# SHORT TERM HOG PRICE FORECASTING MODELS FOR THE MANITOBA HOG INDUSTRY

by

SHAKIB MBABAALI

A Thesis

Submitted to the Faculty of Graduate Studies
in Partial Fulfilment of the Requirements
for the Degree of
MASTER OF SCIENCE

Department of Agricultural Economics and Farm Management
University of Manitoba
Winnipeg, Manitoba.

ISBN 0-315-76834-7

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# TABLE OF CONTENTS


Page

**ABSTRACT** iv

**ACKNOWLEDGEMENTS** v

**DEDICATION** vi

**LIST OF FIGURES** vii

**LIST OF TABLES** viii

**CHAPTER ONE - INTRODUCTORY**

Introduction 1
Relationship Between Planning and Forecasting 4
Limits of Forecasting 4
Problem Statement 6
Scope of the Study 7
Objectives 8
Guide to Choosing the Appropriate Forecasting Technique 8
Layout of the Study 9

**CHAPTER TWO - THEORETICAL FRAMEWORK**

Time-Series Data 12
Univariate Time-Series Models 13
Econometric Modelling 15
Composite Forecasting 16
Forecast Evaluation Methods 16

**CHAPTER THREE - UNIVARIATE TIME-SERIES ANALYSIS**

Advantages of Univariate Models 19
Limitations of Univariate Models 20
Model Identification 21
Stationarity 25
Identifying Degree of Differencing, d 28
Identification of the Seasonal Models 35
Model Estimation 42

TABLE OF CONTENTS (cont'd)


| | Page |
|---|---|
| Model Diagnostic Checking | 44 |
| Forecasting Using Univariate Models | 46 |
| Qualitative Evaluation Results (preliminary) | 49 |
| **CHAPTER FOUR - ECONOMETRIC MODEL** | |
| Introduction | 52 |
| Advantages of Econometric Models | 53 |
| Limitations of Econometric Models | 53 |
| Model Specification | 54 |
| Demand for Hogs | 56 |
| Supply of Hogs | 58 |
| Statistical Model | 61 |
| Estimation and Results | 63 |
| Price Forecasts | 67 |
| **CHAPTER FIVE - COMBINED FORECAST MODEL** | |
| Introduction | 69 |
| Advantages | 70 |
| Disadvantages | 70 |
| Constructing a Combined Model | 71 |
| **CHAPTER SIX- FORECASTING EVALUATION** | |
| Quantitative Forecast Evaluation | 75 |
| Qualitative Forecast Evaluation | 77 |
| 9 x 9 Contingecy Table Method | 79 |
| The Naik and Leuthold Method | 79 |
| Alternative Method | 82 |
| Implication of Forecast Evaluation | 88 |
| **CHAPTER SEVEN - CONCLUSION** | 92 |
| **REFERENCES** | 97 |

# ABSTRACT

The Manitoba hog industry operates under uncertain and changing circumstances. Manitoba Department of Agriculture cites some of the factors responsible for the uncertain and changing environment. Such factors include high costs of new facilities, rising energy costs, variable prices for feed grains and protein supplements, and uncertainties about future hog market prices.

The research reported in this study concentrates on the uncertainties about future hog market prices by identifying the factors responsible for hog price fluctuations both on a weekly and monthly basis. The identified factors are used to generate knowledge about future hog market prices by using univariate time series, econometric and composite models as forecasting tools. The forecasts generated using those models are evaluated against the naive or no change model for their quantitative and qualitative forecasting performance. Evaluation measures used include Mean Squared Error, Mean Absolute Percentage Error and Theil's $U_1$ inequality coefficient for quantitative evaluation. The qualitative evaluation measures include the Naik and Leuthold 4 x 4 contingency table method and the Henriksson-Merton probability-based method. Under certain circumstances the Naik and Leuthold 4 x 4 contingency table method is shown to be inappropriate and a 9 x 9 contingency table is suggested.

Overall, the models developed do not perform very well quantitatively but the univariate time series model performs well at predicting turning points. The study demonstrates how producers could benefit from the turning point information generated by the univariate time series model.

Keywords: forecasting, time series, econometric model, composite model, naive model, quantitative forecast evaluation, qualitative forecast evaluation.

# ACKNOWLEDGEMENTS

While the research reported in this thesis has been primarily developed by me, many individuals have helped in improving the analysis and documentation. In particular, my major academic advisor, Dr. M.D. Faminow for his inspiring assistance and guidance throughout my graduate program; I cannot thank you enough Dr. Faminow. Dr. M.S. Boyd, Dr. R. Dhruvarajan and Dr. B.T. Coyle always provided suggestions and constructive comments that helped improve the quality of my work.

I would also like to thank the following people: Mr. W.A. (Bill) Oakley, Research Economist, Manitoba Pork Board for the help rendered to me during the data collection process; Hamath, Sarah, Eddie, Mbaga, Cam, Hlezy, Nolita, Oscar, Francis, Ernest, Michael and all the other graduate students for the wonderful companionship that we shared. The administrative staff of the Department of Agricultural Economics and Farm Management especially Vydehi, Debra, Elaine, Bonnie, Sari and Laura have all been wonderful people to me during my graduate program.

Lastly, I would like to express my sincere thanks to my family and friends for being there whenever I needed them.

# DEDICATION

*to my mother*
*Hanifah Nakachwa Mbabaali*

# LIST OF FIGURES


| | | Page |
|---|---|---|
| Figure 1: | Sample Autocorrelation Function for the Undifferenced Weekly Series | 29 |
| Figure 2: | Sample Autocorrelation Function for the Undifferenced Monthly Saries | 30 |
| Figure 3: | Sample Autocorrelation Function for the 1st Differences of the Weekly series | 31 |
| Figure 4: | Sample Autocorrelation Function for the Seasonaly Differenced Weekly Series | 33 |
| Figure 5: | Sample Autocorrelation Function of the Seasonaly Differenced Monthly Series | 34 |
| Figure 6: | Graphical Comparison of Different Forecasting Techniques for Hog Prices | 74 |
| Figure 7: | Hypothetical Price Movements | 82 |

# LIST OF TABLES


| | | Page |
|---|---|---|
| Table 1: | Properties of the Autocorrelation and Partial Autocorrelation Functions for Various ARIMA Models | 39 |
| Table 2: | Parameter Estimates for the Univariate Time Series Monthly Models, Manitoba Hog Industry, 1986-1990 | 43 |
| Table 3: | Parameter Estimates for for the Univariate Time Series Weekly Models, Manitoba Hog Industry, January, 1986 to August, 1991 | 43 |
| Table 4: | Computed Q-Statistics for the Univariate Time Series Monthly Price Forecasting Models for the Manitoba Hog Industry | 45 |
| Table 5: | Computed Q-Statistics for the Univariate Time Series Weekly Price Forecasting Models for the Manitoba Hog Industry | 45 |
| Table 6: | Univariate Time Series Monthly Price Forecasts for the Manitoba Hog Industry, January-December, 1991 | 47 |
| Table 7: | Univariate Time Series Weekly Price Forecasts for the Manitoba Hog Industry, September-November, 1991 | 48 |
| Table 8: | Preliminary Quantitative Evaluation Results of Univariate Time Series Monthly Models for the Manitoba Hog Industry | 49 |
| Table 9: | Preliminary Quantitative Evaluation Results of Univariate Time Series Weekly Models for the Manitoba Hog Industry | 49 |
| Table 10: | Preliminary Qualitative Model Evaluation Results of Univariate Time Series Weekly and Monthly Models for the Manitoba Hog Industry | 50 |
| Table 11: | Estimated Equation for the Manitoba Hog Supply, 1986-1990 | 64 |
| Table 12: | Estimated Equation for the Manitoba Packer Hog Demand, 1986-1990 | 65 |

## LIST OF TABLES (cont'd)


| | | Page |
|---|---|---|
| Table 13: | Econometric Model Monthly Hog Price Forecasts for the Manitoba Hog Industry, January-December, 1991 | 68 |
| Table 14: | Composite Model Price Forecasts for the Manitoba Hog Industry, January-December, 1991 | 72 |
| Table 15: | Quantitative Model Evaluation Results of the Manitoba Short Term Hog Price Forecasting Models | 77 |
| Table 16: | Naik and Leuthold 4 x 4 Contingency Table | 81 |
| Table 17: | The Suggested 9 x 9 Contingency Table | 84 |
| Table 18: | Qualitative Model Evaluation Results of the Manitoba Short Term Hog Price Forecasting Models | 87 |
| Table 19: | Time-Series and Naive Model Monthly Hog Price Forecasts for Manitoba, January-May, 1991 | 89 |

## Chapter One

# INTRODUCTION

Economic analysts attempt to understand and explain social and economic phenomena. Accurate and expedient information about relevant economic variables leads to proper business planning (Sullivan and Claycombe). Almost all business organizations encounter the need to assess current and likely future trends of economic variables. The main objective of such an assessment is to access knowledge about risky events that are quite crucial to the decisions made in the present period with intentions of improving the economic pay-off to such decisions. Decision making in an uncertain environment can be based on information generated by forecasts of random variables in the problem that are relevant to current decisions and future consequences (Lawrence). Forecasting general business and economic behaviour provides a basis for making current decisions but whose effects and outcomes can only be realised in the future.

The use of information generated by good and reliable forecasting methods is becoming a necessity to the survival and prosperity of many business organizations (Sullivan and Claycombe). Hence, forecasts can be utilised to reduce the uncertainty about the future course of events and provide as much information as possible to the decision maker, bearing in mind the fact that "... forecasting is a means to aid decision taking and not an end in itself" (Jenkins, 1982, p.3). The usage of forecasts as essential inputs in most decisions concerning the future of a business setting cannot be overemphasised (McLaughlin).

In reference to hog markets, Luby (1957) observes that future knowledge on both

supplies and prices of hogs are essential for an efficient marketing system. More reliable information enables farmers to adjust both production and marketing decisions geared towards profit maximization. Luby (p.1402) states that,

> ...farmers need price forecasts each time they make either a marketing or production decision. A hog producer usually has a period of up to 45 days in which he can market butcher hogs. During some seasons of the year, he will usually net a greater return from marketing at a lower weight while during other periods he will usually gain by feeding to higher weights.

The Manitoba hog industry, like many other industries, changes from time to time. A study by Manitoba Department of Agriculture (MDA) identified some of the factors responsible for the observed changes. Such factors include:

a) high costs of new facilities;

b) rising energy costs;

c) variable prices for feed grains and protein supplements;

d) uncertainties about future hog market prices.

Under such circumstances, it becomes essential for the producers to make use of as much information as they possibly can get to prepare for the likely constraints and at the same time take advantage of possible opportunities. Forecasting of hog prices is one way of providing such information to the producers, particulary as a way of reducing uncertainties about future price levels.

When discussing forecasting as a prerequisite to good decision making, it is important to point out that different business settings may require different forms of forecasts ranging from the simplest and less involved to complex and more cumbersome. For example, consider a local agricultural producer selling only a few products into a

small market. Given such circumstances, that producer may acquire a thorough understanding of the circumstances governing the business and thus be able to produce reasonable intuitive forecasts. On the other hand, consider a large scale agricultural producer operating within an international market framework. Forecasts for such a setting require an understanding of the inter-relationships within and between the different market levels. Another important point is that even within a given business setting, different decisions may call for different forecast characteristics. Such characteristics include (Firth):

a) accuracy - some decisions require a higher degree of accuracy while others could tolerate wider margins of error;

b) time horizon - this refers to the time period over which the decision will have an effect. Decisions may be short-term, medium-term, or long-term;

c) speed and regularity - some decision making processes require regular forecasts with a quick response rate to major changes in patterns of the series concerned.

Although different forecasting situations may call for unique requirements, there still exist many elements that are common to a range of situations (Wheelwright and Makridakis). Such elements include:

a) uncertainty - forecasts are designed, primarily, to generate some information about the uncertain future events; and,

b) historical data - all decision-making processes requiring a forecast, directly or indirectly, make use of information embedded in

historical data.

## Relationship Between Planning and Forecasting

In economics, forecasting is used to predict the possible movements of economic variables in the future, given some specified conditions or assumptions (Wheelwright and Makridakis). Planning comes after forecasting whereby planners make use of information generated by forecasts in making decisions that are best suited for the organizations they represent. In so doing, planners attempt to influence, based on the results of a forecast, the subsequent events in a favourable direction. It is important to point out that as decisions are made, there is a feedback effect in which the decisions impact on the original forecasts. Hence, there is a need to adjust the forecasts so as to incorporate the feedback effect. This prevents the possibility of forecasts becoming misleading since they will no longer represent the circumstances that prevailed at the time of preparation (Wheelwright and Makridakis).

## Limits of Forecasting

It is important to point out the limitations of forecasting since the knowledge of such limitations should enable forecast users to think more appropriately around the decision situation and, therefore, make it possible to consider alternative solutions and/or seek for improved techniques (Wheelwright and Makridakis). It is true that economic forecasts are becoming increasingly important for the strategic planning of business organizations, but at the same time there is an increasing sense of frustration rising at the failures of

forecasts (McAuley). Naylor partly attributes this to the fact that some economic forecasters have a tendency to over-sell their ability to predict the future. McAuley (p. 389) stresses that "... economic forecasts deal with uncertainty, and so it is prudent and honest to set out the risks that may cause a forecast to err."

Forecasts are bound to have errors irrespective of the degree of sophistication of the method used to generate them. That is, all forecasters make errors since it is impossible to know the future with certainty (Webster). Some of the sources of error include the stochastic nature of the process that generates data used in forecasting, errors in measurement of variables used, and misspecification of functional forms. When using conditional forecasts, there is an added source of possible errors due to the forecasting of exogenous variables. Hence, given such possible sources of error, it would be unrealistic to expect perfect forecasts.

In a world that changes continuously, it is difficult to develop simple and reliable quantitative forecasting techniques to signal the nature and magnitude of the likely future changes. Granger and Newbold (1986, p.265) point out that,

> ... given a world in which the amount of potential information is vast and the number of potential ways of employing it enormous (partly because in many areas economic theory is ill structured, or insufficient data are available to distinguish with any high degree of confidence between competing theories), it makes very little sense to view forecast optimality as a useful working concept.

Forecasts are likely to perform best if the future looks similar to the past, which might not necessarily be the case. Hence, forecast users should examine the assumptions underlying the forecasts together with the maintained hypotheses when making use of forecast results.

## Problem Statement

Participants in the hog industry operate under uncertain circumstances. Although some of the factors causing the unpredictable circumstances are quite uncontrollable (weather, for example), the effect of others ( like price and quantity movements) can be managed if appropriate information regarding such circumstances can be obtained. However, the extent to which the effect of these factors can be reduced largely depends on the quantity and quality of information available to decision makers. Both, long-run and short-run information is required in order to enable producers to make more accurate and timely decisions regarding the production and marketing of hogs. Hog producers have about 45 days during which they can make marketing decisions (Luby). Hence, they need to determine whether it is more rewarding to sell their hogs at a point in time at the going price or retain them for sale at a later date at an uncertain price. The final decision will be affected by beliefs about the short-run movements of the market variables.

It has been shown that, although absolute price movements and their variations around the means are essential to both hog producers and commercial parkers, they (producers and packers) are more concerned about the future trends of prices and try to determine the possible production or marketing alternatives in an effort to reducing the effects of any unfavourable trends in price movements ( Myers and Havlicek). The Manitoba hog industry, like many industries, is a dynamic industry that changes from time to time. Decisions taken by market participants under such uncertain circumstances are believed to be crucial to the wellbeing of the enterprise. Provision of reliable information about possible future movements of the variables concerned is likely to

improve the quality of the decisions. Hence, a short-run forecasting model could help generate the knowledge required for short-run profit maximizing marketing decisions.

## Scope of the Study

It is intended, in this study, to develop, evaluate and compare short-run price forecasting models for the Manitoba hog economy. Hog producers require information about the short-term movements of market variables to help them make short-term marketing decisions. It is thought that the provision of such information will help improve the hog industry operational efficiency. In developing the forecasting model, the operational structure of the industry in question is considered. All of the slaughter hog trading activities in Manitoba province are conducted through the Manitoba Pork Board which, like many other pork boards in Canada, operates on a weekly price pool basis (Manitoba Pork Press). Given this information, a weekly price forecasting model is formulated for the Manitoba hog economy. Also, since hog producers have up to 45 days during which to market slaughter hogs (Luby), a monthly price forecasting model is formulated for the hog economy. Information generated by these models may be of use to hog producers when determining the number of slaughter hogs to market at a point in time.

A number of analytical procedures are employed to generate forecasts. Specifically, the methods employed include the following:

a) time-series analysis;

b) econometric analysis; and,

c) composite forecasting methods.

A naive model (that is, the previous period's price prevails to the present) is used as a benchmark against which the performance of the three core models (considered to be more complicated and sophisticated) is measured. The important issue here is to determine whether it is beneficial to use elaborate methods (bearing in mind the increased costs in terms of time and money) relative to using the naive but less expensive methods.

## Objectives

The following are the specific objectives of the study:

a) identify the factors responsible for weekly and monthly hog price fluctuations in the Manitoba hog market and use them to develop models to generate knowledge about the short-run relevant economic variables for the purpose of hog price forecasting; and,

b) determine which of the developed models does a better forecasting job given Manitoba hog market conditions.

## Guide to Choosing the Appropriate Forecasting Technique

Wheelwright and Makridakis suggest four points that can be considered when deciding on a technique to use for a given situation:

a) item to be forecasted - in this case the forecaster should study the characteristics of the situation at hand bearing in mind the purpose of the forecast. The purpose could be to predict the following or a combination of any of them:

i) the continuance of the underlying pattern in the series;

ii) the continuance of the underlying relationship(s) between series; and,

iii) a turning point;

b) relationship(s) between the situation and the characteristics of the available forecasting techniques;

c) quantity and quality of available data; and,

d) time available for preparing the forecast.

## Layout of the Study

This study is primarily concerned with three analytical models (univariate time series, econometric and composite forecasting models) and each model is assigned a separate chapter. A brief theoretical framework of each of the three models and forecast evaluation methods are provided in chapter two. For the univariate time series model, the four basic stages are discussed. These stages include identification, estimation, diagnostic checking and forecasting. Econometric modelling, on the other hand, makes use of economic theory and reported applied research in identifying the variables to include in the model. For deriving the weights to use in constructing the composite forecasting model, a regression method is used.

Weekly and monthly time series models are treated in chapter three. Sample autocorrelation and partial autocorrelation functions are used to identify two monthly and four weekly models. All the six tentatively identified models are estimated using data

covering the period January, 1986 to August, 1991 for the weekly series and from January, 1986 to December, 1990 for the monthly series. The models are checked for white noise using the Ljung-Box test statistic. A preliminary evaluation of the competing time series models is done in order to choose a monthly time series model to be used as part of the composite model.

Chapter four deals with the econometric model. Demand and supply functions are defined for the Manitoba hog industry. The functions are estimated recursively using the Ordinary Least Squares (OLS) estimation procedure for the period 1986-1990. However, because weekly data on most of the explanatory variables were not available, only a monthly econometric model is estimated. The estimated parameters are used to generate twelve monthly forecasts for the year 1991 (data not used in estimation).

A monthly composite model (comprising the best of the monthly time series models and the monthly econometric model) is presented in chapter five. Various methods of deriving weights of the constituent models have been suggested by different people. A restricted regression method developed by Granger and Ramanathan is used because it accounts for any possible biases that may exist in the constituent model forecasts.

Model evaluation is the subject of chapter six which contains a review of the existing forecast evaluation methods. Formal evaluation techniques are used to compare the performance of the alternative forecasting models. Models are evaluated based on their quantitative and qualitative characteristics. Measures used for quantitative evaluation include Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE) and Theils' U1 inequality coefficient. For qualitative evaluation the measures used include the

4 x 4 contingency table method developed by Naik and Leuthold and the Henriksson-Merton probability based test.

Finally, a discussion of the results together with the concluding remarks are presented in chapter seven.

Chapter Two

# THEORETICAL FRAMEWORK

## Time-Series Data

A time-series data set can be described as a series of measurements or values ordered by a time parameter. The order in which the sample is presented is of considerable importance (Granger and Newbold). A time-series can further be categorised as either being a discrete time-series or a continuous time-series. The other characteristic of a time-series is the deterministic nature. The series can be classified as deterministic if it could be represented by a unique and explicit mathematical relationship and as such exact future values of the series could easily be forecasted (Appelbaum). On the other hand, non-deterministic series exhibit random or fluctuating properties and cannot be represented by an explicit mathematical function. Non-deterministic time-series data are considered to be a result of a stochastic process. Hence, forecasting of exact future values for such non-deterministic series is very difficult. Because of the random nature of the series, probability statements are employed to represent the relationships, and different analytical techniques could be employed for investigative purposes. This study deals with non-deterministic time-series data.

Analysts are always in search for new information or better ways of looking at the existing information so as to confirm or change forecast results, and because of that, there are various techniques that can be used in generating forecasts (Webster). This study concentrates on the following methods:

a) univariate time-series;

b) structural or econometric; and

c) composite forecasting.

Following below is a brief discussion of the theoretical underpinning of each method.

## Univariate Time-Series Models

Univariate time-series models are often considered to be *ad hoc*, that is, with little or no theoretical basis. A typical univariate time-series model usually relates dependent variables to lagged values of the dependent variables and to variables that describe the random nature of their past behaviour. That is, the model makes use of information obtained from past behaviour of a given economic variable and replicates it in order to forecast future behaviour of the same variable (Pindyck and Rubinfeld). For example, if the observed price series ($P_1,P_2,P_3,...,P_t$) is regarded as a realisation from the general ARIMA (p,d,q) process and the desire is to forecast a future value $P_{t+j}$, then the forecast value $P_{t+j}$ ($j \geq 1$) will be made at time t at which time only $P_t,P_{t-1},...,P_{t-n}$ observations are available. In this case, t is referred to as the origin and j as the lead time and, in probabilistic terms, the forecast value could be viewed as a conditional expectation of $P_{t+j}$, given $P_t,P_{t-1},...,P_{t-n}$. That is (Mills, p. 104):

$$f_{t,j}=E(P_{t+j}|P_t,P_{t-1},...,P_{t-n})$$

The process of univariate time series forecasting involves four basic stages. These include:

a) identification stage which is concerned with determining the degree of differencing (d) required to induce stationarity in the original data series and determining the orders p and q for the autoregressive and moving average components respectively. In case of seasonal data, the identification stage also involves determining the degree of seasonal differencing (D) and the orders P and Q for the seasonal autoregressive and seasonal moving average components respectively. The major concept used at the identification stage is that of sample autocorrelation function and partial autocorrelation function whose characteristics are data specific (Granger and Newbold). The concepts are defined in detail in the next chapter where they are used extensively;

b) estimation stage which follows the identification stage and is concerned with estimating parameters of the tentatively identified models;

c) diagnostic checking stage which is used as a criterion for model choice (Mills). It is concerned with checking whether a given estimated model is adequate or not and adequacy, in this case, is determined by investigating the residuals. The specific characteristics to be checked include:

    i) the mean of the residuals which should be zero;

    ii) the residual variance which should be approximately constant;

    iii) the residual autocorrelations which should be insignificant;

d) forecasting stage which is the last stage of the process and involves projecting the identified movement patterns of a given series to future periods. The underlying assumption is that some pattern or a combination of them in a given series keep recurring over time (Wheelwright and Makridakis).

## Econometric Modelling

Koutsoyiannis distinguishes two major categories of econometric analysis. These include:

a) theoretical econometrics which basically involves the designing of appropriate techniques to measure economic relationships. In designing such techniques, however, the nature of the process to be analyzed is an important consideration. Some economic relationships may exist independently and, therefore, would require single equation techniques, while other relationships may be inter-related and would, therefore, need simultaneous equation techniques. In this study, a recursive system is used which is a special case of simultaneous equations;

b) applied econometrics which makes use of the theoretical econometric tools in analyzing economic phenomena and forecasting economic behaviour.

In econometric analysis, economic theory, reported applied research and knowledge about any peculiar behaviour of the situation under investigation are indicators of what to expect as far as parameter magnitudes and signs are concerned.

## Composite Forecasting

The field of composite forecasting has received great attention in empirical and academic literature over the last few years. It is contended, in the literature, that there is a need to combine forecasts from different forecasting techniques for better results.

Various methods for combining forecasts have been suggested for different situations. All the suggested methods are concerned with the derivation of weights for the respective forecasts and these weights have been shown to depend on the variances and covariances of the forecast errors (Holden et al). The regression method with a constant term, suggested by Granger and Ramanathan, is employed in this study largely because of its allowance for any possible biases in the forecasts being combined. The method is explained in detail in Chapter Five.

## Forecast Evaluation Methods

Forecast accuracy can be measured in different ways. In this study forecast accuracy is looked at from the quantitative and qualitative perspectives. The quantitative measures are concerned with the size of the forecast error and make use of descriptive statistics to summarise the characteristics of sample evidence. Three of such measures are briefly introduced below:

a) mean squared error (MSE) - this is defined as $\frac{\sum (F_t - A_t)^2}{n}$ (Holden et al., p.14), where $F_t$ refers to the forecast at time t, $A_t$ is the actual