DISCRIMINANT ANALYSIS APPROACH FOR THE STUDY OF INTER-SECTORAL DYNAMICS IN INDIA BASED ON ECONOMIC ACTIVITY: 2020-21

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ABSTRACT
Dynamics of different sectors of the economy determine the economic development of the country. A number of studies has been carried out by researchers and are related to the overall economic development of India. The researchers have noted that there exist larger differences in the constituents of the different sectors of the economy in India. The literature in respect of inter-sectoral dynamics is limited. Keeping in view of these facts the authors of this research study have made an attempt to examine in detail the inter-sectoral dynamics relating to economic activity in India for the period 2020-21. The study is based on the application of Discriminant Analysis for comparing six sectors of the Indian economy with reference to Per Capita Net State domestic Product (PCNSDP)
Keywords: Per Capita Net State Domestic Product, Economic Activity, Inter-Sectoral Dynamics, Discriminant Function, Classification Matrix.

1. Introduction

Dynamics of different sectors of the economy determine the economic development of the country. Over the years India has achieved a significant growth in all sectors. It is important to note that understanding the structure of the economy is critical for both economic planners and the government. Agricultural sector has been supported by the manufacturing and services sectors during the initial stages of planning in India. The introduction of new economic policies has reversed the inter-sector dynamics and currently the agricultural sector is in the final position.

Most of the research studies carried out by researchers in respect of growth effects of economic reforms are related to overall economic development in India. The literature relating to the study of inter-sectoral dynamics is limited. Keeping in view of these aspects the authors have

made an attempt to study in detail the inter-sectoral dynamics relating to economic activity in India for the period 2020-21.The study is based on the application of Discriminant analysis for comparing six sectors with reference to Per Capita Net State Domestic product.

The objectives of the study are.

(i)   To formulate data structure for the study.
(ii)   To develop a Discriminant function relating to inter-sectoral dynamics, and
(iii)   To arrive conclusions based on the Discriminant function developed.

In Section 2 we have given an updated review of literature in respect of structure of sectors in Indian economy. Data description related to the study are given in Section3. Section 4 contains methodological aspects of Discriminant Analysis and related aspects. Detailed empirical analysis based on the data for study are also given in this section. Results and conclusions based on the study are given in Section 5.

1.1.   Meaning of Net State Value added and Economic Activity

Net state value added is the value of the output less the values of both intermediate consumption and the consumption of fixed capital.

An economic activity is a process that is based on input, leads to manufacture of a good or the provision of service. The classification of activities divides the economic activities into categories which by aggregation, makes it possible to define the sectors of activities.

1.2.   A brief description of the Economic Activities considered in the study

(i)Agriculture: It is an important one under the primary sector.It is to be noted that the economic contribution of agriculture sector to India's GrossDomestic Product (GDP) is steadily declining with the country's broad based economic growth.

(ii)   Manufacturing: Manufacturing holds a key position in the Indian economy accounting for 16% of the real GDP and includes steel automobiles,aluminum etc.

(iii)   Construction: The main construction industry includes the real estate,infrastructure and urban development sectors. The construction industry in India operates across nearly 250 subsectors with connection between them.

(iv)   Industry: The industrial sector mostly comprises companies involved in manufacture and distribution of capital goods, transportation or provision of commercial services and supplies.

(v)   Banking and Insurance: Indian Banking and Insurance system is very well structured one. This sector has been always the most preferred avenues for employment.

(vi)   Services: The service sector is highly heterogeneous ranging from software services and business process outsourcing to wholesale and retail trade and personal services.

2.   Review of literature relating to the structure of sectors in the Indian Economy

Ashok Kumar Lahiri et.al (1984) studied in detail in existence of diversity in the industrial sector. Shetty (2003) compared the economic performance of sectors on sectoral decomposition of SDP as a measure of disparities between states. Tarlok Singh (2010) observed that growth of service sector as an important one for absorbing the occurrence of shocks in agricultural and industrial sectors.

Ghosh (2013) attempted to analyze the regional economic growth and differences in income from the different sectors of the economy. Mukherjee (2013) has noted that the service sector is the largest and fastest growth sector in India and has highest labour productivity. Tarlok Singh (2015) studied the interrelationship between the different sectors. The author has also stated the strong – support for the long-run and weak support for short- term interrelationship among the sectors. Naresh Kumar (2016) compared the growth pattern of the three sectors of the economy with GDP growth.

3.   Data description related to the study

The main data source is Handbook of Statistics on Indian States for the year 2021-22.

The data in respect of the study are:

(i)   Criterion variable (Depended variable)

In the present study we have taken Per Capita Net State Domestic Product(PCNSDP) as the criterion variable. Per Capital Net State Domestic Product at factor cost (current prices) denotes the values of the average output of each individual in a state.

(ii)   Predictor variables (Independent variable)

The predictor variables are Agriculture, Manufacturing, Construction, Industry, Banking and Insurance and Services. These are economic activities related to the three different sectors of the Indian Economy.We have taken the data relating to the above aspects for 25 States and excluded 8 states. Data in respect of Andaman and Nicobar are not available for 2020-21. The data in respect of states viz, Chandigarh, Delhi, Goa,Mizoram, Nagaland, Pondicherry and Sikkim are excluded because they are too small to reflectgeneral economic behavior of states in India.

3.1 Per capita Net State Domestic Product(PCNSDP) and Net State value added by Economic Activity

The data relating to Per Capita Net State Domestic Product (PCNSDP) is given in Table1(a)

Table 1(a): PCNSDP

S.No	STATE	Per Capita Net State Domestic Product (in Rs.)
1	West Bengal	121267
2	Tripura	119789
3	Rajasthan	115933
4	Chhattisgarh	104943
5	Madhya Pradesh	104894
6	Jammu & Kashmir-U.T.	102803
7	Odisha	101501
8	Manipur	87832
9	Assam	86857
10	Meghalaya	84638

11	Jharkhand	71071
12	Uttar Pradesh	61666
13	Bihar	43605
14	Karnataka	236451
15	Haryana	235707
16	Telangana	231103
17	Gujarat	212821
18	Tamil Nadu	212174
19	Kerala	205067
20	Maharashtra	193121
21	Arunachal Pradesh	192360
22	Himachal Pradesh	183333
23	Uttarakhand	182698
24	Andhra Pradesh	176707
25	Punjab	149894

The state for which PCNSDP below the national average of PCNSDP and above the national average of PCNSDP are given in Table 1(b)

Table 1(b)

States with PCNSDP below National Average	States with PCNSDP above National Average
1.West Bengal	1. Karnataka
2.Tripura	2. Haryana
3.Rajasthan	3. Telangana
4.Chhattisgarh	4. Gujarat
5.Madhya Pradesh	5. Tamil Nadu
6.Jammu & Kashmir-U.T.	6. Kerala
7. Odisha	7. Maharashtra
8. Manipur	8. Arunachal Pradesh

9. Assam	9.Himachal Pradesh
10. Meghalaya	10. Uttarakhand
11. Jharkhand	11. Andhra Pradesh
12. Uttar Pradesh	12. Punjab
13. Bihar	

The data in respect of Net State Value added by Economic Activity for the different sectors are given in the Table 1(C)

Table 1(C)

Net State Value added by Economic Activity (Rs lakhs)

S.No	State	Agriculture (X_1)	Manufacturing (X_2)	Construction (X_3)	Industry (X_4)	Banking & Insurance (X_5)	Services (X_6)
1	West Bengal	15808770	12337803	7533018	22178103	5805543	62408459
2	Tripura	1159540	125479	239443	770375	146917	1920506
3	Rajasthan	11772816	6911879	7276525	18506061	3787461	38925608
4	Chhattisgarh	3694468	3737602	4219240	11003268	1127502	11028028
5	Madhya Pradesh	30019621	6257898	5711197	16525647	3240466	26820237
6	Jammu & Kashmir-U.T.	1277767	794418	1090375	2525936	564265	7613582
7	Odisha	6496418	7353826	2821137	14134813	1787943	15168979
8	Manipur	527040	43657	164307	241765	79533	1963662
9	Assam	3965071	3442095	1844755	7508721	1020673	12122328
10	Meghalaya	303933	258476	176630	509549	93079	1691077
11	Jharkhand	2376261	5260763	2061078	9016776	900889	10771641
12	Uttar Pradesh	23600981	6833073	14487846	33147086	5810244	58577735
13	Bihar	7028068	3106080	3901025	7759270	2552611	29000530
14	Karnataka	13688462	16795740	7330443	26577689	6791699	93756365
15	Haryana	6147648	12461733	4331093	18083625	3175792	29164301
16	Telangana	7891611	8276830	3270735	14703869	9254823	47229946
17	Gujarat	15232750	42161664	7017846	56209790	8321831	45377768
18	Tamil Nadu	9917719	26566923	16314497	45351372	4783584	80841245
19	Kerala	1402308	5233382	8268795	14437948	3405220	42387360
20	Maharashtra	17660545	34441772	11907875	55695247	25143236	1.23E+08
21	Arunachal Pradesh	338725	22882	167374	528491	48250	1069388

22	Himachal Pradesh	807835	3753769	877312	5307658	452484	5577606
23	Uttarakhand	1039159	14584536	1523009	9023172	753705	7761509
24	Andhra Pradesh	12940244	6739129	5695317	16256819	4076500	34873420
25	Punjab	7607388	5740756	2717044	9654642	2421788	17930639

4. Discriminant Analysis approach for the study of Net Value Added by Economic Activity

4.1 Discriminant Function

Discriminant Analysis is a technique for analyzing the data when the criterion or dependent variable is categorical and the predictor variables are interval in nature or continuous. This technique is used for determining the factors that discriminate between two or more groups. If the criterion variable has two groups, it is referred as two group discriminant analysis and if the criterion variable has three or more groups it is referred as multiple discriminant analysis. The discriminant function is expressed as a linear combination of two or more independent variables and this is given by

$$Y = b_0 + b_1X_1 + \ldots\ldots + b_nX_n$$

where Y => **Criterion variable or Dependent Variable**

b_n => **weight (Coefficients) of independent variables**

X_n => **Predictor or independent variable**

The discriminant function calculates weights (coefficients) that maximize the between group variance, given within group variance. This will make the groups differ as much as possible on the values of the discriminant function. After having estimated the function the bn coefficients are used to compute Y, the discriminant score by substituting the values of xn in the estimated discriminant function. The relative contribution of the independent variables are determined from the standardized discriminant function coefficient and the structure matrix.

4.2. Studies based on Discriminant analysis for Economic Activity

Economists apply discriminant analysis technique for modeling economic activities with respect to global context as well as for studying country's pattern of growth. In the literature there are only a few studies in respect of discriminant analysis for economic modeling. Morison (1969) has given a detailed theoretical account of method of evaluation criteria for discriminant analysis. Egbo and Barthlomew (2017) used discriminant analysis to classify 68 randomly selected countries for their relative economic status (weak or strong) based on World Bank Website data. The authors have used predictor variables viz., Gross Domestic Product, Mortality Rate, Inflation Rate and Access to Electricity. The study has revealed that Mortality Rate, Access to Electricity contributed largely (most) to linear discriminate within group(economic status) for the two levels (weak or strong).

4.3. Empirical Analysis based on the data used for the study.

4.3.1. Group Statistics

For the purpose of comparison, the mean and standard deviation of the predictor variables and presented in Table 2.

Table 2: Group Statistics

States		Mean	Standard Deviation
Below National Average of PCNSDP	Agriculture (X_1)	8310058.00	9482090.91
	Manufacturing (X_2)	4343311.46	3634858.83
	Construction (X_3)	3963582.77	4061138.86
	Industry(X_4)	11063643.85	9750898.45
	Banking&Insurance (X_5)	2070548.15	2036494.27
	Services (X_6)	21385567.08	20694883.57
Above National Average of PCNSDP	Agriculture (X_1)	7889532.83	6119543.52
	Manufacturing (X_2)	14731593.00	13155928.45
	Construction(X_3)	5785111.67	4768274.97
	Industry(X_4)	22652526.83	19273198.32
	Banking&Insurance(X_5)	5719076.00	6799345.24
	Services (X_6)	44076049.83	37773716.86

4.3.2. Test of equality of Group Means

Test of equality of group means is given in Table 3.

Table 3: Test of Equality of Group Means

Predictor Variables	Wilks' Lambda	F	df1	df2	Sig.
Agriculture (X_1)	0.955	1.071	1	23	0.311
Manufacturing (X_2)	0.783	6.391	1	23	0.019
Construction (X_3)	0.849	4.091	1	23	0.055
Industry (X_4)	0.716	9.124	1	23	0.006
Banking & Insurance (X_5)	0.716	9.124	1	23	0.006
Services (X_6)	0.803	5.651	1	23	0.026

There exists differences in the mean for the predictor variables viz., X2,X4, X5 andX6 with p values 0.019, 0.006 ,0.006 and 0.026 which are less than 0.05. There does not exit difference in the mean values for the predictor variables X1 and X3 with p values 0.311 and
0.055 which are greater than 0.05.

4.3.3. Correlation Matrix:

The correlation matrix for the predictor variables is given in Table 4.

Table 4: Correlation Matrix

Predictor Variable	(X_1)	(X_2)	(X_3)	(X_4)	(X_5)	(X_6)
(X_1)	1	-0.164	0.500	-0.188	-0.246	-0.077
(X_2)	-0.164	1	0.085	-0.106	0.259	0.134
(X_3)	0.500	0.085	1	0.05	0.161	0.238
(X_4)	-0.188	-0.106	0.05	1	-0.224	-0.028
(X_5)	-0.246	0.259	0.161	-0.224	1	0.362
(X_6)	-0.077	0.134	0.238	-0.028	0.362	1

It is observed that non of the correlation coefficients is greater than 0.5. We conclude that there does not exist multicollinearity among the predictor variables under study.

4.4 UnstandardizedDiscriminate Function
The estimated unstandardized discriminant function is given in Table 5.

Table 5: Canonical Discriminate Function Coefficient

Predictor Variables	Function Coefficients
Agriculture (X_1)	0.099
Manufacturing (X_2)	0.063
Construction (X_3)	-0.042
Industry (X_4)	0.131
Banking & Insurance (X_5)	0.110
Services (X_6)	0.032
Constant	-5.102

The results presented above can be written in the form of discriminant function as

$$Y = -5.102 + 0.099X_1 + 0.063X_2 - 0.042X_3 + 0.131X_4 + 0.110X_5 + 0.032X_6$$

The discriminant score for each state can be calculated for given values of X1,X2, X3, X4 , X5 and X6.

4.4.2. Significance of the Discriminant Function
The Eigen value for the above discriminant function is 1.759 and the Canonical Correlation is 0.798. The same is given in the following Table 6.

Table 6(a): Eigen Value

Eigen Value	Variance (%)	Cumulative (%)	Canonical Correlation
1.759	100.0	100.0	0.798

The results clearly indicate that 64% of the variance between the two groups of states is explain by the discriminant function. Wilk's Lambda and associated results are given in Table 6(b).

Table 6(b):Wilk's Lambda

Wilk's Lambda	Chi-square	d.f	Sig.
0.362	20.299	6	0.002

Wilk's Lambda value obtained for the data is 0.362 which lies between 0 and 1 . The same indicates the significance of the discriminant function constructedfor the data. The value of the Chi-square is 20.299 with $p = 0.002 < 0.05$. Based on this result we can infer that discrimination between two groups of states is significant.

4.5.   StandardizedDiscriminate Function

Standard Canonical discriminant Coefficients are given in Table 7(a)

Table 7(a): StandardizedCanonical Discriminant Function Coefficients

Predictor Variables	Function Coefficients
Agriculture(X_1)	0.725
Manufacturing (X_2)	0.420
Construction (X_3)	-0.292
Industry (X_4)	0.833
Banking & Insurance (X_5)	0.700
Services (X_6)	0.213

The standardized discriminant function is given by

$$Y = 0.725X_1 + 0.420X_2 - 0.292X_3 + 0.833X_4 + 0.700X_5 + 0.213X_6$$

The relative contribution of the variables in discriminating between two groups of states is based on the absolute values of the coefficient of standardized discriminant function. We can note that Industry (X4) is the most important predictor variable which discriminate between the two groups of states.

The Structure matrix is given in Table7(b).

Table 7(b): Structure Matrix

Predictor Variables	Coefficients
Industry (X_4)	0.475
Banking & Insurance (X_5)	0.474
Manufacturing (X_2)	0.347
Services (X_6)	0.374
Construction (X_3)	0.318
Agriculture (X_1)	0.163

Structural coefficient of the structure matrix will also be used for the study of relative contribution of the predictor variable between the two groups of states. The structure coefficient is obtained by computing the correlation between discriminant score and each of

the predictor variable. We observe that predictor variable viz., Industry (X4) has the correlation coefficient 0.475 followed by Banking & Insurance (X5),Manufacturing (X2),Services (X6),Construction (X3) and Agriculture (X1).

4.6. Group Centroid

We develop a procedure for classifying a State into two categories of statesviz., one for which PCNSDP below the national average and one for which PCNSDP and above the national average . We note that the sample sizes in two groups of states are not equal. The cut-off score for classification is computed using the formula

$$C = \frac{n_1 z_2 + n_2 z_1}{n_1 + n_2}$$

whereZ1andZ2 are mean discriminant score for group 1 and group 2, n1and n2 are the sizesof group 1 and group 2. This is known as Group Centroids. The cut-off score for the states with PCNSDP below average is 1.222 and states with PCNSDP above average is -1.324.The results are given in Table 8(a).

Table 8(a): Function of Group Centroids

PCNSDP	Function
1	1.222
2	-1.324

4.7. ClassificationMatrix

A classification matrix is constructed for summarizing Original and Cross validated data in both the groups of the states on the basis of discriminant function constructed. The results are presented in Table 8 (b)

Table 8(b): Classification Matrix

		PCSDP	PredictedGroupMembership		Total
			MIN	MAX	
Original	Count	MIN	12	1	13
		MAX	1	11	12
	%	MIN	92.3	7.7	100.0
		MAX	8.3	91.7	100.0
Cross-validated	Count	MIN	11	2	13
		MAX	4	8	12
	%	MIN	84.6	15.4	100.0
		MAX	33.3	66.7	100.0

The result clearly shows that 92% of original grouped cases are correctly classified. Based on cross validation results it is expected that 76% of the cases would be classified correctly.

5. Results and Conclusions

The important results obtained relating to the study are :

(i)   There exists significant difference in the means in respect of Predictor variables viz., Manufacturing, Industry, Banking and Insurance and Services.

(ii)   Wilk's Lambda indicates the significant of discriminant function constructed.

(iii)   The Structure matrix reveals that the relative contribution of the predictor variable viz., Industry is significant compared to other predictor variables.

The conclusions arrived based on the study are

(i)   The standardized discriminant function reveals that Industrial sector plays the important role in discriminating the two groups of states based on PCNSDP.

(ii)   The results of the study may help in formulating and implementing effective policies for balancing Inter-Sectoral Dynamics in India.

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