ANALYSIS OF DEVELOPMENT POTENTIALITIES OF MUNICIPALITIES OF THE NORTH REGION OF CEARÁ STATE (BRAZIL)

Espedito Cezário Martins, Alcido Elenor Wander

National Goats Research Center (CNPC), Brazilian Agricultural Research Corporation (EMBRAPA), Sobral-CE, Brazil

ABSTRACT

This study uses factor analysis to examine the development potentialities of the municipalities of the North Region of the Ceará State (Brazil). The study uses survey data from selected towns in Ceará. The source of the data will be demographic census of IBGE and IPLANCE.

KEYWORDS: Development Potentialities, Factor Analysis, Ceará

INTRODUCTION

This study analyzes information related to socioeconomic aspects of cities of the North Region of Ceará State, and aims at contributing to priority setting in development plans for the Region, particularly, in definition and with priority choice of the cities and aspects to be contemplated.

Ceará State has a total area of 146,817 square kilometers, where 136,526 square kilometers (92.24%) are located in the "polígono das secas" - dry lands - generating problems related directly with the availability of water in the soils and climatic conditions of the region. Politically the State is divided into 184 municipalities, of which 45 integrate the Region analyzed in this study.

In terms of economic development, what can be observed is a significant difference between the achieved development indexes between the municipalities of the country side and the metropolitan area of the State capital Fortaleza. This situation can be explained, partially, trough the development policies implemented by the decision makers, which had privileged the metropolitan area. As a result, the urban areas achieved better development indicators while the municipalities of the country side are often excluded of the development process.

However, in the last years the decision makers paid some attention to the effects the development policies have had to the State in general. In this sense, the currently adopted lines of direction try to solve this problem and aim at diminishing the existing differences through the implementation of policies of bringing development to the rural areas.

Thus, the analysis and classification of municipalities of the studied Region considering economic, social, demographic, agricultural and infrastructural indicators is an important input for decision makers in policies to be implemented in these cities. According to Ferreira (1989), regional and spatial studies enable a more accurate understanding of the activities carried out in the regions i.e. looking for reasons that explain spatial concentration of industrial capital and/or agglomeration of activities in some regions.

Ahead of this, the general objective of this study is to classify the municipalities of the North Region of Ceará State according to their socieconomic aspects. The specific objectives are: to define indicators related to social, economic and demographic aspects of the municipalities of the referred Region; to determine indexes that permit the creation of a hierarchy of municipalities after the analyzed aspects; and to ordinate the municipalities of the Region according to the indexes corresponding to the indicators of socioeconomic development.

MATERIALS AND METHODS

Data Source

To obtain the indicators related to socioeconomic aspects secondary data of "Perfil Básico Municipal (PBM)" published by "Instituto de Pesquisa e Estratégia Econômica do Ceará (IPECE)" in 2000 was used. Forty indicators or variables were used for the 45 municipalities that form the North Region of Ceará State. The following indicators or variables were used:

X_1 = total population.
X_2 = urban population.
X_3 = number of households.
X_4 = number of hospital beds/1,000 inhabitants.
X_5 = number of units of basic health services/1,000 inhabitants.
X_6 = medical atendance/100 inhabitants.
X_7 = dental atendance/100 inhabitants.
X_8 = number of teachers of primary and secondary schools.
X_9 = initial number of matriculated students in primary and secondary schools.
X_{10} = number of classrooms.
X_{11} = percent water supply in comparison to the whole State.
X_{12} = household consumption of electrical power.
X_{13} = percent of household electrical power consumption.
X_{14} = number of household consumer of electrical power.
X_{15} = industrial consumption of electrical power.
X_{16} = percent of industrial electrical power consumption.
X_{17} = number of industrial consumers of electrical power.
X_{18} = commercial consumption of electrical power.
X_{19} = percent of commercial electrical power consumption.
X_{20} = number of commercial consumers of electrical power.
X_{21} = rural consumption of electrical power.
X_{22} = percent of rural electrical power consumption.
X_{23} = number of rural consumers of electrical power.
X_{24} = number of vehicles.
X_{25} = total area of municipality (hectares).
X_{26} = gross development product (GDP).
X_{27} = gross development product per caput (GDP per caput).
X_{28} = number of industrial establishments.
X_{29} = number of commercial establishments.
X_{30} = number of operating banks.
X_{31} = percent of value added tax related to total taxes collected in the municipality.
X_{32} = total stocks of cattle.

X_{33} = total stocks of sheep.
X_{34} = total stocks of goats.
X_{35} = per caput consumption of electrical power.
X_{36} = per household consumption of electrical power.
X_{37} = proportion of urban population related to total population.
X_{38} = number of vehicles per caput.
X_{39} = relation between the number of teachers and the number of students.
X_{40} = relation between the number of classrooms and the initial number of matriculated students.

Factor Analysis

Due to the large number of used variables (n=40) there are difficulties in analyzing them simultaneously and, therefore, factor analysis through the principal component method will be used. Factor analysis will be used as a exploratory statistic technique to obtain a small number of factors non-correlated from a large number of variables with problems of multi-colinearity. This method allows to orthogonal components (non-correlated) between themselves, from the assumption that all the factors are variables with an average value of zero and that the respective values, in L-dimensional space of the observations (L=45), have a module equal 1. The principal components are linear combinations of the variables in a way that explain the maximum of the variance of the original variables. Therefore, this method is adjusted for the specific objective that is the construction of synthetic indicators of socioeconomic development of the studied cities.
The matrix that will serve as base to the model used for the factor analysis is the matrix composed of the observations corresponding to the set of indicators (X_i) previously defined. This matrix χ will be of dimension (n x L), i.e. $\chi_{n \times L}$. Applying the factor analysis to this matrix, one extracts the factors that will be used as measurements of the development degree. Initially from the matrix χ, a matrix of simple correlation between the variables is obtained, i.e. between the 40 pointers, of which the characteristic roots will be extracted. These roots catch the variance of the variables and the respective principal components. After that the factors are determined through the method of the principal components, without introducing preliminary estimates of the communalities, that is, without changing the main diagonal line.
From these factors the coefficients of factor loadings will be determined. The indicated model to explain the correlation structure presents each indicator (X_i) as linear combination of *n* main orthogonal components between themselves, of the following form:

$\chi = \Lambda F$
or
$\chi_{ij} = a_{i1} f_{1j} + a_{i2} f_{2j} + ... + a_{in} f_{nj}$,

where i=1,...,n e j=1,...,L.

The matrix (obtained from the matrix of correlation of the variables corresponds to the factor load matrix. These loads define the standard of relation between each factor and each variable. This standard of relation can be defined more clearly by doing an orthogonal rotation of factors while remaining the orthogonality between them. In this study, this matrix of orthogonal transformation will be obtained through the VARIMAX criterion. The number of factors will be chosen in function of the percentage of the explained total variance.

RESULTS AND DISCUSSION

After running the factor analysis four factors that possess eigenvalue higher than the unit and jointly explain 72.40% of the total variance of the model were obtained. Factors 1 and 2 explain 59.46% of this variance, as it can be verified in Table 1. Table 1 also shows the value of the communalities. It can be verified that all the variables have communality above 0.50, what it indicates that more than half of the variance of the variables is reproduced by the common factors. One also perceives that, of the 40 used variables, 6 only have a communality value below 0.80.

TABLE 1 - Eingenvalues, communalities and total variance percentage explained by four components.

Factor	Eigenvalue	% of Variance	Cumulative %
1	19.38	48.44	48.44
2	4.41	11.03	59.46
3	3.16	7.90	67.37
4	2.01	5.03	72.40
Variable	**Communality**	**Variable**	**Communality**
X_1	0.981	X_{21}	0.904
X_2	0.986	X_{22}	0.910
X_3	0.981	X_{23}	0.931
X_4	0.642	X_{24}	0.974
X_5	0.793	X_{25}	0.957
X_6	0.838	X_{26}	0.915
X_7	0.669	X_{27}	0.858
X_8	0.979	X_{28}	0.953
X_9	0.988	X_{29}	0.972
X_{10}	0.972	X_{30}	0.882
X_{11}	0.658	X_{31}	0.694
X_{12}	0.991	X_{32}	0.956
X_{13}	0.904	X_{33}	0.942
X_{14}	0.989	X_{34}	0.922
X_{15}	0.966	X_{35}	0.836
X_{16}	0.884	X_{36}	0.903
X_{17}	0.945	X_{37}	0.871
X_{18}	0.985	X_{38}	0.766
X_{19}	0.831	X_{39}	0.825
X_{20}	0.986	X_{40}	0.813

Source: Own.

Table 2 presents the values of the Kaiser-Meyer-Olkin Test, the Bartlett`s Test of Sphericity and the level of significance test. For the Kaiser-Meyer-Olkin Measure of

Sampling Adequacy the value 0.667 was obtained, which is considered a good index and indicates that the original data are consistent. Concerning the Bartlett`s Test of Sphericity it was verified that, as this test presented a high value and the level of significance was worthless, it is improbable that the matrix of correlations is an identity, what indicates that the use of the model of factor analysis is appropriate for the data.

TABLE 2 - Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett`s Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.667
Bartlett`s Test of Sphericity	3616.495
Significance	0.000

Source: Own elaboration after the results of the model.

Table 3 shows the factor loadings, which determine the association between each variable and the factors. The values in boldface represent factor loadings of higher value for one given variable, what means that this variable has a strong correlation with the respective factor. By detailing more the analysis of the factors, it is verified that:

• **Factor 1** - Can be identified as being inherent to the commercial, industrial and educational development and represents 48.44% of the total variance of the model. The great majority of the used variables is positively related with this factor, besides having a strong correlation with the factor, since they have factor loadings higher than 0.80.

• **Factor 2** - Is the factor of development of the infrastructure of the agricultural sector, being responsible for 11.03% of the total variance. There are 4 variables related to this factor, being 3 of positive form (X21, X22 and X23) and 1 strong negative (X13). The variables X21, X22 and X23 mention rural consumption of electrical power, percent of rural electrical power consumption and number of rural consumers of electrical power, respectively. The negative sign of variable X13 (percent of household electrical power consumption) is coherent, since if the percent of household electrical power consumption diminishes, this could be explained for the increase of the rural consumption of electrical power.

• **Factor 3** - Is responsible for the specific development of the animal production sector and represents 7.90% of the total variance of the model. There are 4 variables positively and strongly related with this factor, which are X25 (total area of municipality), X32 (total stocks of cattle), X33 (total stocks of sheep) and X34 (total stocks of goats). All these variables have factor loadings higher than 0.80.

• **Factor 4** - Represents 5.03% of the total variance and can be identified as inherent to the development of the basic health sector. It has 2 positively and strongly related variables, X6 (medical atendance/100 inhabitants) and X7 (dental atendance/100 inhabitants), all with factor loadings higher than 0.75.

TABLE 3 - Factor loadings.

Variable	Factor 1	Factor 2	Factor 3	Factor 4
X_1	**0.921**	0.194	0.202	-0.104
X_2	**0.972**	0.080	0.092	-0.034
X_3	**0.922**	0.190	0.212	-0.086
X_4	0.490	0.295	0.192	0.385
X_5	-0.087	0.099	-0.195	0.462
X_6	-0.149	0.025	-0.101	**0.852**
X_7	-0.202	0.209	0.046	**0.757**
X_8	**0.908**	0.233	0.195	-0.099
X_9	**0.924**	0.221	0.170	-0.088
X_{10}	**0.902**	0.167	0.273	-0.124
X_{11}	0.028	0.284	0.273	0.099
X_{12}	**0.989**	-0.003	0.089	-0.032
X_{13}	-0.389	**-0.822**	-0.028	-0.078
X_{14}	**0.984**	0.013	0.108	-0.049
X_{15}	**0.954**	-0.058	0.037	-0.010
X_{16}	**0.905**	-0.028	0.142	-0.054
X_{17}	**0.940**	-0.073	0.143	-0.027
X_{18}	**0.985**	0.007	0.068	-0.009
X_{19}	0.006	-0.312	0.048	0.081
X_{20}	**0.976**	0.102	0.111	-0.009
X_{21}	0.466	**0.812**	-0.061	0.043
X_{22}	-0.143	**0.907**	-0.085	0.093
X_{23}	0.139	**0.903**	-0.092	0.133
X_{24}	0.973	0.125	0.059	-0.001
X_{25}	0.287	0.004	**0.919**	-0.085
X_{26}	-0.029	0.127	-0.041	-0.085
X_{27}	0.049	0.092	-0.053	0.078
X_{28}	**0.963**	0.076	-0.066	0.000
X_{29}	**0.945**	0.158	0.146	-0.038
X_{30}	**0.785**	0.353	0.155	0.018
X_{31}	0.281	-0.013	0.168	0.249
X_{32}	0.447	0.056	**0.859**	-0.050
X_{33}	0.284	-0.089	**0.917**	0.007
X_{34}	0.032	-0.142	**0.938**	0.029
X_{35}	**0.720**	0.202	0.165	-0.041
X_{36}	**0.792**	-0.263	-0.074	-0.035
X_{37}	0.391	-0.135	-0.157	0.200
X_{38}	**0.647**	0.395	-0.038	0.068
X_{39}	-0.085	0.000	-0.007	-0.046
X_{40}	-0.174	-0.327	0.146	0.014

Source: Own elaboration after the results of the model.

The factor scores had been used to build a ranking of the municipalities in accordance with their development potentials. It is important to remember that the position occupied by a municipality in the built typology refers to its relative position inside of the analyzed Region. After these scores, the municipalities had been classified in accordance with the following development characteristics: Factor 1 - associates the municipalities that have higher level of commercial, industrial and educational development; Factor 2 - associates the municipalities that present a higher degree in development of infrastructure of the agricultural sector; Factor 3 - associates the municipalities that have a higher level of specific development of the animal production sector; and, Factor 4 - associates the municipalities that have a higher level of development of the basic health sector.

The municipalities more developed with relation to the aspects associated to Factor 1 (commercial, industrial and educational development) are, for degree order development: Sobral, Camocim, Tianguá, Acaraú, Ipu, Marco, Ipueiras, São Benedito, Massapê and Guaraciaba do Norte.
With relation to the aspects associated to Factor 2 (development of the infrastructure of the agricultural sector), the best are classified municipalities: São Benedito, Ubajara, Guaraciaba do Norte, Ibiapina, Tianguá, Croatá, Varjota, Itarema, Cruz and Cariré.
The classification after Factor 3 (specific development of animal production sector), the municipalities that are more associated to this characteristic of development are: Santa Quitéria, Granja, Santana do Acaraú, Irauçuba, Cariré, Hidrolândia, Poranga, Bela Cruz, Ipueiras and Senador Catunda.
The municipalities more developed with relation to the aspects associated to Factor 4 (development of the basic health sector) are, in order of degree of development: Senador Catunda, Poranga, Moraújo, Carnaubal, Frecheirinha, São Benedito, Ibiapina, Hidrolândia, Groaíras and Meruoca.

CONCLUSIONS AND PERSPECTIVES

The article shows how the factor analysis applied to the matrix of the values of the indicators of the basic profile of the municipalities of Ceará State allows describing, in a synthetic way, the nature and the intensity of the economic development process of North region of the State. It is verified, for example, that Sobral is the city that has the best level of commercial, industrial and educational development. In fact, this constatation can be explained by the importance that the city of Sobral has as development engine in the Region, polarizing the investments of these sectors. What also calls the attention is the fact that the great majority of the municipalities that had presented a higher development of the infrastructure of the agricultural sector to be located in the Serra da Ibiapaba. This can be explained by the importance that agriculture has for the economy of the hilly municipalities of that part of Northern Ceará.
It seems to be interesting to carry out studies of this type to verify the performance or evolution of the municipalities considering a longer period of analysis. Additionally, it is possible to use the method of the factor analysis as an instrument to support for decision makers in level of regional planning and public policies.

REFERENCES

Ferreira, C. M. (1989). Espaço, regiões e economia regional. In: Haddad, P. R.(org.).Economia regional, teoria e métodos de análise. Fortaleza: BNB-ETENE.

Fundação Instituto de Pesquisa e Estratégia Econônica do Ceará (2000). Perfil Básico Municipal (PBM). Fortaleza: IPECE. http://www.ipece.ce.gov.br (October/ 30/2003).

Harman, H. H. (1976). Modern factor analysis. The University of Chicago Press. 3.ed.

Hoffman, R. (1992). A dinâmica da modernização da agricultura brasileira em 157 microrregiões homogêneas do Brasil. Revista de Economia e Sociologia Rural. 30(4):217-290.

Hoffman, R.; Kassouf, A. L. (1989). Modernização e desigualdade na agricultura brasileira. Revista Brasileira de Economia. 43(2):273-303.

Hoffman, R.; Kageyama A. A. (1985). Modernização da agricultura e distribuição da renda no Brasil. Pesquisa e Planejamento Econômico. 15(1):171-208.

Reis, J. N. P.; Lima, P. H. (1995). Desenvolvimento sócio-econômico e hierarquização dos municípios cearenses. Revista Econômica do Nordeste. 26(4):401-428.

Corresponding Author

Name: Dr. Alcido Elenor Wander
Position: Research Scientist
Institutional Address: C.P. D-10, 62011-970 Sobral-CE
Country: Brazil
Email: awander@cnpc.embrapa.br
Tel: (++55) (0)88.677.7065, Fax (++55) (0)88.677.7055