CHAPTER VII

CONCLUDING REMARKS AND SUGGESTIONS

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CHAPTER - VII

CONCLUDING REMARKS AND SUGGEGTIONS

This concluding chapter provides an overall conclusion of the whole investigation. Major findings of the study are presented the section 7.1. An outline of the policy to be undertaken along with the suggestions for further study is given in section 7.2. Remarks on the study is reported in section 7.3. Section 7.4 deals with the limitations of the study and finally, the thesis is concluded with an epilogue.

7.1. MAJOR FINDINGS OF THE STUDY

The major findings of the study are as follows: .

i) The regression model

GC = -3400.31 + 0.89 (Gas Production) + 23.22 (Electricity Consumption)

is finally selected for gas consumption. Similarly, the regression model

EC = 1672.84 + 0.359 (Gas Consumption) - 1.215 (Petroleum Consumption)

is finally selected for electricity consumption in Bangladesh.

ii) Quadratic model has been found to outfit all other types of growth models, subject to the considered criteria, for the untransformed and log-transformed gas and electricity consumption.

iii) ARIMA(1,2,1) model has been found to adequately fit the untransformed and log-transformed gas consumption series. ARIMA(1,2,1) model is also selected as the best ARIMA model for untransformed electricity consumption and in case of log-transformed

electricity consumption, ARIMA(1,1,1) model is found to outperform other types of ARIMA models.

iv) ANN model with a single hidden layer consisting of a single neuron has been selected as the best ANN model for both of the untransformed and transformed gas consumption. The input layer contains a single neuron corresponding to the time period and the output layer contains a single output neuron corresponding to the annual gas consumption figure. Again, ANN model with a single hidden layer consisting of two neurons in each layer has been found to best suit the untransformed electricity consumption, while, ANN model with a single hidden layer containing a single neuron has been selected as the best ANN model for log-transformed electricity consumption.

v) Tests of encompassing-in-forecasts for untransformed gas consumption show that none of the three competing models encompasses any one of the other two. MGN and WSR tests for pair wise equal accuracy comparison indicate that there is significant difference between forecast accuracy of ARIMA and ANN models. On the other hand, no significant difference between the prediction accuracy of the growth and ANN models, and growth and ARIMA models are found by pairwise equal accuracy tests. Again, forecasting performance of ANN model supersedes other two models by maximum criteria of individual predictive performance comparison. So, ANN model is selected as the best predictive model for untransformed gas consumption followed by quadratic model and ARIMA model. Interpretation of the results of pair wise forecasts accuracy tests and individual prediction performance tests for log-transformed gas consumption is the same

individual prediction performance tests for log-transformed gas consumption is the same as that of untransformed series. Thus, in this case too, ANN model is selected as the best predictive model for log-transformed gas consumption followed by quadratic model and ARIMA model.

iii) For untransformed electricity consumption, tests of encompassing-in-forecasts show no significant difference between the predictive accuracy of competing three models. The sign test, WSR test and MGN test reveal that predictive performance of ANN model significantly differs from that of growth and ARIMA models. While no significant difference is found in predictive accuracy of growth and ARIMA models, neither of the growth and ARIMA models uniquely outperforms one another by individual predictive performance accuracy tests. However, the values of the most of the criteria are in favour of better performance of growth model. So growth model is considered as the best predictive model for untransformed electricity consumption.

iv) It is found by the tests of encompassing-in-forecasts and pairwise accuracy comparison tests that there are no significant differences between predictive performances of the three types of selected models for log-transformed electricity consumption. Individual predictive performance accuracy also reveals that predictive accuracy of all the three models are almost the same. In this case too, predictive performance of growth model is slightly better so far as the values of the criteria are concerned. So, growth model is selected as the best predictive model for log-transformed electricity consumption followed by ANN and ARIMA models.

7.2. POLICY IMPLICATIONS AND SUGGESTIONS FOR FURTHER STUDY

Forecasting and policy evaluation are very closely related in a feedback system. In general, the need for forecasts arises from the fact that the planners need to have a clear view about the future behavior of the factor(s) of interest. Knowledge about this behaviour pattern is essential for effective economic planning. Energy sector is perhaps the most significant one that needs a thorough management. Hence, modelling energy consumption (in Bangladesh) assumes an extremely important role towards reducing the energy wastage and thereby furthering economic progress. It is expected that the models selected in this study will be helpful for policy makers as well as the concerned authority in efficient energy management in Bangladesh.

To our knowledge, no in-depth study towards modelling and forecasting energy consumption has so far been performed. Such investigation, particularly of growth of energy consumption, may be performed sector-wise using up-to-date data. A neural network technique may be applied to forecast the energy consumption with multiple input layers and hidden layers consisting of more neurons.

7.3. CONCLUDING REMARKS

It is observed that the energy consumption in Bangladesh increased over the study periods. One of the factors could be the high growth rate of population. If the current increasing trend continues, the country will have to face some problems regarding supply of energy to fulfill its demand in near future. So, it is necessary to have some idea about the future demand of energy in the country for proper planning. With this picture in mind the study attempts to identify important factors which affect energy consumption in Bangladesh and at the same time, to forecast energy consumptions up to 2000-2001 by selecting the best predictive models. To identify the important factors influencing the energy consumption, the basic approach employed here is the multiple regression analysis. Selections of influencing factors is performed by two ways, viz., by stepwise regression technique and by factor analysis.

In order to find the best predictive model(s) to the untransformed and log-transformed energy consumption, predictive performances of three types of models are compared using some criteria in two ways - pair wise models' prediction accuracy and individual model's prediction accuracy. The types of forecasting models considered in the study are growth type, ARIMA type and ANN type. Best model of each type is selected analytically. The models are fitted for the data of estimation period and the validity of the models is verified using data for validation period. It is found that ANN technique outperforms all types of

data series, followed by growth type and ARIMA type.

The consumption figures up to the period 2000-2001 are obtained for all types of the selected models and reported in the study.

7.4. LIMITATIONS OF THE STUDY

Like all other empirical works, the study undertaken here also has certain limitations. The analysis is based on the published data collected from three sources viz., BOGMC, BPDB and Bangladesh Bureau of Statistics. It is difficult to ascertain the accuracy of these data.

The gas consumption data used in the study covering the period 1970-71 to 1992-93 has some weaknesses. For example, it is clear from the series that uprising trends of consumption in the study period show a discontinuity of trend in the years 1972-73 and 1975-76, signifying the presence of what are commonly known as outliers of the data. These outliers might have some effect on the results obtained in the study. There was no scope to remove this type of effect.

Another important shortcoming of this study is that the study period contains only 23 observations for gas consumption and 17 observations for electricity consumption, which are not enough for precise modelling and forecasting the series, specially by ARIMA methodology. Moreover, autocorrelation problem remains in case of regression modelling,

which also could not be removed. Single input is considered in case of growth and ARIMA modelling. So, in the study due to convenient of comparison with growth model and ARIMA model, the ANN technique with variant input layers and output layers could not be considered.

7.5. EPILOGUE

The motive of the present study is to reduce the gap between production and consumption of energy in Bangladesh, knowing the consumption level in advance. So, the main focus of the study is on efficient modeling, and thereby, forecasting the future energy consumptions using the best predictive models. Due to unavailability of up-to-date consumption figures, it was not possible to compare forecasted figures with real figures. Time will judge the accuracy of forecasts made in the study.

It is well known that exact forecasting belongs to the clairvoyance rather than science. Science is a very human form of knowledge. One is always at the brink of the feeling what is happening in future. The reality is that every judgement in science stands on the edge of error. Under these rather general axioms on which any scientific investigation is based, what one can do is to attempt to predict results with least error. The body of the analyses presented in this thesis is just one such effort guided primarily by the concern to plan best the energy sector (and hence, also economy) in Bangladesh.