Journal of Science and Technology 17 (June 2019): 104-110

COMPARISON AMONG DIFFERENT SEASONAL ADJUSTMENT METHODS IN FORECASTING EXPORT OF JUTE GOODS

A.S.M. Abu Saeed

Department of Statistics, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

ABSTRACT

In Bangladesh, different organizations like Bangladesh Bank or BBS publish time series data which may have seasonal effects. Different seasonal adjustment methods *X-based* and classical methods which are available do not have practical implementation in accordance with Bangladeshi time series data. So here we have tried to implement some *X-based* seasonal adjustment methods as X-11 and X-12-ARIMA and some classical methods as MA and SARIMA to some seasonal data collected from economic trend published by Bangladesh Bank. We have used export of jute goods which is monthly data and have seasonal effects. At first we divide the full data set into training data set and test data set. Then we deseasonalized the data and calculate some forecasted values by using training data set and measure the forecasting errors by comparing with test data set. We calculate different forecasting errors MAPE, PMAE, MAE and RMSE by applying different *X-based* methods as X-11 and X-12-ARIMA and different classical methods as moving average and SARIMA. We make decision that the seasonal adjustment method returns less forecasting errors gives better performance. Finally we propose a best seasonal adjusted method for selected time series data.

Keywords: Seasonal adjustment, MA, SARIMA,X-11, X-12-ARIMA

INTRODUCTION

Bangladesh is a developing country. The economy of this country is mainly dependent on the agriculture, import-export, foreign remittance etc. Overall development of this country was mainly dependent on agriculture. But now the situation has been changed. In the recent days the export-import of different commodities is gaining its contribution. Researchers need to analyze the economic behavior of these sectors via appropriate econometric or time series models so that we can utilize this sector for economic development. However, most of these financial data are time series data. For example GDP, CPI, production, export-import etc. are time series data.

Time series has four different components of which seasonal variation is an important component. Most of economic time series is influenced by seasonal swing, e.g., prices, production and consumption of commodities, export-import of different goods, sales and profits in a departmental store, bank clearings and bank deposits etc. all are affected by seasonal variation. The various seasons or weather conditions and climate changes play an important role in seasonal movements. Likewise the production or supply of certain commodities such as sugar, jute, tea, rice etc depends on seasons. When the production of different goods increases or decreases it affects the export and import of the country. Hence a study of the seasonal patterns is extremely useful.

In the absence of any knowledge of seasonal variations, a seasonal upswing may be mistaken as indicator of better business conditions while a seasonal slump may be miss-interpreted as

**Corresponding author:* A.S.M. Abu Saeed,Department of Statistics, Hajee Mohammad Danesh Science and TechnologyUniversity, Dinajpur 5200, Bangladesh, Cell Phone: 01725339914, E-mail: iuabusaeed@gmail.com

deteriorating business conditions. Thus, to understand the behavior of the phenomena in a time series properly, the time series data must be adjusted for seasonal variations. Seasonal fluctuation is typically found in quarterly, monthly or weekly data. Seasonal fluctuations in data make it difficult to analyze whether changes in data for a given period reflect important increases or decreases in the level of the data or are due to regularly occurring variation.

MATERIALS AND METHODS

The Seasonal Component

In the deterministic analysis of time series the effect of seasonality is considered constant, that is, the magnitude of the seasonality in similar periods of time is supposed to be identical along the entire length of the time series. The condition of constant seasonality, however, is not fulfilled in the stochastic analysis; in this case the methods in use take into account the so-called moving seasonality as well. This method has the advantage to avoid the under- and overcorrection which might be induced by a fixed seasonal pattern.

From the viewpoint of calculating the seasonal component, the selection between the additive and multiplicative decompositions is mostly a decisive factor in performing the analysis of the time series. Even if not always, yet in a number of cases the time series indicates clearly which decomposition model describes the behavior of the time series better (Foldesi 2007).

Reasons for studying seasonal variation

There are several main reasons for studying seasonal variation (i) the description of the seasonal effect provides a better understanding of the impact this component has upon a particular series, (ii) after establishing the seasonal pattern, methods can be implemented to eliminate it from the time-series to study the effect of other components such as cyclical and irregular variations. This elimination of the seasonal effect is referred to as seasonal adjustment of data, (iii) to project the past patterns into the future knowledge of the seasonal variations is a must for the prediction of the future trends.

Objective of studying seasonal variations is i) to isolate the seasonal variations and ii) to eliminate them from a given series (Gupta and Kapoor 2015).

There are different classical and *X-based* seasonal adjustment methods are available. Some classical methods are simple average, ratio to trend, moving average, seasonal ARIMA etc. Some *X*-based methods are X-11, X-11-ARIMA, X-12 etc. The U.S. Census Bureau devised a general approach to seasonal adjustment in 1965, called the X-11 method, which became the standard method used by many government statistics offices around the world. A major development of the method was made by Statistics Canada in 1980, with the seasonal adjustment method named X-11-ARIMA. It's most important improvement is that it allows the user to augment the observed series, before seasonal adjustment, with forecasts values from ARIMA models. The use of forecast extensions generally results in smaller revisions of the seasonal adjustments, especially at the end of the series, on average; better trend estimation at the end of the series. In 1996, the U.S. Census Bureau developed an enhanced version of the X-11-ARIMA called X-12-ARIMA. X-12-ARIMA's major enhancements include new X-11-ARIMA adjustment options, new and better diagnostics, new modeling capabilities especially for handling calendar effects, and improved user interface (Gomez and Maravall 2000). The classical methods are includes simple average, ratio to trend, moving average, seasonal ARIMA etc. Where the seasonal ARIMA method is the extension of the ARIMA model for seasonal data and is denoted as SARIMA.

Seasonal adjustment is very essential for time series data. In Bangladesh different financial data are time based. But the different organizations do not publish seasonally adjusted data.

So we are motivated to apply different classical and *X-based* seasonal adjustment methods to Bangladeshi data and try to find an appropriate seasonal adjustment method.

Different Seasonal Adjustment Methods

Seasonal adjustment method can be of three kinds. As,

1) Non filter based seasonal adjustment method
2) Filter based seasonal adjustment method

1) The most commonly used non filter based seasonal adjustment methods are;

(i) Method of simple average
(ii) Ratio to trend method
(iii) Moving average method and
(iv) Link relative method.

2) The most commonly used filter based seasonal adjustment methods are;

(i) X-11
(ii) X-11-ARIMA and
(iii) X-12-ARIMA

Using Deseasonalized Data to Forecast

A set of typical indexes is very useful in adjusting a time series, for example, for seasonal fluctuations. The resulting series is called deseasonalized series or seasonally adjusted series. The reason for deseasonalizing the series is to remove the seasonal fluctuations so that the trend and cycle can be studied.

The procedure for identifying trend and the seasonal adjustments can be combined to yield seasonally adjusted forecasts. To identify the trend, we determine the least squares trend equation on the deseasonalized historical data. Then we project this trend into future periods and finally we adjust these trend values to account for the seasonal factors.

Now the deseasonalized data will follow a straight line. Hence it is reasonable to develop a linear trend equation based on this deseasonalized data. The deseasonalized trend equation is:

$$Y' = a + bt$$

where,

Y' is the estimated trend value for the series for the period t.

a is the intercept of the trend line at time 0.

b is the slope of the line.

t is the coded time period.

If we assume that we have n periods of sales, we can use the trend equation to estimate the future values. For example if we have quarterly data. Then for the next years values will be obtained by putting t equal n+1, n+2, n+3 and n+4 in the fitted model (a). This is the forecast series before we consider the effect of seasonality. Finally for getting the original series we have to multiply this forecasted series by the seasonal index. Hence finally forecasted series is obtained (Lind, Marchal and Wathen 2005).

Different Measures of the Forecasting Errors

Several methods have been devised to summarize the errors generated by a particular forecasting technique. Most of these measures involve averaging some functions of the difference between actual values are often referred to as residuals. There are different measures of forecasting errors which are used to check the forecasting performance. Popular measures are discussed in the following:

(i) Mean Absolute Error (MAE):

One method for evaluating a forecasting technique uses the sum of the absolute errors. The mean absolute error (MAE) measures forecast accuracy by averaging the magnitudes of the forecast errors. MAE is computed as $MAE = \frac{\sum_{t=1}^{e} |e_t|}{n}$ (Shcherbakov 2013).

(ii) Mean Absolute Percent Error (MAPE):

The mean absolute percent error (MAPE) is computed by finding the absolute error in each period, dividing this by the actual observed value for that period and then averaging the absolute percentage errors.The mean absolute percent error MAPE can be computed from the equation $MAPE = \frac{\sum_{t=1}^{n} 100 \times \left|\frac{e_t}{y_t}\right|}{n}$ (Shcherbakov 2013).

(iii) Percent Mean Absolute Error (PMAE):

The percent mean absolute error (PMAE) can be calculated from the equation

$PMAE = \frac{\sum_{t=1}^{n} |e_t|}{\sum_{t=1}^{n} y_t}$ (Shcherbakov 2013).

(iv) Root Mean Squared Error (RMSE):

The Root Mean Squared Error (RMSE) can be calculated from the equation $RMSE = \sqrt{\frac{\sum_{t=1}^{N} e_t^2}{n}}$ (Shcherbakov 2013).

RESULTS AND DISCUSSION

As is known, jute was the single most important export item of Bangladesh till the end of the 1980s. With the ascendancy of export-oriented readymade garments (RMG), and later on of shrimp, jute lost its pre-eminent position. It presently occupies the third position in the export basket of Bangladesh. Agro-climatic environment made Bangladesh a natural home for producing the best quality jute in the world. Bangladesh has continued to remain one of the world's largest growers of quality jute. Bangladesh's jute sector started to face a critical time particularly since the 1990s, as jute started to face increasing competitive pressure from synthetic substitutes, with technological developments leading to progressive replacement of natural raw materials. Lack of significant efforts and required investments towards product development and diversification as also an inability to undertake the technological transformation undermined jute's prospects as a fiber. Failure to follow modern marketing procedures and international trade practices led to the demise of jute as an important globally-traded commodity. All these had adverse impact on production, consumption and export performance of jute (Rahman andKhaleda 2011).

The following table contains original and forecasted values obtained by different seasonal adjustment methods.

Table 1. Original and forecasted values obtained by different adjustment methods for Export of Jute Goods series.

Original	MA	SARIMA	X-11	X-12-ARIMA
119	164.2505	155.9898	151.7610	132.1288
87	165.3674	163.466	101.0862	101.3229
121	166.4843	166.6252	98.75734	99.13307
126	167.6012	168.6233	146.2005	146.3767
154	168.7182	170.1045	176.6533	178.0750
221	169.8351	171.3837	214.0359	209.1821
164	170.952	172.5816	202.6985	202.6641
113	172.069	173.7471	161.8527	162.1167
144	173.1859	174.8995	203.6513	183.4239
125	174.3028	176.0468	211.0472	191.3527
172	175.4198	177.1919	199.0770	197.7022
153	176.5367	178.3363	180.1747	170.6362

Now from the above table we can calculate different measurements of forecasting errors as MAPE, PMAE, MAE and RMSE. In the following table the calculated values of different measurements of forecasting accuracy are shown.

Table 2. Measuring forecasting accuracy of different seasonal adjustment methods for Export of Jute Goods series

Methods of seasonal adjustment	Measuring forecasting accuracy			
	MAPE	PMAE	MAE	RMSE
MA	0.30357	26.441	37.43569	42.64986
SARIMA	0.30418	26.372	37.33773	43.02009
X-11	0.25827	24.278	34.37372	40.03651
X-12-ARIMA	0.25549	23.920	33.86744	39.84801

We observed from the above Table that, X-12-ARIMA seasonal adjustment method returns lowest forecasting errors as MAPE, PMAE, MAE and RMSE all are lower, with compare to the forecasting errors obtains from MA, SARIMA and X-11 method. So we can say that, in terms of minimum error method X-12-ARIMA procedure has performed well for forecasting purpose for this series.

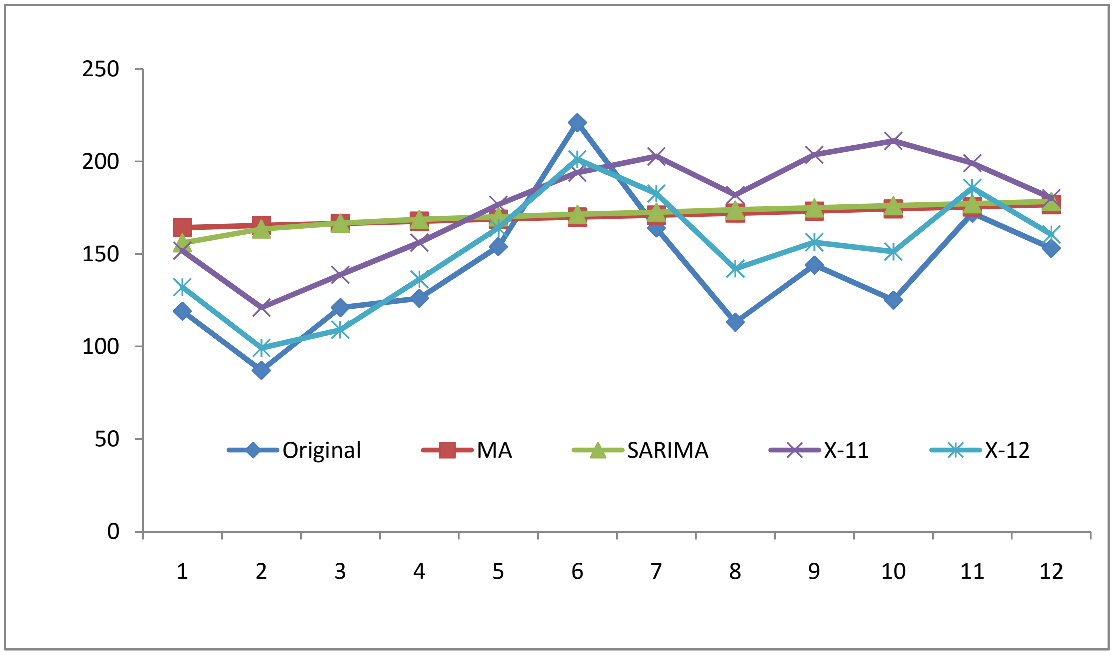

Figure 1. Original and forecasted values for different seasonal adjustment methods forExport of Jute Good series

It is evident from the above figure that the forecasted values obtained by X-12-ARIMA method is very close to the original series than the forecasted values obtained by any other methods. Hence, we can conclude that X-12-ARIMA method of seasonal adjustment is more appropriate for this series.

CONCLUSIONS

Seasonally adjustment is very necessary for analyzing time series data. We have applied different seasonal adjustment methods; *X-based* and classical methods to export of jute good collected from Bangladesh Bank yearly economic trend. We have observed different forecasting errors (the MAPE, PMAE, MAE and RMSE) calculated for MA, SARIMA, X-11 and X-12-ARIMA seasonal adjustment methods. Here we observed that X-12-ARIMA method returns lowest forecasting errors with compare to the forecasting errors obtains from MA, SARIMA and X-11 method. We also have observed the comparative line graph of forecasted values for original and forecasted values obtained from different seasonally adjusted method. From this graph we have also seen that forecasted values obtained from X-12-ARIMA method are closer to the original series in the graph.Finally we conclude that in case of export of jute goods which are affected by seasonality, X-12-ARIMA method performs better than all other methods. Thus, we are recommending touse X-12-ARIMA method to forecast published time series data of Bangladesh.

REFERENCES

Foldesi E, Bauer P, Horvath B and Urr B. 2007.Seasonal Adjustment Methods and Practices.A Journal of Hungarian Central Statistical Office.

Gomez V and Maravall A. 1996.Programs TRAMO (Time series Regression with ARIMA noise, Missing observations, and Outliers) and Seats (Signal Extraction in ARIMA Time Series). Instructions for the user, Working Paper 9628, Servicio de Estudios, Banco de Espana.

Gupta SC and Kapoor VK. 2015. Fundamentals of Applied Statistics, 3rd Edition. Sulatn Chand and Sons, New Delhi. P: 2.44

Lind DA, Marchal WG and Wathen SA. 2005. Statistical Techniques in Business & Economics; 12th Edition. McGraw-Hill.

Rahman M and Khaleda N. 2011.Global Market Opportunities in Export of Jute.Occasional Paper Vol93, P: 1.

Shcherbakov MV, Brebels A, Shcherbakova NL, Tyukov AP, Janovsky TA and Kamaev VA. 2013. A Survey of Forecast Error Measures, World Applied Science Journals,24: 171-175.