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Weakly Trends in Scalar Component Time Series

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Abstract

In this paper, a time series $\{X(t, \omega), t \in T\}$ on (Ω, C, P) is explained. Where X is a random variable (r. v.). X_{it} i = 1,2 are the area and production of total foodgrains of two component series. t is the time in(years) variable.

The properties of stationary time series with supporting real life examples have been taken. Area and production of total foodgrains data for 27 years from five districts of Marathwada region in Maharastra State were analyzed.

A preliminary discussion of properties of time series precedes the actual application to district-wise area and production of total foodgrains data.

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Introduction

Our aim here is to illustrate a few properties of stationary time series with supporting real life examples. Concepts of auto covariance and auto correlation are shown to be useful which can be easily introduced and conclusions have been drawn by testing methodology of hypothesis. In this article we have used area and production of total foodgrains data of 1970 to 1996 at five locations in Marathwada region to illustrate most of properties theoretically established.

Objectives of the Study

1. To develop theory of time series.
2. To develop algorithms for analyzing time series, and
3. To interpret the results of characterization in real social terms

Basic Concepts

Basic definitions and few properties of non-stationary time series are given in this section.

Definition 3.1: Probability space

A probability space is a triplet (Ω, C, P) where

1. Ω is a set of all possible results of an experiment;
2. C is class of subsets of Ω (called events) forming a σ- algebra, i.e.
   i) $\Omega \in C$,
   ii) $A \in C \Rightarrow A^c \in C$,
   iii) $\bigcup_{j=1}^{\infty} Aj \in C$, for any sequence $\{A1, A2, \ldots\} \subseteq C$;
3. P: $C \rightarrow [0, 1]$is a function which assigns to each event $A \in C$ a number $P(A) \in [0, 1]$, called the probability of A and such that
   i) $P(\Omega) = 1$,
   ii) If $\{Aj\}_{j=1}^{\infty}$ is a sequence of disjoint events, then $P(\bigcup_{j=1}^{\infty} Aj) = \sum_{j=1}^{\infty} P(Aj)$

Definition 3.2: A time series

Let (Ω, C, P) be a probability space let T be an index set. A real valued time series is a real valued function $X(t, \omega)$ defined on $T \times \Omega$ such that for each fixed $t \in T$, $X(t, \omega)$ is a random variable on (Ω, C, P).

The function $X(t, \omega)$ is written as $X(\omega)$ or X_t and a time series considered as a collection $\{X_t : t \in T\}$, of random variables [13].

Definition 3.3: Nontationary time series

A process whose probability structure change with time is called nonstationary. Broadly speaking a time series is said to be nonstationary, if there is systematic change in mean i.e. trend and there is systematic change in variance.

Definition 3.4: Strictly stationary time series

A time series is called strictly stationary, if their joint distribution function satisfies

$$F\,(X_{t1}\; X_{t2} \dots X_{tn}) = F\,(X_{t1}\; X_{2t} \dots X_{tn}) \quad \dots (1)$$

$$X_{t1}\; X_{t2} \dots X_{tn} \qquad X_{t1+h}\; X_{t2+h} \dots X_{tn+h}$$

Where, the equality must hold for all possible sets of indices t_i and $(t_i + h)$ in the index set. Further the joint distribution depends only on the distance h between the elements in the index set and not on their actual values.

Theorem 3.1: If $\{X_t: t \in T\}$, is strictly stationary with $E\{|X_t|\} < \alpha$ and

$E\{|X_t - \mu|\} < \beta$ then ,

$E(X_t) = E(X_{t+h})$, for all t, h} .... (2)

$E[(X_{t1} - \mu)(X_{t2} - \mu)] = E[(X_{t1+h} - \mu)(X_{t2+h} - \mu)]$, for all t_1, t_2, h

Proof: Proof follows from definition (3.4).

In usual cases above equation (2) is used to determine that a time series is stationary i.e. there is no trend.

Definition 3.5: Weakly stationary time series

A time series is called weakly stationary if

1. The expected value of X_t is a constant for all t.
2. The covariance matrix of $(X_{t1}, X_{t2}, \dots X_{tn})$ is same as covariance matrix of $(X_{t1+h}, X_{t2+h}, \dots X_{tn+h})$.

A look in the covariance matrix $(X_{t1}\, X_{t2} \dots X_{tn})$ would show that diagonal terms would contain terms covariance (X_{ti}, X_{ti}) which are essentially variances and off diagonal terms would contains terms like covariance (X_{ti}, X_{tj}). Hence, the definitions to follow assume importance. Since these involve elements from the same set $\{X_{ti}\}$, the variances and co- variances are called auto-variances and auto-co variances.

Definition 3.6: Auto-covariance function

The covariance between $\{X_t\}$ and $\{X_{t+h}\}$ separated by h time unit is called auto-covariance at lag h and is denoted by $\Upsilon(h)$.

$$\Upsilon(h) = Cov(X_t, X_{t+h}) = E\{X_t - \mu\}\{X_{t+h} - \mu\} \quad \dots (3)$$

The function $\Upsilon(h)$ is called the auto covariance function.

Definition 3.7: The auto correlation function

The correlation between observation which are separated by h time unit is called auto-correlation at lag h. It is given by

$$P(h) = \frac{E\{X_t - \mu\}\{X_{t+h} - \mu\}}{[E\{X_t - \mu\}^2 E\{X_{t+h} - \mu\}^2]^{½}} \quad \dots (4)$$

$$= \frac{\Upsilon(h)}{[E\{X_t - \mu\}^2 E\{X_{t+h} - \mu\}^2]^{½}}$$

where μ is mean.

Remark 3.1: For a stationary time series the variance at time (t + h) is same as that at time t. Thus, the auto correlation at lag h is

$$\rho(h) = \frac{\Upsilon(h)}{\Upsilon(0)} \quad \dots (5)$$

Remark 3.2: For h = 0, we get, $\rho(0) = 1$.

For application, attempts have been made to establish that area and production of total foodgrain at certain districts of Marathwada satisfy equation (1) and (5).

Theorem 3.2

If the time series $\{X_t: t \in T\}$, is weakly or covariance stationary then there exist function $\Upsilon: Z \rightarrow R$ such that

$Cov(X_t, X_{t+h}) = \Upsilon(h)$, $\forall$ t, t + h $\in$ T.

The function Υ is called the auto covariance function of the process $\{X_t: t \in T\}$ and

$\Upsilon(h)$, for given h, lag h auto covariance of the time series $\{X_t: t \in T\}$.

Proof: Let $r \in T$ any element of T. Since the time series $\{X_t: t \in T\}$ is weakly stationary, we have, for t, t + h $\in$ T such that $t \le t + h$,

$$Cov(X_r, X_{r+t+h-t}) = Cov(X_{r+t-r}, X_{r+t+h-t+t-r})$$
$$= Cov(X_t, X_{t+h}), \text{ if } t \ge r, \quad \dots (6)$$

$$Cov(X_t, X_{t+h}) = Cov(X_{t+r-t}, X_{t+h+r-t})$$
$$= Cov(X_r, X_{t+h-t+r}), \text{ if } t < r. \quad \dots (7)$$

Further, in case where $t > t + h$, we have

$$Cov(X_t, X_{t+h}) = Cov(X_{t+h}, X_t) = Cov(X_r, X_{t-(t+h)+r}). \quad \dots (8)$$

Thus, $Cov(X_t, X_{t+h}) = Cov(X_r, X_{r+|t+h-t|}) = \Upsilon(h)$.

Theorem 3.3: The covariance of a real valued stationary time series is an even function of h.

i. e. $\Upsilon(h) = \Upsilon(-h)$.

Proof: We assume that without loss of generality, $E\{X_t\} = 0$, then since the series is stationary we get , $E\{X_t X_{t+h}\} = \Upsilon(h)$, for all t and t + h contained in the index set. Therefore if we set $t_0 = t_1 - h$,

$$\Upsilon(h) = E\{X_{t0}\, X_{t0+h}\} = E\{X_{t1}\, X_{t1-h}\} = \Upsilon(-h) \quad \dots (9)$$

proved.

Theorem 3.4: Let X_t's be independently and identically distributed with $E(X_t) = \mu$ and $var(X_t) = \sigma^2$

then

$$\Upsilon(t, k) = E(X_t, X_k) = \sigma^2, \quad t = k$$
$$= 0, \quad t \neq k$$

This process is stationary in the strict sense.

Testing Procedure

3.1: Inference concerning slope (β_1)

We set up null hypothesis for test statistic **f**or testing H_0: $\beta_1 = 0$ Vs H_1: $\beta_1 > 0$ for $\alpha = 0.05$ percent level using t distribution with degrees of freedom is equal to n – 2 were considered.

$$t_{n-2} = (b - \beta)\{\sqrt{S_{tt}}\} / s_e ,$$

$$\text{Where,} \quad s_e^2 = \frac{S_{xx} - (S_{xt})^2 / S_{tt}}{n-2}$$

Example of Time Series

The area and production of total foodgrains data of five districts namely Aurangabad(ABD), Parbhani(PBN), Osmanabad(OSM), Beed(BED) and Nanded(NED) in Marathwada region were collected. The data were collected from Socio Economic Review and District Statistical Abstract; Directorate Economics and Statistics Government of Maharastra Bombay and Maharastra Quarterly Bulletin of Economics and Statistics; Directorate of Economics and Statistics Government of Maharastra, Bombay [2, 3]. Hence we have five dimensional time series t_i, i = 1, 2, 3, 4, 5 districts and whole Marathwada region respectively.

Over the years many scientists have analyzed rainfall, temperature, humidity, agricultural area, production and productivity of region of Maharastra state, [1, 4, 5, 6, 7, 8, 9, 10, 15]. Most of them have treated the time series for each of the revenue districts as independent time series and tried to examine the stability or non-stability depending upon series. Most of the times non- stability has been concluded, and hence possibly any sort of different treatment was possibility never thought of. In this investigation we treat the individual series. The method of testing intercept ($\beta_0 = 0$) and regression coefficient ($\beta_1 = 0$), Hooda R.P. [14] and for testing correlation coefficient Bhattacharya G.K. and Johanson R.A., [11]

The regression analysis tool provided in MS-Excel was used to compute β_0, β_1, corresponding SE, t-values for the coefficients in regression models. Results are reported in table 5.1B and table 5.2C. Elementary statistical analysis is reported in table–5.1A. It is evident from the values of CV that there is no any scatter of values around the mean indicating that all the series are having trend.

Table4.1B shows that the model,

$$X_t = \beta_0 + \beta_1 t + \epsilon,$$

when applied to the data indicates H_0: $\beta_1 = 0$ is stationary in Aurangabad and Beed districts. Hence X_t is not having trend in Aurangabad and Beed districts.

$$X_t = \beta_0 + \beta_1 t + \epsilon,$$

where,

1. X_{it} i= 1,2 are the area and production of total foodgrains series.
2. t is the time in(years) variable.
3. ε is a random error term normally distributed as mean 0 and variance σ^2 . X_t is the production of total foodgrain the dependent variable and time t in (years) is the independent variable.

Values of auto covariance computed for various values of h are given in table-4.2A. production of Total foodgrain values for different districts were input as a matrix to the software. Defining

$$A = y_1, y_2 \dots y_{n-h}$$

$$B = y_{h+0}, y_{h+1} \dots y_n$$

$\Upsilon(h)$ = cov(A, B) were computed for various values of h. Since the time series constituted of 27 values, at least 10 values were included in the computation. The relation between $\Upsilon(h)$ and h were examined using model, table-4.2C,

$$\Upsilon(h) = \beta_0 + \beta_1 h + \epsilon,$$

the testing shows that, both the hypothesis $\beta_0 = 0$ and $\beta_1 = 0$ test is positive for both the district. Table-4.2C was obtained by regressing values of $\Upsilon(h)$ and h, using “Data Analysis Tools” provided in MS Excel. Table 5.2A formed the input for table 5.2C. In other wards, Υ (h) are all non zero in two districts, in the area of jawar series of two districts trend were found showing that X_t, X_{t+h} are dependent in production of total foodgrain series of these districts and there is a trend in that series. Hence in these districts production of total foodgrain series X_t is not stationary it is having a trend.

Conclusion

In area series, the 2 series have been found significant. The districts ABD, PBN individually showed the variations are responsible for the non stationary nature of the series. Both the hypothesis $\beta_0 = 0$ and $\beta_1 = 0$ have been rejected. It is noted that a situation where the three scalar series are not having trends, except, two series ABD, PBN have not stationary status when ARMA is considered.

1. In production series,. The districts ABD, PBN individually identified that the variations are highly responsible for the non stationary nature of the series. For production of total foodgrains significant trend were found in Aurngabad and Parbhani districts. Osmanabad, Beed and Nanded district were stationary in area of total foodgrains i.e they were having weak trend time series in the production of total foodgrains.
2. In production series, all the 3 series have been showed significant. The district ABD, PBN and BED individually showed that the variation is totally responsible for the non stationary nature of the series.

Generally it is expected, the area and production of total foodgrains (annual) over a long period at any region to be not stationary time series. The result conforms with the series, in Aurangabad and Parbhani district simply. So rest of the 3 districts they have found stationary. The correlation coefficient (β_1) is significant between Υ and h with negative value showing that this Aurangabadand Parbhani district have been experiencing significantly declining production of total foodgrains over the past years.

Analysis: Area and production of total foodgrains data

The strategy of analyzing individual time series as scalar series has been adapted here for area and production data of total foodgrains

Production data of total foodgrains time series treated as scalar time series

Table 4.1 contains the results for scalar series approach.

The model considered was:

$$X_i(t) = (\beta_0)_i + (\beta_1)_i t + \epsilon_i(t), \quad i = 1, 2 \qquad \dots (10)$$

Where X_i is the annual area and production data of total foodgrains series, t is the time variable, β_0 = the intercept, β_1 = the slope, $€_i$ is the random error. area and production data of total foodgrains X is the dependent variable and time t in years is the independent variable.

Table-5.1: Area and Production (100 Tones Per Hector) Data of Total Foodgrains for Five Stations (Districts) In Marathwada Region

		Area of data of total foodgrains					Production of data of total foodgrains				
SrNo.	Dists → Yrs ↓	ABD	PBN	OSM	BED	NED	ABD	PBN	OSM	BED	NED
1	1970	10106	4429	8009	6703	4417	2725	1889	2021	2199	1132
2	1971	9837	6748	8162	7435	4626	5004	3730	5371	2588	2631
3	1972	8049	6315	7285	4566	4636	5897	4537	5935	4376	5074
4	1973	8240	6183	7662	5630	4701	5639	4436	7831	4457	3797
5	1974	9718	6769	9595	6584	4870	5953	5579	8434	4651	4769
6	1975	9897	7370	9316	6655	4917	5161	4017	5387	2910	2998
7	1976	9897	7370	9316	6655	4917	4181	4979	7137	3707	3319
8	1977	10285	7459	9364	6621	5168	5499	4099	6225	3374	5010
9	1978	10295	7459	9364	6621	5168	6681	3703	6253	3618	2178
10	1979	9957	7377	9523	6897	4980	4255	4363	6817	3495	4233
11	1980	10095	7449	9911	6713	4976	4000	3813	4680	2622	3434
12	1981	10053	7253	4973	7264	463	4268	3042	1748	2369	2096
13	1982	10753	6477	9879	7136	4914	7398	4870	7356	4684	4549
14	1983	10103	6367	9428	7140	4877	6378	3677	7574	3394	1722
15	1984	14061	6813	10087	6719	5030	8803	5460	4376	4752	5433
16	1985	11580	6953	9824	6619	5067	7815	5012	7383	4771	3938
17	1986	11526	6898	9982	6884	5116	4107	3537	2965	1949	2320
18	1987	11015	6745	8894	6982	4815	10532	7237	8830	5879	6206
19	1988	11299	6997	9253	7194	4740	10649	6546	8611	5504	5718
20	1989	12286	7534	9480	7192	4577	8415	5981	6076	3638	4880
21	1990	12286	7312	9473	7443	4652	7249	5789	8303	5693	3398
22	1991	12039	7276	9677	7385	4325	10574	6864	9861	5704	5511
23	1992	9501	6356	8496	6273	4138	5894	3867	3736	3088	2951
24	1993	11808	6991	9652	6491	4526	9266	5289	8755	4256	4250
25	1994	12200	7012	9664	7000	4734	9302	6253	8653	4755	4721
26	1995	11995	7111	9558	6548	4509	7869	5711	8393	5111	4038
27	1996	10994	6737	9577	6622	4465	8703	6455	6878	3281	3891

Table-5.1A Elementary statistics of area (100 hectors)and production (100 tones) data in five districts of Marathwada region for 27 years (1970-1996) of total foodgrains time series data

Cities:	Area of total foodgrains					Production of total foodgrains				
	ABD	PBN	OSM	BED	NED	ABD	PBN	OSM	BED	NED
Mean:	11076.7	7058.8	9548.4	6839.6	4570.5	6748.8	4842.0	6503.3	3956.5	3859.1
S.D.:	999.8	351.8	1040.9	327.0	849.5	2204.1	1258.0	2110.9	1117.2	1283.3
C.V.:	9.0	5.0	10.9	4.8	18.6	32.7	26.0	32.5	28.2	33.3

Table-5.1B: Linear Regression Analysis of Area and Production of Total Foodgrains Data To Determine Trend (Eq 10).

District		Area of total foodgrains				Production of total foodgrains			
		Coefficients	Standard Error	t Stat	Significance	Coefficients	Standard Error	t Stat	Significance
ABD	β_0	10656.67	399.92	26.65	S	4002.35	653.50	6.12	S
	β_1	30.00	24.96	1.20	NS	196.17	40.79	4.81*	S
PBN	β_0	7129.08	143.81	49.57	S	3437.94	405.63	8.48	S
	β_1	-5.02	8.98	-0.56	NS	100.29	25.32	3.96*	S
OSM	β_0	8759.40	388.29	22.56	S	5116.05	808.27	6.33	S
	β_1	56.35	24.24	2.33*	S	99.09	50.45	1.96	NS
BED	β_0	6926.02	133.08	52.05	S	3169.38	422.81	7.50	S
	β_1	-6.17	8.31	-0.74	NS	56.22	26.39	2.13*	S
NED	β_0	4634.78	349.14	13.27	S	3143.50	501.85	6.26	S
	β_1	-4.59	21.79	-0.21	NS	51.12	31.32	1.63	NS

t =2.04 is the critical value for 25 d f at 5% L. S. * shows the significant value

A look at the table 5.1A shows that all of them have distinct values of CV except Nanded. Which indicates that their dispersion is almost not identical? Trends were found to be significant in Nanded district. A simple look at the mean values shows that a classification as

C1 = { Aurangad},

C2 = {Parbhani, Osmanabad, Nanded, Beed }, could be quite feasible.

In absence of linear trend, with reasonably low CV values can be taken as evidence of series being stationary series individually in four districts.

Further search for evidences of stability included determination of auto covariance and their dependency on lag variable h (Table 5.2A). Such an analysis requires an assumption of AR(Auto-regressive) model [13] Eq(11). Therefore a real test for stationary property of the time series can come by way of establishing auto- covariance's which do not depend on the lag variable

$$X_t = C + \Phi X_{t-h} + \epsilon_t, \quad h = 0, 1, 2, \ldots 20 \qquad \ldots (11)$$

Table-5.2A: Auto Variances: Individual Column Treated As Ordinary Time Series For Lag Values (H = 0, 1, 2 … 20) About Area and Production of Total Foodgrains Data.

	Auto variance for Area of total foodgrains Series					Auto variance for Production of total foodgrains Series				
lag h	ABD	PBN	OSM	BED	NED	ABD	PBN	OSM	BED	NED
0	999698.2	123741.1	1083574.8	106956.8	721600.7	4858270.2	1582489.9	4456095.8	1248142.5	1646731.5
1	234653.9	61238.5	41518.6	23105.2	-41175.6	1920659.6	475623.3	-101085.5	69969.9	-276092.5
2	157973.2	12658.3	145579.6	162.3	-57178.6	1601517.2	479681.8	-124797.0	-122771.8	30577.2
3	-39569.4	-30158.9	-13162.7	2364.6	-134520.2	2358191.0	585832.6	802300.4	435936.5	378690.9
4	138790.1	-16098.1	47936.0	-10651.3	-153782.6	1896443.5	114509.5	-396475.0	-628.5	-360690.8
5	133422.2	-20511.8	-1695.0	-24441.6	-131959.4	1772796.2	338653.0	691218.2	106002.2	454347.7
6	130587.3	-43384.1	171647.1	-8490.6	-7292.6	2490287.1	331819.1	835673.1	340395.8	-329854.5
7	-99092.8	-58597.3	79017.6	27721.3	3818.7	1096668.2	228972.2	-1557021.6	-146727.6	74125.1
8	-685703.8	-41051.9	-3662.5	-867.7	32979.8	-328365.8	247409.0	337013.3	-72544.5	27356.0
9	-66935.1	3035.8	15764.8	-18338.1	3468.6	1472599.1	228188.5	-204943.2	-81275.8	-340091.5
10	-27715.5	23958.7	-82357.3	7663.3	74671.3	1107004.5	-2767.8	-870408.8	123270.0	294541.7
11	-23390.9	43097.1	373003.8	-34670.0	114170.5	812261.9	497795.7	2183377.4	223420.3	160870.9
12	-290291.0	33237.4	-9325.6	-32987.4	-6613.1	-68845.9	165369.4	-370400.0	-118284.1	188285.4
13	-243098.9	37461.5	19648.3	-20701.2	-76275.1	480287.9	297214.2	-1051271.1	39302.5	92656.9
14	-554184.4	10245.3	72064.8	-26588.3	-9970.8	-298160.8	206933.7	1012010.1	-173714.5	20637.2
15	-217985.1	-6526.9	164077.2	-2600.9	12779.4	210671.7	352430.5	444259.0	302960.6	493539.7
16	14645.1	-20232.5	64834.6	-17932.9	8752.5	1377148.2	242301.8	1172071.5	325906.9	284275.6
17	-79055.4	-51781.8	250545.0	-9958.9	83952.3	-571555.8	-195188.9	459323.9	-18028.7	-223149.2
18	-160605.1	-95057.6	95716.1	22766.6	-3886.9	-883506.5	-449576.3	-883011.6	618.1	-721838.6
19	14970.3	-106229.6	-164561.8	21068.8	-63700.5	233261.3	-180221.2	163876.6	-49854.2	17531.1
20	-21218.2	-76116.2	-379548.2	31070.8	-137700.0	208893.4	-15405.6	-88616.3	-637340.8	-66301.6

Table-5.2B: Correlation Coefficient between h and Auto covariance is:

	Area of total foodgrains					Production of total foodgrains				
Districts	ABD	PBN	OSM	BED	NED	ABD	PBN	OSM	BED	NED
Corr. Coeff.	-0.490*	-0.557*	-0.425	-0.235	-0.242	-0.772*	-0.697*	-0.254	-0.467*	-0.316

Correlation coefficient r = 0.433 is the critical value for 19 d f at 5% L. S. * shows the significant value.

Correlation's between Υ_{ij} (h) and h were found significant in area of ABD, and PBN districts showing that the time series can be reasonably assumed to be not stationary i.e. having trend. The coefficient is significant, with negative value showing that these four district have been experiencing significantly declining area of total foodgrains over the past years.

Correlation's between Υ_{ij} (h) and h were found significant in production of ABD PBN and BED district only showing that the time series can be reasonably assumed to be not stationary i.e. having trend. The coefficient is significant, with negative value showing that this district has been experiencing significantly declining production of total foodgrains over the past years.

Table-5.2C: Linear Regression Analysis of lag Values vs Covariance.

		Area of Total Foodgrains				Production of Total Foodgrains			
District	**Coefficients**		**Standard Error**	**t Stat**	**Significance**	**Coefficients**	**Standard Error**	**t Stat**	**Significance**
ABD	β_0	225215.6	122935.2	1.8	NS	2673722.81	361764.91	7.39	S
	β_1	-25779.2	10515.9	-2.5*	S	-163817.40	30945.33	-5.29*	S
PBN	β_0	38785.5	19639.6	2.0	NS	706761.74	122212.60	5.78	S
	β_1	-4912.2	1680.0	-2.9*	S	-44333.01	10454.05	-4.24*	S
OSM	β_0	280061.9	106287.0	2.6	S	850521.21	533424.92	1.59	NS
	β_1	-18622.3	9091.8	-2.0	NS	-52151.22	45629.11	-1.14	NS
BED	β_0	13537.5	13168.0	1.0	NS	351243.95	134928.77	2.60	S
	β_1	-1188.7	1126.4	-1.1	NS	-26577.94	11541.79	-2.30*	S
NED	β_0	80673.2	74928.7	1.1	NS	326532.40	192233.21	1.70	NS
	β_1	-6961.9	6409.4	-1.1	NS	-23862.06	16443.61	-1.45	NS

t =2.1 is the critical value for 19 d f at 5% L. S. * shows the significant value

Here the results have been drown in both the component time series. Significant trend were found in area of two district, Simply three districts OSM, BED and NED was stationary in area of total foodgrains i.e they were not having **trend** time series in the area of total foodgrains.

But in production of total foodgrains ABD PBN and BED districts arenotsttionary.

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