ISSN: 2319-6505

Available Online at http://journalijcar.org

International Journal of Current Advanced Research
Vol 5, Issue 4, pp 764-767, April 2016

International Journal of Current Advanced Research

ISSN: 2319 - 6475

RESEARCH ARTICLE

COMPOSITE INDEX OF AGRICULTURE PRODUCTIVITY USING APPLICATION OF PRINCIPLE COMPONENT ANALYSIS

Anil D Gotmare[1*] and Khot P.G.[2]

[1]Directorate of Economics and Statistics, Divisional Commissioner Office, Nagpur, Maharashtra, India
[2]Department of Statistics, RTM University, Nagpur, Maharashtra, India.

A R T I C L E I N F O

Article History:

Received 15th January, 2016
Received in revised form 21st February, 2016
Accepted 06th March, 2016
Published online 28th April, 2016

Key words:

PCA, composite Index, Eigen values, Eigen Vectors, weights.

A B S T R A C T

Principle component analysis is generally used for data reduction technique (1, 2), and play vital role if their exist multi-collinearity in a data set. Composite index can also developed using principle component analysis. In this Paper Composite Index for Block wise agriculture development of Nagpur district is constructed using PCA method.

INTRODUCTION

Analyzing multivariate structures requires techniques for reducing the many dimensions of a data set while keeping as much information as possible. Principle Component analysis is one often used method to obtain a new set of variables that contain maximum amount of variation in the underlying multivariate data set.

The method of Principle Component analysis was first described during the first decades of the 20th century (Jolliffe) 2002), for the purpose of explaning a maximum amount of total variation in a set of underlying variables through "Components" created by using correlation matrices.

Various authors computed composite index by using variety of methods. Narain *et al*. (1991) gave a composite index to measure socio-economic development for each state by using standardized variables (Z SCORE). The composite index was calculated as square root of sum of squared deviations from the best value for variables under study.

Narain *et al*. (2007) modified earlier index by weighing the deviations inversely proportional to coefficient of variation and evaluated the disparities in the level of development among various districts.

The level of socio-economic development was estimated for different states. Pajankar *et al* (2010) calculate the composite indices of development in respect of education development – elementary school education using Narain *et al* (1991) methodology. Raju *et al* (2008) made the index on educational development and highlight the interstate disparity in development of elementary school education.

The study used the method by accommodating expert driven weights in an equal weight in an equal weighing method. Nagar and Basu (2002) developed a composite index using the weights derived from Principle Component Analysis (PCA). The weights are derived objectively from correlation matrix.

The principle component variables are independent and uncorrelated. The objective of Principle component Analysis is to reduce the dimensionality of the data set but retain most of the original variability in the data.

DATA AND METHODOLOGY

Procedure of deriving principle components is based on computations of the covariance matrix of original data. Using the vector X with n random variables, the covariance matrix is given by E (XX') and denoted by $\sum$. The ijth element of $\sum$ is thus the covariance between variables i and j. Defining α' as a vector of weights for forming linear combinations of the original variables, gives the kth principle component by

$$\xi_k = \alpha'_k x$$

The varience of the new variable E ($\xi\xi'$) is equal to $\alpha' \sum \alpha$, and is to be maximized subject to the constraints that $\alpha' \alpha = 1$.

Maximizing the value of a function subject to a constraint is by using Lagrange multipliers, which is also the standard method for deriving principle components. Function to be maximized

$$\xi = \alpha' \sum \alpha - \lambda (\alpha' \alpha - 1)$$

Where λ is the lagrangian multiplier. Taking the first derivative of the above expression with respect to α gives a vector of partial derivatives defined as:

$\frac{\delta\xi}{\delta\alpha} = 2\sum \alpha - 2\lambda\alpha$, setting derivatives to zero yields,

$$(\sum - \lambda I_p)\,\alpha = 0$$

Where I_p is the pxp identity matrix. Λ is therefore an eigenvalues of the correlation matrix ∑, and α is the corresponding Eigen vector (Jolliffe, 2002).

To decide which of the n eigenvectors give maximum varience:

$$\alpha'\sum \alpha = a'\,\lambda\, a = \lambda a'a = \lambda$$

Since Var (α'x) = α'∑ α = λ the maximum varience is λ, the largest Eigen value of the matrix, and α is the corresponding Eigen vector.

The Principle component analysis was carried out using SPSS software. Higher values of the index indicate development in agriculture production. The index is computed as the weighted average of all the principle component variables using Eigen values as weights. Composite Index is computed as as,

$$I = = \frac{\sum_{i=1}^{n} Xi[\sum_{j=1}^{n} |\alpha ij|\lambda j]}{\sum_{i=1}^{n} [\sum_{j=1}^{n} |\alpha ij|\lambda j]}$$

Where I is the index, Xi is the ith Indicator; αij is the factor loading value of the ith variable on the jth factor; λj is the eigen value of the jth factor.

Raw data is converted into normalized form by using,

$$NVij = 1 - \frac{\{Best\ Xi - Observed\ Xij\}}{\{Best\ Xi - Worst\ Xi\}}$$

The best and the worst values in an indicator are identified. The best and the worst values will depend upon the nature of a particular indicator. In case of a positive indicator, the highest value will be treated as the best value and the lowest, will be considered as the worst value.

Similarly, if the indicator is negative in nature, then the lowest value will be considered as the best value and the highest, the worst value. Once the best and worst values are identified, the normalized values should be obtained in case of all the variables in computation of Agriculture Development Index. Normalized values always lie between 0 and 1.

RESULTS AND DISCUSSION

The Status of Agriculture production along with their ranks for all thirteen blocks of Nagpur district have been depicted in tabular form under different heads of development.

Status of Agriculture Production

The table 1 indicates the status and rank of agriculture production of Blocks of Nagpur district. The high production of Pulses is observed for Bhivapur block (14090 MT) followed by Umred, Katol, Kuhi blocks. Ramtek, Kampti, Hingna reported low production of pulses.

The high production of Cereals is observed in Mauda, Ramtek, Bhivapur, Parhivni blocks. Nagpur (Rural), Hingna, Kalmeshwar and Savner reported low production of Cereals.

Table 1 Status and Composite Index for Agriculture Production

blocks	Pulses	Cereals	Cotton	Oil Seed	Composite Index	Rank
Narkhed	8769	7611	6297	12089	1.07	Excellent
Katol	9917	10123	2103	13259	0.93	Excellent
Kalmeshwar	5469	5707	3068	5140	0.47	Good
Savner	5999	6428	4111	3201	0.47	Good
Parshivni	7870	20965	5667	4015	0.62	Good
Ramtek	2248	41866	460	893	-0.12	Poor
Mauda	6447	105498	0	6794	0.04	Poor
Kampti	4782	15515	198	7008	0.32	Poor
nargpur(R)	5010	3633	1399	7568	0.46	Poor
Hingna	3728	6387	3046	4164	0.35	Poor
Umrer	14090	10725	3138	9048	1.00	Excellent
Kuhi	9303	13272	0	12741	0.75	Excellent
Bhivapur	15199	23823	2202	12325	1.08	Excellent

Source: District Statistical Abstract, Nagpur.Directorate of Economics and Statistics, 2013-2014.

The high production of Cotton is observed in Narkhed, Parshivni, Kalmeshwar and Hingna blocks while low production of cotton is observed in Ramtek, Mauda, Kampti blocks. The high production of Oil seed is observed in Narkhed, Katol Kuhi and Bhivapur Blocks while low production of oil seed is observed in Ramtek, Savner, Parshivni and Hingna Blocks of Nagpur district.

Status of Agriculture Subsidiary Variables

The Table 2 indicates the status and rank of agriculture and subsidiary variables of blocks of Nagpur district. High use of electricity for agriculture is observed in Kuhi, Ramtek blocks while low use of electricity is observed at Parshivni, Mauda and Kampti block.

Total irrigation area. More number of wells is observed in Narkhed and Katol blocks, these two blocks are the major orange growing area of Nagpur district with a growing irrigation facilities of while less number of wells observed in Parshivni, Ramtek, Mauda, Nagpur rural and Kampti blocks of district. High number of agriculture pumpsets is observed in Narkhed, Katol kuhi and Kalmeshwar blocks of district while low number of pumpsets observed in Parshivni, Ramtek, Kampti, and Nagpur rural of the district.

Status of Demographic Indicators

The table 3 indicates the status and rank of demographic indicators of blocks of Nagpur district. Percentage of below poverty line is more in Narkhed and Katol Block as compared with other blocks of the district. Blocks Savner, Mauda, Kampti, Nagpur (LRural) having high population density this may attributed due to nearby distance from Nagpur city. Main and marginal workers are more in Nagpur rural and Hingna blocks of district, both of these blocks are nearby Nagpur city and having Maharashtra Industrial Corporation Area. Due to urbanization of Nagpur rural, Kampti and Hingna blocks, Decennial population growth rate is maximum in blocks Nagpur (Rural), Kampti, Hingna 51.6%, 14.3%, 30.8% respectively as compared to other blocks of the district. Total Urban population to total population is maximum in blocks Nagpur (Rural), Kampti, Hingna 50.9%, 59.8% and 50.0% respectively as compared to other blocks of the district. [Selected Block Indicators, 2013-14, Directorate of Economics and Statistics]. These blocks having higher literacy level.

Table 2 Status and Composite Index for Agriculture Subsidiary Variables

blocks	Electricity use for agriculture	Total eographic area	Total Irrigation Area	Use Of fertilizer	Irrigation wells	Agriculture pumpsets	Composite Index	Rank
Narkhed	4136	76825	48424	13079.6	14175	15214	0.90	Excellent
Katol	2445	84182	50575	13147.1	14157	10186	0.83	Excellent
Kalmeshwar	2038	54345	31450	11972.4	6517	8632	0.31	Good
Savner	1689	61859	38566	15504.4	5454	4775	0.35	Good
Parshivni	772	78694	33722	15102.6	1322	2044	0.13	Poor
Ramtek	2467	114290	26878	12178.9	1239	3986	0.18	Poor
Mauda	289	61287	49953	28937.9	1266	5410	0.29	Poor
Kampti	136	42382	26483	11220.1	2265	1680	0.0004	Poor
nargpur(R)	1063	61979	28598	12528.5	2044	3236	0.09	Poor
Hingna	1288	78564	35437	10939.8	4187	6408	0.26	Poor
Umrer	1042	97910	45649	13438.5	3591	3675	0.37	Excellent
Kuhi	3059	82948	50369	16324.3	7302	7422	0.63	Excellent
Bhivapur	1665	70197	36631	11556	4040	4151	0.28	Good

Source: District Statistical Abstract, Nagpur.Directorate of Economics and Statistics, 2013-2014.

Table 3 Status and Composite Index for Demographic indicators

Blocks	Below Poverty Level (%)	Population Density	Main & Marginal Workers	Total Literacy (%)	Composite Index	Rank
Narkhed	50.7	167	75257	83.8	0.89	Excellent
Katol	57	134	79474	84.5	0.83	Excellent
Kalmeshwar	32.1	175	56944	85.5	0.31	Good
Savner	30.3	201	98210	85.2	0.35	Good
Parshivni	29.9	104	63140	81.6	0.13	Poor
Ramtek	44	117	76250	80.2	0.18	Poor
Mauda	35.5	206	72761	82.5	0.29	Poor
Kampti	38.4	267	97069	87.6	0.0004	Poor
nargpur(R)	30	233	118342	89.3	0.09	Poor
Hingna	26.7	155	100616	87.2	0.26	Poor
Umrer	31.7	93	71434	83.3	0.37	Good
Kuhi	41.3	151	70436	78.3	0.63	Good
Bhivapur	36.6	133	44856	78.8	0.28	Poor

Source: District Statistical Abstract, Nagpur.Directorate of Economics and Statistics, 2013-2014.

Table 4 Factor loadings and Eigen values and weights of Agriculture productivity Index, Agriculture subsidiary parameter index and demographic Index

Agriculture Index				
Component			Weights	Eigen Value
Pulses	0.867	0.320	1.86	
Cereals	-0.487	0.675	-1.29	λ1=1.844
Cotton	0.428	-0.749	1.18	λ2=1.325
Oil Seed	0.820	0.453	1.72	

Table 5

Agriculture Subsidiary Parameter Index					
Component				Weights	Eigen Value
Electricity Use	0.857	-0.139	0.368	2.84	
Total Geographic Area	0.078	-0.009	0.992	1.23	λ1=3.115
Total Irrigation Area	0.563	0.750	0.166	3.03	λ2=1.472
Use of Fertilizer	-0.184	0.943	-0.105	0.71	λ3=1.010
No of Irrigation Wells	0.971	0.015	-0.019	3.03	
No of Agriculture Pumpsets	0.957	0.126	0.006	3.17	

Table 6

Demographic Index Eigen Value			
Component		Weights	
Below Poverty Line	-0.372	-0.37	
Population Density	0.812	1.96	λ1=2.417
Main & Marginal Worker	0.888	2.15	
Total Literacy	0.912	2.20	

Table 7

Composite Index			
		Weights	Eigen Value
Agriculture Index	0.843	1.58	
Agriculture Subsidiary Parameter Index	0.840	1.58	λ1=1.880
Demographic Index	-0.680	-1.28	

Table 8 Blockwise Ranking of API, ASPI, DI and Composite Index

Blocks	Agriculture Productivity Index	Rank	Agriculture Subsidiary Parameters Index	Rank	Demo graphic Index	Rank	Composite Index of Agriculture Productivity	Rank
Narkhed	1.07	2	0.89	1	0.45	7	1.33	1
Katol	0.93	4	0.83	2	0.41	8	1.19	2
Kalmeshwar	0.47	7	0.31	6	0.49	6	0.32	7
Savner	0.47	8	0.35	5	0.76	3	0.17	8
Parshivni	0.62	6	0.13	11	0.23	11	0.47	6
Ramtek	-0.12	13	0.18	10	0.24	10	-0.12	11
Mauda	0.044	12	0.29	7	0.52	5	-0.067	10
Kampti	0.32	11	0.004	13	0.95	2	-0.38	13
Nagpur(R)	0.46	9	0.089	12	1.09	1	-0.27	12
Hingna	0.35	10	0.26	9	0.76	4	-0.005	9
Umred	1.00	3	0.37	4	0.31	9	0.93	5
Kuhi	0.75	5	0.63	3	0.22	12	1.01	4
Bhivapur	1.08	1	0.28	8	0.074	13	1.09	3

CONCLUSION

Eastern part of Nagpur district mainly Narkhed, Katol blocks and southern part district which includes Bhivapur Kuhi and Umred are agriculturally developed blocks. Major production of these blocks is oil seeds and pulses production with rank 1-5 respectively. Central part of district mainly Parshivni, Kalmeshwar, Savner, and Hingna are moderately developed in terms of agriculture development. Pulses, Cereals, Cotton and Oil seed production are equally produce in this region with rank 6-9 respectively. Western part of Nagpur district which includes Mauda, Ramtek, Kampti and central Nagpur blocks are poorly developed in terms of agriculture development with rank 10-13. Less number of irrigation wells and agriculture pump sets is reported in these blocks, Moreover growing urbanization is main concern of these blocks for poor development of agriculture. Hence, Intensive agriculture development programme needs to address in the region of Ramtek, Mauda, Kampti, Nagpur (Rural) and Hingna blocks of Nagpur district. Production of Cotton is least in this area as compared to cereals, pulses and oil seeds.

References

1. Narain P., Rai S.C. and Shanti Swarup (1991), Statistical Evaluation of development on Socio-economic front *J. Ind. Soc. Agril*. Statist, 43, 329-345.
2. Narain, P, Sharma S.D., Rai S.C. Bhatia, V.K. (2007), Statistical Evaluation of Socio-Economic development of different States in India. *J. Ind. Soc. Agril.* Statist, 61(3), 328-335.
3. Pajankar V.D.,Khot P.G. Pranali (2010), Statistical Measurement of educational development of school education at state level., Educational Research and Reviews, Vol 5(7), pp 362-365.
4. Raju B.M.K., Singh. A, Bansal (2008), Development of Educational Development Index (EDI), Research Project Report, National Council of Educational Research and Training, New Delhi.
5. Nagar, A.L. Basu S.R., (2002) weighting socio-economic indicators of human development- Latent variable approach, in: Handbook of Applied Econometrics and Statistical Inference, Ullah A. *Et al*. (Eds), Marcel Dekkar, New York.

****