widely used as nonlinear mapping techniques for statistical models. They are valuable where the systems are nonlinear or input is missing and high correlated. Applications of neural networks have been reported in many diverse areas ranging from classification, predictions to clustering arena. For prediction ability, the techniques have been successfully applied in various fields, such as economic studies, science and engineer. Since it has received considerable attention in the early of 1940's, the applications of the rubber prices, especially in Thailand, are relatively rare. Accordingly, the main objectives of this paper are as follows:

- to compare the results of neural networks models between one and two time series of input data set;
- to propose a model that can forecast rubber prices accurately through neural networks.

The rest of this paper is organised as follows. The next section introduces the briefly description of the neural networks approach for predicting short-term rubber prices. Section 3 analyses and discusses the research findings of the study. Lastly, the final section ends with conclusions and comments on possible works in the area.

2. Data and methodology

2.1 Neural networks method

A neural network or an artificial neural network is an information processing model inspired by the operation of biological of neuron systems. It is structured in layers of basis processing unit called neurons or nodes. Basically, the neural network comprises of two layers i.e. input and output layers. Between them, hidden layers can be added to solve non-linear problem. The network is fully-linked together in adjacent layers. It means that neuron in any layer is connected to all nodes in the previous layer. Signals flow in a forward direction from left to right and from one layer to another. Figure 1 illustrates the structure of neural network.

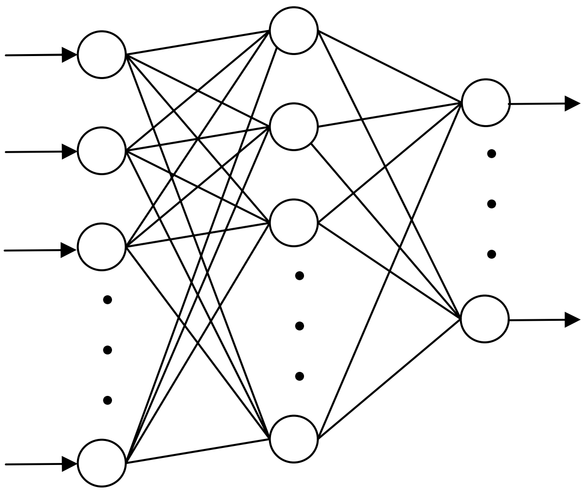

Figure 1. **The structure of neural networks**

Each input neuron has activation value or a signal on it and fall in the closed interval range [0, 1]. Learning process from historical data is a very important task in the development of neural networks system. Basically, there are 2 types of learning process: (1) supervised learning process, and (2) unsupervised learning process. Back propagation, the most common supervised learning algorithm, is utilised for training multiple-layers networks in this study [7, 8]. The strength of the linkage is characterised by a weight (w_i). The Back propagation (BP) employs an optimization algorithm to find optimal values of weights as parameters [8].

The internal activation coming into neurons in the hidden or output layers are the sum of incoming activation level times its respective connection weight. The internal activation is then modified by the sigmoid transfer function and translates into outputs. The sigmoid transfer function is defined as:

$$f(x) = \frac{1}{1+e^{-x}} \qquad (1)$$

where e is the base of natural logarithms.

The range of the sigmoid transfer function is between zero and one [0, 1]. This function employed to helps to reduce the extreme input values. Thus, it produces some degree of robustness to the network [4].The weights are adjusted to minimise the root mean squared error function (RMSE) between the model output and the desired output using the concept of the gradient steepest descent algorithm. The process repeats until no significant improvement in the network performance is obtained.

2.1 Parameter identification

In the following study, the back propagation (BP) learning algorithm is utilised to train the networks. Relevant parameters are determined as follows:

- a set of learning rate (0.1, 0.2 and 0.3, respectively);
- a set of learning momentum (0.5, 0.6, 0.7 and 0.8, respectively);
- training epochs (40,000 iterations).

2.1.1 Measuring forecast accuracy

Measuring the accuracy of the future forecast is also an important task. Therefore, two methods namely: root mean squared error (RMSE) and mean absolute percentage error (MAPE) are selected to compare the accuracy of both neural networks models. They can be defined as [4]:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (e_t)^2}{n}} \qquad (2)$$

$$MAPE = \frac{\sum_{i=1}^{n} \left| e_t / Y_t \right|}{n} \times 100 \qquad (3)$$

where $e_t = Y_t - F_t$
Y_t is the actual observation for time period t
F_t is the forecast value for the same period

2.1.2 Time series of data set

The proposed approach has been employed to forecast the rubber prices at Hatyai central rubber market. Rubber prices data were collected from Rubber Research Institute from the year 2001 to 2003 [10, 11, 12]. The week of 5th to 9th January 2004 has been selected to be a set of test data**.** Moreover, time series data of yen currencies exchange rate has been incorporated into one model as input data to compare the performance accuracy. These data were extracted at the same period from 2001 to 2003.The reason of using yen currencies exchange rate because it seems to partly describe the pattern of rubber prices behaviour [13].

2.1.3 Case studies

In the present study, two models of neural networks are proposed to predict rubber prices at Hatyai central rubber market in Thailand and compare the performance accuracy. The first model is a single time series model called Model A. In this model, there is only the daily data of rubber prices during 2001-2003 are used as input data to forecast the future values. The second model is a multivariate time series model called Model B. This competing model will allow other information i.e. a set of time series of yen currencies exchange rate into the model to make prediction.

3. Forecasting results and discussions

Though combinations of different number of parameters set in section 2, the best candidate networks trained for both models are reported in Table 1.

Table 1. **The best candidate networks trained for both models**

Neural networks	Architecture	Learning rate	Learning momentum
Model A	5-20-5	0.3	0.8
Model B	10-15-5	0.1	0.8

The final results of forecasting data obtained Model A and Model B are shown and compared with the test data in Table 2. As mentioned earlier, root mean squared error (RMSE) and mean absolute percentage error (MAPE) are employed to evaluate the accuracy of the both models. Table 3 reports that the error of Model B is slightly smaller. It is implied that Model B achieved higher performance than Model A. In other words, it can be recommended that yen currencies exchange rate could help to increase the performance accuracy in predicting rubber prices.

Table 2. **Comparison of test data neural network models**

Forecast horizon	Test data	Models	
		A	B
5 January 2004	43.35	43.80	43.40
6 January 2004	42.67	43.38	43.65
7 January 2004	42.39	44.72	43.64
8 January 2004	42.40	44.82	43.56
9 January 2004	43.29	44.89	43.51

Table3. **Statistical accuracy measures**

	Accuracy measures	
	RMSE	MAPE
Model A	0.5295	1.2498
Model B	0.4661	0.9961

The results of the study suggest that multivariate time series forecasting method is a better alternative approach for predicting rubber prices. One possible reason dues to the fact that in today's business environment, rubber prices are strongly driven by other variables [5,13]. In this present study, it reveals that a set of time series of yen currencies exchange rate is an external variable which could help in developing more accuracy prediction. This is also supported by Rubber Research Institute [14]. It is reported that this variable is highly correlated to a time series set of rubber prices. In term of the multivariate time series forecasting model, the findings of this paper are very much similar to Chatchaipun and Atthirawong [6]. They used two statistical methods i.e. Box and Jenkins (the univariate time series forecasting model) and transfer function (the multivariate time series forecasting model) to model and predict rubber smoked sheet prices and to compare the accuracy of both models. It was also revealed that the multivariate time series forecasting model has performed better than the univariate forecasting model.

4. Conclusions and further work

This paper has proposed two neural networks models for predicting rubber prices across the 5 periods ahead in the forecast horizon. These models are based on time series data. The findings revealed that the multivariate time series forecasting model (Model B) is more suitable to predict rubber prices than the single time series forecasting model (Model A).

There are a number of interesting directions in which this research can be pursued. Firstly, in order to improve the prediction accuracy, one possible way is to take into account the inclusion of other information e.g. prices of natural rubber at various markets around the world and geographical factors in the model. Additionally, longer time series data might improve the prediction results. Moreover, the model could be modified in terms of setting learning rule, different training techniques, different of hidden layers, neural network type and topology. Lastly, integrating the neural network model with genetic algorithms may lead to better performance.

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