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ECONOPHYSICS MODEL FOR THE MIGRATION: A Case of Karnataka

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Abstract

Population movement is an essential part for development of any region or country and one of the most distinguished characteristics of human being. Migration is an important element of population redistribution and equilibrium. Urban areas play a vital role in the development of its sound economy. India is not an exception. Migration phenomena have played a pivotal role in the socio- economic expansion of the country.

This paper is to study an Econophysics model for migration phenomena for Karnataka state by using the Coulombs law where it is transformed mathematically into modified gravity law of migration which works on statement 'migration between two places was directly proportional to the product of the power of these two places, and inversely proportional to the square of the distance between them'. The two forces are considered to be rural and urban forces where all the districts of Karnataka except Bangalore urban district are taken in the rural force and remaining one as urban force. M_{ij} is calculated with help of Coulombs law as expected and observed values taken from (Census of India, 2001. The volume of migration ranked according to distance which is obeying gravity law of migration and there is good fit of observed and expected distribution by chi-Square is test.

Keywords: *Migration phenomena, Econophysics models , attraction forces, economic power etc…,*

I. Introduction

Migration is an equilibrium process which reduces regional disparities at different stages of development and a process which is as old as human civilization. Migration today is being increasingly viewed as the major contributing factor to the ubiquitous phenomenon of urban surplus labor and as a force that continues to exacerbate already serious urban unemployment problems caused by growing economic and structural imbalances between urban and rural areas.

Rapid internal migration was thought to be a desirable process by which surplus rural labor was withdrawn from traditional agriculture to provide cheap manpower to fuel a growing modern industrial complex (Lewis 1954; Fei and Ranis 1961).

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Since human resources were being shifted from locations where their marginal social products were often assumed to be zero to places where these marginal products were not only positive but also rapidly growing as a result of capital accumulation and technological progress. Movement from the country to the towns, which is necessary if strictly balanced growth of the two parts of the labor force is to occur, becomes even more important if an increase in the industrial sector is among the goals of the developing economy (Jolly, 1970).

According to Cornwell and Inder (2004) much of the contemporary literature on economic motivations for rural-urban migration builds on the seminal work of Todaro (1969) and Harris and Todaro (1970). Their models has provided a widely accepted theoretical framework that explained the relationship between rural-urban migration and urban unemployment assuming potential migrants respond to the urban employment probability and treating rural-urban migration primarily as an economic phenomenon.

Migration in India is mostly influenced by Social Structures and pattern of development. The development policies by all the governments since Independence have accelerated the process of migration. Uneven development is the main cause of Migration. Added to it, are the disparities, Interregional and amongst different socio-economic classes.

In 2001, 309 million persons were migrants based on place of last residence, which constitute about 30% of the total population of the country. This figure indicates an increase of around 37 per cent from census 1991 which recorded 226 million migrants. And in Karnataka 165 million persons were migrants based on place of last residence, which constitute about 28% of the total population of the State. This figure indicates an increase of around 35 per cent from census 1991 which recorded 92 million migrants. In case of Bangalore, with population 9 million in 2011, Bangalore is the fifth most populous city in India and the 18th most populous city in the world. Bangalore was the faster growing Indian larger cities after New Delhi between 1991 and 2001 with a growth rate of 38% during the decade. The cosmopolitan nature of the city has resulted in the migration of people from other place to Bangalore.

Since the enormous increase in internal migration towards cosmopolitan city Bangalore to understand the intensity of migration phenomena an Econophysics model is studied in this paper.

Ravenstein (1885) recognized the importance of the frictional effect of

distance on migration in formulating his laws of migration back in the nineteenth century but migration models based on gravitational features were first developed in the 1940s (Zipf, 1946). These models incorporated terms measuring the masses of each origin and destination and of the distance between them and were calibrated statistically using log-linear regression techniques. Modifications were made to these early Newtonian gravity models by introducing parameters to weight the influence of the origin and destination factors and by experimenting with alternative distance functions.

The migration model is based on the gravitational attraction principle; hence on the Principles of physics (mechanics) in this case based on coulombs law a Econophysics model is used and analyzed.

II. Methods and Materials

Rural-urban migration occurs at varying rates in every country. This paper focuses on the intensity of rural-urban migration in Karnataka state. It studies in support of that the gravity model by using principles of physics. A new Econophysics model is studied to understand the intensity of rural-urban migration phenomena of Karnataka which is an inevitable component of the development process. The coulombs law of physics 'Force of attraction or repulsion between two charges is directly proportional to product of magnitude of charges and inversely proportional to squares of the distance between them' is transformed in mathematical form which states us that 'migration between two places was directly proportional to the product of the power of these two places, and inversely proportional to the distance between them'.

The two forces are considered to be rural and urban forces where all the districts of Karnataka except Bangalore urban district are taken in the rural force and remaining one as urban force. The volume of migration to Bangalore city from all other districts taken from (census of India, 2001). And also expected migrants are calculated with help of coulombs law.

III. The Coulomb's Model for the Migration Phenomena

The interaction between charged objects is a non-contact force that acts over some distance of separation. Charge, charge and distance. Every electrical interaction involves a force that highlights the importance of these three variables. Whether it is a plastic golf tube attracting

paper bits, two like-charged balloons repelling or a charged Styrofoam plate interacting with electrons in a piece of aluminum, there is always two charges and a distance between them as the three critical variables that influence the strength of the interaction.

The magnitude of the electrostatic force of interaction between two point charges is directly proportional to the scalar multiplication of the magnitudes of charges and inversely proportional to the square of the distance between them. The force is along the straight line joining them. If the two charges have the same sign, the electrostatic force between them is repulsive; if they have different signs, the force between them is attractive.

In the following we will refer in particular at the large-scale migration, especially interregional such as those known as "migrations by two forces". Essentially being an economic type polarization, analytical approaches of the phenomenon by models acting as the attractive forces like gravity, electrostatic or, more generally, electromagnetic are understandable. If for the gravity models, the attractors don't have a sign (positive, negative), in the Coulomb case the centres of influence have a sign and can explain the phenomenon of attraction, or rejection and from this perspective we consider it is a close description of actual economic situations.

As it is well known, the electric attractive forces are determined by the well known Coulomb's law. The magnitude of the electrostatic force of interaction between two point charges is directly proportional to the scalar multiplication of the magnitudes of charges and inversely proportional to the square of the distance between them. The force is along the straight line joining them. If the two charges have the same sign, the electrostatic force between them is repulsive; if they have different signs, the force between them is attractive.

$$F = K\frac{q_1 q_2}{r_{12}^2}$$

q_1 and q_2 are the interacting electric charges of opposite sign (Figure 1).

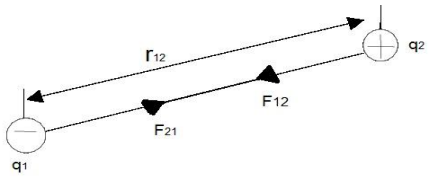


Figure 1. The electrical attraction between two electric charges of different signs.

Where $r_{12}-$ is the distance between the two charges, and $K-$ is proportionality constant, that depends on the properties of the environment between

the two charges and of the chosen units system. The most common is the International System of Units (S.I.), where $K = \frac{1}{4\pi\varepsilon}$, for spherical symmetry and $K = \frac{1}{2\pi\varepsilon}$, for circular symmetry, ε being the dielectric constant of the environment (electric permittivity).

For modeling the phenomenon of migration from neighbor regions (countries) *j*, with a powerful attraction characterized by a high socio- economic status (material resources, capital, developed logistics, information superstructures, banking, commercial or educational etc.) we will appeal to the notion of field (similar with the electric or electrostatic field) *E*, which is determined by the ratio of the power/force (electricity) *F* of the attractor and the charge q_0 on which acts the field

$$E = \frac{F}{q_0} \quad (2)$$

In addition, the subject (individual or capital) can be subjected to the effects of a single centre or of multiple attractor centres, to a greater or lesser extent (attractive or repulsive).

Calculating the force of attraction on a charge q_i symbolizing the number of emigrants from the region we have:

$$F_a = q_i E \quad (3)$$

$$F_a = \frac{q_i}{2\pi\varepsilon}\frac{Q_j}{R^2} \quad (4)$$

Where $Q_j = \sum_1^n jq_j$ –is the change distributed in the "rich region" j.

Knowing the intensity of the attraction forces (see eq. (4)), we can calculate the net migration flow given by M_{ij} migrants mass from the poor (negative) region i, to the rich (positive) region j:

$$M_{ij} = KF_a = K\frac{q_i\rho_j}{3\varepsilon}\frac{a^2}{R^2} \quad (5)$$

Where $q_i -$ symbolizes the power of the region of origin, *i*;

$\rho_j -$ Symbolizes the power of the region of destination, *j*;

$a -$ Characterizes the sizes ("radius") of region *j*;

$R -$ The distance between the two regions;

$K -$ The proportionality coefficient

Using the relation (4) for the Coulomb type force F_a, the total mass of migrants M_{ij} can also be written in the form:

$$M_{ij} = K.F_a = K.\frac{q_i}{2\pi\varepsilon}\frac{Q_j}{R^2} \quad (6)$$

Where $Q_j = \sum_1^n jq_j -$ symbolizes the economic power of the region *j* or all measurable in money resources. In previous equations ε represents the „environment's" permissiveness [1] between the two regions from our example and *j*.

[1] Term proposed by the authors, by similarity with the electromagnetic permittivity from physics.

Table 1 represents the distribution of observed number of migrants from the census 2001 data and estimated number of migrants by the Coulombs law for the Karnatak state. Here Chi-square values shows the greater variability between the observed and expected no. of migrants but the net migration in Figure 2 showing the similar pattern for all the districts.

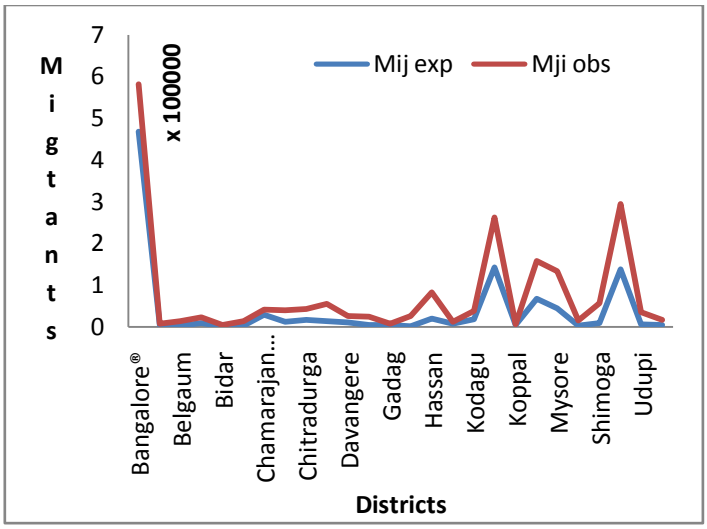
Table 1: Distribution of observed and expected no. of migrants by coulombs law

Districts	Ranks	Distance	Migration (M_{ij})		$\frac{(O_i - E_i)^2}{Ei}$
			Observed (O_i)	Expected (E_i)	
Bangalore(R)	1	50	113520	467619	268137.7
Kolar	2	67	113520	141775	3168.383
Tumkur	3	71	120581	137215	2933.103
Mandya	4	99	157277	67699	7115.336
Mysore	5	146	89647	43526	48118.61
Chamaraja-nagar	6	166	89290	28020	7994.781
Hassan	7	183	13053	19532	99284.55
Chitradurga	8	203	63569	15868	7870.672
Davangere	9	264	27043	9773	4236.198
Kodagu	10	267	16207	17515	664.0747
Chickmagalur	11	278	20926	11740	21311.03
Dakshina Kannada	12	299	27557	13422	62180.06
Bellary	13	308	42311	8035	6352.502
Shimoga	14	311	15179	8907	173626.9
Haveri	15	334	48233	6895	218.1394
Koppal	16	378	5669	4445	832.9328
Udupi	17	402	2521	6171	91614.5
Dharwad	18	429	29948	4857	41937.41
Gadag	19	431	19130	3889	78.02925
Uttara Kannada	20	438	4440	3825	24077.81
Raichur	21	457	13421	2583	35684.83
Bagalkote	22	476	12183	3468	621.7366
Belgaum	23	506	4936	3329	13466.67
Bijapur	24	524	10025	2185	48409.03
Gulbarga	25	639	12469	1478	382761.9
Bidar	26	690	25263	1057	6499.414
Chi Square value	1359196				

Source : Observed data Census of India,2001 and rest authors Calculations

As for the Coulombs law of migration the results showing high migration in shorter distance districts like Bangalore rural, Kolar, Tumkur etc.., and low migration in the higher distance districts like Bijapur, Gulburga, Bidar etc.., and observed data also exhibiting similar behavior by obeying the laws of Migration.

Figure 2: Patterns of Net migration phenomena by Expected and Observed data for the Districts



Source : Observed data Census of India,2001 and rest authors Calculations

IV. Conclusion

Based on the analogy between the migration phenomena and electrostatic, electrical interactions has been used a new Econophysics model for the migration phenomena.

Although the model utilize the basic assumptions of Ravenstein's Laws of Migration (1889) statements

1. Most migrants move only a short distance.
2. There is a process of absorption, whereby people immediately surrounding a rapidly growing town move into it and the gaps they leave are filled by migrants from more distant areas, and so on until the attractive force [pull factors] is spent.
3. Long-distance migrants go to one of the great centers of commerce and industry.

And also utilize the Gravity law of migration with the statement 'migration between two places was directly proportional to the product of the power of these two places and inversely proportional to the distance between them' mathematically with the principle of mechanics.

The results of estimated values of net migration satisfying the assumptions that longer the distance of migration is less and smaller the distance migration is more. The new model has its limits in explaining the massive migration phenomena and the individual reasons of the immigrants, but at the same time it offers a summary of the phenomenon from a macroeconomic point of view.

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