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台灣季節性消費品銷售量預測之研究

Investigation on Forecasting Models for Predicting the Sales of Seasonal Consumer Products in Taiwan

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ABSTRACT

The trend seasonal demand pattern is encountered when both trend and seasonal influences are interactive. The problem of this research is to project the seasonal market sales using ice cream and fresh milk in Taiwan as examples. In order to improve the accuracy of forecast, two different methods are validated and the best forecasting method is selected based on the minimum Mean Square Error.

In this study, we present two forecasting models used for evaluation to predict seasonal market sales of ice cream, fresh milk, and air conditioner in Taiwan. It includes Winters multiplicative seasonal trend model and the Decomposition method. Two different methods are validated and the best forecasting method is selected based on the minimum Mean Square Error.

After the validation process, Winters multiplicative seasonal trend model is selected based on the minimum MSE, and the monthly sales forecast for the year of 2011 is conducted using the data(60 months). Number Cruncher Statistical System (NCSS) is used for analyzing the data which proves useful and powerful.

In summary, the results demonstrate that Winters multiplicative seasonal trend model has the smallest mean square error in this case. Therefore, we conclude that both Winters multiplicative seasonal trend model and the Decomposition model are well fitted for forecasting the seasonal market sales. Yet, Winters multiplicative seasonal trend model is the better method to be used in this study since it generates the smallest mean square error (MSE) during the period of validation.

Key word: mean square error, Winters multiplicative seasonal trend model, Decomposition, seasonal trend demand

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CHAPTER 1

Introduction

In today's business, management is challenged with rapid changes and competitive environments. Forecasting product demand with trend and seasonality is very important to any company including supplier, manufacturer, and retailer.

Market demands of most products remain uncertain until the selling season begins. In many cases, trend and seasonality are important features for company's products. Trends may stem from changes in social environment, technological environment, economical environment, political environment, market conditions, or other industrial competition. Business cycles include the recurrent patterns of prosperity, warning, recession, depression, and recovery. Many products have seasonal effects. For example, the life cycles of these seasonal products are short and the demands are uncertain. For instance, the demand for ice cream, fresh milk, electricity, air condition equipment, winter apparel, fashion goods, Christmas gifts are higher during specific seasons and hold seasonality, trends, or cyclic demand patterns. Moreover, future market sales of these seasonal products may not follow the historical pattern of past demand, which may imply different predictions at different time periods. Therefore, market sales planning for seasonal and short life-cycle products are considered a vital task for an effective manager. The most popular forecasting techniques currently available are based on extrapolation of historical market sales data. For accurate forecasting, it is important to estimate the parameters of forecasting models with the most recent market sales information and forecast can then be updated as new market sales information becomes available.

The high levels of customer service and efficient operations come from accurate demand forecasts, while inaccurate forecasts tend to lead to poor levels of customer satisfaction and higher cost operations. One of the first steps a business can take to improve its efficiency and effectiveness is to improve the quality of the market sales forecasts.

Over a hundred NT a scoop, the high-price premium quality ice cream in Taiwan has already become a very popular and common consumer good. At first there was the monopolistic ice

cream brand Haagen-Dazs, then came the addition of Movenpick. In the year of 2007, Uni-president's Convenience Store subsidiary 7-ELEVEN had obtained the authorization of Cold Stone and opened its first franchise store in Taiwan. As of January, 2011, there are 28 Cold Stone ice cream stores in Taiwan.

In the past, there had been very little market sales forecast-related research on ice cream in Taiwan. One sunny day in the summer of 2010, as I was enjoying the melting cream in my mouth, cotton-candy flavored ice cream that was scooped into a cookie-made bowl at Cold Stone, it had occurred to me, got me thinking and wondering about what the demand of ice cream is like in Taiwan. The demand of ice cream obviously follows a seasonal trend, but how can we more accurately project the sales of ice cream in Taiwan to prevent from over-production or importation of ice cream-related products, since the ice cream market had changed over the past five years or even before that. As consumers are more and more willing to pay over a hundred NT a scoop for premium quality ice cream, more popular and bigger brands had entered to compete in Taiwan, including Haagen-Dazs, Movenpick, Cold Stone, etc. And that was when I thought that it would be a good topic to do study and research on for my thesis. Fresh milk also possesses a pattern of trend and seasonality. And it is a necessity to each family. The demand of fresh milk is strong in summer and slow in winter. Both ice cream and fresh milk are categorized as consumer products. Because of the similarity, their demand data are selected for the research. In addition, air conditioner is another seasonal consumer product that is selected for comparison.

Little research hadinvestigated on the comparison of the Winters Model and the Decomposition Model to forecast the market sales of seasonal products in Taiwan, such as ice cream, fresh milk, and air conditioner. Therefore, it initiates the motive of this research.

1.1 Problem Statement

The trend seasonal demand pattern is encountered when both trend and seasonal influences are interactive. The problem of this research is to project the seasonal market sales using ice cream,fresh milk, and air conditioner in Taiwan as examples. In order to improve the accuracy of forecast, two different methods are validated and the best forecasting method is selected based on the minimum Mean Square Error.

1.2 Research Objectives

The goal of this study is to project the market sales of a seasonal product such as ice cream, fresh milk, and air conditioner. Winters multiplicative seasonal trend model and the Decomposition method will be discussed and evaluated. In order to gain forecast accuracy, we will compare these two forecasting models and adopt the best forecasting technique through the validation procedure based on the minimum Mean Squared Error (MSE). The improvement in market sales forecast offers an organization with potential cost reductions, profit increase, operations improvement, and assists top managers to formulate some competitive strategies.

1.3 Research Data

The dataset used in the research for ice cream and milk was obtained from the Monthly Report of Industrial Production in Taiwan through the Department of Statistics, Ministry of Economic Affairs, ROC. The dataset for air conditioner was obtained from the Industrial Raw Material Price and Volume Information Database. The datasets represents the partial market demand of ice cream, fresh milk, and air conditioner in Taiwan over a time period from January 2006 to December 2010(60 months). The monthly demand from January 2006 to December 2009(48 months) is used to estimate the parameters of the forecasting models and validate the forecasts for the period from January 2010 to December 2010(12 months). Through validation process, a good model is determined and forecasts are performed for the period from January 2011 to December 2011(12 months).

1.4 Organization of the Thesis

This thesis is organized into five chapters. Chapter 1 is the introduction of this paper. Chapter 2 presents the literature review and some comments. Chapter 3 describes and discusses the models in this study. Chapter 4 covers data analysis and finds. Finally, Chapter 5 summarizes conclusions, implications, and future research.

CHAPTER 2

Literature Review

Forecasting techniques have been discussed and classified by researchers (Small,1980; Georgoff and Murdick, 1986; Rao and Cox, 1987; Bails, Peppers, 1993; Bolt, 1994; Mentzer and Kahn, 1995; Peterson and Lewis, 1999; Cox and Loomis, 2001).Johnston and Marshall (2003) summarized some advantages and limitations of the various forecasting methods.

Scott Armstrong (2001) developed one hundred and thirty-nine principles for forecasting, which include defining a problem, collecting information about it, selecting and applying methods, evaluating methods, and deriving forecasts. Later, Armstrong (2005) summarized nine generalizations that can improve forecast accuracy. In his article, Scott Armstrong suggested on how to formulate a forecasting problem, how to tap managers' knowledge, and how to select appropriate forecasting methods.

Furthermore, Armstrong (2010) developed a very useful Methodology Tree (see Figure 1) for forecasting which classifies all possible types of forecasting methods into categories and shows how they relate to one another.

The content of the Methodology Tree are summarized as follows:

Causal models: Theory, prior research and expert domain knowledge are used to specify relationships between a variable to be forecast and explanatory variables.

Classification: If the problem is composed of groups that act in different ways in response to a change, one can study each group separately, then add across segments.

Conjoint analysis: Elicit preferences from consumers for various offerings by using combinations of features. Regression-like analyses are then used to predict the most desirable design.

Data-based: Experience and prior research are not available and so one must try to infer relationships from the data.

Data mining: Letting the data speak for themselves. In general, theory is not considered. Despite its widespread use and many claims of accuracy, we have been unable to find evidence that data mining provides forecasts that are more accurate than those from alternative methods.

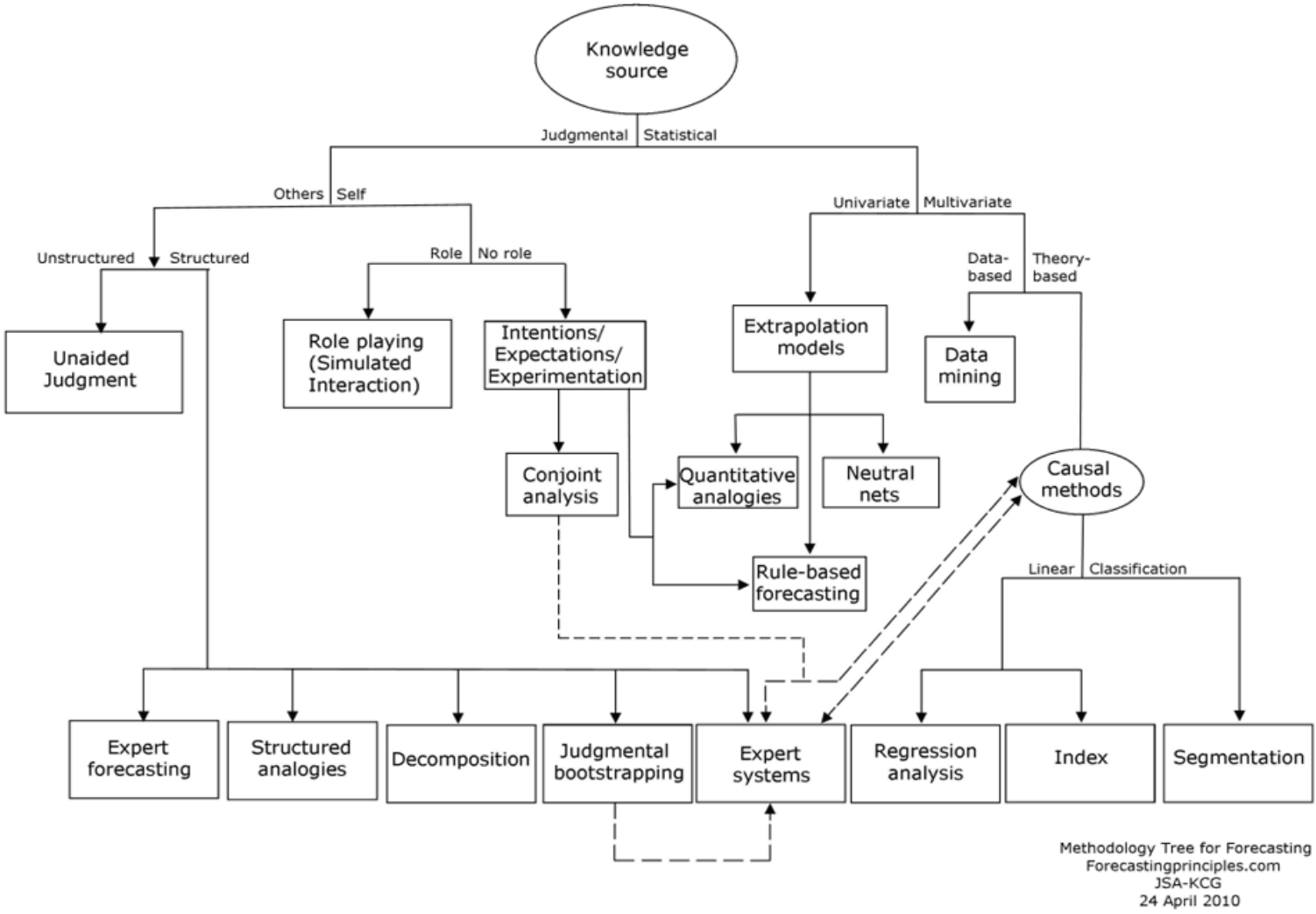


Figure 1: Methodology tree for forecasting (Forecastingprinciples.com)

Decomposition: Decomposition is a method for dealing with such problems by breaking down (decomposing) the estimation task down into a set of components that can be more readily estimated, and then combining the component estimates to produce a target estimate.

Expert Forecasting refers to forecasts obtained in a structured way from two or more experts.

Expert systems: Rules for forecasting are derived from the reasoning experts use when making forecasts. Obtain knowledge from diverse sources such as surveys, interviews, protocol analysis, and research papers.

Extrapolation: Use time-series data, or similar cross-sectional data, to predict.

Index: In situations with many causal variables and few observations, the forecaster can nevertheless often use prior domain knowledge to assess the directional influence of individual variables on the outcome. The values of explanatory variables can be assessed subjectively, for example as zero or one, or can be normalized quantitative data where available. An index forecast is the sum of the values of the explanatory variables.

Intentions/expectations/experimentation: Survey people about their intentions or expectations regarding their future behavior or those of their organization. Analyze the survey data to derive forecasts. Conduct an experiment by changing key causal variables in a systematic way such that the independent variables are not correlated with one another. Estimate relationships from responses to the changes and use these estimates to derive forecasts. Experiments can be used to predict the effects of different policies or regulatory schemes, or to assess the effectiveness of alternative advertisements.

Judgmental: Available data are inadequate for quantitative analysis or qualitative information is likely to increase accuracy, relevance, or acceptability of forecasts.

Judgmental bootstrapping: Derive a model from knowledge of experts' forecasts and the factors they used to make their forecasts using regression analysis.

Knowledge source: When reliable objective data are available, they should be used. Still, one might benefit from also using subjective methods.

Linear: The problem can be modeled as linear in the parameters.

Multivariate: Data are available on variables that might affect the behaviour of interest.

No role: Roles are not expected to influence behavior, or knowledge about the roles is lacking, or there are many actors with different roles.

Others: Knowledge exists about the expected behavior of other people or organizations.

Quantitative analogies: Experts identify analogous situations for which time-series or cross-sectional data are available, and rate the similarity of each analogy to the data-poor target situation. These inputs are used to derive a forecast.

Regression analysis: Sometimes referred to as "econometric modeling", forecasting using models with parameters estimated from historical data using statistical techniques is, however, widely relevant.

Role: People's roles influence their behaviors and there is knowledge about these roles.

Role playing/Simulated interaction: In role playing, people are expected to think in ways consistent with the role and situation described to them. If this involves interacting with people with different roles for the purpose of predicting the behavior of actual protagonists, we call it simulated interaction. That is, people act out prospective interactions in a realistic manner. The role-players' decisions are used as forecasts of the actual decision.

Rule-based forecasting: Expert domain knowledge and statistical techniques are combined using an expert system to extrapolate time series. Most series features are identified by automated analysis, but experts identify some factors. In particular they identify the causal forces acting on trends.

Segmentation: Where a heterogeneous whole can be divided into parts that act in different ways in response to changes, that are relatively homogenous, and that can be forecast more accurately than can the whole.

Self: People have valid intentions or expectations about their behavior. Both are most useful when (1) responses can be obtained from a representative sample, (2) responses are based on good knowledge, (3) there are no reasons to lie, (4) new information is unlikely to change the

behavior. Intentions are more limited than expectations in that they are most useful when (5) the event is important, (6) the behavior is planned, and (7) the respondent can fulfill the plan (so, for example, the behavior is not dependent on the agreement of other people.

Statistical: Relevant numerical data are available.

Structured: Formal methods are used to analyze the information. This means that the rules for analysis are written in advance and they are rigorously adhered to. Records should be kept of how the procedures were administered.

Structured analogies: An expert lists analogies to a target, describes similarities and differences, rates similarity, and matches each analogy's decision (or outcome) with a potential target situation decision (or outcome). The outcome implied by the top-rated analogy is used as a forecast.

Theory-based: Experience and prior research provide useful information about relationships relevant to the forecast.

Unaided judgment: Experts think about a situation and predict how people will behave. They might have access to data and advice, but their forecasts are not aided by formal forecasting methods. This is the most commonly used method. It is fast, inexpensive when only a few forecasts are needed, and can be used in cases where small changes are expected. It is most likely to be useful when the forecaster gets good feedback about the accuracy of his forecasts (e.g., weather forecasting, betting on sports, and bidding in bridge games.)

Univariate : Historical data are available on the behaviour that is to be predicted.

Unstructured: The information is used in an informal manner.

Many researchers have investigated the classification criteria for forecasting methods such as Clemen(1989), McGuiganandMoyler (1989),BailsandPerpers (1993), Bolt (1994), Hall (1994),Taylor (1996), Kinnear, Reekie, and Crook (1998), Makridakis and Wheelwright(1998), Kennedy (1999), Peterson and Lewis (1999), Kirsten (2000), Goodwin (2002), LarrickandSoll (2006), Green and Armstrong (2007).

Decomposition is a method designed for solving this kind of problems by breaking down (decomposing) the forecasting task into a set of components that can be more readily estimated, and then combining the component estimates to produce a target estimate (Armstrong,2001). Persons (1919, 1923) started the research on decomposing a seasonal time series. Since then, many forecasters had devoted to developing forecasting methods to predict data time series with trend and seasonality. Those methods include Decomposition, Winters exponential smoothing, Time series regression, and ARIMA models (Bowerman and O'Connell, 1993; Hanke and Reitsch, 1995).

Winters multiplicative seasonal trend model, one of the most popular forecasting models, was first developed by Charles C. Holt. Then, Peter R. Winters extended the model to forecast the seasonal demands. (Holt, 1957; Winters, 1960). Later, Box and Jenkins (1976) extended Holt-Winters model to the seasonal ARIMA model. The applications of ARIMA model are well adopted by the industries. (Kurawarwala and Matsuo, 1998; Hyndman, 2004)

Neural Networks (NN) models are also used for time series forecasting (Hill, O'Connor and Reus, 1996; Faraway and Chatfield,1998; Zhang et al., 1998; Nelson et al., 1999; Hansen and Nelson, 2003; Yamaha and Eurasia, 1991;A.N. Refenes,1993;White,1988; Kamijo and Tanigawa,1990; Kimoto and Asakawa,1990; Schoeneburg, 1990; Hearing, 2006;Chang,Liu and Fan,2009; Chang, et al.,2009; Chang, et al., 2009).

Suhartono, et al. (2005) compare some forecasting methods including Decomposition, Winters, Time Series Regression, ARIMA and Neural Networks models. In this empirical research, their focus is to study whether a complex method always give a better forecast than a simpler method. A real time series data of airline passenger was performed on these models. The findings show that the more complex model does not always yield a better result than a simpler one.

Little research compared the forecasts of the market sales of seasonal products (such as ice cream, fresh milk, and air conditioner) in Taiwan, betweentheWinters Model and Decomposition Model. Therefore, it creates the motive of this research.

This study tries to compare the performance of the Winters Model and the Decomposition Model for seasonal consumer products in Taiwan, using ice cream, fresh milk, and air conditioner as examples, to determine the better forecasting model. Through the validation process, the best method is to be selected based on the minimum Mean Square Error.

CHAPTER 3

Two Forecasting Models for the Seasonal Demand

Two forecasting models to predict seasonal market sales of ice cream, fresh milk, and air conditioner in Taiwan will be presented in this chapter—including theWinter's multiplicative trend seasonal model and the Decomposition method. The two forecasting models are presented as follows.

3.1 Winters Multiplicative Trend Seasonal Model

The method presented here is a slight modification by Nick T. Thomopoulos (1988) to Winters (1960) original description .Seasonal Demand of a product follows a pattern that has both "trend" and "seasonal" influences. The trend is either increasing or decreasing at a steady rate, and the same for the seasonal influence as shown in the horizontal seasonal market sales pattern. The two factors coupled together give a pattern where the seasonal changes are bigger for the higher levels of the trend than for the lower. A forecasting technique that applies for this type of market sales pattern is the multiplicative trend seasonal model.

The multiplicative trend seasonal model is appropriate when the expected demand for a product or item is $\mu_t = (a + bt)\rho_t$. Here a is the intercept or level at $t = 0$, b is the slope, and ρ_t is the seasonal ratio at time t. In this pattern, $(a + bt)$ defines the general trend of the expected demand. This trend is influenced by the seasonal ratio ρ_t to yield the specific expected demand at time t. Again, when ρ_t >1, then μ_t is larger than the trend, and when ρ_t <1, then μ_t is below the trend. With this pattern the seasonal influence is larger when the trend is at a higher level than when it is at a lower level.

The expected demand at time $(t + \tau)$ is defined by

$$\mu_{t+\tau} = (a_t + b\tau)\rho_{t+\tau}$$

where a_t is the level at time t, b is the slope, and $\rho_{t+\tau}$ is the seasonal ratio at $(t + \tau)$.

The role of the forecasting model is to use the history of demands to estimate 14 unknown coefficients in the demand pattern. At the current time *T,* these estimates are

$$\hat{a}_T \text{ for } a_T$$

$$\hat{b}_T \text{ for } b$$

and

$$r_{T+\tau} \text{ for } \rho_{T+\tau} \quad \tau = 1,2,\cdots,12$$

Three smoothing parameters (α, β, and γ) are used for this purpose, where each lie in the interval (0,1). Parameter α is a smoothing parameter for $\hat{a}_T$, β is used to find $\hat{b}_T$, and γ is for $r_{T+\tau}$.

Two phases are followed in applying the model. The first is the initialization phase, which uses past demands to get the system started. The second is the updating phase, where the forecasts are altered as each new market sales entry becomes available. Descriptions of each of these phases follow.

Initialization

The purpose of the initialization phase is to start the system off with good estimates of a_T, b, and $\rho_{T+\tau}$ ($\tau = 1,2,\cdots,12$). These estimates are found through the use of the past market sales entries that are available to the forecaster. The past sales are again conveniently grouped into J years：

$$\text{Year 1：} \ x_1, x_2, \cdots, x_{12}$$

$$\text{Year 2：} \ x_{13}, x_{14}, \cdots, x_{24}$$

$$\vdots$$

$$\text{Year } J\text{：} \ x_{T-11}, x_{T-10}, \cdots, x_T$$

where

$$J = \frac{T}{12}$$

In order to carry out the initialization, the following nine steps are followed：

1. Find the average monthly market sales for the first and last year(year *J*).
   These are

$$\bar{x}_{(1)} = \frac{1}{12}(x_1 + \cdots + x_{12})$$

$$\bar{x}_{(J)} = \frac{1}{12}(x_{T-11} + \cdots + x_T)$$

2. Estimate the slope using

$$\bar{b}_0 = \frac{\bar{x}_{(J)} - \bar{x}_{(1)}}{T - 12}$$

   Note that the change from $\bar{x}_{(1)}$ to $\bar{x}_{(J)}$ takes place over $(T-12)$ months. This is because $\bar{x}_{(1)}$ is the average of the first year and is representative of time period $t = 6.5$, and in a like way $\bar{x}_{(J)}$ is representative of $t = T - 5.5$. Hence, the time span separating these time periods is $T-12$ months.
3. The deseasonalized level at $t = 0$ is now estimated by

$$\bar{a}_0 = \bar{x}_{(1)} - 6.5\bar{b}_0$$

4. Carrying forward this trend, the deseasonalized level at time t becomes

$$\bar{a}_t = \bar{a}_0 + \bar{b}_{0t}$$

5. A seasonal ratio for each month is now found. For month t this is

$$\tilde{r}_t = \frac{x_t}{\bar{a}_t} \; t = 1,2,\cdots,T$$

6. The seasonal ratio are grouped by calendar months to find the average for each such month, i.e.,

$$\bar{r}_1 = \frac{1}{J}(\tilde{r}_1 + \tilde{r}_{13} + \cdots + \tilde{r}_{T-11})$$

$$\bar{r}_2 = \frac{1}{J}(\tilde{r}_2 + \tilde{r}_{14} + \cdots + \tilde{r}_{T-10})$$

$$\vdots$$

$$\bar{r}_{12} = \frac{1}{J}(\tilde{r}_{12} + \tilde{r}_{24} + \cdots + \tilde{r}_T)$$

7. The seasonal ratios $(\bar{r}_1, \cdots, \bar{r}_{12})$ are normalized so that their average value is 1. This is by

$$\bar{r} = \frac{1}{12}(\bar{r}_1 + \cdots + \bar{r}_{12})$$

$$\hat{r}_t = \bar{r}_t \Big/ \bar{r} \text{ for } t = 1,2,\cdots,12$$

8. Starting at $t = 1$ and continuing until $t = T$, the following three recursive relations are carried forward：

$$\hat{a}_t = \alpha(\frac{x_t}{\hat{r}_t}) + (1-\alpha)(\hat{a}_{t-1} + \hat{b}_{t-1})$$

$$\hat{b}_t = \beta(\hat{a}_t - \hat{a}_{t-1}) + (1-\beta)\hat{b}_{t-1}$$

$$\hat{r}_{t+12} = \gamma(\frac{x_t}{\hat{a}_t}) + (1-\gamma)\hat{r}_t$$

9. The 12 most current estimates of the seasonal ratios are now normalized so that their average is 1. This step is performed as follows：

$$\bar{r} = \frac{1}{12}(\hat{r}_{T+1} + \cdots + \hat{r}_{T+12})$$

$$r_{T+\tau} = \frac{1}{\bar{r}}\hat{r}_{T+\tau} \text{ for } \tau = 1,2,\cdots,12$$

Having performed the preceding nine steps, the initialization process is complete. The estimates that are carried forward are $\hat{a}_T$, $\hat{b}_T$, and $r_{T+1}, r_{T+2}, \cdots, r_{T+12}$. These may also be used to generate forecasts as of $t = T$. The forecast for the τ th future time period is

$$\hat{x}_T(\tau) = (\hat{a}_T + \hat{b}_{T\tau})r_{T+\tau}$$

Note that a seasonal ratio is estimated for each of the 12 calendar months.

In this way

$$r_{T+13} = r_{T+1}$$

$$r_{T+14} = r_{T+2}$$

$$\vdots$$

$$r_{T+24} = r_{T+12}$$

can be used should forecasts be required for $\tau > 12$.

Updating

With each passing time period, a new market sales entry becomes available and is used to update the 14 coefficients. Again using x_T as the current demand, then

$$\hat{a}_T = \alpha(\frac{x_T}{r_T}) + (1-\alpha)(\hat{a}_{T-1} + \hat{b}_{T-1})$$

$$\hat{b}_T = \beta(\hat{a}_T - \hat{a}_{T-1}) + (1-\beta)\hat{b}_{T-1}$$

$$r_{T+12} = \gamma(\frac{x_T}{\hat{a}_T}) + (1-\gamma)r_T$$

Now r_{T+1} to r_{T+12} are normalized so that their average is 1.

The updated forecasts are generated at this time. For the τ th future time period, the forecast is

$$\hat{x}_T(\tau) = (\hat{a}_T + \hat{b}_T\tau)r_{T+\tau}$$

As before, should τ exceed 12, the seasonal ratios are repeated. For example, $r_{T+13} = r_{T+1}$, $r_{T+14} = r_{T+2}$, and so forth.

3.2 Decomposition Forecasting

Decomposition is a method for dealing with forecast problems by breaking down (decomposing) the estimation task down into a set of components that can be more readily estimated, and then combining the component estimates to produce a target estimate. Classical time series decomposition separates a time series into five components: mean, trend, seasonality, cycle, and randomness. Makridakis (1998) expressed decomposition model as

Value=(Mean)x (Trend)x (Seasonality)x (Cycle)x (Random)

Note that this model is multiplicative rather than additive. Although additive models are more popular in other areas of statistics, forecasters have found that the multiplicative model fits a wider range of forecasting situations.

Decomposition is often used by forecasters for it is easy to understand (and to explain to others). Complex ARIMA models are popular among statisticians. However, they are not as well-accepted among forecasting practitioners. For seasonal (monthly, weekly, or quarterly)

data, decomposition methods are often as accurate as the ARIMA methods and they provide additional information about the trend and cycle, which may not be available in ARIMA methods.

Decomposition has one disadvantage: the cycle component must be input by the forecaster since it is not estimated by the algorithm. This may be avoided by ignoring the cycle, or by assuming a constant value. Some forecasters consider this a strength, because it allows the forecaster to enter information about the current business cycle into the forecast.

Decomposition Method

The basic decomposition method consists of estimating the five components of the model

$$X_t = UT_tC_tS_tR_t$$

where

X_t denotestheseriesorlogofseries.

U denotesthemeanoftheseries.

T_t denotesthelineartrend.

C_t denotescycle.

S_t denotesseason.

R_t denotesrandomerror.

t denotesthetime period.

Makridakislistedthe following stepsusedbytheprogramtoperformadecompositionofa time series.

Step1–RemovetheMean

Thefirststepistoremovethemeanbydividingeachindividualvaluebytheseriesmean.Thiscreatesanewseriesthathasvaluesnearone.Thisstepisrepresentedsymbolicallyas

$$Y_t = X_t / U$$

Step2–CalculateaMovingAverage

Thenextstepcalculatesan L-stepmovingaveragecenteredatthetimeperiod *t*, where *L* isthelengthoftheseasonality(e.g., *L* wouldbe12fora monthlyseriesor4forquarterlyseries).Since themovingaveragegivesthemeanofayear'sdata,theseasonalityfactorisremoved.Usually, theaveragingremovestherandomnesscomponentaswell.Symbolically,thisstepisrepresented as

$$M_t = \sum Y_t$$

Step3–CalculatetheTrend

Thenextstepistocalculateandremovethetrendcomponentoftheseries.Thiscalculation is madeonthemovingaverages, M_t,ratherthanonthe Y_t series.Aleastsquaresfitismadeofthemodel

$$M_t = a + bt + e_t$$

Where

a istheintercept.

b istheslope.

e_t istheresidualorlack-of-linear-fit.

Thelinearportionoftheabovemodelisusedtodefinethetrend.Thatis,weuse

$$T_t = a + bt$$

Step4–CalculatetheCycle

Thecycletermisfoundbydividingthemovingaveragebythecomputedtrend.Symbolically, thisis

$$\rho_t = \frac{M_t}{T_t}$$

Step5–CalculatetheSeasonality

Theseasonalityiscomputedbydividingthe*Y*seriesbythemovingaverages.Symbolically,this is

$$K_t = \frac{Y_t}{M_t}$$

Notethatthe*K*seriesiscomposedofboththeseasonalityandtherandomness.Tocalculate the seasonalcomponentforeachseason,wesimplyaverageall like seasons.Thatis,theaverageof all Januarysiscomputed,theaverageofallFebruarysgivestheseasonalvalueforFebruary,andsoon.Mat hematically,thisisstatedas

$$S_g = \Sigma K_t$$

wherethesummationisoverall*t* inwhichtheseasonis*g*.

Step6–CalculatetheRandomness

Thefinalstepistocalculatetherandomnesscomponent.Thisisaccomplishedbydividingthe*K*seriesb y$S_i$wherethevaluesof$S_1, S_2, \ldots, S_g$arerepeatedas needed. This is represented mathematically as follows

$$R_t = \frac{K_t}{S_t}$$

Step 7 Creating Forecasts

Once the series decomposition is complete, forecastsmaybe generated fairlyeasily. The trend component is calculated using

$$T_t = a + bt$$

The seasonal factor is read from

$$S_g = \Sigma K_t$$

The cycle factor is input by hand, andtherandomfactor is assumed to be one. If the series was transformed using the log transformation, the forecastsare transformed back using the appropriate inverse function.

3.3 Estimation and Validation

In forecasting, it is very important to conduct the process of testing how accurate a model is for making forecasts. Validation is the process that determines whether or not a model is correct or appropriate. To determine the accuracy of the forecast, the approach is to separate the data into two categories—the estimation (calibration) period and the validation period. A specific number of data points were left out for the validation period. In general, the data in the estimation period are used to help select the model andto estimate its parameters. The model is further tested on the data that were left out in the validation period. If results are acceptable, then the later on forecasts are considered to be valid.

3.4 Forecasting Accuracy

To choose the value of the smoothing constant(s) objectively, values that are best in some sense are noted. The Number Cruncher Statistical System (NCSS) program searches for those values that minimize the size of the combined forecast errors of the currently available series. Mean Square Error (MSE) is one of the popular methods of summarizing the amount of error in the forecasts. The average squared residual (MSE) is a measure of how closely the forecasts track the actual data. The statistic is popular because it shows up in analysis of variance tables. However, because of the squaring, it tends to exaggerate the influence of outliers (points that do not follow the regular pattern). The forecast error is the difference between the forecast of the current period made at the last period and the value of the series at the current period. This is written as $\ell_t = X_t - F_{t-1}$

Then ,

$$\text{MSE}=\frac{1}{n}\sum \ell_t^2$$

To find the value of the smoothing constants objectively, look for those values of α and β that minimize this function. The NCSS program conducts a search for the appropriate values using an efficient grid-searching algorithm. Grid Search Method involves setting up grids in the decision space and evaluating the values of the objective function at each grid point. The point which corresponds to the best value of the objective function is considered to be the optimal solution.

3.5 Software used in the research

Dr. Jerry L. Hintze (2009) designed the useful software, Number Cruncher Statistical System (NCSS), which was used for analyzing statistical data. It is an advanced, user-friendly statistical analysis software package. The present version, written for 32-bit versions of Microsoft Windows (95, 98, ME, 2000, NT, etc.) computer systems, is the result of several iterations. NCSS maintains a website at www.ncss.com.

CHAPTER 4

Data Collection and Analysis

The dataset of ice cream and fresh milk presented in this study was collected from the Monthly Report of Industrial Production in Taiwan through the Department of Statistics, Ministry of Economic Affairs, ROC. The dataset of air conditioner was collected from the Industrial Raw Material Price and Volume Information Database.

4.1 Data

The datasetrepresents the partial market demand of the ice cream, fresh milk, and air conditioner industry in Taiwan over a time period from January 2006 to December 2010(60 months) as in Table 1.

The monthly demand from January 2006 to December 2009(48 months) is used to find the parameters of the forecasting models and validate the forecasts for the period from January 2010 to December 2010(12 months). Using the models, forecasts are made for the period from January 2011 to December 2011(12 months).

Table 1: Monthly market sales report for ice cream and fresh milkin Taiwan

年 (月) 別 Year (Month)	冰淇淋 Ice Cream 銷售 Sales 數量 Quant. (公噸) (M.T.)	鮮奶 Fresh Milk 銷售 Sales 數量 Quant. (公噸) (M.T.)	冷氣機 Air Conditioner 銷售 Sales 數量 Quant. (公噸) (M.T.)
95 年 2006			
1 月 Jan.	1,586	17,263	27,486
2 月 Feb.	1,137	16,452	52,957
3 月 Mar	1,471	19,355	78,204
4 月 Apr.	2,302	21,954	116,473
5 月 May	2,651	24,242	93,163
6 月 June	2,822	24,164	63,238
7 月 July	3,377	27,492	96,299
8 月 Aug.	3,305	29,099	35,477
9 月 Sep.	2,215	26,740	18,649
10 月 Oct.	1,807	25,574	21,219

11月 Nov.	971	23,704	25,793
12月 Dec.	881	20,779	31,280
96年 2007			
1月 Jan.	1,179	18,703	40,219
2月 Feb.	1,346	16,645	62,879
3月 Mar	1,637	20,433	78,855
4月 Apr.	1,717	21,322	94,385
5月 May	2,440	24,406	93,782
6月 June	3,173	24,066	69,081
7月 July	3,743	26,041	91,320
8月 Aug.	3,434	24,348	43,093
9月 Sep.	2,258	23,167	19,727
10月 Oct.	1,531	23,505	23,511
11月 Nov.	949	20,084	24,506
12月 Dec.	903	19,439	34,369
97年 2008			
1月 Jan.	958	17,357	45,931
2月 Feb.	1,097	15,271	67,051
3月 Mar	1,473	19,081	87,890
4月 Apr.	1,522	20,514	109,988
5月 May	1,704	22,044	92,893
6月 June	2,255	22,121	69,084
7月 July	2,657	23,875	55,706
8月 Aug.	2,460	24,697	23,724
9月 Sep.	1,728	23,972	19,859
10月 Oct.	1,177	23,762	23,324
11月 Nov.	714	20,720	21,921
12月 Dec.	632	20,820	32,745
98年 2009			
1月 Jan.	905	18,686	24,494
2月 Feb.	1,038	18,911	66,216
3月 Mar	1,350	21,995	73,731
4月 Apr.	1,565	22,062	89,082
5月 May	1,903	24,287	77,147
6月 June	2,475	25,094	69,648
7月 July	4,454	26,091	65,989
8月 Aug.	4,005	24,859	45,259
9月 Sep.	3,647	23,934	34,410
10月 Oct.	1,359	23,928	31,477

11 月 Nov.	820	23,225	30,200
12 月 Dec.	735	23,388	44,441
99 年 2010			
1 月 Jan.	742	21,513	46,198
2 月 Feb.	936	19,069	64,560
3 月 Mar	1,864	23,576	96,523
4 月 Apr.	1,959	24,613	95,333
5 月 May	2,096	26,646	97,656
6 月 June	2,324	26,905	87,720
7 月 July	3,600	27,054	112,769
8 月 Aug.	3,226	26,610	52,779
9 月 Sep.	2,603	26,092	35,877
10 月 Oct.	1,871	26,432	32,687
11 月 Nov.	964	24,471	38,619
12 月 Dec.	780	25,337	69,289

Source:

1. Department of Statistics, Ministry of Economic Affairs.www.coa.gov.tw/view.php?catid=7820
2. The Industrial Raw Material Price and Volume Information Database (產業原物料價量情報資料庫, 2011)

4.2 Results of Forecasting for the Monthly Sales of Ice Cream

4.2.1 Validation

The monthly market demand from January 2006 to December 2009 (48 months) is used to find the parameters of the forecasting models and validate the projections for the period from January 2010 to December 2010(12 months). In this research, the above sales data was ran using Number Cruncher Statistical System (NCSS) based on two models—winters multiplicative trend seasonal model and the decomposition model.

A. Forecast (Validation) Based on Winters Multiplicative Trend Seasonal Model

The result was obtained at 11:31:29 PM on 2011/5/15 using NCSS software and summarized as in Table 2. A search is conducted to find the values of the smoothing

constants that minimize MSE. The Mean Squared Error is 106207.5 and Pseudo R-Squared is 0.887048. A value near zero indicates a poorly fitting model, while a value near one indicates a well fitting one. Thus, this model is well fitted. 167 iterations were needed to find the best values for the smoothing constants. The values of the smoothing constants, α, β, and γ are 0.5, 0, and 0, respectively. In the current month, Intercept(A) is 3.27012 and Slope(B) is -1.260789E-03.

The seasonal ratios for the next 12 months are also listed from Seasonal 1 Factor to Seasonal 12 Factor.

Figure 2 shows the monthly market sales forecast for ice cream in Taiwan.

Table 2: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for validation based on Winters Multiplicative Trend Seasonal Model (ice cream)

Log10(Variable)	Sales
Number of Rows	48
Mean	1905.583
Pseudo R-Squared	0.887048
Mean Square Error	106207.5
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	167
Search Criterion	Mean Square Error
Alpha	0.5
Beta	0
Gamma	0
Intercept (A)	3.27012
Slope (B)	-1.260789E-03
Season 1 Factor	0.9444247
Season 2 Factor	0.9474447
Season 3 Factor	0.9818625
Season 4 Factor	1.004788
Season 5 Factor	1.03204
Season 6 Factor	1.061784
Season 7 Factor	1.099116
Season 8 Factor	1.089718
Season 9 Factor	1.047505
Season 10 Factor	0.9816289
Season 11 Factor	0.9110703

Season 12 Factor	0.8986188

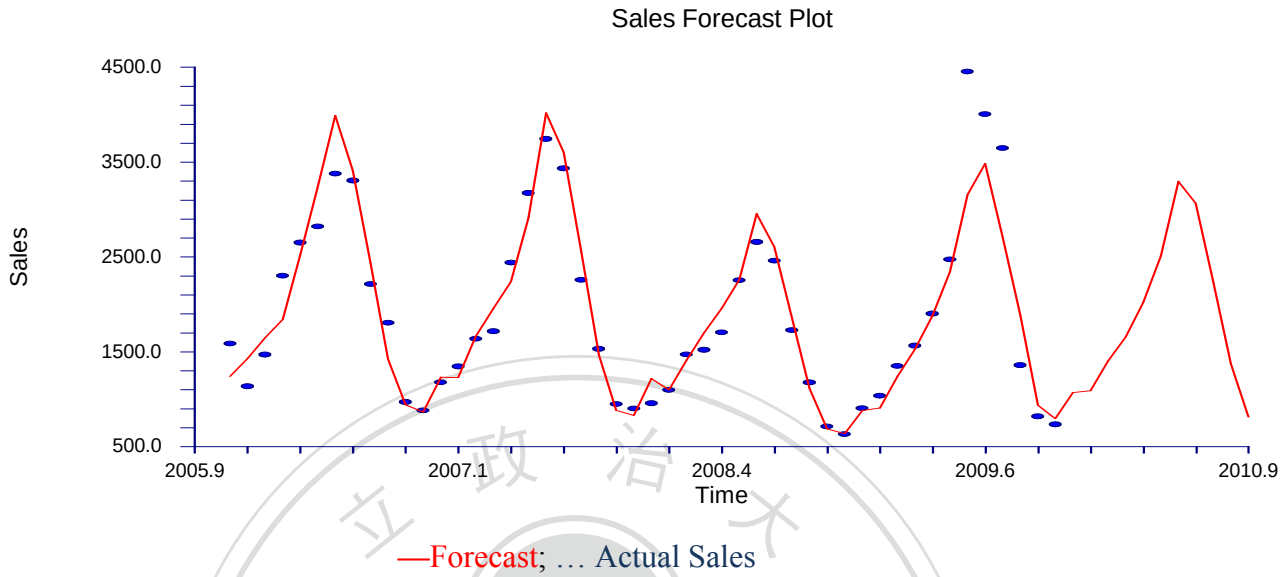


Figure 2: The monthly market sales and forecasts for ice cream in Taiwan(ton) for validation based on WintersMultiplicativeTrend Seasonal Model.

Table 3 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual – forecast).

Table 3: The monthly market sales for ice cream in Taiwan (forecasts vs. actual) for validation based on WintersMultiplicativeTrend Seasonal Model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	1242.734	1586	343.2662
2	2006 2	1432.882	1137	-295.882
3	2006 3	1650.359	1471	-179.3592
4	2006 4	1844.471	2302	457.5287
5	2006 5	2526.791	2651	124.2091
6	2006 6	3236.049	2822	-414.0494
7	2006 7	3992.717	3377	-615.7171
8	2006 8	3412.266	3305	-107.2655
9	2006 9	2444.522	2215	-229.5221

10	2006 10	1424.998	1807	382.0023
11	2006 11	941.5372	971	29.46283
12	2006 12	868.2816	881	12.71842
13	2007 1	1231.921	1179	-52.92105
14	2007 2	1229.437	1346	116.5634
15	2007 3	1663.764	1637	-26.76422
16	2007 4	1956.274	1717	-239.274
17	2007 5	2240.271	2440	199.7294
18	2007 6	2914.731	3173	258.2688
19	2007 7	4018.957	3743	-275.9573
20	2007 8	3602.52	3434	-168.52
21	2007 9	2555.711	2258	-297.7107
22	2007 10	1468.176	1531	62.82398
23	2007 11	883.9935	949	65.00647
24	2007 12	832.2333	903	70.76675
25	2008 1	1220.491	958	-262.4913
26	2008 2	1102.7	1097	-5.69981
27	2008 3	1414.413	1473	58.58673
28	2008 4	1705.652	1522	-183.6525
29	2008 5	1962.618	1704	-258.6176
30	2008 6	2263.763	2255	-8.763535
31	2008 7	2954.817	2657	-297.8171
32	2008 8	2609.806	2460	-149.8065
33	2008 9	1864.651	1728	-136.6507
34	2008 10	1117.35	1177	59.64984
35	2008 11	689.3211	714	24.67889
36	2008 12	639.7789	632	-7.778899
37	2009 1	881.2134	905	23.78662
38	2009 2	910.1361	1038	127.8639
39	2009 3	1244.36	1350	105.6396
40	2009 4	1527.74	1565	37.26005
41	2009 5	1881.396	1903	21.60371
42	2009 6	2344.578	2475	130.4219
43	2009 7	3157.478	4454	1296.522
44	2009 8	3484.256	4005	520.7438
45	2009 9	2708.018	3647	938.982
46	2009 10	1888.497	1359	-529.4974
47	2009 11	940.0931	820	-120.0931
48	2009 12	798.235	735	-63.23501
49	2010 1	1071.611		
50	2010 2	1092.778		
51	2010 3	1404.994		
52	2010 4	1659.212		
53	2010 5	2022.697		
54	2010 6	2511.14		

55	2010 7	3296.294		
56	2010 8	3065.983		
57	2010 9	2239.691		
58	2010 10	1374.872		
59	2010 11	815.7147		
60	2010 12	742.3581		

B. Forecast (Validation) Based on Decomposition Model

The result was obtained at 3:01:31 PM on 2011/5/13 using NCSS software and summarized as in Table 4. The Mean Squared Error (MSE) is 95391.411. Pseudo R-Squared is 0.8985508. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is also well fitted.

The equation used to predict the trend is:

$$\text{Trend} = a + bt$$

where

a is the intercept

b is the slope

t is the time period

Table 4 shows that*a*is 1.013007 and *b* is -0.000675. Note that the trend value obtained from this equation will be a ratio type value that will be multiplied by the mean to obtain the actual forecast.

Table 4: Summary of the output report for validation based ontheDecompositionModel (ice cream)

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	3.224856
Mean Square Error	95391.411
Pseudo R-Squared	0.8985508
Forecast Std. Error	308.855
Trend Equation	Trend = (1.013007) + (-0.000675) * (Time Season Number)
Number of Seasons	12
First Year	2006

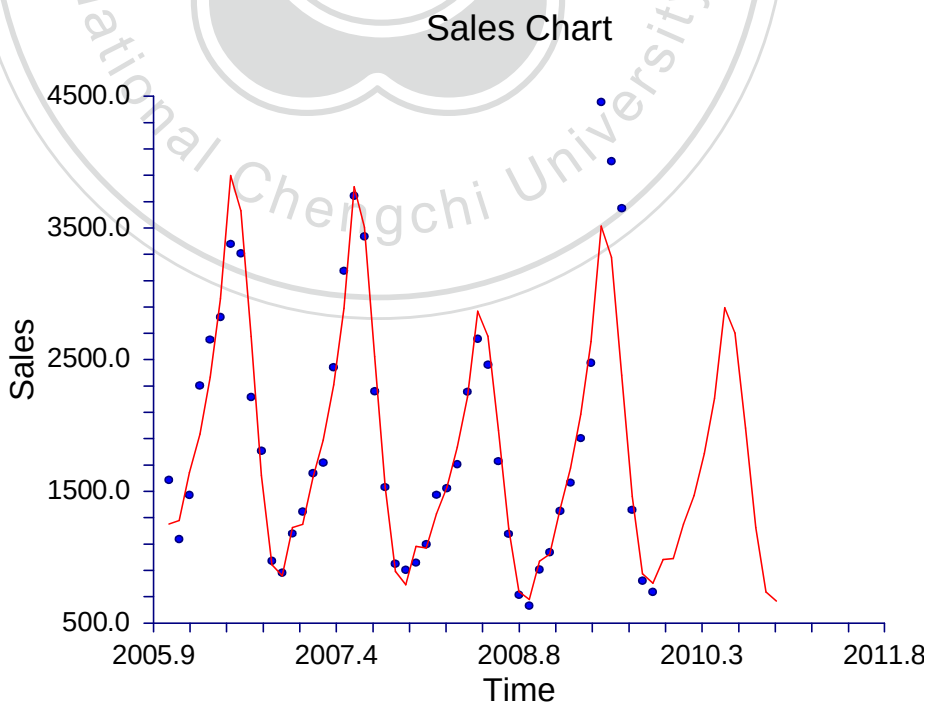
First Season	1

Table 5 shows the seasonal component ratios in the Decomposition model. The ratios used to adjust for each season (month or quarter). For example, the last ratio in this example is 0.900578. This indicates that the December correction factor is a 9.9422% decrease in the forecast.

Table 5: Seasonal component ratios for validation based on the Decomposition Model (ice cream)

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.946733	2	0.948577	3	0.981609	4	1.004087
5	1.031877	6	1.061734	7	1.099833	8	1.091168
9	1.048965	10	0.983347	11	0.913054	12	0.900578

Figure 3 shows the monthly market sales forecast for ice cream in Taiwan for validation based on the Decomposition Model. The data plot allows us to analyze how closely the forecasts track the data. The plot also shows the forecasts at the end of the data series.



—Forecast; … Actual Sales

Figure 3: The monthly market sales and forecasts for ice cream in Taiwan(ton) for validation based on the Decomposition Model

Table 6 shows the values of the forecasts, the dates, the actual values, and the residuals for validation based on the Decomposition Model. The residual is the difference between the actual sales and the forecast sales. A value of one is used for all future cycle components. This ignores the cycle in the forecasts, and the random factor is assumed to be one.

Table 6: The monthly sales forecast for ice cream in Taiwan (forecast vs. actual) for validation based on the Decomposition Model

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	1252.73	1586	333.2697	1.0123	1.0023	0.9467	1.0331
2	2006 2	1277.37	1137	-140.3695	1.0117	1.0038	0.9486	0.9837
3	2006 3	1642.504	1471	-171.5037	1.0110	1.0047	0.9816	0.9851
4	2006 4	1934.099	2302	367.9007	1.0103	1.0046	1.0041	1.0230
5	2006 5	2365.452	2651	285.5477	1.0096	1.0042	1.0319	1.0147
6	2006 6	2961.898	2822	-139.8977	1.0090	1.0049	1.0617	0.9939
7	2006 7	3897.027	3377	-520.0268	1.0083	1.0041	1.0998	0.9827
8	2006 8	3630.126	3305	-325.1261	1.0076	1.0040	1.0912	0.9886
9	2006 9	2675.873	2215	-460.873	1.0069	1.0062	1.0490	0.9760
10	2006 10	1620.869	1807	186.1308	1.0063	1.0059	0.9833	1.0147
11	2006 11	942.0839	971	28.9161	1.0056	1.0044	0.9131	1.0044
12	2006 12	859.0311	881	21.96893	1.0049	1.0053	0.9006	1.0037
13	2007 1	1225.034	1179	-46.03437	1.0042	1.0072	0.9467	0.9946
14	2007 2	1249.074	1346	96.92551	1.0036	1.0087	0.9486	1.0105
15	2007 3	1604.868	1637	32.13174	1.0029	1.0097	0.9816	1.0027
16	2007 4	1888.78	1717	-171.7796	1.0022	1.0095	1.0041	0.9874
17	2007 5	2308.51	2440	131.4903	1.0015	1.0092	1.0319	1.0072
18	2007 6	2888.56	3173	284.4402	1.0009	1.0099	1.0617	1.0118
19	2007 7	3812.631	3743	-69.63076	1.0002	1.0095	1.0998	0.9978
20	2007 8	3506.5	3434	-72.49986	0.9995	1.0079	1.0912	0.9974
21	2007 9	2522.786	2258	-264.7858	0.9988	1.0068	1.0490	0.9858
22	2007 10	1531.279	1531	-0.2791941	0.9982	1.0062	0.9833	1.0000
23	2007 11	890.1275	949	58.87253	0.9975	1.0042	0.9131	1.0094
24	2007 12	790.1924	903	112.8076	0.9968	1.0009	0.9006	1.0200
25	2008 1	1082.73	958	-124.7297	0.9961	0.9978	0.9467	0.9825

26	2008 2	1068.622	1097	28.37787	0.9955	0.9946	0.9486	1.0038
27	2008 3	1329.282	1473	143.7183	0.9948	0.9919	0.9816	1.0143
28	2008 4	1532.883	1522	-10.88312	0.9941	0.9896	1.0041	0.9990
29	2008 5	1834.214	1704	-130.2142	0.9934	0.9872	1.0319	0.9902
30	2008 6	2215.919	2255	39.08103	0.9928	0.9842	1.0617	1.0023
31	2008 7	2866.632	2657	-209.6315	0.9921	0.9826	1.0998	0.9905
32	2008 8	2678.669	2460	-218.6687	0.9914	0.9826	1.0912	0.9892
33	2008 9	1961.694	1728	-233.6937	0.9907	0.9825	1.0490	0.9833
34	2008 10	1217.887	1177	-40.88695	0.9901	0.9828	0.9833	0.9952
35	2008 11	736.754	714	-22.75405	0.9894	0.9842	0.9131	0.9952
36	2008 12	678.358	632	-46.35798	0.9887	0.9861	0.9006	0.9891
37	2009 1	970.5469	905	-65.54693	0.9880	0.9902	0.9467	0.9898
38	2009 2	1023.457	1038	14.54307	0.9874	0.9966	0.9486	1.0020
39	2009 3	1370.286	1350	-20.28604	0.9867	1.0043	0.9816	0.9979
40	2009 4	1678.138	1565	-113.1383	0.9860	1.0100	1.0041	0.9906
41	2009 5	2086.167	1903	-183.1672	0.9853	1.0123	1.0319	0.9880
42	2009 6	2636.045	2475	-161.0448	0.9847	1.0147	1.0617	0.9920
43	2009 7	3512.23	4454	941.7696	0.9840	1.0159	1.0998	1.0291
44	2009 8	3276.689	4005	728.3111	0.9833	1.0160	1.0912	1.0248
45	2009 9	2381.017	3647	1265.983	0.9826	1.0159	1.0490	1.0548
46	2009 10	1460.412	1359	-101.4123	0.9820	1.0162	0.9833	0.9901
47	2009 11	872.0739	820	-52.07383	0.9813	1.0177	0.9131	0.9909
48	2009 12	801.1042	735	-66.10418	0.9806	1.0196	0.9006	0.9871
49	2010 1	981.4221			0.9799	1.0000	0.9467	1.0000
50	2010 2	989.9675			0.9793	1.0000	0.9486	1.0000
51	2010 3	1252.561			0.9786	1.0000	0.9816	1.0000
52	2010 4	1467.416			0.9779	1.0000	1.0041	1.0000
53	2010 5	1786.271			0.9772	1.0000	1.0319	1.0000
54	2010 6	2206.635			0.9766	1.0000	1.0617	1.0000
55	2010 7	2892.841			0.9759	1.0000	1.0998	1.0000
56	2010 8	2701.978			0.9752	1.0000	1.0912	1.0000
57	2010 9	1980.025			0.9746	1.0000	1.0490	1.0000
58	2010 10	1225.491			0.9739	1.0000	0.9833	1.0000
59	2010 11	733.7712			0.9732	1.0000	0.9131	1.0000
60	2010 12	667.4899			0.9725	1.0000	0.9006	1.0000

Note: This section shows the values of the forecasts, the dates, the actual values, the residuals, and the forecast ratios. A value of one is used for all future cycle components. This ignores the cycle in the forecasts. And the random factor is assumed to be one.

From Table 7 and Table 8, we compare the MSEs for forecasts based on two models—the Winters Multiplicative Trend Seasonal Model and the Decomposition

Model. It shows that the Decomposition Model generates better forecasts than those from Winters Multiplicative Trend Seasonal Model. Therefore, we complete the validation procedure.

Table 7: MSE of forecast for validation based on Winters Multiplicative Trend Seasonal Model (ice cream)

Year season	Winter's Trend Seasonal (Forecast Sales)	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	1071.611	742	108643.4113
2010 2	1092.778	936	24579.34128
2010 3	1404.994	1,864	210686.508
2010 4	1659.212	1,959	89872.84494
2010 5	2022.697	2,096	5373.329809
2010 6	2511.14	2,324	35021.3796
2010 7	3296.294	3,600	92237.33444
2010 8	3065.983	3,226	25605.44029
2010 9	2239.691	2,603	131993.4295
2010 10	1374.872	1,871	246142.9924
2010 11	815.7147	964	21988.5302
2010 12	742.3581	780	1416.912636
			MSE (winter's trend)
			82,796.79

Table 8: MSE of Forecast for validation based on the Decomposition Model (ice cream)

Year season	Decomposition (Forecast Sales)	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	981.4221	742	57322.94197
2010 2	989.9675	936	2912.491056
2010 3	1252.561	1,864	373857.6507
2010 4	1467.416	1,959	241654.8291
2010 5	1786.271	2,096	95932.05344
2010 6	2206.635	2,324	13774.54322

2010 7	2892.841	3,600	500073.8513
2010 8	2701.978	3,226	274599.0565
2010 9	1980.025	2,603	388097.8506
2010 10	1225.491	1,871	416681.8691
2010 11	733.7712	964	53005.30035
2010 12	667.4899	780	12658.5226
			MSE (decomposition)
			202,547.58

4.2.2 Forecasts

After the validation procedures on the monthly market sales from January 2006 to December 2009 (48 months) of ice cream,the Winters multiplicative trend seasonal model is selected as the forecasting model to project the sales of next 12 months. In this section, we will use theWinters model to generate forecasts for the period from January 2011 to December 2011(12 months).

The result was obtained at11:39:18 PM on 2011/5/15 using NCSS software and summarized as in Table 9. A search is conducted to find the values of the smoothing constants that minimize MSE. The mean square error is 100919.1 and Pseudo R-Squared is 0.889704. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is well-fitted. 176 iterations were required to find the best values for the smoothing constants. The values of the smoothing constants, α, β, γ, are 0.5, 0, 0, respectively. In the current month, Intercept(A) is 3.298883 and Slope(B) is -9.053888E-04.

Figure 4 shows the monthly market sales forecasts for ice cream in Taiwan.

Table 9: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for forecasting based on Winters Multiplicative Trend Seasonal Model (ice cream)

Forecast Method	**Winter's with multiplicative seasonal adjustment.**
Forecasts are made for the period from January 2011 to December 2011(12 months)	
Forecast Summary Section	
Log10(Variable)	Sales
Number of Rows	60

Mean	1907.217
Pseudo R-Squared	0.889704
Mean Square Error	100919.1
Mean |Error|	223.2138
Mean |Percent Error|	11.22653
Search Iterations	176
Search Criterion	Mean Square Error
Alpha	0.5
Beta	0
Gamma	0
Intercept (A)	3.298883
Slope (B)	-9.053888E-04
Season 1 Factor	0.9336358
Season 2 Factor	0.9422643
Season 3 Factor	0.9883024
Season 4 Factor	1.007955
Season 5 Factor	1.031548
Season 6 Factor	1.05809
Season 7 Factor	1.099702
Season 8 Factor	1.089195
Season 9 Factor	1.049619
Season 10 Factor	0.9880086
Season 11 Factor	0.9136869
Season 12 Factor	0.8979931

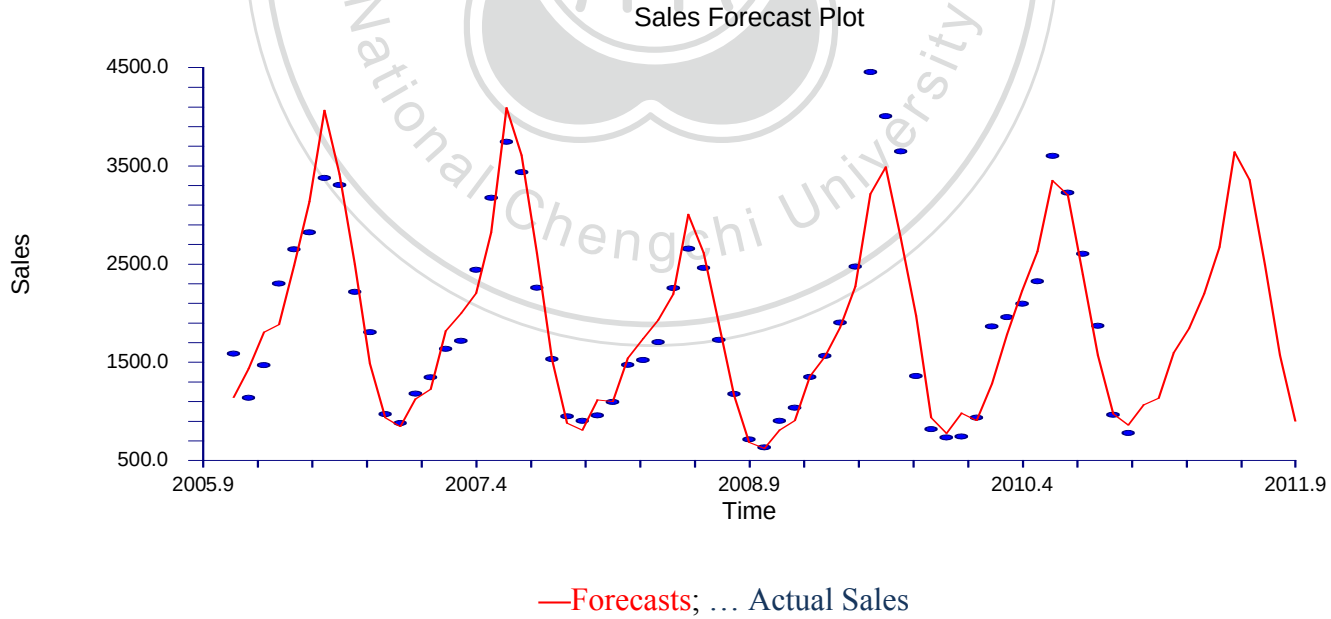


Figure 4: The monthly market sales forecast for ice cream in Taiwan(ton) based on Winters Multiplicative Trend Seasonal Model

Table 10 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual-forecast).

Table 10: The monthly market sales for ice cream in Taiwan (forecast vs actual) based on Winters Multiplicative Trend Seasonal Model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	1141.22	1586	444.7796
2	2006 2	1435.157	1137	-298.1566
3	2006 3	1808.038	1471	-337.0376
4	2006 4	1885.285	2302	416.7146
5	2006 5	2485.917	2651	165.0826
6	2006 6	3134.856	2822	-312.856
7	2006 7	4064.346	3377	-687.3457
8	2006 8	3417.266	3305	-112.2658
9	2006 9	2496.554	2215	-281.5543
10	2006 10	1487.892	1807	319.108
11	2006 11	937.8013	971	33.19866
12	2006 12	846.5882	881	34.41182
13	2007 1	1127.265	1179	51.7352
14	2007 2	1228.041	1346	117.9586
15	2007 3	1820.302	1637	-183.3016
16	2007 4	1997.809	1717	-280.8089
17	2007 5	2204.002	2440	235.9978
18	2007 6	2824.453	3173	348.5469
19	2007 7	4091.818	3743	-348.8176
20	2007 8	3607.933	3434	-173.9333
21	2007 9	2610.447	2258	-352.4465
22	2007 10	1533.274	1531	-2.273921
23	2007 11	880.7653	949	68.23475
24	2007 12	811.6894	903	91.31062
25	2008 1	1117.096	958	-159.0959
26	2008 2	1100.871	1097	-3.87082
27	2008 3	1544.03	1473	-71.02991
28	2008 4	1740.687	1522	-218.6865
29	2008 5	1931.099	1704	-227.099
30	2008 6	2195.462	2255	59.53773
31	2008 7	3005.954	2657	-348.9541
32	2008 8	2613.534	2460	-153.534
33	2008 9	1903.018	1728	-175.0181
34	2008 10	1165.017	1177	11.98301
35	2008 11	686.9086	714	27.09146
36	2008 12	624.6168	632	7.383211

37	2009 1	809.8107	905	95.18927
38	2009 2	909.4203	1038	128.5797
39	2009 3	1356.912	1350	-6.91211
40	2009 4	1558.833	1565	6.166496
41	2009 5	1851.291	1903	51.7087
42	2009 6	2273.668	2475	201.3322
43	2009 7	3212.855	4454	1241.145
44	2009 8	3488.607	4005	516.3934
45	2009 9	2766.078	3647	880.9222
46	2009 10	1974.475	1359	-615.4746
47	2009 11	936.9445	820	-116.9445
48	2009 12	778.7621	735	-43.76217
49	2010 1	982.3508	742	-240.3508
50	2010 2	906.9282	936	29.07175
51	2010 3	1283.419	1864	580.5806
52	2010 4	1786.146	1959	172.8543
53	2010 5	2226.52	2096	-130.5196
54	2010 6	2626.334	2324	-302.3345
55	2010 7	3351.405	3600	248.5954
56	2010 8	3205.901	3226	20.09929
57	2010 9	2392.863	2603	210.1373
58	2010 10	1573.596	1871	297.4036
59	2010 11	978.0168	964	-14.01678
60	2010 12	861.1707	780	-81.17062
61	**2011 1**	**1067.558**		
62	**2011 2**	**1136.387**		
63	**2011 3**	**1599.269**		
64	**2011 4**	**1848.076**		
65	**2011 5**	**2199.113**		
66	**2011 6**	**2674.779**		
67	**2011 7**	**3639.806**		
68	**2011 8**	**3357.914**		
69	**2011 9**	**2494.585**		
70	**2011 10**	**1572.923**		
71	**2011 11**	**902.4263**		
72	**2011 12**	**801.3745**		

4.3 Results of Forecasting for the Monthly Sales of Fresh Milk

4.3.1 Validation

The monthly market demand from January 2006 to December 2009 (48 months) of fresh milk is used to find the parameters of the forecasting models and validate the projections for the period

from January 2010 to December 2010(12 months). In this research, the above sales data was ran using Number Cruncher Statistical System (NCSS) based on the same two models that was also used for ice cream—winters multiplicative trend seasonal model and the decomposition model.

A. Forecast (Validation) Based on Winters Multiplicative Trend Seasonal Model

The result was obtained at4:52:29 PM on 2011/6/11 using NCSS software and summarized as in Table 11. A search is conducted to find the values of the smoothing constants that minimize MSE. The Mean Squared Error is 790666.8 and Pseudo R-Squared is 0.914516. A value near zero indicates a poorly fitting model, while a value near one indicates a well fitting one. Thus, this model is well fitted. 151 iterations were needed to find the best values for the smoothing constants. The values of the smoothing constants, α, β, and γ are 0.8145158, 5.716994E-08, and 2.286691E-03, respectively. In the current month, Intercept(A) is 4.380449 and Slope(B) is 1.021276E-04.

The seasonal ratios for the next 12 months are also listed from Seasonal 1 Factor to Seasonal 12 Factor.

Figure 5 shows the monthly market sales forecast for fresh milk in Taiwan.

Table 11: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for validation based on Winters Multiplicative Trend Seasonal Model (fresh milk)

Forecast Method	**Winter's with multiplicative seasonal adjustment.**
Log10(Variable)	Sales
Number of Rows	48
Mean	22284.81
Pseudo R-Squared	0.914516
Mean Square Error	790666.8
Mean |Error|	723.2148
Mean |Percent Error|	3.293337
Search Iterations	151
Search Criterion	Mean Square Error
Alpha	0.8145158
Beta	5.716994E-08

Gamma	2.286691E-03
Intercept (A)	4.380449
Slope (B)	1.021276E-04
Season 1 Factor	0.9797085
Season 2 Factor	0.9726461
Season 3 Factor	0.9911656
Season 4 Factor	0.9972439
Season 5 Factor	1.007274
Season 6 Factor	1.00772
Season 7 Factor	1.015774
Season 8 Factor	1.015128
Season 9 Factor	1.01006
Season 10 Factor	1.009061
Season 11 Factor	0.9990233
Season 12 Factor	0.9951959

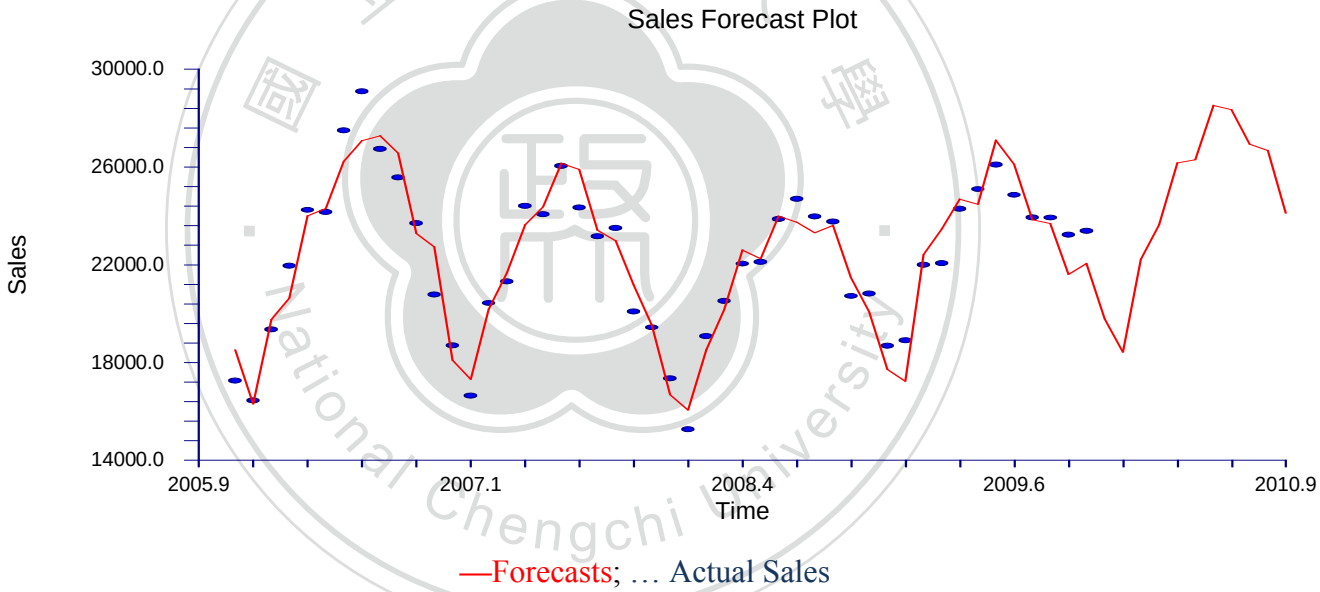


Figure 5: The monthly sales and forecasts for fresh milk in Taiwan(ton) for validation based on Winters Multiplicative Trend Seasonal Model.

Table 12 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual – forecast).

Table 12: The monthly market sales for fresh milk in Taiwan (Forecasts vs. Actual) for validation based on Winters Multiplicative Trend Seasonal Model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	18524.37	17263	-1261.367
2	2006 2	16304.96	16452	147.0355
3	2006 3	19763.45	19355	-408.4469
4	2006 4	20647.93	21954	1306.069
5	2006 5	24004.4	24242	237.5971
6	2006 6	24311.96	24164	-147.9632
7	2006 7	26230.05	27492	1261.954
8	2006 8	27083.58	29099	2015.417
9	2006 9	27286.1	26740	-546.0951
10	2006 10	26577.32	25574	-1003.32
11	2006 11	23287.58	23704	416.4235
12	2006 12	22737.37	20779	-1958.372
13	2007 1	18098.91	18703	604.0874
14	2007 2	17322.6	16645	-677.6018
15	2007 3	20185.11	20433	247.8888
16	2007 4	21671.71	21322	-349.7108
17	2007 5	23647.33	24406	758.6683
18	2007 6	24377.85	24066	-311.8484
19	2007 7	26156.49	26041	-115.4931
20	2007 8	25900.96	24348	-1552.966
21	2007 9	23421	23167	-253.9982
22	2007 10	22989.44	23505	515.5574
23	2007 11	21184.72	20084	-1100.717
24	2007 12	19531.2	19439	-92.19598
25	2008 1	16688.12	17357	668.8781
26	2008 2	16064.96	15271	-793.9627
27	2008 3	18526.66	19081	554.3356
28	2008 4	20163.89	20514	350.1097
29	2008 5	22600.62	22044	-556.6193
30	2008 6	22249.29	22121	-128.2872
31	2008 7	23994.6	23875	-119.5966
32	2008 8	23749.86	24697	947.1389
33	2008 9	23317.1	23972	654.9006
34	2008 10	23618.25	23762	143.7509
35	2008 11	21476.79	20720	-756.7885
36	2008 12	20082.71	20820	737.2847
37	2009 1	17722.46	18686	963.5344
38	2009 2	17241.8	18911	1669.195
39	2009 3	22422.36	21995	-427.355

40	2009 4	23475.92	22062	-1413.921
41	2009 5	24687.64	24287	-400.6447
42	2009 6	24475.45	25094	618.5548
43	2009 7	27090.71	26091	-999.7139
44	2009 8	26110.6	24859	-1251.595
45	2009 9	23854.44	23934	79.55725
46	2009 10	23687.36	23928	240.6438
47	2009 11	21608.9	23225	1616.096
48	2009 12	22056.95	23388	1331.054
49	2010 1	19790.93		
50	2010 2	18432.91		
51	2010 3	22228.67		
52	2010 4	23641.38		
53	2010 5	26167.59		
54	2010 6	26292.02		
55	2010 7	28526.69		
56	2010 8	28348.08		
57	2010 9	26939.96		
58	2010 10	26675.74		
59	2010 11	24109.64		
60	2010 12	23200.82		

B. Forecast (Validation) Based on Decomposition Model

The result was obtained at 4:50:35 PM on 2011/6/11 using NCSS software and summarized as in Table 13. The Mean Squared Error (MSE) is 1006689.149. Pseudo R-Squared is 0.8911608. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is also well fitted.

The equation used to predict the trend is:

$$\text{Trend} = a + bt$$

where

a is the intercept

b is the slope

t is the time period

Table 13 shows that a is0.999829 and b is -0.000019. Note that the trend value obtained from this equation will be a ratio type value that will be multiplied by the mean to obtain the actual forecast.

Table 13: Summary of the output report for validation based on the Decomposition Model (fresh milk)

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	4.343749
Mean Square Error	1006689.149
Pseudo R-Squared	0.8911608
Forecast Std. Error	1003.339
Trend Equation	Trend = (0.999829) + (-0.000019) * (Time Season Number)
Number of Seasons	12
First Year	2006
First Season	1

Table 14 shows the seasonal component ratios in the Decomposition model. The ratios used to adjust for each season (month or quarter). For example, the last ratio in this example is 0.993180. This indicates that the December correction factor is a 0.682% decrease in the forecast.

Table 14: Seasonal Component Ratios for validation based on the Decomposition Model (fresh milk)

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.977703	2	0.971128	3	0.990244	4	0.996752
5	1.007150	6	1.007762	7	1.015624	8	1.014469
9	1.008775	10	1.007440	11	0.997255	12	0.993180

Figure 6 shows the monthly market sales forecast for fresh milk in Taiwan for validation based on the Decomposition model. The data plot allows us to analyze how closely the forecasts track the data. The plot also shows the forecasts at the end of the data series.

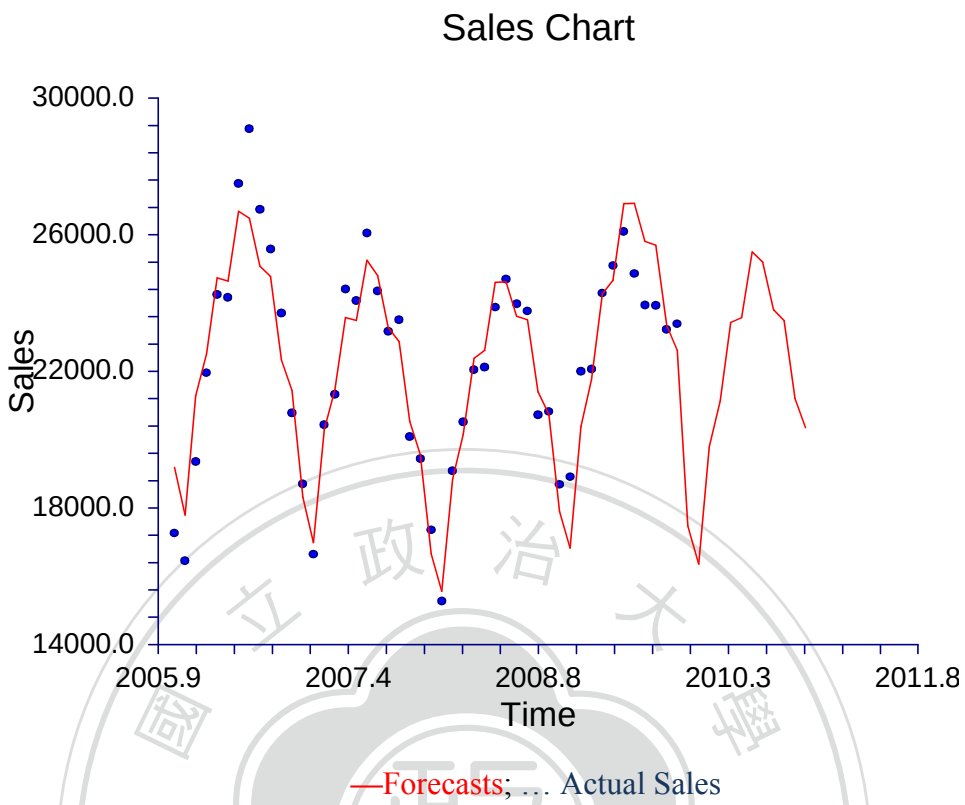


Figure 6: The monthly market sales and forecasts for fresh milk in Taiwan(ton) for validation based on the Decomposition Model

Table 15 shows the values of the forecasts, the dates, the actual values, and the residuals for validation based on the decomposition model. The residual is the difference between the actual sales and the forecast sales. A value of one is used for all future cycle components. This ignores the cycle in the forecasts, and the random factor is assumed to be one.

Table 15: The monthly sales forecast for fresh milk in Taiwan (forecast vs. actual) for validation based on the Decomposition Model.

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	19189.66	17263	-1926.658	0.9998	1.0087	0.9777	0.9893

2	2006 2	17790.11	16452	-1338.109	0.9998	1.0078	0.9711	0.9920
3	2006 3	21285.06	19355	-1930.065	0.9998	1.0064	0.9902	0.9905
4	2006 4	22511.74	21954	-557.7376	0.9998	1.0055	0.9968	0.9975
5	2006 5	24731.82	24242	-489.8178	0.9997	1.0045	1.0072	0.9980
6	2006 6	24642.65	24164	-478.6522	0.9997	1.0035	1.0078	0.9981
7	2006 7	26680.74	27492	811.259	0.9997	1.0036	1.0156	1.0029
8	2006 8	26475.63	29099	2623.374	0.9997	1.0040	1.0145	1.0093
9	2006 9	25074.18	26740	1665.821	0.9997	1.0043	1.0088	1.0063
10	2006 10	24766.27	25574	807.7272	0.9996	1.0044	1.0074	1.0032
11	2006 11	22337.32	23704	1366.683	0.9996	1.0043	0.9973	1.0059
12	2006 12	21444.19	20779	-665.1892	0.9996	1.0044	0.9932	0.9968
13	2007 1	18314.07	18703	388.9309	0.9996	1.0042	0.9777	1.0021
14	2007 2	16983.71	16645	-338.7123	0.9996	1.0032	0.9711	0.9979
15	2007 3	20301.7	20433	131.2979	0.9995	1.0019	0.9902	1.0006
16	2007 4	21465.03	21322	-143.0292	0.9995	1.0010	0.9968	0.9993
17	2007 5	23570.17	24406	835.8257	0.9995	0.9999	1.0072	1.0035
18	2007 6	23484.51	24066	581.4897	0.9995	0.9990	1.0078	1.0024
19	2007 7	25251.3	26041	789.699	0.9995	0.9984	1.0156	1.0030
20	2007 8	24792.58	24348	-444.5848	0.9995	0.9978	1.0145	0.9982
21	2007 9	23272.21	23167	-105.215	0.9994	0.9971	1.0088	0.9995
22	2007 10	22861.6	23505	643.3984	0.9994	0.9967	1.0074	1.0028
23	2007 11	20535.24	20084	-451.2422	0.9994	0.9961	0.9973	0.9978
24	2007 12	19567.51	19439	-128.5135	0.9994	0.9954	0.9932	0.9993
25	2008 1	16658.45	17357	698.5532	0.9994	0.9947	0.9777	1.0042
26	2008 2	15558.52	15271	-287.5247	0.9993	0.9944	0.9711	0.9981
27	2008 3	18851.7	19081	229.3056	0.9993	0.9946	0.9902	1.0012
28	2008 4	20149.25	20514	364.751	0.9993	0.9948	0.9968	1.0018
29	2008 5	22383.48	22044	-339.4853	0.9993	0.9950	1.0072	0.9985
30	2008 6	22614.69	22121	-493.6901	0.9993	0.9955	1.0078	0.9978
31	2008 7	24602.55	23875	-727.5468	0.9993	0.9961	1.0156	0.9970

32	2008 8	24618.56	24697	78.44176	0.9992	0.9973	1.0145	1.0003
33	2008 9	23611.03	23972	360.9675	0.9992	0.9988	1.0088	1.0015
34	2008 10	23509.59	23762	252.4112	0.9992	0.9997	1.0074	1.0011
35	2008 11	21385.09	20720	-665.0854	0.9992	1.0004	0.9973	0.9968
36	2008 12	20721.76	20820	98.24145	0.9992	1.0014	0.9932	1.0005
37	2009 1	17904.67	18686	781.3312	0.9991	1.0023	0.9777	1.0044
38	2009 2	16828.29	18911	2082.705	0.9991	1.0027	0.9711	1.0120
39	2009 3	20385.17	21995	1609.828	0.9991	1.0027	0.9902	1.0077
40	2009 4	21763.6	22062	298.3979	0.9991	1.0028	0.9968	1.0014
41	2009 5	24276.68	24287	10.31796	0.9991	1.0033	1.0072	1.0000
42	2009 6	24663.57	25094	430.4343	0.9990	1.0043	1.0078	1.0017
43	2009 7	26903.91	26091	-812.9073	0.9990	1.0051	1.0156	0.9970
44	2009 8	26918.68	24859	-2059.677	0.9990	1.0063	1.0145	0.9922
45	2009 9	25804.08	23934	-1870.08	0.9990	1.0078	1.0088	0.9926
46	2009 10	25690.19	23928	-1762.194	0.9990	1.0087	1.0074	0.9930
47	2009 11	23347.69	23225	-122.6869	0.9990	1.0095	0.9973	0.9995
48	2009 12	22615.37	23388	772.6312	0.9989	1.0104	0.9932	1.0034
49	2010 1	17470.36			0.9989	1.0000	0.9777	1.0000
50	2010 2	16356.65			0.9989	1.0000	0.9711	1.0000
51	2010 3	19795.06			0.9989	1.0000	0.9902	1.0000
52	2010 4	21120.88			0.9989	1.0000	0.9968	1.0000
53	2010 5	23428.6			0.9988	1.0000	1.0072	1.0000
54	2010 6	23567.85			0.9988	1.0000	1.0078	1.0000
55	2010 7	25488.83			0.9988	1.0000	1.0156	1.0000
56	2010 8	25191.5			0.9988	1.0000	1.0145	1.0000
57	2010 9	23794.24			0.9988	1.0000	1.0088	1.0000
58	2010 10	23474.64			0.9988	1.0000	1.0074	1.0000
59	2010 11	21199.69			0.9987	1.0000	0.9973	1.0000
60	2010 12	20350.38			0.9987	1.0000	0.9932	1.0000

Note: This section shows the values of the forecasts, the dates, the actual values, the residuals, and the forecast ratios. A value of one is used for all future cycle components. This ignores the cycle in the forecasts. And the random factor is assumed to be one.

From Table 16 and Table 17, we compare the MSEs for forecasts based on two models—the Winters Multiplicative Trend Seasonal Model and the Decomposition Model. It shows that the Decomposition Model generates better forecasts than those from Winters Multiplicative Trend Seasonal Model. Therefore, we complete the validation procedure.

Table 16: MSE of Forecast for validation based on Winters Multiplicative Trend Seasonal Model (fresh milk)

Year season	Winters Forecast	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	19790.93	21513	2965525.085
2010 2	18432.91	19069	404610.4881
2010 3	22228.67	23576	1815298.129
2010 4	23641.38	24613	944045.4244
2010 5	26167.59	26646	228876.1281
2010 6	26292.02	26905	375744.4804
2010 7	28526.69	27054	2168815.836
2010 8	28348.08	26610	3020922.086
2010 9	26939.96	26092	719036.1616
2010 10	26675.74	26432	59409.1876
2010 11	24109.64	24471	130581.0496
2010 12	23200.82	25337	4563264.992
			MSE (winter's trend)
			1,449,677.42

Table 17: MSE of Forecast for validation based on the Decomposition Model (fresh milk)

Year season	Decomposition Forecast	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	17470.36	21513	16342938.17
2010 2	16356.65	19069	7356842.523
2010 3	19795.06	23576	14295507.28
2010 4	21120.88	24613	12194902.09
2010 5	23428.6	26646	10351662.76
2010 6	23567.85	26905	11136570.12
2010 7	25488.83	27054	2449757.129
2010 8	25191.5	26610	2012142.25
2010 9	23794.24	26092	5279701.018
2010 10	23474.64	26432	8745978.17
2010 11	21199.69	24471	10701469.12
2010 12	20350.38	25337	24866379.02
			MSE (decomposition)
			10,477,820.80

4.3.2 Forecasts

After the validation procedures on the monthly market sales from January 2006 to December 2009 (48 months) of fresh milk, the Winters multiplicative trend seasonal model is selected as the forecasting model to project the sales of next 12 months. In this section, we will use the Winters model to generate forecasts for the period from January 2011 to December 2011(12 months).

The result was obtained at 4:56:48 PM on 2011/6/11 using NCSS software and summarized as in Table 18. A search is conducted to find the values of the smoothing constants that minimize MSE. The mean square error is 797011.9 and Pseudo R-Squared is 0.916643. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is well-fitted. 136 iterations were required to find the best values for the smoothing constants. The values of the smoothing constants, α, β, γ, are 0.8730332, 3.756879E-08,

3.947698E-03, respectively. In the current month, Intercept(A) is 4.373165 and Slope(B) is 7.648958E-04.

Figure 6 shows the monthly market sales forecasts for fresh milk in Taiwan.

Table 18: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for forecasting of fresh milk based on Winters Multiplicative Trend Seasonal Model

Forecast Method	**Winter's with multiplicative seasonal adjustment.**
Forecasts are made for the period from January 2011 to December 2011(12 months)	
Forecast Summary Section	
Log10(Variable)	Sales
Number of Rows	60
Mean	22799.82
Pseudo R-Squared	0.916643
Mean Square Error	797011.9
Mean |Error|	712.8579
Mean |Percent Error|	3.172555
Search Iterations	136
Search Criterion	Mean Square Error
Alpha	0.8730332
Beta	3.756879E-08
Gamma	3.947698E-03
Intercept (A)	4.373165
Slope (B)	7.648958E-04
Season 1 Factor	0.9818563
Season 2 Factor	0.9736617
Season 3 Factor	0.9925297
Season 4 Factor	0.9980898
Season 5 Factor	1.007528
Season 6 Factor	1.007919
Season 7 Factor	1.014312
Season 8 Factor	1.01331
Season 9 Factor	1.008709
Season 10 Factor	1.008008
Season 11 Factor	0.9983027
Season 12 Factor	0.9957737

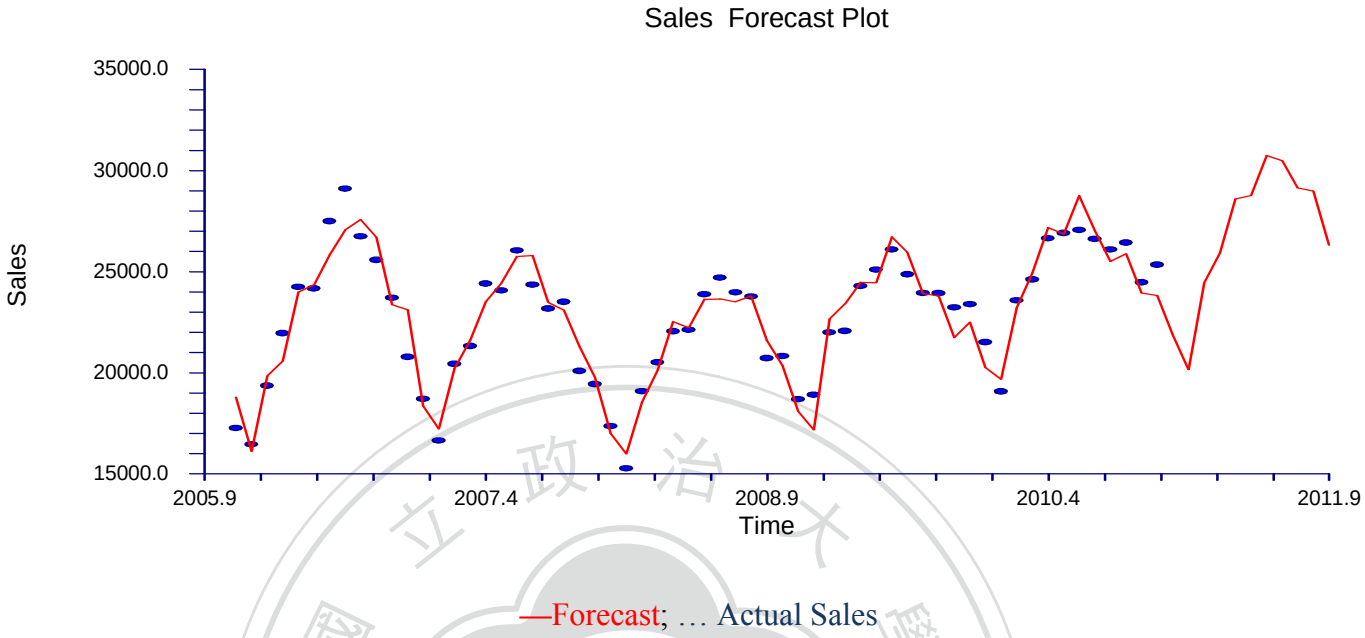


Figure 7: The monthly market sales forecast for fresh milk in Taiwan(ton) based on Winters Multiplicative Trend Seasonal Model

Table 19 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual-forecast).

Table 19: The monthly market sales for fresh milk in Taiwan (Forecast vs Actual) based on Winters Multiplicative trend seasonal model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	18786.5	17263	-1523.498
2	2006 2	16111.33	16452	340.6747
3	2006 3	19838.37	19355	-483.3698
4	2006 4	20556.02	21954	1397.978
5	2006 5	23970.55	24242	271.4522
6	2006 6	24345.36	24164	-181.3639
7	2006 7	25832.35	27492	1659.653
8	2006 8	27049.8	29099	2049.197
9	2006 9	27566.1	26740	-826.1008
10	2006 10	26701.19	25574	-1127.194
11	2006 11	23360.32	23704	343.6839
12	2006 12	23104.55	20779	-2325.548

13	2007 1	18355.65	18703	347.346
14	2007 2	17219.05	16645	-574.0549
15	2007 3	20218.14	20433	214.8584
16	2007 4	21611.04	21322	-289.041
17	2007 5	23511.05	24406	894.9453
18	2007 6	24428.79	24066	-362.7858
19	2007 7	25752.43	26041	288.5715
20	2007 8	25790.35	24348	-1442.348
21	2007 9	23466.98	23167	-299.9824
22	2007 10	23084.05	23505	420.9515
23	2007 11	21323.73	20084	-1239.727
24	2007 12	19768.79	19439	-329.7863
25	2008 1	16997.98	17357	359.0195
26	2008 2	15985.05	15271	-714.049
27	2008 3	18546.95	19081	534.0519
28	2008 4	20127.27	20514	386.7318
29	2008 5	22518.43	22044	-474.4281
30	2008 6	22228.12	22121	-107.1171
31	2008 7	23628.18	23875	246.8245
32	2008 8	23648.67	24697	1048.332
33	2008 9	23500.65	23972	471.3493
34	2008 10	23787	23762	-25.00126
35	2008 11	21605.67	20720	-885.6664
36	2008 12	20347.09	20820	472.9115
37	2009 1	18098.05	18686	587.9476
38	2009 2	17173.88	18911	1737.116
39	2009 3	22643.87	21995	-648.8704
40	2009 4	23390.41	22062	-1328.408
41	2009 5	24475.77	24287	-188.7715
42	2009 6	24448.85	25094	645.1514
43	2009 7	26719.79	26091	-628.7867
44	2009 8	25954.18	24859	-1095.18
45	2009 9	23913.81	23934	20.19368
46	2009 10	23806.44	23928	121.5641
47	2009 11	21737.89	23225	1487.106
48	2009 12	22491.32	23388	896.6757
49	2010 1	20256.48	21513	1256.518
50	2010 2	19679.5	19069	-610.4973
51	2010 3	23216.34	23576	359.662
52	2010 4	24939.16	24613	-326.1627
53	2010 5	27176.58	26646	-530.5823
54	2010 6	26865.81	26905	39.18773
55	2010 7	28750.25	27054	-1696.253
56	2010 8	27037.49	26610	-427.4862
57	2010 9	25503.13	26092	588.8686

58	2010 10	25879.15	26432	552.8517
59	2010 11	23942.08	24471	528.9158
60	2010 12	23827.88	25337	1509.125
61	**2011 1**	**21859.07**		
62	**2011 2**	**20144.56**		
63	**2011 3**	**24452.56**		
64	**2011 4**	**25922.16**		
65	**2011 5**	**28587.76**		
66	**2011 6**	**28752.58**		
67	**2011 7**	**30742.26**		
68	**2011 8**	**30484.26**		
69	**2011 9**	**29140.02**		
70	**2011 10**	**28983.88**		
71	**2011 11**	**26300.12**		
72	**2011 12**	**25675.7**		

4.4 Results of Forecasting for the Monthly Sales of Air Conditioner

4.4.1 Validation

The monthly market demand from January 2006 to December 2009 (48 months) is used to find the parameters of the forecasting models and validate the projections for the period from January 2010 to December 2010(12 months). In this research, the above sales data was ran using Number Cruncher Statistical System (NCSS) based on two models—winters multiplicative trend seasonal model and the decomposition model.

A. Forecast (Validation) Based on Winters Multiplicative Trend Seasonal Model

The result was obtained at5:38:23 PM on 2011/6/30 using NCSS software and summarized as in Table 20. A search is conducted to find the values of the smoothing constants that minimize MSE. The Mean Squared Error is 9.854667E+07and Pseudo R-Squared is 0.874496. A value near zero indicates a poorly fitting model, while a value near one indicates a well fitting one. Thus, this model is well fitted. 150 iterations were needed to find the best values for the smoothing constants. The values of the smoothing constants, α, β, and γ are 6.259737E-07, 2.238804E-02, and 0.5738754, respectively. In the current month, Intercept(A) is 4.686174 and Slope(B) is 5.427435E-10.

The seasonal ratios for the next 12 months are also listed from Seasonal 1 Factor to Seasonal 12 Factor.

Figure 8 shows the monthly market sales forecast for air conditioner in Taiwan.

Table 20: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for validation based on Winters Multiplicative Trend Seasonal Model (air conditioner)

Log10(Variable)	Sales
Number of Rows	48
Mean	54961.98
Pseudo R-Squared	0.874496
Mean Square Error	9.854667E+07
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	150
Search Criterion	Mean Square Error
Alpha	6.259737E-07
Beta	2.238804E-02
Gamma	0.5738754
Intercept (A)	4.686174
Slope (B)	5.427435E-10
Season 1 Factor	0.9569405
Season 2 Factor	1.026979
Season 3 Factor	1.043513
Season 4 Factor	1.062904
Season 5 Factor	1.050147
Season 6 Factor	1.032684
Season 7 Factor	1.03014
Season 8 Factor	0.9768854
Season 9 Factor	0.9463719
Season 10 Factor	0.947819
Season 11 Factor	0.9456754
Season 12 Factor	0.9799403

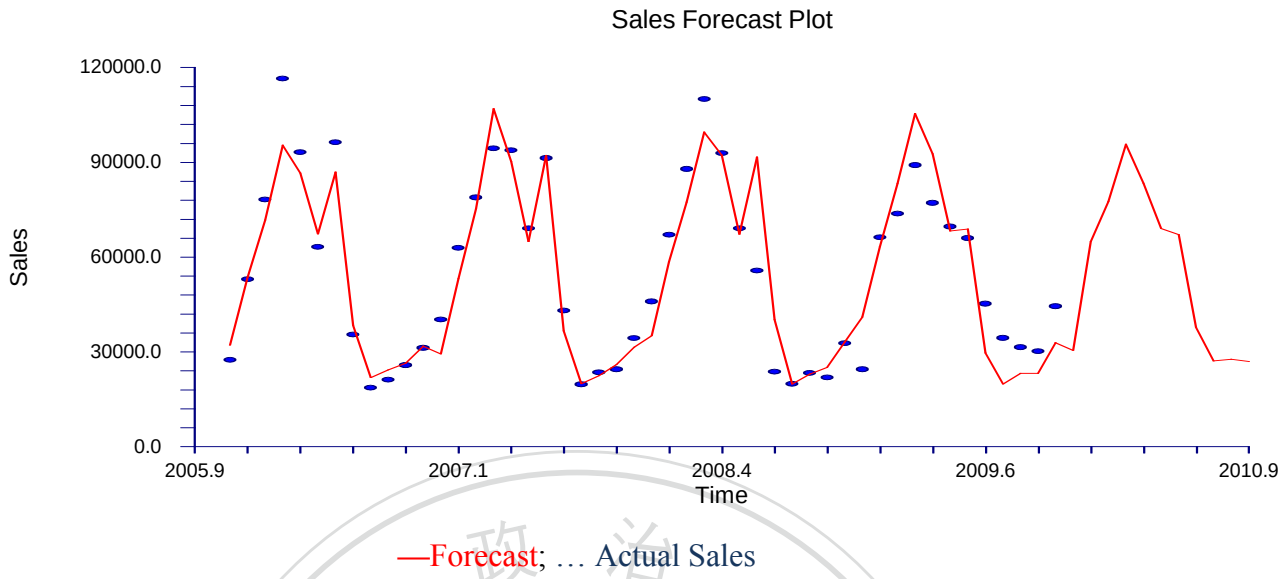


Figure 8: The monthly market sales and forecasts for air conditioner in Taiwan(ton) for validation based on WintersMultiplicativeTrend Seasonal Model

Table 21 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual – forecast).

Table 21: The monthly market sales for air conditioner in Taiwan (forecasts vs. actual) for validation based on WintersMultiplicativeTrend Seasonal Model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	32145.6	27486	-4659.604
2	2006 2	53538.58	52957	-581.5829
3	2006 3	71706.66	78204	6497.341
4	2006 4	95442.55	116473	21030.45
5	2006 5	86570.91	93163	6592.089
6	2006 6	67374.88	63238	-4136.874
7	2006 7	86912.03	96299	9386.967
8	2006 8	38444.5	35477	-2967.498
9	2006 9	21929.44	18649	-3280.439
10	2006 10	24307.1	21219	-3088.102
11	2006 11	26477.6	25793	-684.6022

12	2006 12	31841.59	31280	-561.5923
13	2007 1	29382.73	40219	10836.27
14	2007 2	53204.05	62879	9674.949
15	2007 3	75366.29	78855	3488.714
16	2007 4	106997.3	94385	-12612.26
17	2007 5	90294.69	93782	3487.314
18	2007 6	64968.82	69081	4112.182
19	2007 7	92180.98	91320	-860.9882
20	2007 8	36712.44	43093	6380.564
21	2007 9	19982.18	19727	-255.1779
22	2007 10	22483.81	23511	1027.192
23	2007 11	26082.54	24506	-1576.542
24	2007 12	31518.1	34369	2850.905
25	2008 1	35183.09	45931	10747.91
26	2008 2	58557.93	67051	8493.065
27	2008 3	77349.08	87890	10540.93
28	2008 4	99566.69	109988	10421.32
29	2008 5	92279.84	92893	613.1529
30	2008 6	67297.83	69084	1786.17
31	2008 7	91685.95	55706	-35979.95
32	2008 8	40248.65	23724	-16524.65
33	2008 9	19835.33	19859	23.66716
34	2008 10	23067.67	23324	256.3333
35	2008 11	25165.8	21921	-3244.799
36	2008 12	33123.91	32745	-378.9044
37	2009 1	40998.92	24494	-16504.92
38	2009 2	63290.77	66216	2925.226
39	2009 3	83233.04	73731	-9502.042
40	2009 4	105420	89082	-16337.96
41	2009 5	92631.09	77147	-15484.09
42	2009 6	68317.04	69648	1330.959
43	2009 7	68883.48	65989	-2894.482
44	2009 8	29717.35	45259	15541.65
45	2009 9	19848.9	34410	14561.1
46	2009 10	23214.42	31477	8262.582
47	2009 11	23249.13	30200	6950.872
48	2009 12	32905.93	44441	11535.07
49	2010 1	30506.29		
50	2010 2	64953.36		
51	2010 3	77639.74		
52	2010 4	95709.3		
53	2010 5	83400.74		
54	2010 6	69077.78		
55	2010 7	67207.31		
56	2010 8	37831.59		

57	2010 9	27218.44		
58	2010 10	27646.79		
59	2010 11	27014.64		
60	2010 12	39099.44		

B. Forecast (Validation) Based on Decomposition Model

The result was obtained at 5:42:16 PM on 2011/6/30 using NCSS software and summarized as in Table 22. The Mean Squared Error (MSE) is4.677556. Pseudo R-Squared is 0.9183424. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is also well fitted.

The equation used to predict the trend is:

$$\text{Trend} = a + bt$$

where

a is the intercept

b is the slope

t is the time period

Table 22 shows that*a*is0.999897 and *b* is -0.000064. Note that the trend value obtained from this equation will be a ratio type value that will be multiplied by the mean to obtain the actual forecast.

Table 22: Summary of the output report for validation based on the Decomposition Model (air conditioner)

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	4.677556
Mean Square Error	64,118,246.6
Pseudo R-Squared	0.9183424
Forecast Std. Error	8007.387
Trend Equation	Trend = (0.999897) + (-0.000064) * (Time Season Number)
Number of Seasons	12
First Year	2006

First Season	1

Table 23 shows the seasonal component ratios in the Decomposition model. The ratios used to adjust for each season (month or quarter). For example, the last ratio in this example is 0.975439. This indicates that the December correction factor is a 2.4561% decrease in the forecast.

Table 23: Seasonal component ratios for validation based on the Decomposition Model (air conditioner)

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.970635	2	1.028424	3	1.050456	4	1.072341
5	1.059104	6	1.033179	7	1.043449	8	0.974671
9	0.931187	10	0.940598	11	0.944458	12	**0.975439**

Figure 9 shows the monthly market sales forecast for air conditioner in Taiwan for validation based on the Decomposition Model. The data plot allows us to analyze how closely the forecasts track the data. The plot also shows the forecasts at the end of the data series.

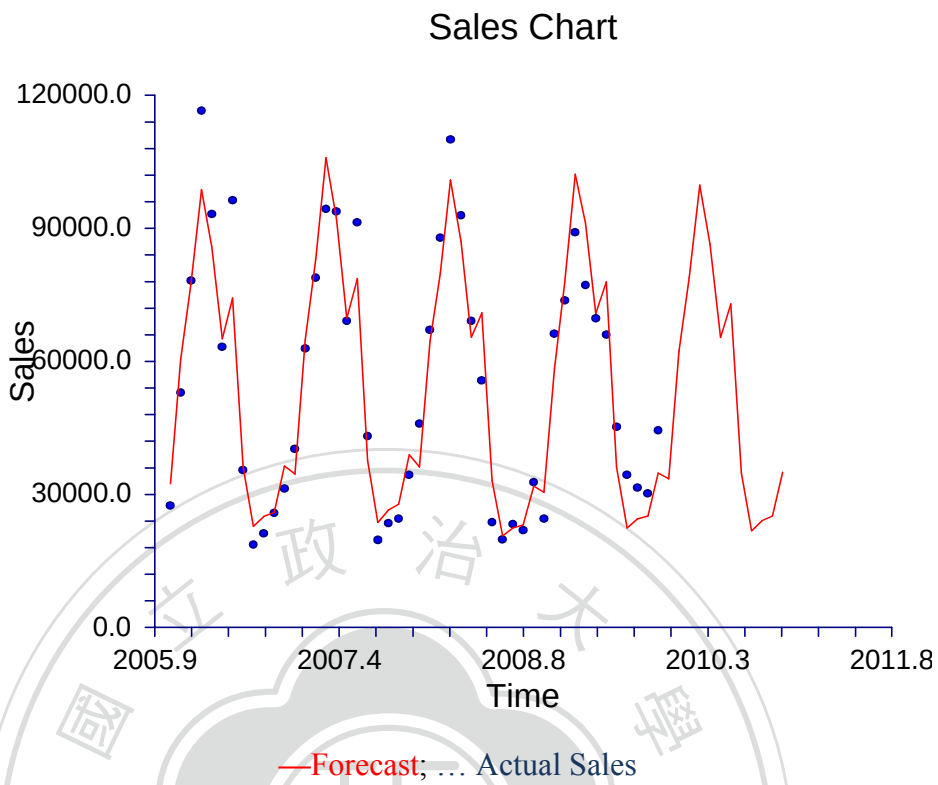


Figure 9: The monthly market sales and forecasts for air conditioner in Taiwan(ton) for validation based on the Decomposition Model

Table 24 shows the values of the forecasts, the dates, the actual values, and the residuals for validation based on the Decomposition Model. The residual is the difference between the actual sales and the forecast sales. A value of one is used for all future cycle components. This ignores the cycle in the forecasts, and the random factor is assumed to be one.

Table 24: The monthly sales forecast for air conditioner in Taiwan (forecast vs. actual) for validation based on the Decomposition Model

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	32435.32	27486	-4949.324	0.9998	0.9937	0.9706	0.9841
2	2006 2	60565.01	52957	-7608.007	0.9998	0.9943	1.0284	0.9878
3	2006 3	77524.3	78204	679.6945	0.9997	0.9954	1.0505	1.0008

4	2006 4	98714.84	116473	17758.15	0.9996	0.9961	1.0723	1.0144
5	2006 5	85845.14	93163	7317.856	0.9996	0.9963	1.0591	1.0072
6	2006 6	65125.73	63238	-1887.734	0.9995	0.9966	1.0332	0.9973
7	2006 7	74228.03	96299	22070.97	0.9994	0.9985	1.0434	1.0232
8	2006 8	36246.94	35477	-769.9415	0.9994	1.0007	0.9747	0.9980
9	2006 9	22850.44	18649	-4201.438	0.9993	1.0014	0.9312	0.9798
10	2006 10	25090.58	21219	-3871.58	0.9993	1.0007	0.9406	0.9835
11	2006 11	25946.83	25793	-153.8295	0.9992	1.0000	0.9445	0.9994
12	2006 12	36354.46	31280	-5074.455	0.9991	1.0004	0.9754	0.9857
13	2007 1	34571.55	40219	5647.455	0.9991	1.0006	0.9706	1.0145
14	2007 2	64799.48	62879	-1920.481	0.9990	1.0012	1.0284	0.9973
15	2007 3	83064.68	78855	-4209.683	0.9989	1.0023	1.0505	0.9954
16	2007 4	105921.9	94385	-11536.85	0.9989	1.0029	1.0723	0.9900
17	2007 5	92032.46	93782	1749.537	0.9988	1.0032	1.0591	1.0016
18	2007 6	69700.85	69081	-619.8524	0.9987	1.0034	1.0332	0.9992
19	2007 7	78644.15	91320	12675.85	0.9987	1.0044	1.0434	1.0133
20	2007 8	37709.26	43093	5383.738	0.9986	1.0052	0.9747	1.0127
21	2007 9	23723.66	19727	-3996.665	0.9985	1.0059	0.9312	0.9817
22	2007 10	26536.94	23511	-3025.938	0.9985	1.0070	0.9406	0.9881
23	2007 11	27826.38	24506	-3320.383	0.9984	1.0076	0.9445	0.9876
24	2007 12	38911.88	34369	-4542.884	0.9984	1.0077	0.9754	0.9883
25	2008 1	36207.4	45931	9723.602	0.9983	1.0058	0.9706	1.0227
26	2008 2	64551.73	67051	2499.269	0.9982	1.0017	1.0284	1.0034
27	2008 3	79750.47	87890	8139.535	0.9982	0.9994	1.0505	1.0086
28	2008 4	100885.2	109988	9102.766	0.9981	0.9995	1.0723	1.0075
29	2008 5	87050.25	92893	5842.753	0.9980	0.9991	1.0591	1.0057
30	2008 6	65443.4	69084	3640.596	0.9980	0.9985	1.0332	1.0049
31	2008 7	70949.8	55706	-15243.8	0.9979	0.9960	1.0434	0.9783
32	2008 8	33105.11	23724	-9381.114	0.9978	0.9936	0.9747	0.9680
33	2008 9	20657.15	19859	-798.1517	0.9978	0.9929	0.9312	0.9960
34	2008 10	22495.91	23324	828.0914	0.9977	0.9915	0.9406	1.0036
35	2008 11	23077.35	21921	-1156.35	0.9976	0.9900	0.9445	0.9949
36	2008 12	31855.02	32745	889.978	0.9976	0.9894	0.9754	1.0027
37	2009 1	30487.38	24494	-5993.376	0.9975	0.9901	0.9706	0.9788
38	2009 2	58379.97	66216	7836.027	0.9975	0.9933	1.0284	1.0115
39	2009 3	77821.58	73731	-4090.575	0.9974	0.9980	1.0505	0.9952
40	2009 4	102207.3	89082	-13125.31	0.9973	1.0014	1.0723	0.9881
41	2009 5	91102.37	77147	-13955.37	0.9973	1.0039	1.0591	0.9854
42	2009 6	70767.05	69648	-1119.046	0.9972	1.0064	1.0332	0.9986
43	2009 7	77971.28	65989	-11982.28	0.9971	1.0052	1.0434	0.9852
44	2009 8	36155.74	45259	9103.263	0.9971	1.0027	0.9747	1.0214
45	2009 9	22472.15	34410	11937.85	0.9970	1.0021	0.9312	1.0425
46	2009 10	24493.3	31477	6983.696	0.9969	1.0006	0.9406	1.0248
47	2009 11	25135.14	30200	5064.856	0.9969	0.9992	0.9445	1.0181
48	2009 12	34792.87	44441	9648.134	0.9968	0.9985	0.9754	1.0234

49	2010 1	33530.56			0.9967	1.0000	0.9706	1.0000
50	2010 2	62310.73			0.9967	1.0000	1.0284	1.0000
51	2010 3	78879.24			0.9966	1.0000	1.0505	1.0000
52	2010 4	99692.17			0.9966	1.0000	1.0723	1.0000
53	2010 5	86424.8			0.9965	1.0000	1.0591	1.0000
54	2010 6	65386.72			0.9964	1.0000	1.0332	1.0000
55	2010 7	72952.94			0.9964	1.0000	1.0434	1.0000
56	2010 8	34850.31			0.9963	1.0000	0.9747	1.0000
57	2010 9	21841.27			0.9962	1.0000	0.9312	1.0000
58	2010 10	24146.33			0.9962	1.0000	0.9406	1.0000
59	2010 11	25150.88			0.9961	1.0000	0.9445	1.0000
60	2010 12	35043.92			0.9960	1.0000	0.9754	1.0000

Note: This section shows the values of the forecasts, the dates, the actual values, the residuals, and the forecast ratios. A value of one is used for all future cycle components. This ignores the cycle in the forecasts. And the random factor is assumed to be one.

From Table 25 and Table 26, we compare the MSEs for forecasts based on two models—the Winters Multiplicative Trend Seasonal Model and the Decomposition Model. It shows that the Decomposition Model generates better forecasts than those from Winters Multiplicative Trend Seasonal Model. Therefore, we complete the validation procedure.

Table 25: MSE of forecast for validation based on Winters Multiplicative Trend Seasonal Model (air conditioner)

Year season	Winter's Trend Seasonal (Forecast Sales)	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	30506.29	46198	8208.628
2010 2	64953.36	64560	-24259.54
2010 3	77639.74	96523	-1168.432
2010 4	95709.3	95333	-25495.7
2010 5	83400.74	97656	-3786.486
2010 6	69077.78	87720	3746.408
2010 7	67207.31	112769	31021.96
2010 8	37831.59	52779	3713.022

2010 9	27218.44	35877	1518.764
2010 10	27646.79	32687	-711.8906
2010 11	27014.64	38619	6795.067
2010 12	39099.44	69289	21443.42
			MSE (winter's trend)
			383,298,846

Table 26: MSE of Forecast for validation based on the Decomposition Model (air conditioner)

Year season	Decomposition (Forecast Sales)	Actual Monthly Sales	(Actual-Forecast)Squared
2010 1	33530.56	46198	57322.94197
2010 2	62310.73	64560	2912.491056
2010 3	78879.24	96523	373857.6507
2010 4	99692.17	95333	241654.8291
2010 5	86424.8	97656	95932.05344
2010 6	65386.72	87720	13774.54322
2010 7	72952.94	112769	500073.8513
2010 8	34850.31	52779	274599.0565
2010 9	21841.27	35877	388097.8506
2010 10	24146.33	32687	416681.8691
2010 11	25150.88	38619	53005.30035
2010 12	35043.92	69289	12658.5226
			MSE (decomposition)
			387,630,017.6

4.4.2 Forecasts

After the validation procedures on the monthly market sales from January 2006 to December 2009 (48 months) of air conditioner,the Winters multiplicative trend seasonal model is selected as the forecasting model to project the sales of next 12 months. In this section, we will use

theWinters model to generate forecasts for the period from January 2011 to December 2011(12 months).

The result was obtained at 12:25:13 PM on 2011/6/30 using NCSS software and summarized as in Table 27. A search is conducted to find the values of the smoothing constants that minimize MSE. The mean square error is 1.416344E+08 and Pseudo R-Squared is 0.824081. A value near zero indicates a poorly fitting model, while a value near one indicates a well-fitting one. Thus, this model is well-fitted. 86 iterations were required to find the best values for the smoothing constants. The values of the smoothing constants, α, β, γ, are 0.191321, 1.564809E-02, 0.696428, respectively. In the current month, Intercept(A) is 4.707559 and Slope(B) is 2.590202E-03.

Figure 10 shows the monthly market sales forecasts for air conditioner in Taiwan.

Table 27: Summary of the values of the smoothing constants, α, β, γ, and the 14 coefficients for forecasting based on Winters Multiplicative Trend Seasonal Model (air conditioner)

Forecast Method	**Winter's with multiplicative seasonal adjustment.**
Forecasts are made for the period from January 2011 to December 2011(12 months)	
Forecast Summary Section	
Log10(Variable)	Sales
Number of Rows	60
Mean	57803.08
Pseudo R-Squared	0.824081
Mean Square Error	1.416344E+08
Mean |Error|	7717.047
Mean |Percent Error|	14.11755
Search Iterations	86
Search Criterion	Mean Square Error
Alpha	0.191321
Beta	1.564809E-02
Gamma	0.696428
Intercept (A)	4.707559
Slope (B)	2.590202E-03
Season 1 Factor	0.9661455
Season 2 Factor	1.012807
Season 3 Factor	1.042347
Season 4 Factor	1.049959
Season 5 Factor	1.048082
Season 6 Factor	1.035443

Season 7 Factor	1.046123
Season 8 Factor	0.9812949
Season 9 Factor	0.9459578
Season 10 Factor	0.9389964
Season 11 Factor	0.9455498
Season 12 Factor	0.9872943

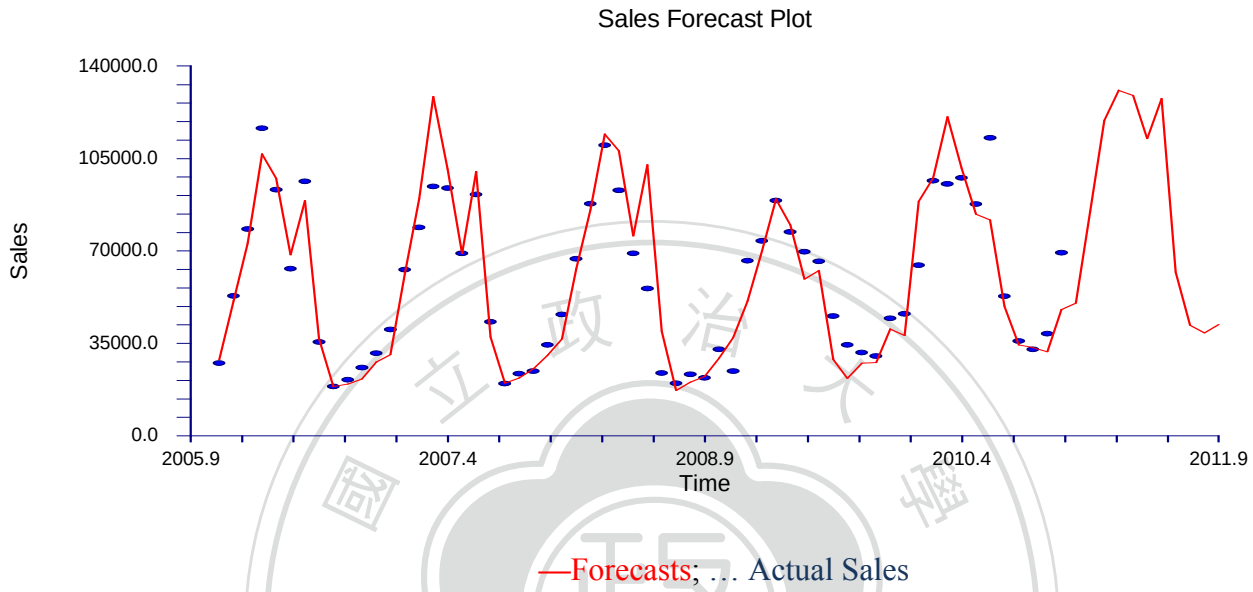


Figure 10: The monthly market sales forecast for air conditioner in Taiwan(ton) based on Winters Multiplicative Trend Seasonal Model

Table 28 shows the values of the forecasts, the dates, the actual values, and the residuals. The residual is the difference between the actual sales and the forecast sales (actual-forecast).

Table 28: The monthly market sales for air conditioner in Taiwan (forecast vs actual) based on Winters Multiplicative Trend Seasonal Model

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	28879.4	27486	-1393.397
2	2006 2	51101.12	52957	1855.884
3	2006 3	72953.38	78204	5250.621
4	2006 4	106764.5	116473	9708.522
5	2006 5	97479.74	93163	-4316.741
6	2006 6	68512.74	63238	-5274.741
7	2006 7	89102.81	96299	7196.19
8	2006 8	36805.44	35477	-1328.441
9	2006 9	18674.17	18649	-25.17243

10	2006 10	19640.96	21219	1578.037
11	2006 11	21584.89	25793	4208.114
12	2006 12	28029.33	31280	3250.667
13	2007 1	30720.46	40219	9498.541
14	2007 2	61304.61	62879	1574.392
15	2007 3	89720.34	78855	-10865.33
16	2007 4	128445.6	94385	-34060.64
17	2007 5	100895.6	93782	-7113.563
18	2007 6	69081.13	69081	-0.1217377
19	2007 7	100010.5	91320	-8690.451
20	2007 8	37389.23	43093	5703.765
21	2007 9	19953.33	19727	-226.3326
22	2007 10	21923.02	23511	1587.981
23	2007 11	25497.24	24506	-991.2367
24	2007 12	30571.29	34369	3797.715
25	2008 1	36701.99	45931	9229.012
26	2008 2	63336.18	67051	3714.819
27	2008 3	85532.13	87890	2357.87
28	2008 4	114179.7	109988	-4191.672
29	2008 5	107908.7	92893	-15015.71
30	2008 6	75745.3	69084	-6661.298
31	2008 7	102658.5	55706	-46952.46
32	2008 8	39639.38	23724	-15915.38
33	2008 9	17250.72	19859	2608.282
34	2008 10	20353.51	23324	2970.493
35	2008 11	22479.87	21921	-558.8668
36	2008 12	29382.22	32745	3362.784
37	2009 1	37231.77	24494	-12737.77
38	2009 2	51036.69	66216	15179.31
39	2009 3	69861.54	73731	3869.461
40	2009 4	89662.89	89082	-580.8927
41	2009 5	79895.7	77147	-2748.704
42	2009 6	59340.33	69648	10307.67
43	2009 7	62621.05	65989	3367.95
44	2009 8	28972.63	45259	16286.37
45	2009 9	21821.97	34410	12588.03
46	2009 10	27445.29	31477	4031.705
47	2009 11	27768.33	30200	2431.672
48	2009 12	40452.3	44441	3988.704
49	2010 1	37989.37	46198	8208.628
50	2010 2	88819.54	64560	-24259.54
51	2010 3	97691.43	96523	-1168.432
52	2010 4	120828.7	95333	-25495.7
53	2010 5	101442.5	97656	-3786.486
54	2010 6	83973.59	87720	3746.408

55	2010 7	81747.04	112769	31021.96
56	2010 8	49065.98	52779	3713.022
57	2010 9	34358.23	35877	1518.764
58	2010 10	33398.89	32687	-711.8906
59	2010 11	31823.93	38619	6795.067
60	2010 12	47845.58	69289	21443.42
61	**2011 1**	**50215.78**		
62	**2011 2**	**85211.59**		
63	**2011 3**	**119399.9**		
64	**2011 4**	**130858.1**		
65	**2011 5**	**128934.2**		
66	**2011 6**	**112569.2**		
67	**2011 7**	**127712.1**		
68	**2011 8**	**61993.04**		
69	**2011 9**	**41900.33**		
70	**2011 10**	**38961.39**		
71	**2011 11**	**42181.54**		
72	**2011 12**	**67900.21**		

CHAPTER 5

Conclusion, Implications, and Future Research

5.1 Conclusions

In this study, we present two forecasting models used for evaluation to predict seasonal market sales of ice cream, fresh milk, and air conditioner in Taiwan. It includes Winters multiplicative seasonal trend model and the Decomposition method. The aim of this research is to select an appropriate method to forecast the market sales for the seasonal products in Taiwan, using ice cream, fresh milk, and air conditioner in Taiwan as examples. Two different methods are validated and the best forecasting method is selected based on the minimum Mean Square Error. The forecast of seasonal demand is vital to companies as the basis for strategic management. In market sales forecasting, a single model may not be adequate to represent a particular demand series for all times. Further, the chosen model may have been restricted to a certain class of time series. The dataset used in the research for ice cream and fresh milk was obtained from the Monthly Report of Industrial Production in Taiwan through the Department of Statistics, Ministry of Economic Affairs, ROC. The dataset for air conditioner was obtained from the Industrial Raw Material Price and Volume Information Database (產業原物料價量情報資料庫, 2011).The datasets represents the partial market demand of ice cream, fresh milk, and air conditioner in Taiwan over a time period from January 2006 to December 2010(60 months). The monthly demand from January 2006 to December 2009(48 months) is used to find the parameters of the forecasting models and validate the forecasts for the period from January 2010 to December 2010(12 months). Using the models, forecasts are made for the period from January 2011 to December 2011(12 months). After the validation process, Winters multiplicative seasonal trend model is selected based on the minimum MSE, and the monthly sales forecast of the year of 2011 is conducted using the data above (60 months). Number Cruncher Statistical System (NCSS) is used for analyzing the data which proves useful and powerful. In summary, the results demonstrate that Winters multiplicative seasonal trend model has the smallest mean square error in this case. Therefore, we conclude that both Winters multiplicative seasonal trend model and the Decomposition model are well fitted for forecasting the seasonal market sales. Yet,

Winters multiplicative seasonal trend model is the better method to be used in this study since it generates the smallest mean Square error (MSE) during the period of validation.

5.2 Implications

The forecasting activity is a critical part of managers' responsibility. It is essential for managers to plan the resource allocation and how to obtain. An overestimation or underestimation of market sales could result in an additional operations cost, inventory cost or direct sales loss. Thus, the precise market forecast is an essential process in any organization and this study help improve the forecasting accuracy. In the past, a large number of forecasting methods have been developed, yet the more complex model does not always yield better forecast than the simple one. Each method may provide some validity; nevertheless, no single method provides perfect forecast results all the time.

Although both Decomposition method and Winters multiplicative trend seasonal model are well fitting models in this research, the Winters multiplicative seasonal trend model offers the best accuracy for predicting the market sales of ice cream and fresh milk in Taiwan. Simplicity of the methods in this research also helps managers' understanding and implementation, reduces the possibility of mistakes, and is less expensive.

The results show the market sales of ice cream and fresh milk in Taiwan is of seasonal trend pattern. Inventory control and production planning becomes important problems for the managers. Marketing promotion strategy and creative manpower leveling strategy should be carefully formulated in order to reduce the costs due to seasonal demand.

These methods are good for managers to forecast total market sales. Then, an estimate of market share or a brand's sales can be obtained. The forecasting results can be useful for the companies in the business of seasonal products in Taiwan. The results can serve as the basis of formulating business strategies and plans.

5.3 Research Limitations

Some limitations of this research are listed as follows:

1. Winters multiplicative seasonal trend model provides a good starting point, nevertheless, we perform the study on only two products in Taiwan. Therefore, we cannot conclude that this method will always provide better accuracy for forecasting other seasonal products. This would be an extension of our work submitted as suggested future research.

2. The data from surveys may be flawed. The respondents may not send their survey forms back or send back but not on a timely basis, causing the market sales data to be unreliable.

3. One of the important assumptions about forecasting methods used in this research is that a certain reasonable linkage that existed in the past will remain in the future (Herbig, et al, 1994). It means many forecasters assume that the behavior of the past is a good indication of the future. However, the future market sales involves a lot of uncertainties that are unpredictable such as changes in political environment, economical environment , climate, macro-economics, consumer behavior, market competition, price, and market strategies that may affect the accuracy of the forecast.

5.4 Future Research

To improve the forecasting accuracy, we suggest some future studies as follows:

1. Try to experiment the same data with other forecasting methods, such as expert systems, fuzzy logic, regression analysis, Box—Jenkins time series model and neural networks, etc.

2. Try to use the same models in this study to forecast on some other industrial sectors, such as beverage, automobiles, gasoline, electricity, air travel, restaurant accommodations, air travel, and beverage.

3. Conduct the same methods in this study with different error measures such as MPE (Mean Percent Error), MAPE (Mean Absolute Percent Error), etc..

4. Try to combine the forecasts performed from several independent forecasters.

5. Experiment with different combining methods. Try to combine forecasts derived from methods that differ substantially and draw from different sources of information in order to improve forecasting accuracy.

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Appendix A

Winter's Report (Validation, 48 months) for Ice Cream

Forecast Method: Winter's with multiplicative seasonal trend adjustment

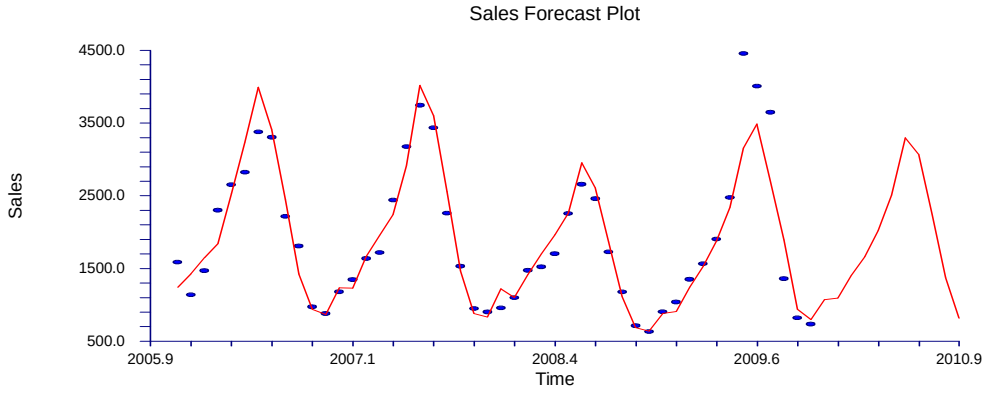
Seasonal - Trend Report

Page/Date/Time	1 5/15/2011 11:31:29 PM
Database	C:\USERS\JP1219\DOCUMENTS\NCSS\NCSS 2007\DATA\ICECREAM.S0
Title	MONTHLY MARKET SALES---ICECREAM IN TAIWAN

Forecast Summary Section

Log10 (Variable)	Sales
Number of Rows	48
Mean	1905.583
Pseudo R-Squared	0.887048
Mean Square Error	106207.5
Mean |Error|	216.5652
Mean |Percent Error|	10.45767
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	167
Search Criterion	Mean Square Error
Alpha	0.5
Beta	0
Gamma	0
Intercept (A)	3.27012
Slope (B)	-1.260789E-03
Season 1 Factor	0.9444247
Season 2 Factor	0.9474447
Season 3 Factor	0.9818625
Season 4 Factor	1.004788
Season 5 Factor	1.03204
Season 6 Factor	1.061784
Season 7 Factor	1.099116
Season 8 Factor	1.089718
Season 9 Factor	1.047505
Season 10 Factor	0.9816289
Season 11 Factor	0.9110703
Season 12 Factor	0.8986188

Forecast and Residuals Plots



Seasonal - Trend Report

Page/Date/Time	2 5/15/2011 11:31:29 PM
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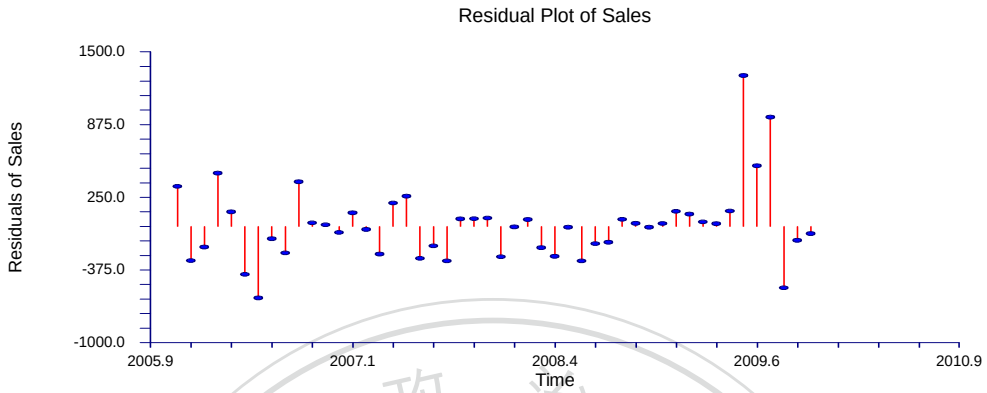
Title	MONTHLY MARKET SALES---ICECREAM IN TAIWAN



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	1242.734	1586	343.2662
2	2006 2	1432.882	1137	-295.882
3	2006 3	1650.359	1471	-179.3592
4	2006 4	1844.471	2302	457.5287
5	2006 5	2526.791	2651	124.2091
6	2006 6	3236.049	2822	-414.0494
7	2006 7	3992.717	3377	-615.7171
8	2006 8	3412.266	3305	-107.2655
9	2006 9	2444.522	2215	-229.5221
10	2006 10	1424.998	1807	382.0023
11	2006 11	941.5372	971	29.46283
12	2006 12	868.2816	881	12.71842
13	2007 1	1231.921	1179	-52.92105
14	2007 2	1229.437	1346	116.5634
15	2007 3	1663.764	1637	-26.76422
16	2007 4	1956.274	1717	-239.274
17	2007 5	2240.271	2440	199.7294
18	2007 6	2914.731	3173	258.2688
19	2007 7	4018.957	3743	-275.9573
20	2007 8	3602.52	3434	-168.52
21	2007 9	2555.711	2258	-297.7107
22	2007 10	1468.176	1531	62.82398
23	2007 11	883.9935	949	65.00647
24	2007 12	832.2333	903	70.76675
25	2008 1	1220.491	958	-262.4913
26	2008 2	1102.7	1097	-5.69981
27	2008 3	1414.413	1473	58.58673
28	2008 4	1705.652	1522	-183.6525
29	2008 5	1962.618	1704	-258.6176
30	2008 6	2263.763	2255	-8.763535
31	2008 7	2954.817	2657	-297.8171
32	2008 8	2609.806	2460	-149.8065

Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
33	2008 9	1864.651	1728	-136.6507
34	2008 10	1117.35	1177	59.64984
35	2008 11	689.3211	714	24.67889
36	2008 12	639.7789	632	-7.778899
37	2009 1	881.2134	905	23.78662
38	2009 2	910.1361	1038	127.8639
39	2009 3	1244.36	1350	105.6396
40	2009 4	1527.74	1565	37.26005
41	2009 5	1881.396	1903	21.60371
42	2009 6	2344.578	2475	130.4219
43	2009 7	3157.478	4454	1296.522
44	2009 8	3484.256	4005	520.7438
45	2009 9	2708.018	3647	938.982
46	2009 10	1888.497	1359	-529.4974
47	2009 11	940.0931	820	-120.0931
48	2009 12	798.235	735	-63.23501
49	2010 1	1071.611		
50	2010 2	1092.778		
51	2010 3	1404.994		
52	2010 4	1659.212		
53	2010 5	2022.697		
54	2010 6	2511.14		
55	2010 7	3296.294		
56	2010 8	3065.983		
57	2010 9	2239.691		
58	2010 10	1374.872		
59	2010 11	815.7147		
60	2010 12	742.3581		

Appendix B

Decomposition Report (Validation, 48 months) Ice Cream

Forecast Method: Decomposition Seasonal Trend

Time Series Decomposition Report

Page/Date/Time	1 5/13/2011 3:01:31 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\IceCream.S0
Variable	Sales
Title	MONTHLY MARKET SALES--IceCream in Taiwan

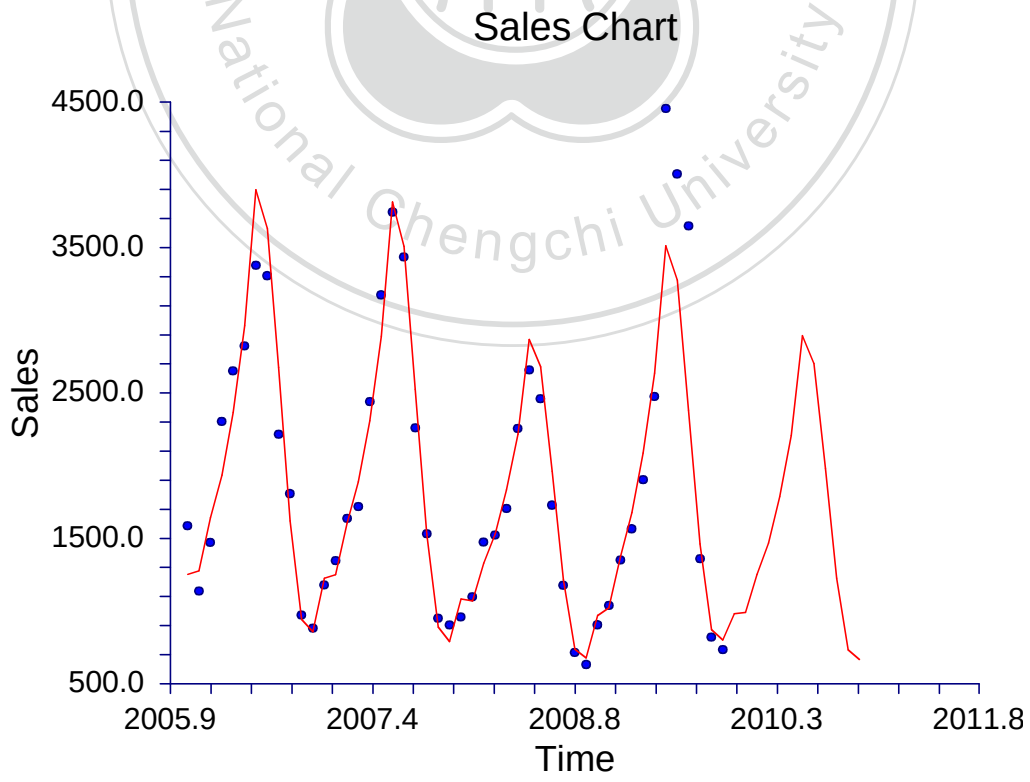
Forecast Summary Section

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	3.224856
Pseudo R-Squared	0.8985508
Forecast Std. Error	308.855
Mean Square Error	95391.411
Trend Equation	Trend = (1.013007) + (-0.000675) * (Time Season Number)
Number of Seasons	12
First Year	2006
First Season	1

Seasonal Component Ratios

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.946733	2	0.948577	3	0.981609	4	1.004087
5	1.031877	6	1.061734	7	1.099833	8	1.091168
9	1.048965	10	0.983347	11	0.913054	12	0.900578

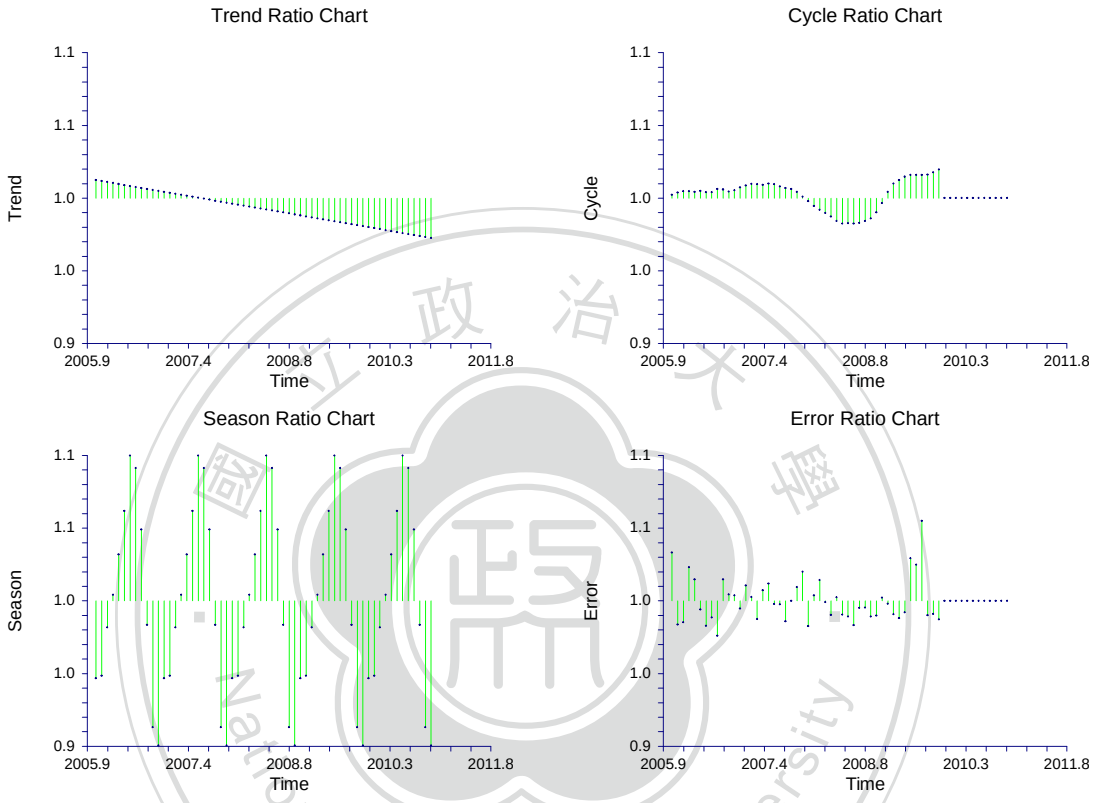
Forecast and Data Plot



Time Series Decomposition Report

Page/Date/Time	2 5/13/2011 3:01:31 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\IceCream.S0
Variable	Sales
Title	MONTHLY MARKET SALES--IceCream in Taiwan

Decomposition Ratio Plots



Time Series Decomposition Report

Page/Date/Time	3 5/13/2011 3:01:31 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\IceCream.S0
Variable	Sales
Title	MONTHLY MARKET SALES--IceCream in Taiwan

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	1252.73	1586	333.2697	1.0123	1.0023	0.9467	1.0331
2	2006 2	1277.37	1137	-140.3695	1.0117	1.0038	0.9486	0.9837
3	2006 3	1642.504	1471	-171.5037	1.0110	1.0047	0.9816	0.9851
4	2006 4	1934.099	2302	367.9007	1.0103	1.0046	1.0041	1.0230
5	2006 5	2365.452	2651	285.5477	1.0096	1.0042	1.0319	1.0147
6	2006 6	2961.898	2822	-139.8977	1.0090	1.0049	1.0617	0.9939
7	2006 7	3897.027	3377	-520.0268	1.0083	1.0041	1.0998	0.9827
8	2006 8	3630.126	3305	-325.1261	1.0076	1.0040	1.0912	0.9886
9	2006 9	2675.873	2215	-460.873	1.0069	1.0062	1.0490	0.9760
10	2006 10	1620.869	1807	186.1308	1.0063	1.0059	0.9833	1.0147
11	2006 11	942.0839	971	28.9161	1.0056	1.0044	0.9131	1.0044
12	2006 12	859.0311	881	21.96893	1.0049	1.0053	0.9006	1.0037
13	2007 1	1225.034	1179	-46.03437	1.0042	1.0072	0.9467	0.9946
14	2007 2	1249.074	1346	96.92551	1.0036	1.0087	0.9486	1.0105
15	2007 3	1604.868	1637	32.13174	1.0029	1.0097	0.9816	1.0027
16	2007 4	1888.78	1717	-171.7796	1.0022	1.0095	1.0041	0.9874
17	2007 5	2308.51	2440	131.4903	1.0015	1.0092	1.0319	1.0072
18	2007 6	2888.56	3173	284.4402	1.0009	1.0099	1.0617	1.0118
19	2007 7	3812.631	3743	-69.63076	1.0002	1.0095	1.0998	0.9978
20	2007 8	3506.5	3434	-72.49986	0.9995	1.0079	1.0912	0.9974
21	2007 9	2522.786	2258	-264.7858	0.9988	1.0068	1.0490	0.9858
22	2007 10	1531.279	1531	-0.2791941	0.9982	1.0062	0.9833	1.0000
23	2007 11	890.1275	949	58.87253	0.9975	1.0042	0.9131	1.0094
24	2007 12	790.1924	903	112.8076	0.9968	1.0009	0.9006	1.0200
25	2008 1	1082.73	958	-124.7297	0.9961	0.9978	0.9467	0.9825
26	2008 2	1068.622	1097	28.37787	0.9955	0.9946	0.9486	1.0038
27	2008 3	1329.282	1473	143.7183	0.9948	0.9919	0.9816	1.0143
28	2008 4	1532.883	1522	-10.88312	0.9941	0.9896	1.0041	0.9990
29	2008 5	1834.214	1704	-130.2142	0.9934	0.9872	1.0319	0.9902
30	2008 6	2215.919	2255	39.08103	0.9928	0.9842	1.0617	1.0023
31	2008 7	2866.632	2657	-209.6315	0.9921	0.9826	1.0998	0.9905
32	2008 8	2678.669	2460	-218.6687	0.9914	0.9826	1.0912	0.9892
33	2008 9	1961.694	1728	-233.6937	0.9907	0.9825	1.0490	0.9833
34	2008 10	1217.887	1177	-40.88695	0.9901	0.9828	0.9833	0.9952
35	2008 11	736.754	714	-22.75405	0.9894	0.9842	0.9131	0.9952
36	2008 12	678.358	632	-46.35798	0.9887	0.9861	0.9006	0.9891
37	2009 1	970.5469	905	-65.54693	0.9880	0.9902	0.9467	0.9898
38	2009 2	1023.457	1038	14.54307	0.9874	0.9966	0.9486	1.0020
39	2009 3	1370.286	1350	-20.28604	0.9867	1.0043	0.9816	0.9979
40	2009 4	1678.138	1565	-113.1383	0.9860	1.0100	1.0041	0.9906
41	2009 5	2086.167	1903	-183.1672	0.9853	1.0123	1.0319	0.9880
42	2009 6	2636.045	2475	-161.0448	0.9847	1.0147	1.0617	0.9920
43	2009 7	3512.23	4454	941.7696	0.9840	1.0159	1.0998	1.0291
44	2009 8	3276.689	4005	728.3111	0.9833	1.0160	1.0912	1.0248
45	2009 9	2381.017	3647	1265.983	0.9826	1.0159	1.0490	1.0548

Time Series Decomposition Report

Page/Date/Time	4 5/13/2011 3:01:32 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\IceCream.S0
Variable	Sales
Title	MONTHLY MARKET SALES--IceCream in Taiwan

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
46	2009 10	1460.412	1359	-101.4123	0.9820	1.0162	0.9833	0.9901
47	2009 11	872.0739	820	-52.07383	0.9813	1.0177	0.9131	0.9909
48	2009 12	801.1042	735	-66.10418	0.9806	1.0196	0.9006	0.9871
49	2010 1	981.4221			0.9799	1.0000	0.9467	1.0000
50	2010 2	989.9675			0.9793	1.0000	0.9486	1.0000
51	2010 3	1252.561			0.9786	1.0000	0.9816	1.0000
52	2010 4	1467.416			0.9779	1.0000	1.0041	1.0000
53	2010 5	1786.271			0.9772	1.0000	1.0319	1.0000
54	2010 6	2206.635			0.9766	1.0000	1.0617	1.0000
55	2010 7	2892.841			0.9759	1.0000	1.0998	1.0000
56	2010 8	2701.978			0.9752	1.0000	1.0912	1.0000
57	2010 9	1980.025			0.9746	1.0000	1.0490	1.0000
58	2010 10	1225.491			0.9739	1.0000	0.9833	1.0000
59	2010 11	733.7712			0.9732	1.0000	0.9131	1.0000
60	2010 12	667.4899			0.9725	1.0000	0.9006	1.0000

Appendix C

Winter's Report (Forecast, 60 months) for Ice Cream

Forecast Method: Winter's with multiplicative seasonal trend adjustment

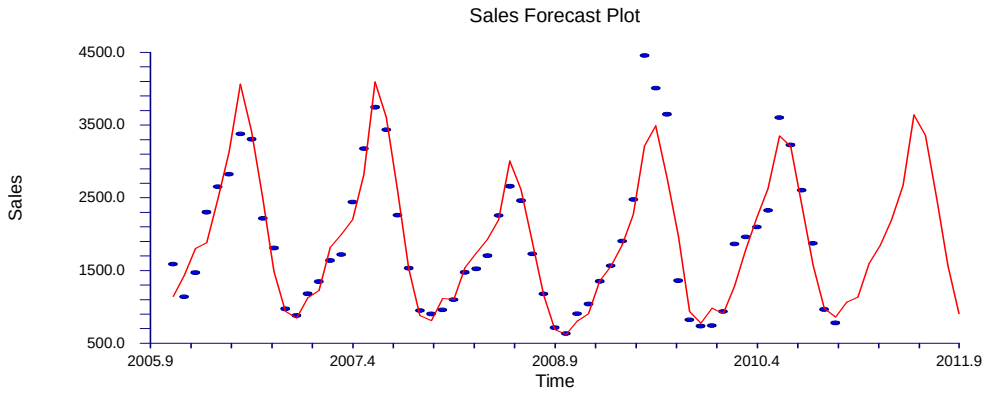
Seasonal - Trend Report

Page/Date/Time	1 5/15/2011 11:39:18 PM
Database	C:\USERS\JP1219\DOCUMENTS\NCSS\NCSS 2007\DATA\ICECREAM.S0
Title	MONTHLY MARKET SALES---ICECREAM IN TAIWAN

Forecast Summary Section

Log10(Variable)	Sales
Number of Rows	60
Mean	1907.217
Pseudo R-Squared	0.889704
Mean Square Error	100919.1
Mean |Error|	223.2138
Mean |Percent Error|	11.22653
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	176
Search Criterion	Mean Square Error
Alpha	0.5
Beta	0
Gamma	0
Intercept (A)	3.298883
Slope (B)	-9.053888E-04
Season 1 Factor	0.9336358
Season 2 Factor	0.9422643
Season 3 Factor	0.9883024
Season 4 Factor	1.007955
Season 5 Factor	1.031548
Season 6 Factor	1.05809
Season 7 Factor	1.099702
Season 8 Factor	1.089195
Season 9 Factor	1.049619
Season 10 Factor	0.9880086
Season 11 Factor	0.9136869
Season 12 Factor	0.8979931

Forecast and Residuals Plots



Seasonal - Trend Report

Page/Date/Time	2 5/15/2011 11:39:18 PM
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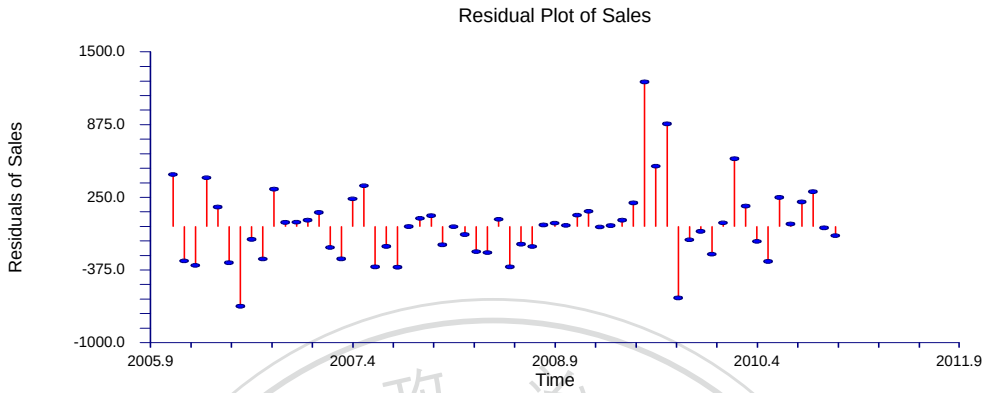
Title	MONTHLY MARKET SALES---ICECREAM IN TAIWAN



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	1141.22	1586	444.7796
2	2006 2	1435.157	1137	-298.1566
3	2006 3	1808.038	1471	-337.0376
4	2006 4	1885.285	2302	416.7146
5	2006 5	2485.917	2651	165.0826
6	2006 6	3134.856	2822	-312.856
7	2006 7	4064.346	3377	-687.3457
8	2006 8	3417.266	3305	-112.2658
9	2006 9	2496.554	2215	-281.5543
10	2006 10	1487.892	1807	319.108
11	2006 11	937.8013	971	33.19866
12	2006 12	846.5882	881	34.41182
13	2007 1	1127.265	1179	51.7352
14	2007 2	1228.041	1346	117.9586
15	2007 3	1820.302	1637	-183.3016
16	2007 4	1997.809	1717	-280.8089
17	2007 5	2204.002	2440	235.9978
18	2007 6	2824.453	3173	348.5469
19	2007 7	4091.818	3743	-348.8176
20	2007 8	3607.933	3434	-173.9333
21	2007 9	2610.447	2258	-352.4465
22	2007 10	1533.274	1531	-2.273921
23	2007 11	880.7653	949	68.23475
24	2007 12	811.6894	903	91.31062
25	2008 1	1117.096	958	-159.0959
26	2008 2	1100.871	1097	-3.87082
27	2008 3	1544.03	1473	-71.02991
28	2008 4	1740.687	1522	-218.6865
29	2008 5	1931.099	1704	-227.099
30	2008 6	2195.462	2255	59.53773
31	2008 7	3005.954	2657	-348.9541
32	2008 8	2613.534	2460	-153.534

Page/Date/Time	3 5/15/2011 11:39:18 PM
Database	C:\USERS\JP1219\DOCUMENTS\NCSS\NCSS 2007\DATA\ICECREAM.S0
Title	MONTHLY MARKET SALES---ICECREAM IN TAIWAN

Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
33	2008 9	1903.018	1728	-175.0181
34	2008 10	1165.017	1177	11.98301
35	2008 11	686.9086	714	27.09146
36	2008 12	624.6168	632	7.383211
37	2009 1	809.8107	905	95.18927
38	2009 2	909.4203	1038	128.5797
39	2009 3	1356.912	1350	-6.91211
40	2009 4	1558.833	1565	6.166496
41	2009 5	1851.291	1903	51.7087
42	2009 6	2273.668	2475	201.3322
43	2009 7	3212.855	4454	1241.145
44	2009 8	3488.607	4005	516.3934
45	2009 9	2766.078	3647	880.9222
46	2009 10	1974.475	1359	-615.4746
47	2009 11	936.9445	820	-116.9445
48	2009 12	778.7621	735	-43.76217
49	2010 1	982.3508	742	-240.3508
50	2010 2	906.9282	936	29.07175
51	2010 3	1283.419	1864	580.5806
52	2010 4	1786.146	1959	172.8543
53	2010 5	2226.52	2096	-130.5196
54	2010 6	2626.334	2324	-302.3345
55	2010 7	3351.405	3600	248.5954
56	2010 8	3205.901	3226	20.09929
57	2010 9	2392.863	2603	210.1373
58	2010 10	1573.596	1871	297.4036
59	2010 11	978.0168	964	-14.01678
60	2010 12	861.1707	780	-81.17062
61	2011 1	1067.558		
62	2011 2	1136.387		
63	2011 3	1599.269		
64	2011 4	1848.076		
65	2011 5	2199.113		
66	2011 6	2674.779		
67	2011 7	3639.806		
68	2011 8	3357.914		
69	2011 9	2494.585		
70	2011 10	1572.923		
71	2011 11	902.4263		
72	2011 12	801.3745		

Appendix D

Winter's Report (Validation, 48 months) for Fresh Milk

Forecast Method: Winter's with multiplicative seasonal trend adjustment

Seasonal - Trend Report

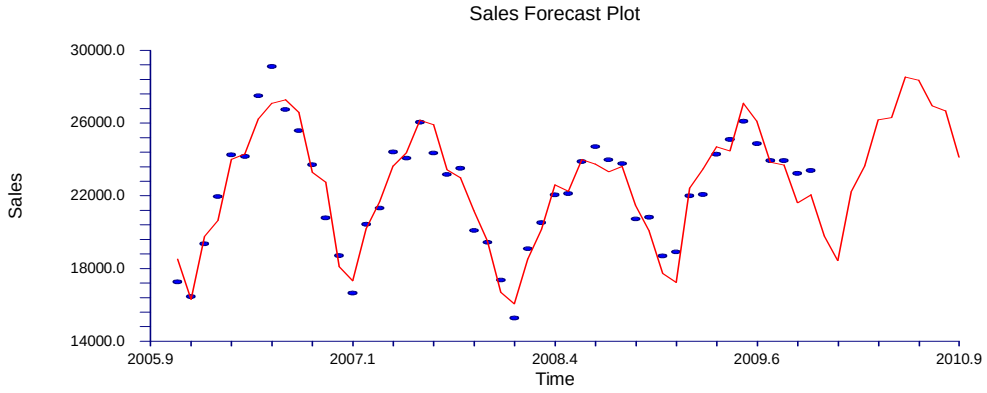
Page/Date/Time	1 6/11/2011 4:52:29 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Title	MONTHLY MARKET SALES---FRESH MILK IN TAIWAN

Forecast Summary Section

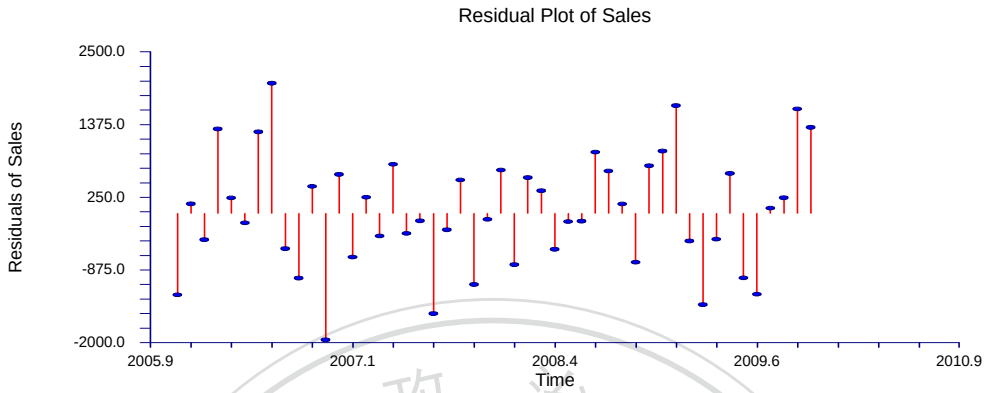
Log10(Variable)	Sales
Number of Rows	48
Mean	22284.81
Pseudo R-Squared	0.914516
Mean Square Error	790666.8
Mean |Error|	723.2148
Mean |Percent Error|	3.293337

Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	151
Search Criterion	Mean Square Error
Alpha	0.8145158
Beta	5.716994E-08
Gamma	2.286691E-03
Intercept (A)	4.380449
Slope (B)	1.021276E-04
Season 1 Factor	0.9797085
Season 2 Factor	0.9726461
Season 3 Factor	0.9911656
Season 4 Factor	0.9972439
Season 5 Factor	1.007274
Season 6 Factor	1.00772
Season 7 Factor	1.015774
Season 8 Factor	1.015128
Season 9 Factor	1.01006
Season 10 Factor	1.009061
Season 11 Factor	0.9990233
Season 12 Factor	0.9951959

Forecast and Residuals Plots



Page/Date/Time	2 6/11/2011 4:52:29 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Title	MONTHLY MARKET SALES---FRESH MILK IN TAIWAN



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	18524.37	17263	-1261.367
2	2006 2	16304.96	16452	147.0355
3	2006 3	19763.45	19355	-408.4469
4	2006 4	20647.93	21954	1306.069
5	2006 5	24004.4	24242	237.5971
6	2006 6	24311.96	24164	-147.9632
7	2006 7	26230.05	27492	1261.954
8	2006 8	27083.58	29099	2015.417
9	2006 9	27286.1	26740	-546.0951
10	2006 10	26577.32	25574	-1003.32
11	2006 11	23287.58	23704	416.4235
12	2006 12	22737.37	20779	-1958.372
13	2007 1	18098.91	18703	604.0874
14	2007 2	17322.6	16645	-677.6018
15	2007 3	20185.11	20433	247.8888
16	2007 4	21671.71	21322	-349.7108
17	2007 5	23647.33	24406	758.6683
18	2007 6	24377.85	24066	-311.8484
19	2007 7	26156.49	26041	-115.4931
20	2007 8	25900.96	24348	-1552.966
21	2007 9	23421	23167	-253.9982
22	2007 10	22989.44	23505	515.5574
23	2007 11	21184.72	20084	-1100.717
24	2007 12	19531.2	19439	-92.19598
25	2008 1	16688.12	17357	668.8781
26	2008 2	16064.96	15271	-793.9627
27	2008 3	18526.66	19081	554.3356
28	2008 4	20163.89	20514	350.1097
29	2008 5	22600.62	22044	-556.6193
30	2008 6	22249.29	22121	-128.2872
31	2008 7	23994.6	23875	-119.5966
32	2008 8	23749.86	24697	947.1389

Page/Date/Time	3 6/11/2011 4:52:29 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Title	MONTHLY MARKET SALES---FRESH MILK IN TAIWAN

Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
33	2008 9	23317.1	23972	654.9006
34	2008 10	23618.25	23762	143.7509
35	2008 11	21476.79	20720	-756.7885
36	2008 12	20082.71	20820	737.2847
37	2009 1	17722.46	18686	963.5344
38	2009 2	17241.8	18911	1669.195
39	2009 3	22422.36	21995	-427.355
40	2009 4	23475.92	22062	-1413.921
41	2009 5	24687.64	24287	-400.6447
42	2009 6	24475.45	25094	618.5548
43	2009 7	27090.71	26091	-999.7139
44	2009 8	26110.6	24859	-1251.595
45	2009 9	23854.44	23934	79.55725
46	2009 10	23687.36	23928	240.6438
47	2009 11	21608.9	23225	1616.096
48	2009 12	22056.95	23388	1331.054
49	2010 1	19790.93		
50	2010 2	18432.91		
51	2010 3	22228.67		
52	2010 4	23641.38		
53	2010 5	26167.59		
54	2010 6	26292.02		
55	2010 7	28526.69		
56	2010 8	28348.08		
57	2010 9	26939.96		
58	2010 10	26675.74		
59	2010 11	24109.64		
60	2010 12	23200.82		

Appendix E

Decomposition Report (Validation, 48 months) Fresh Milk

Forecast Method: Decomposition Seasonal Trend

Time Series Decomposition Report

Page/Date/Time	1 6/11/2011 4:50:35 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Variable	Sales
Title	MONTHLY MARKET SALES—Fresh Milk in Taiwan

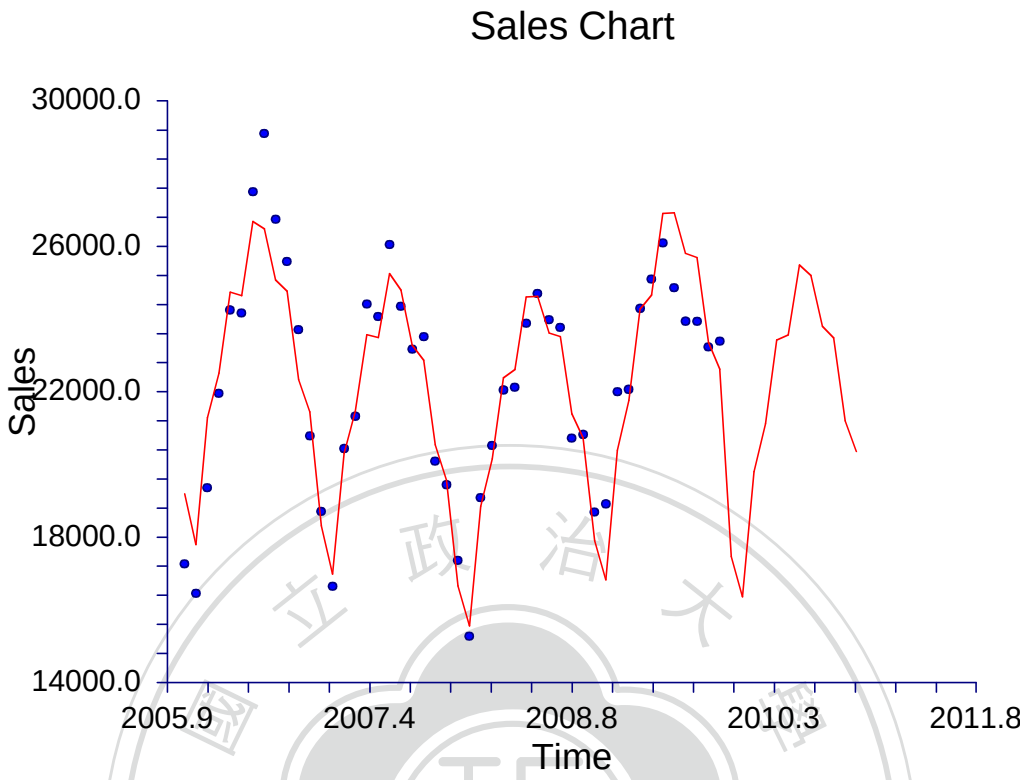
Forecast Summary Section

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	4.343749
Pseudo R-Squared	0.8911608
Forecast Std. Error	1003.339
Trend Equation	Trend = (0.999829) + (-0.000019) * (Time Season Number)
Number of Seasons	12
First Year	2006
First Season	1

Seasonal Component Ratios

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.977703	2	0.971128	3	0.990244	4	0.996752
5	1.007150	6	1.007762	7	1.015624	8	1.014469
9	1.008775	10	1.007440	11	0.997255	12	0.993180

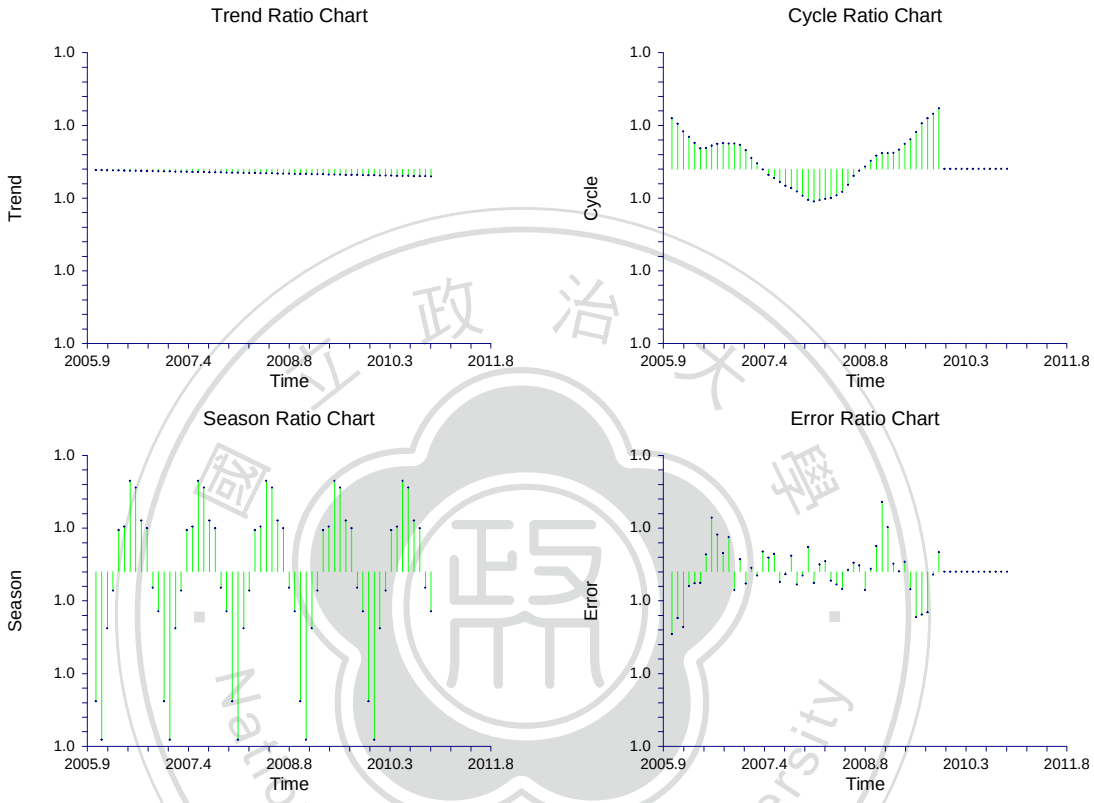
Forecast and Data Plot



Time Series Decomposition Report

Page/Date/Time	2 6/11/2011 4:50:35 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Variable	Sales
Title	MONTHLY MARKET SALES—Fresh Milk in Taiwan

Decomposition Ratio Plots



Time Series Decomposition Report

Page/Date/Time	3 6/11/2011 4:50:35 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Variable	Sales
Title	MONTHLY MARKET SALES—Fresh Milk in Taiwan

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	19189.66	17263	-1926.658	0.9998	1.0087	0.9777	0.9893
2	2006 2	17790.11	16452	-1338.109	0.9998	1.0078	0.9711	0.9920
3	2006 3	21285.06	19355	-1930.065	0.9998	1.0064	0.9902	0.9905
4	2006 4	22511.74	21954	-557.7376	0.9998	1.0055	0.9968	0.9975
5	2006 5	24731.82	24242	-489.8178	0.9997	1.0045	1.0072	0.9980
6	2006 6	24642.65	24164	-478.6522	0.9997	1.0035	1.0078	0.9981
7	2006 7	26680.74	27492	811.259	0.9997	1.0036	1.0156	1.0029
8	2006 8	26475.63	29099	2623.374	0.9997	1.0040	1.0145	1.0093
9	2006 9	25074.18	26740	1665.821	0.9997	1.0043	1.0088	1.0063
10	2006 10	24766.27	25574	807.7272	0.9996	1.0044	1.0074	1.0032
11	2006 11	22337.32	23704	1366.683	0.9996	1.0043	0.9973	1.0059
12	2006 12	21444.19	20779	-665.1892	0.9996	1.0044	0.9932	0.9968
13	2007 1	18314.07	18703	388.9309	0.9996	1.0042	0.9777	1.0021
14	2007 2	16983.71	16645	-338.7123	0.9996	1.0032	0.9711	0.9979
15	2007 3	20301.7	20433	131.2979	0.9995	1.0019	0.9902	1.0006
16	2007 4	21465.03	21322	-143.0292	0.9995	1.0010	0.9968	0.9993
17	2007 5	23570.17	24406	835.8257	0.9995	0.9999	1.0072	1.0035
18	2007 6	23484.51	24066	581.4897	0.9995	0.9990	1.0078	1.0024
19	2007 7	25251.3	26041	789.699	0.9995	0.9984	1.0156	1.0030
20	2007 8	24792.58	24348	-444.5848	0.9995	0.9978	1.0145	0.9982
21	2007 9	23272.21	23167	-105.215	0.9994	0.9971	1.0088	0.9995
22	2007 10	22861.6	23505	643.3984	0.9994	0.9967	1.0074	1.0028
23	2007 11	20535.24	20084	-451.2422	0.9994	0.9961	0.9973	0.9978
24	2007 12	19567.51	19439	-128.5135	0.9994	0.9954	0.9932	0.9993
25	2008 1	16658.45	17357	698.5532	0.9994	0.9947	0.9777	1.0042
26	2008 2	15558.52	15271	-287.5247	0.9993	0.9944	0.9711	0.9981
27	2008 3	18851.7	19081	229.3056	0.9993	0.9946	0.9902	1.0012
28	2008 4	20149.25	20514	364.751	0.9993	0.9948	0.9968	1.0018
29	2008 5	22383.48	22044	-339.4853	0.9993	0.9950	1.0072	0.9985
30	2008 6	22614.69	22121	-493.6901	0.9993	0.9955	1.0078	0.9978
31	2008 7	24602.55	23875	-727.5468	0.9993	0.9961	1.0156	0.9970
32	2008 8	24618.56	24697	78.44176	0.9992	0.9973	1.0145	1.0003
33	2008 9	23611.03	23972	360.9675	0.9992	0.9988	1.0088	1.0015
34	2008 10	23509.59	23762	252.4112	0.9992	0.9997	1.0074	1.0011
35	2008 11	21385.09	20720	-665.0854	0.9992	1.0004	0.9973	0.9968
36	2008 12	20721.76	20820	98.24145	0.9992	1.0014	0.9932	1.0005
37	2009 1	17904.67	18686	781.3312	0.9991	1.0023	0.9777	1.0044
38	2009 2	16828.29	18911	2082.705	0.9991	1.0027	0.9711	1.0120
39	2009 3	20385.17	21995	1609.828	0.9991	1.0027	0.9902	1.0077
40	2009 4	21763.6	22062	298.3979	0.9991	1.0028	0.9968	1.0014
41	2009 5	24276.68	24287	10.31796	0.9991	1.0033	1.0072	1.0000
42	2009 6	24663.57	25094	430.4343	0.9990	1.0043	1.0078	1.0017
43	2009 7	26903.91	26091	-812.9073	0.9990	1.0051	1.0156	0.9970
44	2009 8	26918.68	24859	-2059.677	0.9990	1.0063	1.0145	0.9922
45	2009 9	25804.08	23934	-1870.08	0.9990	1.0078	1.0088	0.9926

Time Series Decomposition Report

Page/Date/Time	4 6/11/2011 4:50:35 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Variable	Sales
Title	MONTHLY MARKET SALES—Fresh Milk in Taiwan

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
46	2009 10	25690.19	23928	-1762.194	0.9990	1.0087	1.0074	0.9930
47	2009 11	23347.69	23225	-122.6869	0.9990	1.0095	0.9973	0.9995
48	2009 12	22615.37	23388	772.6312	0.9989	1.0104	0.9932	1.0034
49	2010 1	17470.36			0.9989	1.0000	0.9777	1.0000
50	2010 2	16356.65			0.9989	1.0000	0.9711	1.0000
51	2010 3	19795.06			0.9989	1.0000	0.9902	1.0000
52	2010 4	21120.88			0.9989	1.0000	0.9968	1.0000
53	2010 5	23428.6			0.9988	1.0000	1.0072	1.0000
54	2010 6	23567.85			0.9988	1.0000	1.0078	1.0000
55	2010 7	25488.83			0.9988	1.0000	1.0156	1.0000
56	2010 8	25191.5			0.9988	1.0000	1.0145	1.0000
57	2010 9	23794.24			0.9988	1.0000	1.0088	1.0000
58	2010 10	23474.64			0.9988	1.0000	1.0074	1.0000
59	2010 11	21199.69			0.9987	1.0000	0.9973	1.0000
60	2010 12	20350.38			0.9987	1.0000	0.9932	1.0000

Appendix F

Winter's Report (Forecast, 60 months) for Fresh Milk

Forecast Method: Winter's with multiplicative seasonal trend adjustment

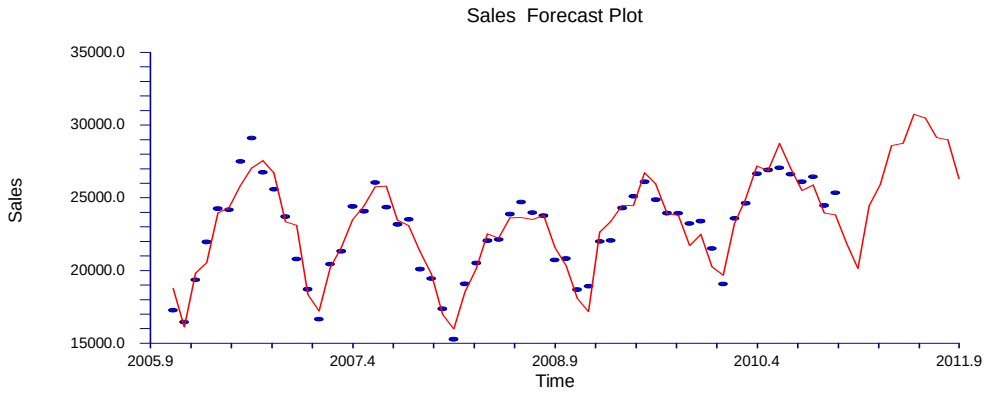
Seasonal - Trend Report

Page/Date/Time	1 6/11/2011 4:56:48 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Title	MONTHLY MARKET SALES---FRESH MILK IN TAIWAN

Forecast Summary Section

Log10(Variable)	Sales
Number of Rows	60
Mean	22799.82
Pseudo R-Squared	0.916643
Mean Square Error	797011.9
Mean |Error|	712.8579
Mean |Percent Error|	3.172555
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	136
Search Criterion	Mean Square Error
Alpha	0.8730332
Beta	3.756879E-08
Gamma	3.947698E-03
Intercept (A)	4.373165
Slope (B)	7.648958E-04
Season 1 Factor	0.9818563
Season 2 Factor	0.9736617
Season 3 Factor	0.9925297
Season 4 Factor	0.9980898
Season 5 Factor	1.007528
Season 6 Factor	1.007919
Season 7 Factor	1.014312
Season 8 Factor	1.01331
Season 9 Factor	1.008709
Season 10 Factor	1.008008
Season 11 Factor	0.9983027
Season 12 Factor	0.9957737

Forecast and Residuals Plots



Page/Date/Time 2 6/11/2011 4:56:48 PM
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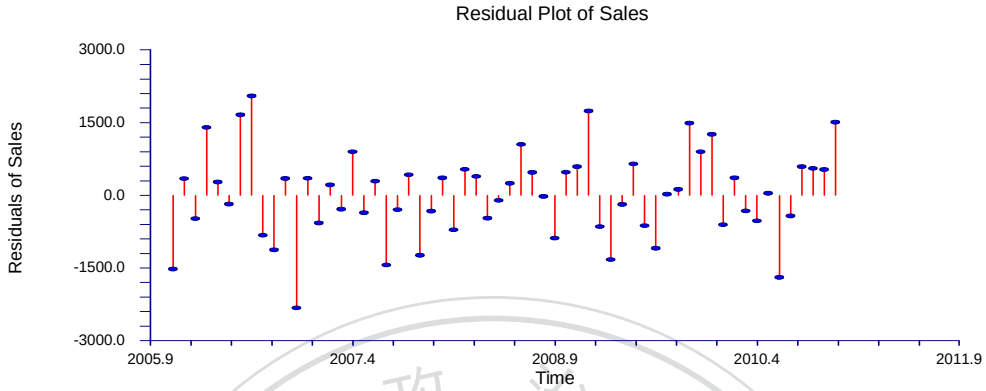
Title MONTHLY MARKET SALES---FRESH MILK IN TAIWAN



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	18786.5	17263	-1523.498
2	2006 2	16111.33	16452	340.6747
3	2006 3	19838.37	19355	-483.3698
4	2006 4	20556.02	21954	1397.978
5	2006 5	23970.55	24242	271.4522
6	2006 6	24345.36	24164	-181.3639
7	2006 7	25832.35	27492	1659.653
8	2006 8	27049.8	29099	2049.197
9	2006 9	27566.1	26740	-826.1008
10	2006 10	26701.19	25574	-1127.194
11	2006 11	23360.32	23704	343.6839
12	2006 12	23104.55	20779	-2325.548
13	2007 1	18355.65	18703	347.346
14	2007 2	17219.05	16645	-574.0549
15	2007 3	20218.14	20433	214.8584
16	2007 4	21611.04	21322	-289.041
17	2007 5	23511.05	24406	894.9453
18	2007 6	24428.79	24066	-362.7858
19	2007 7	25752.43	26041	288.5715
20	2007 8	25790.35	24348	-1442.348
21	2007 9	23466.98	23167	-299.9824
22	2007 10	23084.05	23505	420.9515
23	2007 11	21323.73	20084	-1239.727
24	2007 12	19768.79	19439	-329.7863
25	2008 1	16997.98	17357	359.0195
26	2008 2	15985.05	15271	-714.049
27	2008 3	18546.95	19081	534.0519
28	2008 4	20127.27	20514	386.7318
29	2008 5	22518.43	22044	-474.4281
30	2008 6	22228.12	22121	-107.1171
31	2008 7	23628.18	23875	246.8245
32	2008 8	23648.67	24697	1048.332

Page/Date/Time	3 6/11/2011 4:56:48 PM
Database	C:\Users\jp1219\Documents\NCSS\NCSS 2007\Data\SALES.S0
Title	MONTHLY MARKET SALES---FRESH MILK IN TAIWAN

Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
33	2008 9	23500.65	23972	471.3493
34	2008 10	23787	23762	-25.00126
35	2008 11	21605.67	20720	-885.6664
36	2008 12	20347.09	20820	472.9115
37	2009 1	18098.05	18686	587.9476
38	2009 2	17173.88	18911	1737.116
39	2009 3	22643.87	21995	-648.8704
40	2009 4	23390.41	22062	-1328.408
41	2009 5	24475.77	24287	-188.7715
42	2009 6	24448.85	25094	645.1514
43	2009 7	26719.79	26091	-628.7867
44	2009 8	25954.18	24859	-1095.18
45	2009 9	23913.81	23934	20.19368
46	2009 10	23806.44	23928	121.5641
47	2009 11	21737.89	23225	1487.106
48	2009 12	22491.32	23388	896.6757
49	2010 1	20256.48	21513	1256.518
50	2010 2	19679.5	19069	-610.4973
51	2010 3	23216.34	23576	359.662
52	2010 4	24939.16	24613	-326.1627
53	2010 5	27176.58	26646	-530.5823
54	2010 6	26865.81	26905	39.18773
55	2010 7	28750.25	27054	-1696.253
56	2010 8	27037.49	26610	-427.4862
57	2010 9	25503.13	26092	588.8686
58	2010 10	25879.15	26432	552.8517
59	2010 11	23942.08	24471	528.9158
60	2010 12	23827.88	25337	1509.125
61	2011 1	21859.07		
62	2011 2	20144.56		
63	2011 3	24452.56		
64	2011 4	25922.16		
65	2011 5	28587.76		
66	2011 6	28752.58		
67	2011 7	30742.26		
68	2011 8	30484.26		
69	2011 9	29140.02		
70	2011 10	28983.88		
71	2011 11	26300.12		
72	2011 12	25675.7		

Appendix G

Winter's Report (Validation, 48 months) for Air Conditioner

Seasonal - Trend Report

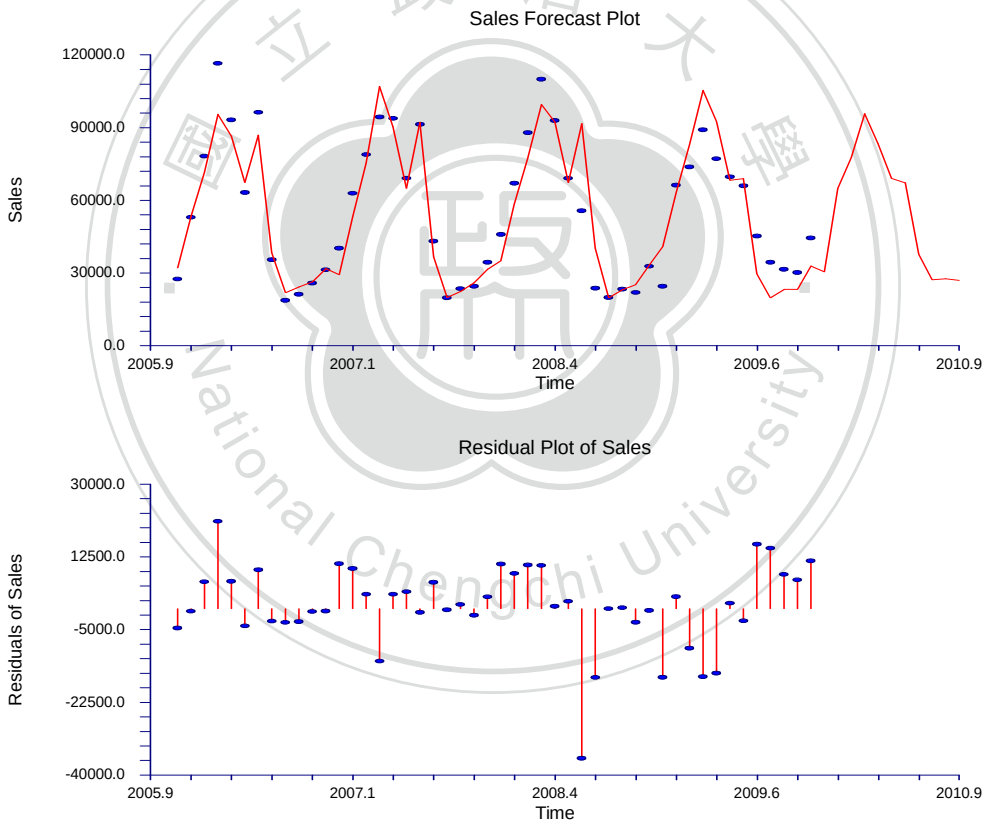
Page/Date/Time	1 2011/6/30 ¤U¤È 05:38:23
Database	C:\Documents and Settings\us ... NCSS\NCSS 2007\Data\SALES.S0
Title	AC MONTHLY MARKET SALES(EACH)

Forecast Summary Section

Log10(Variable)	Sales
Number of Rows	48
Mean	54961.98
Pseudo R-Squared	0.874496
Mean Square Error	9.854667E+07
Mean |Error|	7114
Mean |Percent Error|	14.83629
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	150
Search Criterion	Mean Square Error
Alpha	6.259737E-07
Beta	2.238804E-02
Gamma	0.5738754
Intercept (A)	4.686174
Slope (B)	5.427435E-10
Season 1 Factor	0.9569405
Season 2 Factor	1.026979
Season 3 Factor	1.043513
Season 4 Factor	1.062904
Season 5 Factor	1.050147

Season 6 Factor	1.032684
Season 7 Factor	1.03014
Season 8 Factor	0.9768854
Season 9 Factor	0.9463719
Season 10 Factor	0.947819
Season 11 Factor	0.9456754
Season 12 Factor	0.9799403

Forecast and Residuals Plots



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	32145.6	27486	-4659.604

2	2006 2	53538.58	52957	-581.5829
3	2006 3	71706.66	78204	6497.341
4	2006 4	95442.55	116473	21030.45
5	2006 5	86570.91	93163	6592.089
6	2006 6	67374.88	63238	-4136.874
7	2006 7	86912.03	96299	9386.967
8	2006 8	38444.5	35477	-2967.498
9	2006 9	21929.44	18649	-3280.439
10	2006 10	24307.1	21219	-3088.102
11	2006 11	26477.6	25793	-684.6022
12	2006 12	31841.59	31280	-561.5923
13	2007 1	29382.73	40219	10836.27
14	2007 2	53204.05	62879	9674.949
15	2007 3	75366.29	78855	3488.714
16	2007 4	106997.3	94385	-12612.26
17	2007 5	90294.69	93782	3487.314
18	2007 6	64968.82	69081	4112.182
19	2007 7	92180.98	91320	-860.9882
20	2007 8	36712.44	43093	6380.564
21	2007 9	19982.18	19727	-255.1779
22	2007 10	22483.81	23511	1027.192
23	2007 11	26082.54	24506	-1576.542
24	2007 12	31518.1	34369	2850.905
25	2008 1	35183.09	45931	10747.91
26	2008 2	58557.93	67051	8493.065
27	2008 3	77349.08	87890	10540.93
28	2008 4	99566.69	109988	10421.32
29	2008 5	92279.84	92893	613.1529
30	2008 6	67297.83	69084	1786.17
31	2008 7	91685.95	55706	-35979.95

32	2008 8	40248.65	23724	-16524.65
33	2008 9	19835.33	19859	23.66716
34	2008 10	23067.67	23324	256.3333
35	2008 11	25165.8	21921	-3244.799
36	2008 12	33123.91	32745	-378.9044
37	2009 1	40998.92	24494	-16504.92
38	2009 2	63290.77	66216	2925.226
39	2009 3	83233.04	73731	-9502.042
40	2009 4	105420	89082	-16337.96
41	2009 5	92631.09	77147	-15484.09
42	2009 6	68317.04	69648	1330.959
43	2009 7	68883.48	65989	-2894.482
44	2009 8	29717.35	45259	15541.65
45	2009 9	19848.9	34410	14561.1
46	2009 10	23214.42	31477	8262.582
47	2009 11	23249.13	30200	6950.872
48	2009 12	32905.93	44441	11535.07
49	2010 1	30506.29		
50	2010 2	64953.36		
51	2010 3	77639.74		
52	2010 4	95709.3		
53	2010 5	83400.74		
54	2010 6	69077.78		
55	2010 7	67207.31		
56	2010 8	37831.59		
57	2010 9	27218.44		
58	2010 10	27646.79		
59	2010 11	27014.64		
60	2010 12	39099.44		

Appendix H

Decomposition Report (Validation, 48 months) for Air Conditioner

Page/Date/Time	1 2011/6/30 ¤U¤È 05:42:16
Database	C:\Documents and Settings\us ... NCSS\NCSS 2007\Data\SALES.S0
Variable	Sales
Title	AIR CONDITIONER MONTHLY MARKET SALES(EACH)

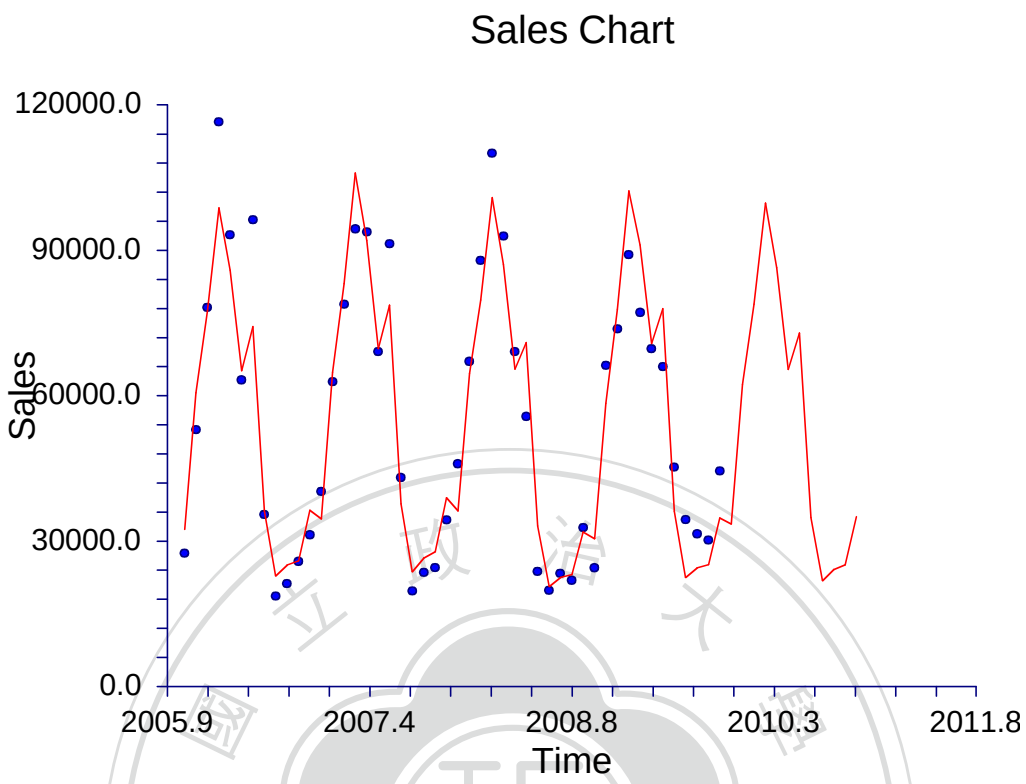
Forecast Summary Section

Forecast	10^[(Mean) x (Trend) x (Cycle) x (Season)]
Variable	Sales
Number of Rows	48
Mean	4.677556
Pseudo R-Squared	0.9183424
Forecast Std. Error	8007.387
Trend Equation	Trend = (0.999897) + (-0.000064) * (Time Season Number)
Number of Seasons	12
First Year	2006
First Season	1

Seasonal Component Ratios

No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
1	0.970635	2	1.028424	3	1.050456	4	1.072341
5	1.059104	6	1.033179	7	1.043449	8	0.974671
9	0.931187	10	0.940598	11	0.944458	12	0.975439

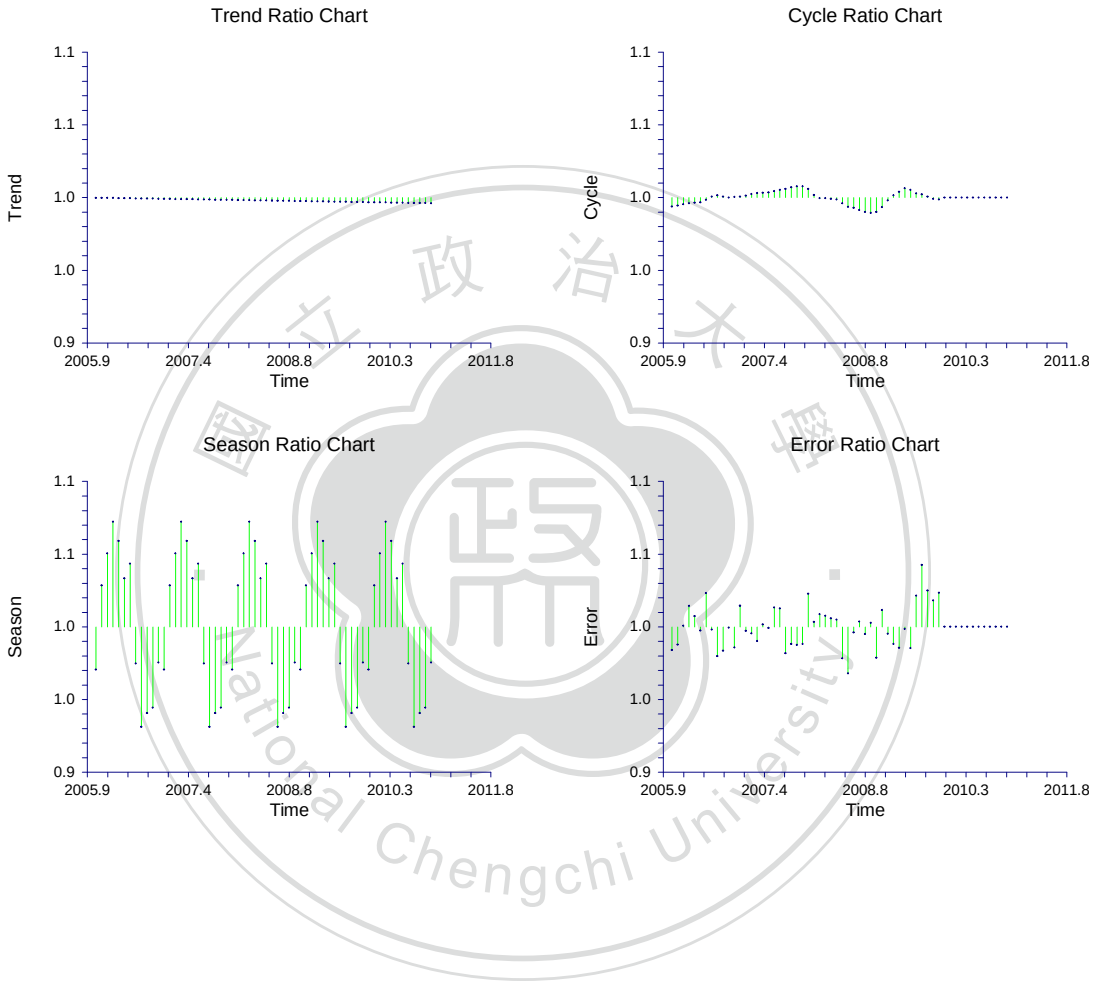
Forecast and Data Plot



Time Series Decomposition Report

Title AIR CONDITIONER MONTHLY MARKET SALES(EACH)

Decomposition Ratio Plots



Time Series Decomposition Report

Title AIR CONDITIONER MONTHLY MARKET SALES(EACH)

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
1	2006 1	32435.32	27486	-4949.324	0.9998	0.9937	0.9706	0.9841
2	2006 2	60565.01	52957	-7608.007	0.9998	0.9943	1.0284	0.9878
3	2006 3	77524.3	78204	679.6945	0.9997	0.9954	1.0505	1.0008
4	2006 4	98714.84	116473	17758.15	0.9996	0.9961	1.0723	1.0144
5	2006 5	85845.14	93163	7317.856	0.9996	0.9963	1.0591	1.0072
6	2006 6	65125.73	63238	-1887.734	0.9995	0.9966	1.0332	0.9973
7	2006 7	74228.03	96299	22070.97	0.9994	0.9985	1.0434	1.0232
8	2006 8	36246.94	35477	-769.9415	0.9994	1.0007	0.9747	0.9980
9	2006 9	22850.44	18649	-4201.438	0.9993	1.0014	0.9312	0.9798
10	2006 10	25090.58	21219	-3871.58	0.9993	1.0007	0.9406	0.9835
11	2006 11	25946.83	25793	-153.8295	0.9992	1.0000	0.9445	0.9994
12	2006 12	36354.46	31280	-5074.455	0.9991	1.0004	0.9754	0.9857
13	2007 1	34571.55	40219	5647.455	0.9991	1.0006	0.9706	1.0145
14	2007 2	64799.48	62879	-1920.481	0.9990	1.0012	1.0284	0.9973
15	2007 3	83064.68	78855	-4209.683	0.9989	1.0023	1.0505	0.9954
16	2007 4	105921.9	94385	-11536.85	0.9989	1.0029	1.0723	0.9900
17	2007 5	92032.46	93782	1749.537	0.9988	1.0032	1.0591	1.0016
18	2007 6	69700.85	69081	-619.8524	0.9987	1.0034	1.0332	0.9992
19	2007 7	78644.15	91320	12675.85	0.9987	1.0044	1.0434	1.0133
20	2007 8	37709.26	43093	5383.738	0.9986	1.0052	0.9747	1.0127
21	2007 9	23723.66	19727	-3996.665	0.9985	1.0059	0.9312	0.9817
22	2007 10	26536.94	23511	-3025.938	0.9985	1.0070	0.9406	0.9881
23	2007 11	27826.38	24506	-3320.383	0.9984	1.0076	0.9445	0.9876
24	2007 12	38911.88	34369	-4542.884	0.9984	1.0077	0.9754	0.9883

25	2008	1	36207.4	45931	9723.602	0.9983	1.0058	0.9706	1.0227
26	2008	2	64551.73	67051	2499.269	0.9982	1.0017	1.0284	1.0034
27	2008	3	79750.47	87890	8139.535	0.9982	0.9994	1.0505	1.0086
28	2008	4	100885.2	109988	9102.766	0.9981	0.9995	1.0723	1.0075
29	2008	5	87050.25	92893	5842.753	0.9980	0.9991	1.0591	1.0057
30	2008	6	65443.4	69084	3640.596	0.9980	0.9985	1.0332	1.0049
31	2008	7	70949.8	55706	-15243.8	0.9979	0.9960	1.0434	0.9783
32	2008	8	33105.11	23724	-9381.114	0.9978	0.9936	0.9747	0.9680
33	2008	9	20657.15	19859	-798.1517	0.9978	0.9929	0.9312	0.9960
34	2008	10	22495.91	23324	828.0914	0.9977	0.9915	0.9406	1.0036
35	2008	11	23077.35	21921	-1156.35	0.9976	0.9900	0.9445	0.9949
36	2008	12	31855.02	32745	889.978	0.9976	0.9894	0.9754	1.0027
37	2009	1	30487.38	24494	-5993.376	0.9975	0.9901	0.9706	0.9788
38	2009	2	58379.97	66216	7836.027	0.9975	0.9933	1.0284	1.0115
39	2009	3	77821.58	73731	-4090.575	0.9974	0.9980	1.0505	0.9952
40	2009	4	102207.3	89082	-13125.31	0.9973	1.0014	1.0723	0.9881
41	2009	5	91102.37	77147	-13955.37	0.9973	1.0039	1.0591	0.9854
42	2009	6	70767.05	69648	-1119.046	0.9972	1.0064	1.0332	0.9986
43	2009	7	77971.28	65989	-11982.28	0.9971	1.0052	1.0434	0.9852
44	2009	8	36155.74	45259	9103.263	0.9971	1.0027	0.9747	1.0214
45	2009	9	22472.15	34410	11937.85	0.9970	1.0021	0.9312	1.0425
46	2009	10	24493.3	31477	6983.696	0.9969	1.0006	0.9406	1.0248
47	2009	11	25135.14	30200	5064.856	0.9969	0.9992	0.9445	1.0181
48	2009	12	34792.87	44441	9648.134	0.9968	0.9985	0.9754	1.0234
49	2010	1	33530.56			0.9967	1.0000	0.9706	1.0000

Time Series Decomposition Report

Title AIR CONDITIONER MONTHLY MARKET SALES(EACH)

Forecasts Section

Row No.	Year Season	Forecast Sales	Actual Sales	Residual	Trend Factor	Cycle Factor	Season Factor	Error Factor
50	2010 2	62310.73			0.9967	1.0000	1.0284	1.0000
51	2010 3	78879.24			0.9966	1.0000	1.0505	1.0000
52	2010 4	99692.17			0.9966	1.0000	1.0723	1.0000
53	2010 5	86424.8			0.9965	1.0000	1.0591	1.0000
54	2010 6	65386.72			0.9964	1.0000	1.0332	1.0000
55	2010 7	72952.94			0.9964	1.0000	1.0434	1.0000
56	2010 8	34850.31			0.9963	1.0000	0.9747	1.0000
57	2010 9	21841.27			0.9962	1.0000	0.9312	1.0000
58	2010 10	24146.33			0.9962	1.0000	0.9406	1.0000
59	2010 11	25150.88			0.9961	1.0000	0.9445	1.0000
60	2010 12	35043.92			0.9960	1.0000	0.9754	1.0000

Appendix I

Winter's Report (Forecast, 60 months) for Air Conditioner

Seasonal - Trend Report

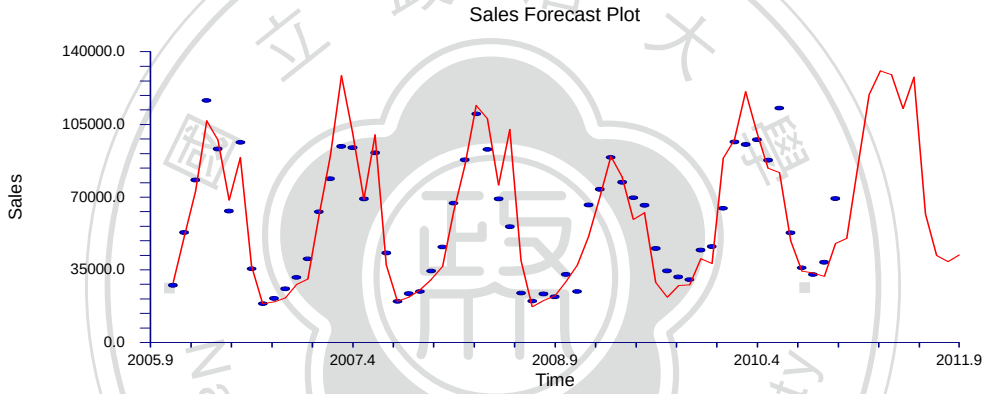
Page/Date/Time	1 2011/7/2 ¤W¤È 12:25:13
Database	C:\DOCUMENTS AND SETTINGS\US ... NCSS\NCSS 2007\DATA\SALES.S0
Title	AC MARKET SALES(EACH) WINTER'S

Forecast Summary Section

Log10(Variable)	Sales
Number of Rows	60
Mean	57803.08
Pseudo R-Squared	0.824081
Mean Square Error	1.416344E+08
Mean |Error|	7717.047
Mean |Percent Error|	14.11755
Forecast Method	Winter's with multiplicative seasonal adjustment.
Search Iterations	86
Search Criterion	Mean Square Error
Alpha	0.191321
Beta	1.564809E-02
Gamma	0.696428
Intercept (A)	4.707559
Slope (B)	2.590202E-03
Season 1 Factor	0.9661455
Season 2 Factor	1.012807
Season 3 Factor	1.042347
Season 4 Factor	1.049959
Season 5 Factor	1.048082

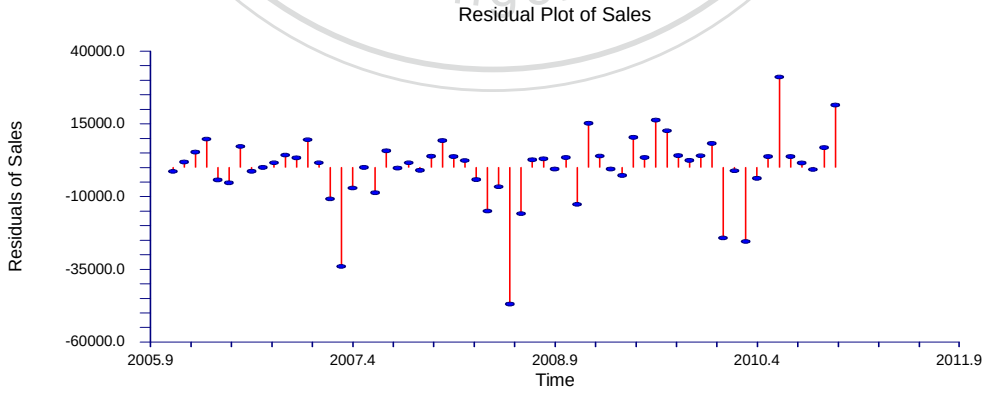
Season 6 Factor	1.035443
Season 7 Factor	1.046123
Season 8 Factor	0.9812949
Season 9 Factor	0.9459578
Season 10 Factor	0.9389964
Season 11 Factor	0.9455498
Season 12 Factor	0.9872943

Forecast and Residuals Plots



Seasonal - Trend Report

Title AC MARKET SALES(EACH) WINTER'S



Forecasts Section

Row No.	Date	Forecast Sales	Actual Sales	Residuals
1	2006 1	28879.4	27486	-1393.397
2	2006 2	51101.12	52957	1855.884
3	2006 3	72953.38	78204	5250.621
4	2006 4	106764.5	116473	9708.522
5	2006 5	97479.74	93163	-4316.741
6	2006 6	68512.74	63238	-5274.741
7	2006 7	89102.81	96299	7196.19
8	2006 8	36805.44	35477	-1328.441
9	2006 9	18674.17	18649	-25.17243
10	2006 10	19640.96	21219	1578.037
11	2006 11	21584.89	25793	4208.114
12	2006 12	28029.33	31280	3250.667
13	2007 1	30720.46	40219	9498.541
14	2007 2	61304.61	62879	1574.392
15	2007 3	89720.34	78855	-10865.33
16	2007 4	128445.6	94385	-34060.64
17	2007 5	100895.6	93782	-7113.563
18	2007 6	69081.13	69081	-0.1217377
19	2007 7	100010.5	91320	-8690.451
20	2007 8	37389.23	43093	5703.765
21	2007 9	19953.33	19727	-226.3326
22	2007 10	21923.02	23511	1587.981
23	2007 11	25497.24	24506	-991.2367
24	2007 12	30571.29	34369	3797.715
25	2008 1	36701.99	45931	9229.012
26	2008 2	63336.18	67051	3714.819

27	2008 3	85532.13	87890	2357.87
28	2008 4	114179.7	109988	-4191.672
29	2008 5	107908.7	92893	-15015.71
30	2008 6	75745.3	69084	-6661.298
31	2008 7	102658.5	55706	-46952.46
32	2008 8	39639.38	23724	-15915.38
33	2008 9	17250.72	19859	2608.282
34	2008 10	20353.51	23324	2970.493
35	2008 11	22479.87	21921	-558.8668
36	2008 12	29382.22	32745	3362.784
37	2009 1	37231.77	24494	-12737.77
38	2009 2	51036.69	66216	15179.31
39	2009 3	69861.54	73731	3869.461
40	2009 4	89662.89	89082	-580.8927
41	2009 5	79895.7	77147	-2748.704
42	2009 6	59340.33	69648	10307.67
43	2009 7	62621.05	65989	3367.95
44	2009 8	28972.63	45259	16286.37
45	2009 9	21821.97	34410	12588.03
46	2009 10	27445.29	31477	4031.705
47	2009 11	27768.33	30200	2431.672
48	2009 12	40452.3	44441	3988.704
49	2010 1	37989.37	46198	8208.628
50	2010 2	88819.54	64560	-24259.54
51	2010 3	97691.43	96523	-1168.432
52	2010 4	120828.7	95333	-25495.7
53	2010 5	101442.5	97656	-3786.486
54	2010 6	83973.59	87720	3746.408
55	2010 7	81747.04	112769	31021.96
56	2010 8	49065.98	52779	3713.022

57	2010 9	34358.23	35877	1518.764
58	2010 10	33398.89	32687	-711.8906
59	2010 11	31823.93	38619	6795.067
60	2010 12	47845.58	69289	21443.42
61	2011 1	50215.78		
62	2011 2	85211.59		
63	2011 3	119399.9		
64	2011 4	130858.1		
65	2011 5	128934.2		
66	2011 6	112569.2		
67	2011 7	127712.1		
68	2011 8	61993.04		
69	2011 9	41900.33		
70	2011 10	38961.39		
71	2011 11	42181.54		
72	2011 12	67900.21		