

**Problem Definition:**

Examination and comparison of Holts and Winters forecasting techniques for forecasting Southwest Airlines Quarterly Income from 1988 to 1999.

**Hypothesis –**

$H_0: p = 0$

$H_1: p \neq 0$

**Decision Rule –**

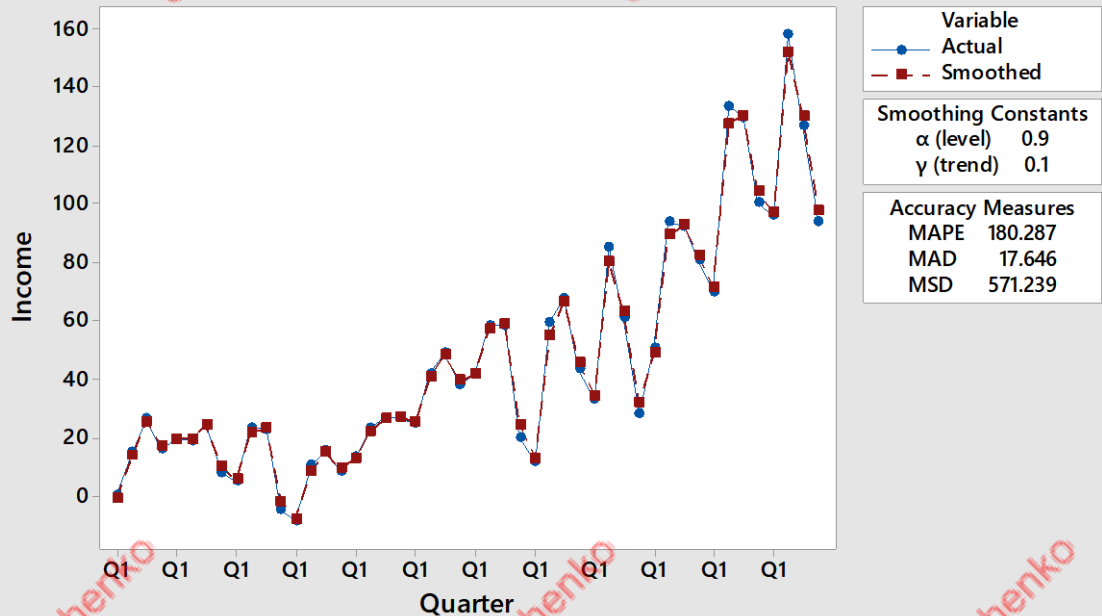
If  $t$  critical ratio less than -2.01174 or greater than 2.01174, reject null.  
If the LBQ exceeds 21.06261, reject null.

If chi-square exceeds 29.9562, reject null.

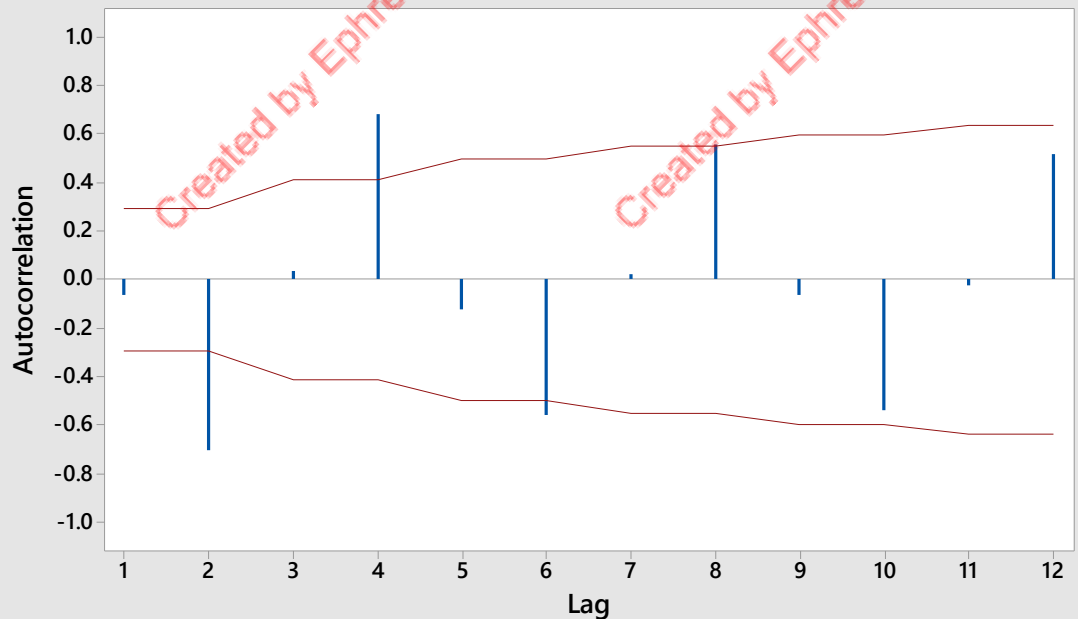
**Conclusion –** The  $t$  critical ratio is significant at lags 3, 5, 7, 9, 11, and 13. The LBQ of 124.15 exceeds 21.06261.

**Interpretation –** The time series plot and autocorrelating both show seasonality and a stationary time series. While the predicted fits line was close to the actual fits line, the autocorrelation shows significant seasonality and would recommend doing a Winters Multiplicative Smoothing Technique to deal with the seasonality and trend at the same time.

**Smoothing Plot for Income**  
Double Exponential Method



**Autocorrelation Function for RESI1**  
(with 5% significance limits for the autocorrelations)



Accuracy Measures		Autocorrelations			
		Lag	ACF	T	LBQ
MAPE	180.287	1	-0.063068	-0.44	0.20
		2	-0.703068	-4.85	25.99
MAD	17.646	3	0.034141	0.17	26.06
		4	0.679251	3.33	51.22
MSD	571.239	5	-0.118815	-0.48	52.01
		6	-0.556039	-2.24	69.68
		7	0.022786	0.08	69.71
		8	0.555604	2.04	88.23
		9	-0.060537	-0.20	88.45
		10	-0.533996	-1.81	106.46
		11	-0.023340	-0.07	106.50
		12	0.514567	1.63	124.15

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Airlines Quarterly Income from 1988 to 1999.

#### Hypothesis –

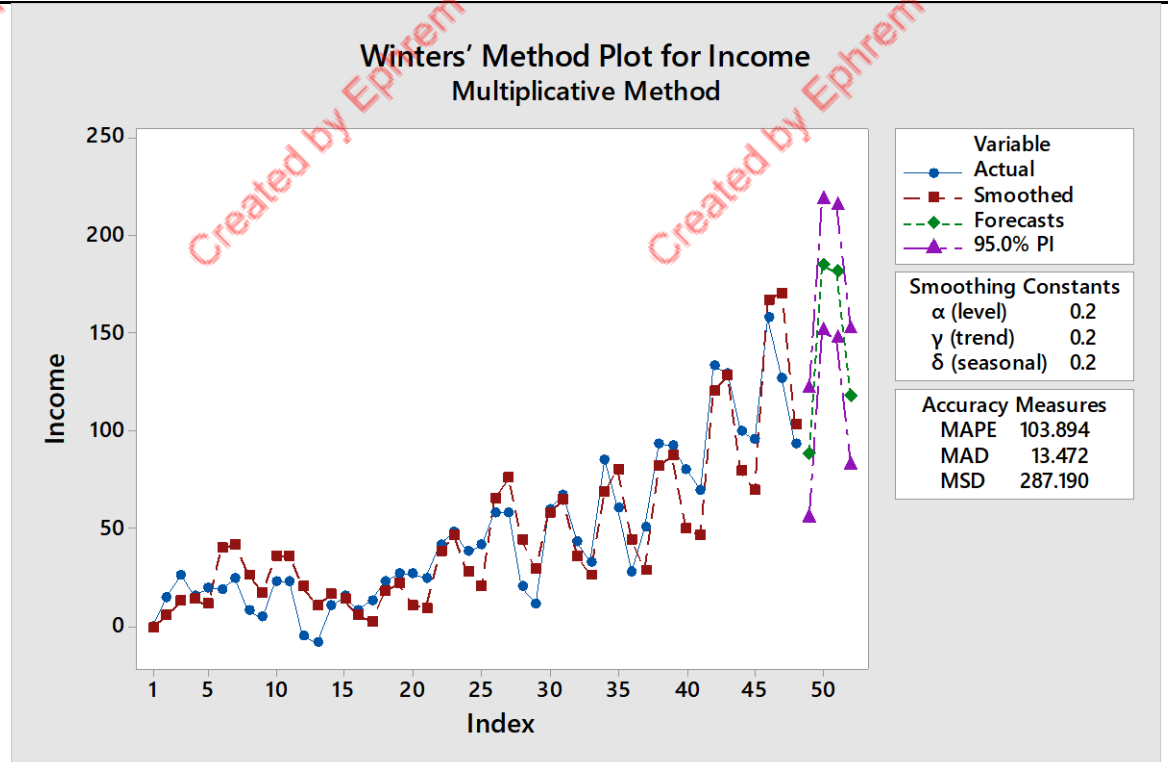
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**Decision Rule –** If t critical ratio less than - 2.01174 or greater than 2.01174, reject null.  
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**Conclusion –** After running Winters, we can



see that all the accuracy measures are better than the Holts method. Even though, the graph seems to be over and underestimating more than the Holts method plot, Winters MAPE of 103.894 is still lower than Holts MAPE of 180.287. This means Winters method is more accurate and deals with seasonality and trend a little better than the Holts method.

**Interpretation** – After reviewing the both plots and autocorrelation using the Holts and Winters method, we can safely recommend using the Winters method due to the accuracy measures all being lower than the Holts method. When comparing the accuracy measures, Winters mean absolute percentage error was 103.894 or 79.393 lower than the Holts MAPE. Winters mean absolute deviation was 13.472 or 4.174 lower, and Winters mean squared deviation was 287.19 or 284.049 lower than Holts MSD accuracy measure. Also looking at the forecasts, forecast 2 is more accurate due to using the Winters method.

### Accuracy Measures

MAPE	103.894
MAD	13.472
MSD	287.190

### Forecasts

Period	Forecast	Lower	Upper
49	88.960	55.954	121.966
50	184.811	151.288	218.334
51	181.464	147.364	215.564
52	117.985	83.252	152.718

### Data

Row	FORE1	FORE2
1	98.920	88.960
2	99.926	184.811
3	100.932	181.464
4	101.938	117.985

## Memo

**To:** Southwest Airlines Senior Management

**Re:** Forecast Errors of the Holts and Winters Methods

To Management Personal:

As per your request we have completed the requested forecast errors using Holts and Winters methods. Using the Holts technique we found that Southwest Airlines data mean absolute difference was \$17.64 million which indicates the forecast accuracy by averaging the magnitudes of the forecast errors and provides an average size of the “miss” regardless of direction. Also using the Holts technique we can see that Southwest Airlines mean absolute percentage error was 180.287 which is used to compare the accuracy of the same or different techniques of different series, keep this number in mind since it is vital to Southwest Airlines quarterly income accuracy. But using the Winters technique we saw that Southwest Airlines mean absolute difference had dropped to \$13.47 million which indicates a smaller value of error from the forecasted quarterly income that Southwest Airlines could potentially experience. The Winters technique also reveals a mean absolute percentage error of 103.89 which shows that using the Winters method is more accurate. We recommend that Southwest Airlines use the Winters technique and output for future business decisions due to its greater accuracy and better handling of seasonality and trend within the data.