International Journal of
Research and Current Development
Available Online at http://www.journalijrcd.com
vol. 2, Issue, 4, pp.134-138, April, 2017

IJRCD

ISSN: XXX-XXXX

RESEARCH ARTICLE

USING A BINARY TRANSFER FUNCTION MODEL TO CONSTRUCT A STATISTICAL MODEL OF FATALITIES AND SEVERE TRAFFIC ACCIDENTS

Elnazeer Mohamed Elnoor Elobaid., Amal Alsir Alkhidir andObaid Mahmood Mohsin

Department of Microbiology, ShriSathyaSai Medical College & Research Institute, Thiruporur, Sri Balaji Vidyapeeth University, Tamil Nadu, India

ARTICLE INFO

Article History:

Received 5th January, 2016
Received in revised form 12th February, 2016
Accepted 16th March, 2017
Published online 28th April, 2017

Key words:

Transfer function model, Stationary, Box- Jenkins, Estimation, Cross-Correlation, Forecasting .

ABSTRACT

The transfer function models have an important role in multivariate time series analysis and it consider as one of the subjects that have an urgent application ,in the economic, social, industrial and other fields.

This study was applied on monthly data for the period (2011 to 2015) for time series representing death accidents and traffic damage using the descriptive approach to the realization of the hypotheses, we found that the two-time time series of traffic accidents are stationary, and we concluded that the estimated model of the conversion function is

y_t=(4.642-.208β)/(1+.419β+.986β^2@) β^2 xt+(1+2.216β+1.418β^2)/(1+1.8β)

Based on the criteria (RMSE, MAPE MAE, Normalized BIC), On the model, the traffic accidents occurring in the main roads were calculated.

INTRODUCTION

The planning process is one of the main factors in the development and progress of nations. Good planning depends on building the development programs on advanced scientific methods, especially recent statistics, including the use of time series in the analysis of phenomena in general. The general trend in research and economic studies And social and administrative is the use of means of statistical persuasion to identify the characteristics and highlight the general trends of phenomena, and statistics gives many methods and methods to carry out studies and research on the basis of the measurement of the movement of many of the variables identified Of the phenomena studied. Multivariate time series or transformational model models are among the most modern statistical methods that deal with the behavior of different phenomena by controlling the parameters of the model and constructing a statistical model to predict what will happen in the phenomenon. It helps the concerned parties and control by drawing up necessary and approved plans to preserve the safety of life and property. And human and economic development.

*✉ ***Corresponding author:*** **Elnazeer Mohamed Elnoor Elobaid**
Department of Microbiology, ShriSathyaSai Medical College & Research Institute, Thiruporur, Sri BalajiVidyapeeth University, Tamil Nadu, India

The problem of Research

Traffic accidents occurring in Sudan have become a major concern for all members of society and have become one of the most important problems that drain material resources and human resources and target societies in the most important elements of life, which is the human element in addition to any social and psychological problems and material losses.

The objective of Research

The purpose of using multivariate time series is to construct a statistical model of the conversion function to predict the traffic accidents occurring in the main and quick roads on a monthly basis and by controlling the parameters of the model, it is possible to plan the crisis to reduce the traffic accidents, thus benefiting the planning and economic development

Assumption of research

To achieve the objectives, the following assumptions must be made

1. The hypotheses of study are the following , bivariate time series traffic accidents in Sudan during the period(2011 to 2015) is non stationary .
2. Multivariate time series models (conversion function) are appropriate for the studied data and are characterized by a ticker

3 Two-dimensional conversion function models represent the appropriate model for describing the investigated variables.

Theoretical part

Concept of Transfer Function model

For many of the phenomena, it is necessary to use the conversion function. The dynamic descriptor of the dynamic relationship that links the input string to the output string is by constructing a dynamic model that converts the input series through a dynamic system to the output series, The input series is shown in the output series by the transfer function where this effect is distributed over future time periods.

Mathematical formulas for the conversion function model

The dynamic relationship between X_t and Y_t represented by the following conversion function models:

$$\begin{aligned} Y_t &= v_0 X_t + v_1 X_{t-1} + \ldots + v_k X_{t-k} + N_t \rightarrow (1) \\ &= (v_0 + v_1\beta + \ldots + v_K \beta^K) X_t + N_t \\ &= v(\beta) X_t + N_t \end{aligned}$$

Y_t :output series

X_t :In put series

N_t :The noise

K : The rank of the transformational function

v_K : The weights of the transformational function.

Steps to build a transformational function model

Determine the form of the model

Processing of the input and output series

This means making the necessary differences to stabilize the average and make the necessary transfers to stabilize the variance and remove any seasonal effect if any.

Pre-bleaching procedure for both the input and output sequence (Prewhitening)

Calculate the aut-correlations and (cross-covariance) of the inlet and outlet chains and the cross-correlation is equal to

$$c_{xy}(k) = \frac{1}{n}\sum_{t=1}^{n-k}(x_t - \bar{x})(y_{t+k} - \bar{y})$$

, $c_{xx}(0)$ $c_{yy}(0)$

$$r_{xy}(k) = \frac{c_{xy}(k)}{\sqrt{c_{xx}(0)c_{yy}(0)}} \rightarrow (3)$$

Direct estimation of transformer function weight

In this step the weights v_k are

estimated based on cross correlation values and are estimated as follows

$$v_k = r_{\alpha\beta}(k)\frac{\delta_\beta}{\delta_\alpha} \rightarrow (4)$$

Determination of Values r, s, b

Preliminary estimation of noise $n(t)$

The initial estimate of the noise is based on the following formula

$$\begin{aligned} n_t &= y_t - v(\beta)x_t \rightarrow (5) \\ &= y_t - v_0 x_t - v_1 x_{t-1} - \ldots - v_g x_{t-g} \end{aligned}$$

Determining the Arima model is appropriate for noise:

This is done on the basis of the criteria for selecting the best model

($R^2, RMSE, MAE, BIC$) where the model that has the largest value of the coefficient of determination and the lowest values for the other criteria is selected.

Estimating the parameters of the transformational function model

This includes estimating all parameters in model (2) using a marquard algorithm, for example.

Diagnostic test of the model

After determining the form of the transformational function model and estimating all its parameters, it must be tested for its validity and its use in prediction.

Predicting the use of the model of the forecasting function

After being sure that the model is appropriate and accurate in the previous step, this model can be used to predict x_t و y_t

There are criteria for testing the predictive accuracy of the conversion function model, which is the mean of MSE, MAE and MAPE. These criteria give preference to the model that gives the lowest value.

Mathematical formulas for these standards are as follows

$$MSE = \sum_{t=1}^{n}\frac{\left(y_t - \hat{y}_t\right)^2}{n} \rightarrow (24\text{-}2)$$

$$MAE = \sum_{t=1}^{n}\frac{\left|y_t - \hat{y}_t\right|}{n} \rightarrow (25\text{-}2)$$

$$MAPE = \sum_{t=1}^{n}\frac{\left|y_t - \hat{y}_t\right|}{y_t} / n \rightarrow (26\text{-}2)$$

The applied part

Data were analyzed according to the stages of building the transformational model using the Spss program as follows:

Stationary Test

Time series 〖Xt〗 for accidents Traffic death:

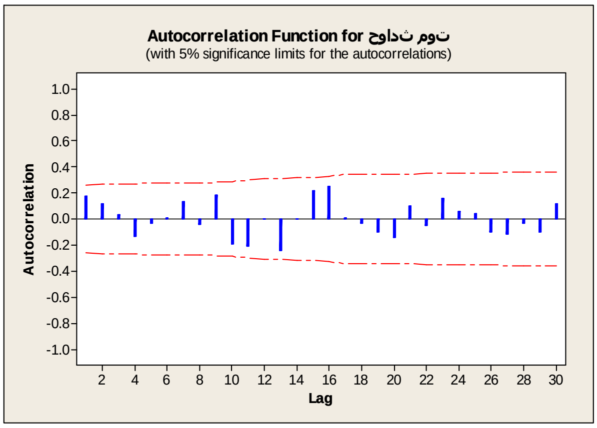

Figure 1 shows the coefficients of the auto correlation and confidence of the time series of death accidents on highways in Sudan ⟦Xt⟧

From the above figure we find that all the coefficients of auto-correlation are located within the confines of confidence indicating the silence of the time series of traffic accident data for the period (2011 to 2015).

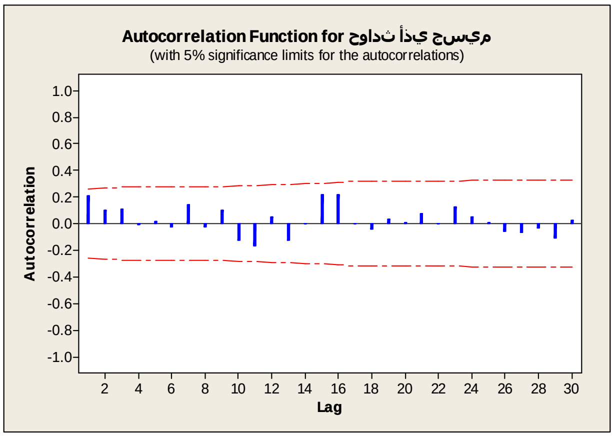

Figure 2 Shows the coefficients of the autocorrelation and confidence for the time series of traffic accidents in Sudan's highways

From the above figure we find that all self-correlation coefficients are located within the confines of confidence, indicating the time series of traffic accident data for the period from (2011 to 2015).

Table 1 Criteria for selecting the best Arima model

Normalized BIC	MAPE	MAE	RMSE	Model
10.719	162.018	128.406	191.964	X_t (1,0,1) Y_t
7.386	43.190	24.929	36.262	
10.805	162.080	128.053	193.677	(1,0,2) Y_t
7.468	42.566	24.825	36.502	
10.722	164.488	128.00	192.240	X_t (2,0,4) Y_t
7.383	41.282	24.802	36.204	
10.805	162.621	128.032	193.621	X_t (3,0,0) Y_t
7.469	36.526	24.813	36.526	
10.800	159.880	128.313	193.880	X_t (3,0,4) Y_t
7.469	42.882	24.805	36.525	
10.960	161.623	129.209	195.621	X_t (5,0,1) Y_t
7.585	41.025	24.810	36.157	
10.960	161.673	129.509	195.921	X_t (5,0,4) Y_t
7.685	41.325	24.832	36.457	

Diagnostic

From the table above, we see that the model (2,0,4) takes the lowest RMSE (MAPE MAE, Normalized BIC) for the time series, Y_t the Arima model suitable for the output series. (1.0.1) RMSE, MAE MAPE MAE, Normalized BIC) for the time series, X_t , the Arima model suitable for the input series, So we have pre whitening

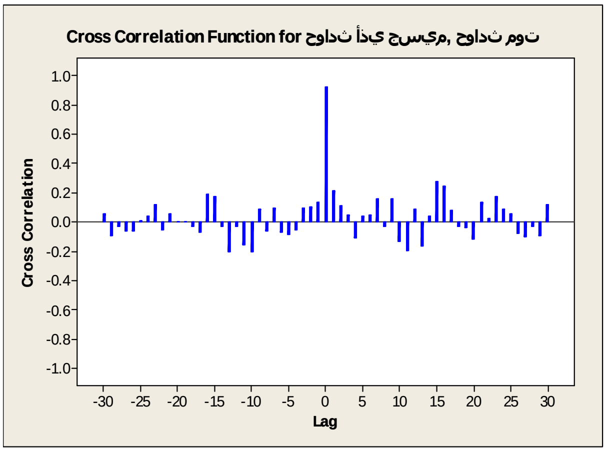

Figure 3 shows the calculation of intersecting links between the two series of death and serious injury incidents occurring in the main roads

The figure above shows the calculation of intersectal links between the two series of serious injury accidents occurring in the main roads in Sudan for the period 2011 to 2015.

Table 2 Shows cross-correlation values between the two series

Lag	Cross Correlation	Std. Error(a)	Lag	Cross Correlation	Std. Error(a)
-15	.207	.149	0	.941	.129
-14	-.035	.147	1	.256	.130
-13	-.179	.146	2	.111	.131
-12	-.091	.144	3	.016	.132
-11	-.152	.143	4	-.112	.134
-10	-.162	.141	5	.010	.135
-9	.094	.140	6	.059	.136
-8	-.004	.139	7	.192	.137
-7	.083	.137	8	.015	.139
-6	-.038	.136	9	.171	.140
-5	-.097	.135	10	-.151	.141
-4	-.062	.134	11	-.175	.143
-3	.058	.132	12	.028	.144
-2	.123	.131	13	-.156	.146
-1	.180	.130	14	-.017	.147

Direct estimation of transformer function weights based on cross correlation values

Table 3 The weights of the transformer function were estimated using equation as in the below

v_4	v_3	v_2	v_1	v_0	the weight
0.00	8.92	9.37	12.71	3.12	Weight value

Table 4 Values of model parameters of the conversion function

p- value	Z	Standard error	Estimated	Parameter
.832	-.214	4.38	-.610	constant
.000	-4.48	.386	-1.800	ϕ_1
.082	-1.69	.539	-2.58	ϕ_2
.692	-.264	.355	-.087	ϕ_3
.000	-14.75	.158	-2.216	$\theta 1$
.000	-5.116	.369	-1.418	θ_2
.247	-.953	.285	-.345	θ_3
.104	1.589	3.602	4.642	w_0
.006	2.73	.074	.208	w_1
.000	-12.05	.042	-.419	s_1
.000	-20.66	.043	-.986	s_2

From the above table, we note that the estimated parameters, less than Statistical significance level of 0.05 ($\phi_1, \theta_1, \theta_2, \delta_1, \delta_2$)which affect the model.
And applying this equation in the theoretical part

$$y_t = \frac{\omega(\beta)}{\delta(\beta)}\beta^b x_t + \frac{\theta(\beta)}{\phi(\beta)}a_t \rightarrow (3-2)$$

We obtain the estimated conversion function model as follows

$$y_t = \frac{4.642 - .208\beta}{1 + .419\beta + .986\beta^2}\beta^2 xt + \frac{1 + 2.216\beta + 1.418\beta^2}{1 + 1.8\beta}$$

Testing and evaluation of the estimated model
Examine the auto-correlations as small and random between e_t, α_t

Table 5 These correlations were examined using the Box-Luong test to make sure they were small and random. The results were as follows

.059	.013	-.068	-.024	.121	.019	-.013	autocorrelation α_t
.489	.448	.580	.571	.421	.951	.891	Box-Lounge (sig)
-.069	-.036	.057	-.032	-.003	-.094	.023	autocorrelation e_t
.731	.846	.78	.762	.642	.433	.762	Box-Luong (sig)

Table 6 The result was as shown in below

Sig	coefficient value correlation
.999	.000083

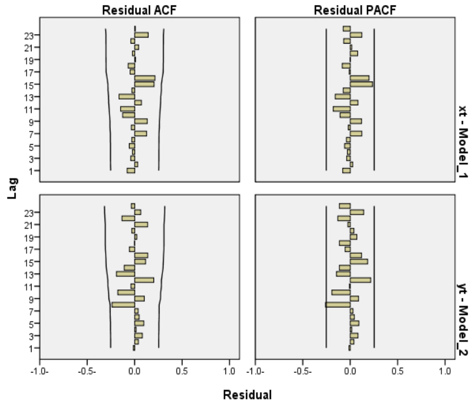

Figure (4)

From Table 5 and Figure 4 we observe that the coefficients of the auot-correlations are small and random for the two series, since the probabilistic values of the Box –Lounge test are not significant, indicating that they are small and random, and the graphs support this.

checking the insignificant correlation between the two series e_t, α_t

The values of cross-correlation coefficients were calculated between the two chains and the relationship between them was tested by Pearson test.
Note that the probability value is not significant, indicating the significance of the moral associations between the two series e_t, α_t .
We conclude from the result of test 1, 2, that the model of the estimated conversion function is the model that is appropriate for the study data and is accurate and predictable.

Forecasting of irrigated deaths for the period (2019-2020)

Forecast Death Accidents	Lower Death Accidents	Upper Death Accidents	Months and year
123.04394	59.107956	186.97991	JAN 2019
123.04393	59.107949	186.97991	FEB 2019
123.04392	59.107945	186.9799	MAR 2019
123.04392	59.107941	186.9799	APR 2019
123.04392	59.107939	186.9799	MAY 2019
123.04392	59.107937	186.97989	JUN 2019
123.04391	59.107936	186.97989	JUL 2019
123.04391	59.107935	186.97989	AUG 2019
123.04391	59.107934	186.97989	SEP 2019
123.04391	59.107934	186.97989	OCT 2019
123.04391	59.107934	186.97989	NOV 2019
123.04391	59.107933	186.97989	DEC 2019
123.04391	59.107933	186.97989	JAN 2020
123.04391	59.107933	186.97989	FEB 2020
123.04391	59.107933	186.97989	MAR 2020
123.04391	59.107933	186.97989	APR 2020
123.04391	59.107933	186.97989	MAY 2020
123.04391	59.107933	186.97989	JUN 2020
123.04391	59.107933	186.97989	JUL 2020
123.04391	59.107933	186.97989	AUG 2020
123.04391	59.107933	186.97989	SEP 2020
123.04391	59.107933	186.97989	OCT 2020
123.04391	59.107933	186.97989	NOV 2020
123.04391	59.107933	186.97989	DEC 2020

forcasting of Traffic Accidents for Serious Illness for the Period (2019-2020)

Forcasting Accidents of serious injury	lower of serious injury accidents	The upper limit of serious injury accidents	Months and year
507.73732	177.81913	837.65551	JAN 2019
507.7373	177.81911	837.65549	FEB 2019
507.73728	177.81909	837.65548	MAR 2019
507.73727	177.81908	837.65547	APR 2019
507.73727	177.81907	837.65546	MAY 2019
507.73726	177.81907	837.65545	JUN 2019
507.73726	177.81907	837.65545	JUL 2019
507.73726	177.81906	837.65545	AUG 2019
507.73725	177.81906	837.65545	SEP 2019
507.73725	177.81906	837.65545	OCT 2019
507.73725	177.81906	837.65544	NOV 2019
507.73725	177.81906	837.65544	DEC 2019
507.73725	177.81906	837.65544	JAN 2020
507.73725	177.81906	837.65544	FEB 2020
507.73725	177.81906	837.65544	MAR 2020
507.73725	177.81906	837.65544	APR 2020
507.73725	177.81906	837.65544	MAY 2020
507.73725	177.81906	837.65544	JUN 2020
507.73725	177.81906	837.65544	JUL 2020
507.73725	177.81906	837.65544	AUG 2020
507.73725	177.81906	837.65544	SEP 2020
507.73725	177.81906	837.65544	OCT 2020
507.73725	177.81906	837.65544	NOV 2020
507.73725	177.81906	837.65544	DEC 2020

Conclusions and Recommendations

CONCLUSIONS

1- Bivariate time series of traffic accidents (death, severe injury) is stationary .

2- Prewhitening time series are modeled with the ARMA model (1.0.1) because it is the appropriate model for these series.

3- The appropriate form of noise is ARMA (2,0.4).

4- 5. The model of the appropriate conversion function for the bivariate time series is

$$y_t = \frac{4.642 - .208\beta}{1 + .419\beta + .986\beta^2}\beta^2 xt + \frac{1 + 2.216\beta + 1.418\beta^2}{1 + 1.8\beta}$$

5 - The use of conversion function models give greater accuracy in the prediction.

Recommendations

1. Models of multivariate conversion function A reliable structured modeling and prediction system. The study recommends that it be used in multivariate time series analysis as it provides solutions and predictions close to reality during the forecast years.
2. Training the staff in the Department of Statistics and Planning on the use of modern software for forecasting and statistical analysis in accordance with modern methods.
3. The concerned parties in the field of traffic prevention must take into account the results reached for their use as auxiliary data in taking decisions and developing the necessary plans to reduce the aggravation of the phenomenon of traffic accidents in the country.
4. Develop integrated traffic awareness programs that harness all means of information and education in the country.
5. Taking care of the scientific studies and field research related to traffic accidents and using the results of these researches and studies when preparing plans.

References

1- Bartlett, M.S (1946), "On the Theoretical Specification of sampling properties of Autocorrelated time series " *J.of the Royal stat . Socity , Series* B,.

2- EudersW."Applied Econometrics Time series (2004), John Wiley & sons.

3- Box G.E.P & Jenkins, G, M. (1976). Time –series Analysis : Forecasting and control, Revised Holden – Day series .

4- A.Yaffee, Robert “Introduction to Time Series Analysis and Forecasting with Application of Sas and Spss “Stat University of New York Health Science.

5- John Wiley, Sons (2008) “Introduction to Time Series Analysis and Forecasting“, Technical University of Denmark.

6- Lukepoli, Helmut, (2005)” New Introduction to Multiple Time Series Analysis”, Springer Berlin Heidelberg, New York.

7- Richard a. Davis, Peter J. Brockweel (2006) “Time Series Theory and Method “, Second Edition, Springer Series in Statistics.

8- Seppo, P, (2003). Nonlinear Univariate and linear multivariate time Series, department of mathematics and statistic, University of Vaasa, United of America.