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RESEARCH ARTICLE

STATISTICAL MODELING IN AGRICULTURE FOR STRUCTURAL CHANGE

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ABSTRACT

A statistical model is assumed for testing the structural change in agricultural data in different time periods (2000-2007 and 2008-2015) and in different regions (states) using G.C.Chow test (1960) and Damodar Gujarati dummy variable approach (1970) to analyze the data relating to India ,Andhra Pradesh, Karnataka and Tamil Nadu. Chow test is general in nature, it merely tells whether the regressions are different or not without specifying whether the differences if any is due to difference in intercept terms or due to difference in the coefficients of particular explanatory variables. Dummy variable approach clearly explains the differences if any in intercept terms or in slope coefficients.

INTRODUCTION

The purpose of present study is not only to construct a test for structural change in Production of Principal Crops (PPC) but also to analyze the structural change in production of principal crops assuming PPC (Y) as dependent variable; area under cereals (X_1), area under pulses (X_2), area under oilseeds (X_3) and area under other crops (X_4) are as four independent variables. Relevant data is taken from Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare Government of India and presented in appendix.

Aim

To construct Chow test as well as dummy variable approach for testing the structural change involving four independent variables, two sets of observations; four independent variables, three sets of observations. And the same may be applied for testing the structural change in PPC during the two periods 2000 - 2007 and 2008 – 2015 for the data of India, Andhra Pradesh, Karnataka and Tamil Nadu. Also to test the structural change in PPC among three states Andhra Pradesh, Karnataka and Tamil Nadu during the period 2000 – 2015.

Chow test

To study the structural change between two sets of observations in the linear relationship between a dependent variable Y and a set of four independent variables X_1 , X_2 , X_3 and X_4, we make an attempt to develop Chow test statistic. Let n_1 be the number of observations on the variables. Suppose, further we obtain additional n_2 observations on the same variables. Denote n_1, n_2 as the number of observations in first and second sets of data respectively.

Let the relation between Y and X_1 , X_2 , X_3 , X_4 be

$$Y = \alpha + \beta X_1 + \gamma X_2 + \delta X_3 + \eta X_4 + \varepsilon \quad (1)$$

In particular this relation for the two sets namely first and second of data may be written respectively as

$$Y_{1j_1} = \alpha_1 + \beta_1 X_{1j_1} + \gamma_1 X_{2j_1} + \delta_1 X_{3j_1} + \eta_1 X_{4j_1} + \varepsilon_{1j_1},$$

$$j_1 = 1, 2, \ldots, n_1 \quad (2)$$

$$Y_{2j_2} = \alpha_2 + \beta_2 X_{1j_2} + \gamma_2 X_{2j_2} + \delta_2 X_{3j_2} + \eta_2 X_{4j_2} + \varepsilon_{2j_2},$$

$$j_2 = 1, 2, \ldots, n_2 \quad (3)$$

In equations (2) and (3) ε's are stochastic error terms. It is assumed that ε_2 has the same normal distribution as ε_1 with variance covariance matrix $\sigma^2 I$. Y_1 , Y_2 are first and second sets of observations respectively on dependent variable Y.

Given (2) and (3) we can think of the following possibilities regarding the coefficients.

i. $\alpha_1 = \alpha_2$; $\beta_1 = \beta_2$; $\gamma_1 = \gamma_2$; $\delta_1 = \delta_2$; $\eta_1 = \eta_2$ (4a)

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i.e., all the coefficients are same in the two regressions.

ii. $\alpha_1 \neq \alpha_2$; $\beta_1 = \beta_2$; $\gamma_1 = \gamma_2$; $\delta_1 = \delta_2$; $\eta_1 = \eta_2$ (4b)

i.e., the two regressions are different in intercepts only.

iii. $\alpha_1 = \alpha_2$; $\beta_1 \neq \beta_2$; $\gamma_1 = \gamma_2$; $\delta_1 = \delta_2$; $\eta_1 = \eta_2$ (4c)

i.e., the two regressions are different in X_1 coefficients only.

iv. $\alpha_1 \neq \alpha_2$; $\beta_1 \neq \beta_2$; $\gamma_1 \neq \gamma_2$; $\delta_1 \neq \delta_2$; $\eta_1 \neq \eta_2$ (4d)

i.e., the two regressions are different in all regression coefficients. In the similar fashion we may have different possibilities. To test whether the two regressions are different or not we can construct the Chow test procedure as follows.

i. Combine all the (n_1+n_2) observations and compute the OLS estimates of α, β, γ, δ and η from the combined regression equation (1). From this obtain the residual sum of squares S_1 with degrees of freedom (n_1+n_2-k), k is the number of parameters involved in the model. Here k=5.
ii. Run the regressions (2) and (3) separately and obtain the respective residual sum of squares say S_2 and S_3 with degrees of freedom n_1-k and n_2-k respectively. Add these two residual sum of squares and denote it as S_4.

i.e., $S_4 = S_2 + S_3$ with degrees of freedom (n_1+n_2-2k)

iii. Obtain $S_5 = S_1 - S_4$ with degrees of freedom k.

iv. Apply the F-test

$$F = \frac{S_5/k}{S_4/(n_1+n_2-2k)} \sim F_{(k,n_1+n_2-2k)} \quad (5)$$

If F-calculated value is greater than F-critical value, reject the hypothesis that the parameters α's, β's, γ's, δ's and η's are the same for two sets of observations, otherwise accept the hypothesis at required level of significance.

For three sets of observations Chow test may be constructed as follows. In addition to the equations (2) and (3) for two sets of observations of sizes n_1 and n_2, let us consider another equation (6) for third set of observations on the same variables of size n_3 as

$$Y_{3j_3} = \alpha_3 + \beta_3 X_{1j_3} + \gamma_3 X_{2j_3} + \delta_3 X_{3j_3} + \eta_3 X_{4j_3} + \varepsilon_{3j_3}, \; j_3 = 1, 2, \ldots, n_3 \quad (6)$$

Now given (2) , (3) and (6) we can think of the following possibilities regarding the coefficients.

i. $\alpha_1 = \alpha_2 = \alpha_3$; $\beta_1 = \beta_2 = \beta_3$; $\gamma_1 = \gamma_2 = \gamma_3$; $\delta_1 = \delta_2 = \delta_3$; $\eta_1 = \eta_2 = \eta_3$ (7a)

i.e., all the coefficients are same in the three regressions.

ii. $\alpha_1 \neq \alpha_2 \neq \alpha_3$; $\beta_1 = \beta_2 = \beta_3$; $\gamma_1 = \gamma_2 = \gamma_3$; $\delta_1 = \delta_2 = \delta_3$; $\eta_1 = \eta_2 = \eta_3$ (7b)

i.e., the three regressions are different in intercepts only.

iii. $\alpha_1 = \alpha_2 = \alpha_3$; $\beta_1 \neq \beta_2 \neq \beta_3$; $\gamma_1 = \gamma_2 = \gamma_3$; $\delta_1 = \delta_2 = \delta_3$; $\eta_1 = \eta_2 = \eta_3$ (7c)

i.e., the three regressions are different in X_1 coefficients only.

iv. $\alpha_1 \neq \alpha_2 \neq \alpha_3$; $\beta_1 \neq \beta_2 \neq \beta_3$; $\gamma_1 \neq \gamma_2 \neq \gamma_3$; $\delta_1 \neq \delta_2 \neq \delta_3$; $\eta_1 \neq \eta_2 \neq \eta_3$ (7d)

i.e., the three regressions are different in all regression coefficients. In the similar fashion we may have different possibilities. To test whether the three regressions are different or not we can construct the Chow test procedure as follows.

i. Combine all the $(n_1+n_2+n_3)$ observations and compute the OLS estimates of α, β, γ, δ and η from the combined regression equation (1). From this obtain the residual sum of squares S_1 with degrees of freedom $(n_1+n_2+n_3-k)$, k is the number of parameters involved in the model. Here k=5.
ii. Run the regressions (2), (3) and (6) separately and obtain the respective residual sum of squares say S_2, S_3 and S_4 with degrees of freedom n_1-k, n_2-k and n_3-k respectively. Add these three residual sum of squares and denote it as S_5.

i.e., $S_5 = S_2 + S_3 + S_4$ with degrees of freedom $(n_1+n_2+n_3-3k)$

iii. Obtain $S_6 = S_1 - S_5$ with degrees of freedom 2k.

iv. Apply the F-test

$$F = \frac{S_6/2k}{S_5/(n_1+n_2+n_3-3k)} \sim F_{(2k,n_1+n_2+n_3-3k)} \quad (8)$$

If F-calculated value is greater than F-critical value, reject the hypothesis that the parameters α's, β's, γ's, δ's and η's are the same for three sets of observations, otherwise accept the hypothesis at required level of significance.

In the similar lines we can construct the Chow test for any number of variables, any number of sets of observations. Chow test is general in nature, it merely tells whether the regressions are different or not without specifying whether the differences if any is due to difference in intercept terms or due to difference in the coefficients of particular explanatory variables.

Dummy variable approach:

It is assumed that PPC *(Y)* depends on area under cereals (X_1), area under pulses (X_2), area under oilseeds (X_3) and area under other crops (X_4). Also it is to be assumed that there is linear relationship between the dependent variable *Y* and the set of four independent variables X_1, X_2, X_3 and X_4. Let us assume that as the equation (1) represents the relation between dependent variable *Y* and independent variables X_1, X_2, X_3 and X_4 for the period 2000-2015, similarly equations (2) and (3) respectively represents the same relation for the time periods 2000-2007 and 2008-2015.To test the structural change in production of principal crops in the above said two selected time periods, we can write the regression equation using dummy variables by extending the procedure of Damodar Gujarati(1970) as given below

$$Y_i = a_0 + a_1 D_1 + a_2 X_{1i} + a_3 D_1 X_{1i} + a_4 X_{2i} + a_5 D_1 X_{2i} + a_6 X_{3i} + a_7 D_1 X_{3i} + a_8 X_{4i} + a_9 D_1 X_{4i} + \varepsilon_i, \quad i = 1, 2, 3, \ldots (n_1+n_2) \quad (9)$$

where

Y = Production of principal crops
X_1 = Area under cereals
X_2 = Area under pulses
X_3 = Area under oilseeds
X_4 = Area under other crops
D_1 = 1, if the observation belongs to the period 2008-2015
= 0, otherwise

a_0 : Intercept for set-1
a_1 : Differential intercept for set-2.
a_2, a_4, a_6, a_8 : Slope co-efficient of Y with respect to X_1, X_2, X_3, X_4 respectively for set-1.
a_3, a_5, a_7, a_9 : Differential slope co-efficient of Y with respect to X_1, X_2, X_3, X_4 respectively for set-2.

Note that set-1 and set-2 respectively refers to the data pertaining to the time periods 2000-2007 and 2008-2015.

From the above differential intercepts and differential slope coefficients we can easily obtain the actual values of intercept and slope coefficients for two sets as follows.

For set-1: $Y_1 = a_0 + a_2 x_1 + a_4 x_2 + a_6 x_3 + a_8 x_4$ (10)

For set-2: $Y_2 = (a_0+a_1) + (a_2+a_3) x_1 + (a_4+a_5) x_2 + (a_6+a_7) x_3 + (a_8+a_9) x_4$ (11)

To determine the equations (10) and (11), we need equation (9) which can be estimated by the method of ordinary least squares, provided of course the usual assumptions hold about the error term U_j namely.

$$E(U_j) = 0; E(U_jX_j) = 0 \text{ and}$$
$$E(U_j U_{j+k}) = \sigma^2 I \text{ for } k = 0$$
$$= 0 \text{ for } k \neq 0 \quad (12)$$

Depending up on the statistical significance of estimated differential intercepts and differential slope coefficients we can find out the structural change in production of principal crops in two different periods i.e., 2000-2007 and 2008-2015. In general we may develop dummy variable approach for testing the structural change for the given number of groups and variables.

To test for the structural change in production of principal crops in three southern states of India. i.e., Andhra Pradesh, Karnataka and Tamil Nadu during the period 2000-2015, we consider the same variables and same functional form between Y and X_1, X_2, X_3, X_4 as we considered in test for structural change in production of principal crops in two different time periods. Here the number of independent variables are four and the number of sets are three. For this purpose we consider the model represented in equation (1). If the data are divided in to three groups, we would like to find out whether equation (1) differs from group to group. Here the groups are southern states of India (Andhra Pradesh, Karnataka and Tamil Nadu respectively).

For this purpose here we assume equations (2),(3) and (6) as the models between the variables Y and X_1, X_2, X_3, X_4 for the states Andhra Pradesh, Karnataka and Tamil Nadu respectively. Our problem is to find out whether the regressions (2),(3) and (6) differ from one another. These equations might differ in a variety of ways. To test whether the three regressions (2), (3) and (6) differ from one another, we consider the following dummy variable approach (i.e., for four independent variables and three groups) as

$$Y_i = a_0 + a_1D_1 + a_2D_2 + a_3X_{1i} + a_4D_1X_{1i} + a_5D_2X_{1i} + a_6X_{2i} + a_7D_1X_{2i} + a_8D_2X_{2i} + a_9X_{3i} + a_{10}D_1X_{3i} + a_{11}D_2X_{3i} + a_{12}X_{4i} + a_{13}D_1X_{4i} + a_{14}D_2X_{4i} + \varepsilon_i$$
$$i = 1, 2, 3, \ldots (n_1+n_2+n_3) \quad (13)$$

Where

$D_1 = 1$, if the data belongs to Karnataka State
$= 0$, otherwise
$D_2 = 1$, if the data belongs to Tamil Nadu State
$= 0$, otherwise

Also a_i's entering into (13) are interpreted as follows:
a_0: Intercept for the model of Andhra Pradesh.
a_1, a_2 : Differential intercept for the models of Karnataka and Tamil Nadu respectively.
a_3, a_6, a_9, a_{12} : Slope coefficients of Y with respect to X_1, X_2, X_3, X_4 respectively for the state Andhra Pradesh.
a_4, a_7, a_{10}, a_{13} : Differential slope coefficients of Y with respect to X_1, X_2, X_3, X_4 respectively for the state Karnataka.
a_5, a_8, a_{11}, a_{14} : Differential slope coefficients of Y with respect to X_1, X_2, X_3, X_4 respectively for the state Tamil Nadu.
From the above differential intercepts and differential slope coefficients we can easily obtain the actual values of intercept and slope coefficients for three regions as follows.

For Andhra Pradesh state

$Y_1 = a_0 + a_3 x_1 + a_6 x_2 + a_9 x_3 + a_{12} x_4$ (14)

For Karnataka state

$Y_2 = (a_0+a_1) + (a_3+a_4) x_1 + (a_6+a_7) x_2 + (a_9+a_{10}) x_3 + (a_{12}+a_{13}) x_4$ (15)

For Tamil Nadu state

$Y_3 = (a_0+a_2) + (a_3+a_5) x_1 + (a_6+a_8) x_2 + (a_9+a_{11}) x_3 + (a_{12}+a_{14}) x_4$ (16)

To derive equations (14), (15) and (16) all we need is equation (13) which can be estimated by the method of ordinary least squares provided of course the usual assumptions hold about the error terms as given in (12). Now depending up on the statistical significance of estimated differential intercepts and differential slope coefficients we can find out the presence or absence of structural change in production of principal crops among the three states Andhra Pradesh, Karnataka and Tamil Nadu.

Empirical Study for structural change

In this section we can test the structural change in production of principal crops (i) in two selected periods namely 2000 – 2007and 2008 – 2015 for India, Andhra Pradesh, Karnataka and Tamil Nadu, (ii) in three selected states namely Andhra Pradesh, Karnataka and Tamil Nadu**.**

Chow test for two periods 2000-2007 and 2000-2015

For India

S_1= 1050391542.4858, S_2=52871675.5015, S_3= 64582256.82
S_4= 117453932.3205, S_5= 932937610.1652, F = 9.5316 Since F(5,6) at 1% = 8.75, we reject H_0 and conclude that there is structural change in the two periods.

For Andhra Pradesh State

S_1= 58886576.3932,S_2= 5411534.9787, S_3= 5655421.1906
S_4= 11066956.1694, S_5= 47819620.2238, F = *5.1851*

Since F(5,6) at 1% = 8.75, We accept H_0 and conclude that there is no structural change in the two periods.

For Karnataka State
S_1= 34959730.9640, S_2= 3632432.9487, S_3=2468292.6550
S_4=6100725.6037, S_5= 28859005.3603, F= 5.6765
Since F(5,6) at 1% = 8.75, We accept H_0 and conclude that there is no structural change in the two periods.

For Tamil Nadu State
S_1=14530305.2520, S_2=3397143.5056, S_3=7235482.0418
S_4=10632625.5474, S_5= 3897679.7046, F= 0.4399
Since F(5,6)at 1% =8.75, we accept H_0 and conclude that there is no structural change in the two periods.

Chow test for three states Andhra Pradesh, Karnataka and Tamil Nadu

S_1= 395577478.6446, S_2= 58886576.3932, S_3= 34959730.9640, S_4= 14530305.2520
S_5= 108376612.6092, S_6= 287200866.0354, F= 8.7451
Since F(10,33) at 5% = 2.13 , we reject H_0 and conclude that there is structural change among the three states.

Dummy variable approach for two periods 2000-2007 and 2008-2015

To test the structural change in production of principal crops in two selected periods, we can estimate the regression model (9) for India , Andhra Pradesh, Karnataka and Tamil Nadu and presented in tables (1),(2) , (3) and (4) respectively.

Table 1. India - Estimation of parameters

Variables	Parameters	Coefficients	Standard Error	t Stat	Pr > |t|
Intercept	a_0	-366753.0889	64723.9142	-5.6664	0.0013
D_1	a_1	24676.6581	168461.1120	0.1465	0.8883
X_1	a_2	3.9250	0.6848	5.7318	0.0012
D_1X_1	a_3	-2.7387	1.8489	-1.4813	0.1890
X_2	a_4	7.6012	1.8154	4.1871	0.0058
D_1X_2	a_5	-9.1715	2.3609	-3.8848	0.0081
X_3	a_6	0.8141	0.8935	0.9111	0.3974
D_1X_3	a_7	10.6346	2.7634	3.8484	0.0085
X_4	a_8	0.9742	2.2875	0.4259	0.6851
D_1X_4	a_9	10.6800	2.6150	4.0842	0.0065

Table 2. Andhra Pradesh: Estimation of parameters

Variables	Parameters	Coefficients	Standard Error	t Stat	Pr > |t|
Intercept	a_0	-41161.6607	22164.2339	-1.8571	0.1127
D_1	a_1	32589.6600	24886.4583	1.3095	0.2383
X_1	a_2	3.7284	1.1144	3.3459	0.0155
D_1X_1	a_3	-0.8854	2.0239	-0.4375	0.6771
X_2	a_4	9.0393	5.4026	1.6731	0.1453
D_1X_2	a_5	-5.8562	6.9505	-0.8425	0.4318
X_3	a_6	4.5010	2.3946	1.8796	0.1092
D_1X_3	a_7	-0.9995	3.4729	-0.2878	0.7832
X_4	a_8	7.0658	6.6612	1.0607	0.3296
D_1X_4	a_9	-7.0598	6.7060	-1.0528	0.3330

The individual estimated regression equations for the two time periods using the equations (10) and (11) may be written from each table (1),(2) , (3) and (4) for India, Andhra Pradesh ,Karnataka and Tamil Nadu respectively. Regarding India from table (1), it is observed that the differential slope coefficients a_5, a_7 , a_9 are significant at 1% level , hence we infer that there is structural change in PPC during 2008-2015 with respect to the variables area under pulses(X_2), area under oilseeds (X_3) and area under other crops(X_4).

Table 3. Karnataka: Estimation of parameters

Variables	Parameters	Coefficients	Standard Error	t Stat	Pr > |t|
Intercept	a_0	-33751.6536	9178.8062	-3.6771	0.0104
D_1	a_1	23882.0807	12689.7048	1.8820	0.1089
X_1	a_2	3.6748	2.2634	1.6236	0.1556
D_1X_1	a_3	-5.2692	2.6293	-2.0040	0.0919
X_2	a_4	1.7517	2.8400	0.6168	0.5600
D_1X_2	a_5	-0.0026	3.5661	-0.0007	0.9994
X_3	a_6	6.2878	2.7820	2.2601	0.0645
D_1X_3	a_7	0.3768	4.8263	0.0781	0.9403
X_4	a_8	9.2772	6.8612	1.3521	0.2251
D_1X_4	a_9	8.5475	11.6318	0.7348	0.4902

Table 4. Tamil Nadu: Estimation of parameters

Variables	Parameters	Coefficients	Standard Error	t Stat	Pr > |t|
Intercept	a_0	-5668.7173	7541.6393	-0.7517	0.4807
D_1	a_1	13312.5296	12173.4915	1.0936	0.3161
X_1	a_2	2.3937	5.7838	0.4139	0.6934
D_1X_1	a_3	-2.0784	6.0596	-0.3430	0.7433
X_2	a_4	7.1518	12.3572	0.5788	0.5838
D_1X_2	a_5	1.2799	14.0831	0.0909	0.9305
X_3	a_6	-2.8360	13.5165	-0.2098	0.8408
D_1X_3	a_7	0.9434	15.0139	0.0628	0.9519
X_4	a_8	11.4694	13.3775	0.8574	0.4242
D_1X_4	a_9	-20.5736	21.2040	-0.9703	0.3694

Regarding Andhra Pradesh, Karnataka and Tamil Nadu from tables (2), (3) and (4) respectively we observed that none of the differential intercepts and differential slope coefficients are significant. Hence we infer that there is no structural change in PPC between the two time periods 2000-2007 and 2008-2015.

Dummy variable approach for three states Andhra Pradesh, Karnataka and Tamil Nadu

To test the structural change in production of principal crops in three selected states Andhra Pradesh, Karnataka and Tamil Nadu during the period 2000-2015, we can estimate the regression model (13) and presented in table (5).

Table 5. Estimation of parameters

Variables	Parameters	Coefficients	Standard Error	t Stat	Pr > |t|
Intercept	a_0	-22145.4797	11972.6602	-1.8497	0.0733
D_1	a_1	2124.6617	15240.3743	0.1394	0.8900
D_2	a_2	19491.2337	12711.4251	1.5334	0.1347
X_1	a_3	4.8045	1.0385	4.6262	0.0001
D_1X_1	a_4	-4.0234	1.6920	-2.3778	0.0234
D_2X_1	a_5	-3.8426	2.1585	-1.7802	0.0843
X_2	a_6	7.1767	3.5235	2.0368	0.0498
D_1X_2	a_7	-1.1535	4.0463	-0.2851	0.7774
D_2X_2	a_8	-1.1578	6.6138	-0.1751	0.8621
X_3	a_9	0.5705	1.9170	0.2976	0.7679
D_1X_3	a_{10}	3.0745	3.1759	0.9681	0.3400
D_2X_3	a_{11}	-1.3480	3.3368	-0.4040	0.6888
X_4	a_{12}	0.0769	0.5899	0.1304	0.8970
D_1X_4	a_{13}	8.5733	6.8611	1.2496	0.2202
D_2X_4	a_{14}	11.5936	8.0738	1.4360	0.1604

The individual estimated regression equations for the three selected states using the equations (14), (15) and (16) may be written from Table (5). Form table (5), since the differential slope coefficient a_4 is significant at 5% level, we conclude that, there is structural change in production of principal crops in Karnataka with respect to the variable area under cereals (X_1).

Conclusion

In the present study Chow test is developed for testing the structural change involving four independent variables, two sets of observations and four independent variables, three sets of observations. The method of dummy variable approach is also developed and applied for testing the structural change in production of principal crops in two different time periods say 2000-2007 and 2008 – 2015, and also procedure for testing the structural change in production of principal crops in three states of India, i.e., Andhra Pradesh, Karnataka and Tamil Nadu during 2000 -2015 is developed and analyzed. Through Chow test we infer that there is structural in production of principal crops during the two periods 2000-2007 and 2008-2015 in India, but not in Andhra Pradesh, Karnataka and Tamil Nadu. Also during 2000-2015 there is structural change in production of principal crops among three states Andhra Pradesh, Karnataka Tamil Nadu. Using dummy variable approach it is observed that, regarding India, there is structural change during 2008-2015 with respect to the variables area under pulses, area under oilseeds and area under other crops. Regarding Andhra Pradesh, Karnataka and Tamil Nadu, there is no structural change in the production of principal crops in two different periods with respect to the study variables. Also during 2000-2015 there is structural in Karnataka with respect to the area under cereals.

REFERENCES

Chow, G.C. 1960. "Tests of equality between sets of coefficients in two linear regressions", Econometrica, 28,591-605.

Gregory C. Chow. 1983. "Econometrics", International Edition, McGraw Hill Book Company, SINGAPORE.

Gujarati, Damodar N. 1970a. Use of Dummy Variables in Testing for Equality between Sets of Coefficients in Two Linear Regressions: A Note", American Statistician, 24(1):50-52.

Gujarati, Damodar N. 1970b. Use of Dummy Variables in Testing for Equality between Sets of Coefficients in Two Linear Regressions: A Generalization", American Statistician, 24(5):18-22.

Reports from "Directorate of Economics and Statistics", Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare Government of India from 2000-2015.

Appendix

Abbreviations:

PPC: Production of principal crops in '000 Tonnes (Y)

AC: Area under cereals in '000 hectares (X_1)

AP: Area under pulses in '000 hectares (X_2)

AO: Area under oilseeds in '000 hectares (X_3)

AOC: Area under other crops in '000 hectares (X_4)

India						Andhra Pradesh					
year	PPC	AC	AP	AO	AOC	year	PPC	AC	AP	AO	AOC
2000	230511.6	101987.8	21116.0	24258.1	16767.9	2000	15078.9	5493.1	1644.9	2566.2	1422.6
2001	215253.7	100699.9	20348.1	22769.9	16709.2	2001	18540.1	5770.7	1902.2	2707.5	1395.1
2002	233513.5	100771.2	22008.4	22636.3	17461.7	2002	16449.5	5136.4	1920.0	2441.0	1483.8
2003	189609.8	93363.8	20496.2	21488.8	16192.8	2003	11909.9	4189.3	2099.9	2315.5	1197.8
2004	238375.7	99988.4	23458.1	23662.9	15461.1	2004	15311.1	4622.0	2185.0	2546.3	1164.0
2005	222716.3	97315.0	22763.0	27523.3	16213.2	2005	15605.4	4463.0	1803.8	2918.4	1494.0
2006	236579.5	99208.3	22391.3	27862.8	16609.2	2006	18992.0	5386.0	1781.7	2922.0	1363.0
2007	241571.5	100516.3	23191.7	26512.7	18112.3	2007	17591.0	5290.0	1984.0	2235.0	1360.0
2008	260530.3	100434.5	23633.0	26692.6	18292.7	2008	22693.0	5274.0	2113.0	2657.0	1495.0
2009	262185.1	100739.3	22094.2	27557.7	17518.5	2009	22610.1	5671.0	1771.0	2599.0	1669.0
2010	242989.0	98051.2	23282.4	25959.0	18012.3	2010	16795.0	4734.0	1932.0	2072.0	1671.0
2011	276970.8	100269.7	26401.7	27224.3	19759.9	2011	22310.6	5898.0	2131.8	2319.0	2121.0
2012	289121.9	100292.7	24462.2	26308.2	21095.7	2012	19627.8	5358.0	1931.0	1945.0	2135.0
2013	288065.0	97519.0	23257.0	26484.0	20902.7	2013	20314.2	5041.0	1949.0	1945.0	2626.0
2014	297793.0	99829.0	25211.0	28051.0	20786.5	2014	21550.8	5718.0	1972.0	2030.6	2599.0
2015	279351.0	98973.0	23098.0	25726.0	21490.8	2015	19799.0	6576.0	1367.0	1569.0	8412.0

Karnataka						Tamil Nadu					
year	PPC	AC	AP	AO	AOC	year	PPC	AC	AP	AO	AOC
2000	11052.1	5745.4	1920.5	1982.4	925.1	2000	10445.2	2968.0	860.4	998.8	494.9
2001	12527.7	5735.0	2046.7	1913.2	977.5	2001	10058.5	2812.9	687.9	839.4	485.4
2002	9716.6	5281.9	1893.1	1737.3	1022.9	2002	9044.9	2766.0	734.9	781.0	509.0
2003	7738.4	4963.7	2060.6	2005.3	781.6	2003	5202.1	2229.0	527.4	592.5	337.4
2004	7496.2	5007.4	1874.3	2267.4	568.2	2004	5370.2	2327.2	537.0	695.0	290.1
2005	12065.0	5457.0	2106.0	2674.0	703.4	2005	7236.9	2696.6	599.3	715.7	361.4
2006	15204.0	5615.0	1981.0	2857.0	636.2	2006	7280.1	2791.6	525.3	709.9	475.9
2007	10724.0	5077.0	2369.0	2354.0	704.0	2007	9346.5	2629.6	536.5	592.4	491.5
2008	13735.0	5488.0	2383.0	2276.0	711.0	2008	7729.0	2487.7	609.8	659.3	453.5
2009	12487.0	5374.0	2087.0	2178.0	692.0	2009	8145.3	2655.8	536.1	585.4	423.4
2010	11960.0	5476.0	2479.0	2001.0	796.0	2010	8451.0	2498.2	534.8	494.9	397.3
2011	15147.3	5447.1	2792.0	1624.0	972.0	2011	8528.0	2537.1	636.8	449.4	438.0
2012	13037.1	5122.0	2303.0	1416.0	986.0	2012	11265.5	2541.8	668.5	449.2	479.4
2013	11783.0	5030.0	2269.0	1422.0	910.0	2013	6409.9	2118.0	507.6	389.0	511.0
2014	14971.4	5040.0	2498.0	1410.0	1082.0	2014	9747.5	2623.7	815.8	408.2	465.3
2015	14514.0	7156.0	2286.0	1361.0	1275.0	2015	10786.3	3741.0	886.9	419.0	489.0

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