# A comparison between a network of predictive values of the Linear General Trend model and the Holt - Winter models in analyzing the annual production level of live meat chickens for the period from 2014-2019 in Iraq

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**Abstract:** The research aims to conduct a time series analysis network using the general linear trend model and Holt - Winter models and diagnose and test the suitability of the models to find the best model that predicts the annual production quantities of live meat poultry product for the period from 2014-2019 by six annual observations and each observation consists of 12 A monthly sample and the results showed that the appropriate model was the multiplicative Winter model, and through this model, the annual production quantities were predicted monthly and for another two years, as the predictive values were consistent with the original series values and this is an indication of the efficiency of the model.



***Keywords:*** Holt - Winter models ،linear general trend model ،Minitab ،SPSS

## 1. Introduction

Most of the agricultural and animal production sectors in Iraq are witnessing a remarkable decline in production levels as a result of the conditions of government negligence and the absence of support in light of the policies of the governments that succeeded to rule in Iraq in the years after 2003 unbalanced. Among these sectors was the poultry sector, including the failure to provide poultry requirements of feed, equipment, vaccines, medicines, etc., as well as opening the door wide open to the foreign product to compete with Iraqi production in the local market, so from this point this study driven, to investigate the scientific statistical methods to be used with electronic packages and programs (SPSS and Minitab) in determining and monitoring production levels in rise and fall as well as forecasting by time series used in analyzing production data obtained by the researcher from the Ministry of Planning and Development Cooperation / Central

Statistical Organization and comparing predictive values as well as determining which of those models are highly significant in predicting production levels For the upcoming periods.

## 2. Aim of the Study

The aim of this research is to study the Time Series models, from which we aim to identify the best and most efficient statistical model that is used in forecasting the annual production quantities of poultry for the period 2020-2021 and to present a set of conclusions and recommendations to the concerned authorities in order to reconsider The production process and the development of a future policy that would promote better levels of production and fill the local need to reach self-sufficiency as well as export, which has another matter in supporting the national product and enriching sources of income and not relying on specific income.

## 3. Research problem

The general linear trend model and Holt- Winter models are models that depend on predicting the future values of the phenomenon under study, so the research problem lies in the following question:

Is the linear general trend model or Holt-Winter (additive or multiplicative) models best suited for forecasting?

## 4. Materials and Methods

The research methodology was adopted in reviewing the theoretical side of the general linear trend model and the Holt- Winter models, which are both the Winter multiplicative model and the winter additive model. This is supported by an application aspect based on real data on production obtained By the researcher from the official authorities represented by the Central Statistical Organization of the Ministry of Planning and Development Cooperation. On the practical side, highly efficient electronic statistical packages were used for the two programs (SPSS and Minitab) in data analysis.

## 5. Literature Review

In 1990, researcher Khandakar Quddrat – I Elahi used a linear general trend model to estimate growth rates in production, area and yield of agricultural crops on a large scale, where he built a model to estimate the general linear trend of grain production quantities, areas and yields of agricultural crops. The results showed a weakening of the general trend of wheat crop production, which is unacceptable due to the increase and growth of the population.

In 2015 researchers used Eke, Charles N. Egwim, Kenneth C. Igbo Celestine A. Onuoha, Petrinus E. C. A comparison between three models for the time series, which is the general linear trend model, the quadratic trend model, and the exponential trend model in analyzing the annual data of the gross domestic product of Nigeria, and it was found that the exponential trend model contains the lowest value for the MAPE scale, which made it the best model for data. Use it to forecast

the amount of GDP for the next five years.

In 2015 researchers Eimutis Valakevicius and Mindaugas Brazenas applied Holt-Winter additive and multiplier models in analyzing and predicting fluctuations in the euro (EUR) exchange rate against the US dollar (USD). He concluded that these models are suitable for time series with a linear trend and seasonal changes. The study has shown that the best method to predict volatility is a simplified version of the Holt-Winter multiplicative model.

In 2018, researcher Sebastian Reyalt Gnanapragasam used Holt-Winter models in comparison with Box-Jenkin's models in analyzing the number of foreign tourists arriving in Sri Lanka after the civil war. With little superiority to Box- Jenkin's models.

In 2020, the researcher Mrutyunjaya Panda used Holt - Winter models compared with ARIMA models in analyzing the numbers of people infected with covid-19 in India, and the results showed that the ARIMA model is the best model in prediction compared to Holt-Winter models

## 6. Time Series Concept (1)(2)(9)

The time series is defined as a number of observations recorded during successive and equal periods of time and describes a phenomenon or state of phenomena or economic, scientific or health conditions, or quantities of a specific product during a period of time. Also, the time series is consecutive time observations of the variable of the phenomenon under study and in All areas of financial, administrative, economic, health and other life. The analysis of the time series has a set of goals, the most important of which is prediction, as there are components and concepts related to the concept of the time series, which is the concept of the general trend of the time series, which is concerned with the fluctuations and changes that occur to the phenomenon, and it is either up or down associated with the time series data, here it reflects the general trend is the long-term changes in the chain that are based on a set of circumstances and factors, either political, social, economic or even political surrounding the circumstances of the phenomenon.

## 7. General Trend Model (3)(4)(8)

What is meant by the general trend is the tendency of the phenomenon under investigation towards increase or decrease over a period of time and it is linear and takes the following relationship:

$$Y_t = \beta_0 - \beta_1 t + e_t \dots\dots\dots (1)$$

Where $\beta_0, \beta_1$ represent the model parameters.

And the parameter $\beta_1$ represents the amount of change (if the sign is positive, then it means that it increases, and if it is negative, then it represents decrease) in the phenomenon $Y_t$ when the time changes by one unit of time.

$e_t$ represents the amount of random error at time $t$

Equation (1) represents the equation of the general linear trend of the first degree. If the general linear trend model is multiple, then the variables are taken and the equation takes the following form:

$$Y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + \cdots + \beta_n t^n \quad \text{.....(2)}$$

**8. Winter models (Holt- Winter model)(5)(6)(7)**

One of the data preamble methods is the Holt-Winter introduction method and is used in the case of a general trend or seasonal pattern in the behavior of the data and the model estimates three dynamic capabilities represented by seasonality, general trend and level, including the following models:

**8-1 Winters multiplicative model**

It is the appropriate method for forecasting in general for predicting time series and its compounds can be written as follows:

$$L_t = \alpha\,(Y_t / S_{t-p}) + (1-\alpha)[\,L_{t-1} + T_{t-1}]$$
$$T_t = \gamma[\,L_t - L_{t-1}] + (1-\gamma)T_{t-1}$$
$$S_t = \delta(\,Y_t/L_t) - (1-\delta)\,S_{t-p}$$
$$\widehat{Y_t} = (\,L_{t-1} - T_{t-1})S_{t-p}$$

Whereas:

$S_t$ seasonal

$L_t$ length of time series

$T_t$ Trend Linear Model

$(\alpha, \gamma, \beta)$ smoothing constant

**8-2 Winters Additive Model**

This method is also suitable and in general for predicting time series whose compounds can be written in the following form:

$$L_t = \alpha\,(Y_t - S_{t-p}) + (1-\alpha)[\,L_{t-1} + T_{t-1}]$$
$$T_t = \gamma[\,L_t - L_{t-1}] + (1-\gamma)T_{t-1}$$
$$S_t = \delta(\,Y_t - L_t) - (1-\delta)\,S_{t-p}$$
$$\widehat{Y_t} = L_{t-1} + T_{t-1} + S_{t-p}$$

This method is preferred when seasonal variations are constant along the time series. The Winter method uses the general direction vehicle, the plane and the seasonal vehicle at each point in time, and in particular, the model uses three weights to prepare for the data revision and through the use of the regression model over time as an independent variable, the initial values of the weights are determined, and the

determination of the values for the seasonal vehicle is done using variables. Phantom and a regression model estimation of series data from which the general trend component is removed.

## 9. Applied side

The analysis will be carried out for the actual data of the live meat chicken product, which the researcher obtained from the official authorities represented by the Central Bureau of Statistics, one of the Ministry of Planning and Development Cooperation formations, shown in Table No. (1), and using the statistical programs SPSS and Minitab, a general trend model will be built to predict the annual production quantities for the coming period. And building two Holt Winter models (aggregate and multiplier) with the calculation of the predictive values of the product for the next period with a comparison between the best of those models in explaining the phenomenon of production and predicting other productivity levels for the next two years.

## 10. General Trend Model

The general trend of the time series will be drawn and as shown in Fig.(1)

Table No. (1) Monthly production data for the period from 2014-2019 and per 1000 tons of live meat chicken

| year<br>Mon | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| **Jan** | 6.3 | 6.2 | 5.3 | 7.5 | 7.6 | 8.4 |
| **Feb** | 7.4 | 6.5 | 4.6 | 7.2 | 7.3 | 8.2 |
| **Mar** | 8.2 | 5.8 | 4.1 | 6.8 | 6.9 | 7.7 |
| **Apr** | 6.8 | 6.7 | 3.9 | 6.4 | 6.5 | 7.4 |
| **May** | 6.4 | 7.3 | 3.5 | 6.1 | 6.9 | 6.9 |
| **Jun** | 5.1 | 6.6 | 4.2 | 6.9 | 7.2 | 7.1 |
| **Jul** | 4.9 | 5.2 | 4.3 | 5.8 | 5.5 | 6.6 |
| **August** | 6.7 | 4.7 | 3.9 | 6.7 | 5.7 | 7.4 |
| **Sep** | 8.0 | 5.7 | 6.5 | 7.3 | 7.4 | 8.9 |
| **Oct** | 7.8 | 5.1 | 7.2 | 6.8 | 7.8 | 8.8 |
| **Nov** | 7.9 | 5.0 | 8.3 | 6.8 | 8.7 | 9.7 |
| **Dec** | 10.5 | 5.0 | 8.1 | 7.2 | 9.5 | 9.6 |

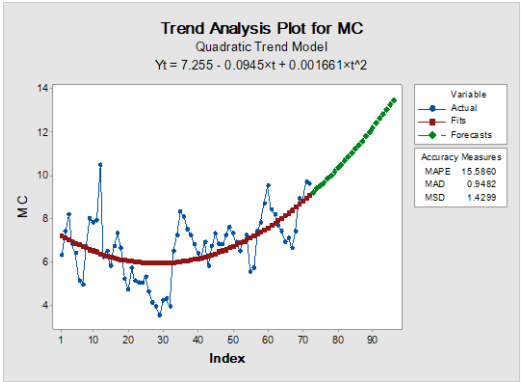


Fig. (1) shows a model of the general linear square trend of the annual production data of live meat chickens

product

Accuracy Measures

MAPE = 15.5860

MAD = 0.9482

MSD = 1.4299

The associated results were as follows:

**Method**

| | |
|---|---|
| **Model type** | **Quadratic Trend Model** |
| Data | MC |
| Length | 72 |
| NMissing | 0 |

The estimated general trend equation was as follows:

Fitted Trend Equation

$y_t = 7.255 - 0.0945\, t + 0.001661 t^2$

As for the predictive values of the linear general model, they were as follows:

Table No. (2) shows the predictions of the time series for the general linear model

| Period | Forecast | Period | Forecast |
|---|---|---|---|
| 73 | 9.2050 | 85 | 11.2194 |
| 74 | 9.3546 | 86 | 11.4089 |
| 75 | 9.5075 | 87 | 11.6017 |
| 76 | 9.6637 | 88 | 11.7978 |
| 77 | 9.8233 | 89 | 11.9972 |
| 78 | 9.9862 | 90 | 12.1999 |
| 79 | 10.1524 | 91 | 12.4060 |
| 80 | 10.3219 | 92 | 12.6154 |
| 81 | 10.4948 | 93 | 12.8281 |
| 82 | 10.6710 | 94 | 13.0441 |
| 83 | 10.8505 | 95 | 13.2635 |
| 84 | 11.0333 | 96 | 13.4862 |

## 11. Statistical analysis of the general trend model

The results of the general linear model indicate that an increase of one time unit leads to a decrease in the production quantity of the live meat poultry product by the value of the parameter $\beta_1$, which is (0.0945). As for

the quadratic effect, it indicates the opposite, that is, an increase of one time unit leads to an increase in the quantity of the product and by the value of the parameter $\beta_2$, whose value is (0.001661) .

The graph of the model shows the general trend for it and the original and concurrent data as well as the calculated values, predictive values and measures of efficiency, as the model indicates the existence of a general trend and the direction vehicle was not well matched, as is the case for the seasonal vehicle, so it is suggested to use another method to analyze the model data. And calculate better predictive values .

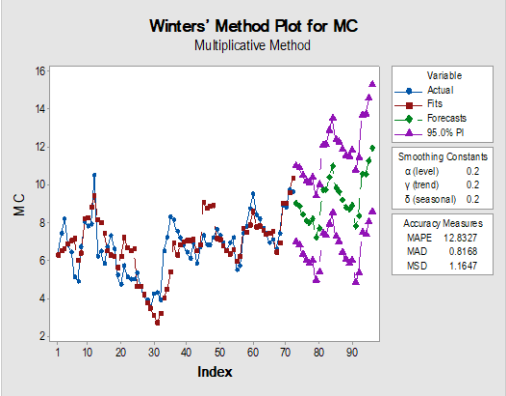


Fig. (2) illustrates the Winters multiplier model

Winters' Method for MC Method

| | |
|---|---|
| **Model type** | **Multiplicative Method** |
| **Data** | MC |
| **Length** | **72** |

**Smoothing Constants**

| | |
|---|---|
| α (level) | 0.2 |
| γ (trend) | 0.2 |
| δ (seasonal) | 0.2 |

## 12. Holt – Winter Models

### 12-1 Winters multiplicative model

The time series of the multiplexed Holt Winter model will be drawn and as in Fig. (2). The form of the spread of the annual production data per month for the live meat chicken product will be

drawn with the calculation of accuracy measures and priming constants as

follows:

**Accuracy Measures**

MAPE = 12.8327

MAD = 0.8168

MSD = 1.1647

As for the predictive values of the

Winter multiplicative, they are as

shown in the following table :

Table No. (2) shows the predictions of the time series for the multiplier Winter model

| Period | Forecast | Lower | Upper |
|---|---|---|---|
| 73 | 8.9815 | 6.98030 | 10.9826 |
| 74 | 8.8160 | 6.78350 | 10.8485 |
| 75 | 8.3921 | 6.32460 | 10.4595 |
| 76 | 8.0669 | 5.96100 | 10.1727 |
| 77 | 7.9533 | 5.80584 | 10.1008 |
| 78 | 8.1810 | 5.98888 | 10.3732 |
| 79 | 7.1643 | 4.92457 | 9.4040 |
| 80 | 7.6882 | 5.39826 | 9.9782 |
| 81 | 9.7305 | 7.38771 | 12.0732 |
| 82 | 9.7067 | 7.30885 | 12.1046 |
| 83 | 10.3805 | 7.92533 | 12.8357 |
| 84 | 10.9945 | 8.47987 | 13.5090 |
| 85 | 9.7976 | 7.22174 | 12.3735 |
| 86 | 9.6111 | 6.97219 | 12.2500 |
| 87 | 9.1433 | 6.43966 | 11.8469 |
| 88 | 8.7836 | 6.01375 | 11.5534 |
| 89 | 8.6548 | 5.81728 | 11.4923 |
| 90 | 8.8973 | 5.99083 | 11.8038 |
| 91 | 7.7870 | 4.81030 | 10.7637 |
| 92 | 8.3517 | 5.30361 | 11.3998 |
| 93 | 10.5642 | 7.44364 | 13.6847 |
| 94 | 10.5325 | 7.33855 | 13.7264 |
| 95 | 11.2574 | 7.98909 | 14.5257 |
| 96 | 11.9167 | 8.57315 | 15.2602 |

**13. Analyze the results the**

**Winter multiplicative model**

The results of the analysis show that he used the product model Winter to build the model and the smoothing constants were equal for all its components, amounting to 0.2, and the efficiency measures of the model were as follows (MAPE = 12.8327), (MAD =0.8168) and (MSD =1.1647) and that The lowest of those measures of the model indicates the significance and

preference of the model compared to others. Therefore, we tend to build the Winter additive model and compare it with the doubled model through the lowest value of efficiency measures to reach the best model that predicts the amount of annual production for the next period, and therefore decisions can be made regarding the phenomenon under consideration.

## 13-1 Additive Model Winters

The time series of Holt Winter additive model has been drawn and as in Fig. (3), and the form of the spread of annual production data per month for live meat poultry product is drawn with the calculation of accuracy measures and priming constants as follows:

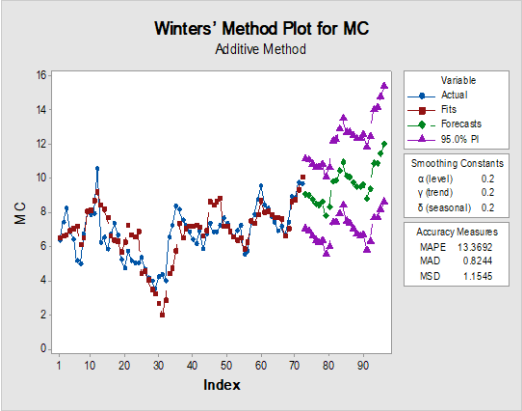


Fig. (3) the time series Winter Synthesis model

Winters' Method for MC

**Model type** **Additive Method**

**Data** MC

**Length** **72**

**Smoothing Constants**

α (level) 0.2

γ (trend) 0.2

δ (seasonal) 0.2

**Accuracy Measures**

MAPE = 13.3692

MAD = 0,8244

MSD= 1,1545

As for the predictive values of the

Winter Aggregation model, they are as

shown in the following table:

Table No. (3) shows the predictions of the time series for the Winter Aggregation model

| Period | Forecast | Lower | Upper |
|---|---|---|---|
| 73 | 9.0224 | 7.00256 | 11.0423 |
| 74 | 8.9514 | 6.89990 | 11.0029 |
| 75 | 8.6625 | 6.57572 | 10.7493 |
| 76 | 8.4295 | 6.30396 | 10.5550 |
| 77 | 8.3790 | 6.21151 | 10.5466 |
| 78 | 8.5344 | 6.32175 | 10.7470 |
| 79 | 7.7429 | 5.48227 | 10.0035 |
| 80 | 8.2568 | 5.94544 | 10.5681 |
| 81 | 9.7674 | 7.40280 | 12.1320 |
| 82 | 9.7884 | 7.36811 | 12.2086 |
| 83 | 10.3747 | 7.89660 | 12.8529 |
| 84 | 10.9020 | 8.36394 | 13.4401 |
| 85 | 10.0586 | 7.45873 | 12.6586 |
| 86 | 9.9876 | 7.32407 | 12.6512 |
| 87 | 9.6987 | 6.96987 | 12.4276 |
| 88 | 9.4657 | 6.67000 | 12.2614 |
| 89 | 9.4153 | 6.55128 | 12.2793 |
| 90 | 9.5706 | 6.63699 | 12.5043 |
| 91 | 8.7791 | 5.77463 | 11.7836 |
| 92 | 9.2930 | 6.21649 | 12.3696 |
| 93 | 10.8037 | 7.65401 | 13.9533 |
| 94 | 10.8246 | 7.60084 | 14.0484 |
| 95 | 11.4110 | 8.11214 | 14.7098 |
| 96 | 11.9382 | 8.56348 | 15.3130 |

**Statistical Analysis of the Winter additive model**

The results of the Winter additive model show that the model was used with equal priming constants and for all its components, with a value of (0.2), and the measures of the efficiency of the model reached (MAPE = 13.3692), (MAD = 0.8244) and (MSD =1.1545), which is somewhat higher than its predecessors in The multiplier model, so we must consider that the multiplier model was the most efficient and the highest significant model compared to the aggregate model and the general trend model by comparing models through measures of efficiency, and that the lowest amount of these measures is the most efficient model in predicting production levels for the coming years and considering the predicted values

They are the most acceptable values in making decisions regarding the phenomenon under consideration.

## 14. Analyze the results for a linear trend model

The results of the general linear model indicate that an increase of one time unit leads to a decrease in the production quantity of the live meat poultry product by the value of the parameter β_1 which is (0.0945). As for the quadratic effect, it indicates the opposite, that is, an increase of one time unit leads to an increase in the quantity of the product and by the value of the parameter β_2, whose value is (0.001661).

The graph of the model shows the general trend of it and the original and successful data, as well as the calculated values, predictive values, and efficiency measures that were very high, as the MAPE scale was equal to 15.5860 and the MAD scale was equal to 0.9482, while the MSD scale was its value equal to 1.4299, which is what It prompts us to build another time series model that has fewer and higher moral measures to be adopted in predicting production levels for the coming period, as the model indicates the presence of a general trend and the direction component has not been well matched, as is the case for the seasonal vehicle, so it is suggested to use another method to analyze the model data and Calculate better predictive values

## 15. Conclusions and Recommendations

1- The results of the general linear model indicated that an increase of one time unit leads to a decrease in the production quantity of live chickens by the value of the parameter $\beta_1$ , which is (0.0945). As for the quadratic effect, it indicates the opposite, that is, an increase of one time unit leads to an increase in the quantity of the product and by the value of the parameter $\beta_2$, whose value is (0.001661). This indicates that the general trend vehicle and the seasonal vehicle were not well matched, and the efficiency measures were high as their values reached respectively (MAPE = 15.5860 , MAD = 0.9482 and MSD = 1.4299). Therefore, the prediction values of this model cannot be used in making decisions related to this The studied phenomenon, and we aspire to build another model with fewer measures. The prediction values associated with the model are adopted in explaining the annual production phenomenon.

2- The results of the doubled model show that he used the product model Winter to build the model and the primer constants were equal for all its components, amounting to 0.2, and the efficiency measures of the model were as follows (MAPE = 12.8327,MAD =0.8168, and MSD =1.1647) And it is less if compared to the general trend model, which indicates a good acceptability of the model and its prediction values can be adopted in explaining the phenomenon of the annual production of live chickens in Iraq.

3- The results of the additive Winter model showed that the model was built with equal priming constants and all its

components, with a value of (0.2), and the measures of the efficiency of the model reached ( MAPE = 13.3692), (MAD = 0.8244) and (MSD =1.1545), which is somewhat higher. From its predecessors in the multiplier model, it is imperative that we consider that the multiplier model was the most efficient and the highest significant model compared to the aggregate model and the general trend model.

4- Through the values of the multiplier Winter model, the expected production quantities for the years 2020 and 2021 are shown and shown in the following table. It is noticed that there is an acceptable improvement in the level of production for the next two years, but with the growth of the population and the increase in the demand for the product locally, the study recommends the concerned authorities in the Ministry of Agriculture to work on Providing the necessary requirements and setting up the necessary plans that would raise the production ceiling as much as possible in order to meet the local need to reach self-sufficiency and export the surplus, which can be another source of income in addition to the sources of national income for the state.

Table No. (5) forecast of the annual production of live meat chicken product, monthly and for the years (2020-2021)

| Month | 2020 | 2021 | Month | 2020 | 2021 |
|---|---|---|---|---|---|
| **January** | 8.9815 | 9.7976 | **July** | 7.1643 | 7.7870 |
| **February** | 8.8160 | 9.6111 | **August** | 7.6882 | 8.3517 |
| **March** | 8.3921 | 9.1433 | **September** | 9.7305 | 10.5642 |
| **April** | 8.0669 | 8.7836 | **October** | 9.7067 | 10.5325 |
| **May** | 7.9533 | 8.6548 | **November** | 10.3805 | 11.2574 |
| **June** | 8.1810 | 8.8973 | **December** | 10.9945 | 11.9167 |

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