An Application of Gravity and Modified Gravity-Models to a Developing Economy

*Khalid I. Aldakhil**

ملخص

دراسة تطبيقية لنماذج الجاذبية على اقتصاد نام

تعتبر نماذج الجاذبية بنوعيها التقليدى والمعدل من الأدوات التحليلية الهامة فى حقل الاقتصاد الإقليمى والسكانى، وقد تم اختيار هذه النماذج والاستفادة منها فى العديد من الدول المتقدمة وكذلك بعض الدول النامية التى توفرت عنها بيانات مناسبة.

تقدم هذه الدراسة تطبيقاً قياسياً لنماذج الجاذبية على الاقتصاد المصرى الذى تم اختياره كمجتمع للبحث وذلك لتوفر بيانات عن الهجرة الداخلية لعدد كاف من الأقاليم، وتهدف هذه الدراسة بشكل رئيسى إلى معرفة وتحديد أهمية بعض العوامل التى يعتقد أنها تؤثر فى قرار الهجرة بين المحافظات والأقاليم المصرية، ومن هذه العوامل البعد الجغرافى وحجم السكان ومعدلات البطالة ومستويات الدخل والتعليم، بالإضافة إلى ذلك فإن الدراسة تقوم بتقدير مرونات الهجرة للعوامل السابقة على مستوى الاقتصاد المصرى ككل ولكل محافظة على حده.

أوضحت النتائج القياسية أن البعد الجغرافى يمثل أهم المحددات الرئيسة للهجرة بين الأقاليم والمحافظات فى جمهورية مصر العربية خلال فترة الدراسة، وقد بلغت مرونة الهجرة بالنسبة للبعد الجغرافى (-٠,٧٣) بمعنى أن زيادة المسافة بين الإقليم المصدر (i) والإقليم المستقبل (j) بنسبة ١٠% يؤدى إلى انخفاض تيار الهجرة بين الإقليمين بنسبة ٧% تقريباً. كما بينت الدراسة الأهمية التى تحظى بها بعض العوامل الاقتصادية والديموغرافية مثل معدلات البطالة وحجم السكان فى قرار الهجرة للفرد وذلك فى الأقاليم المصدرة والمستقبلة للمهاجرين، هذا وقد قدمت الدراسة تقديراً لمرونات الهجرة بالنسبة لهذه العوامل على مستوى الدولة والإقليم، وبصفة عامة يمكن القول بأن نتائج الدراسة كانت متفقة مع التوقعات النظرية، وتؤكد على فروض نماذج الجاذبية، وخاصة فيما يتعلق بالبعد الجغرافى بين الأقاليم المختلفة فى جمهورية مصر العربية.

- أستاذ مشارك ـــ قسم الاقتصاد جامعة الملك سعود بالرياض..

- Associate Professor, Department of Economics King Saud University.

1 - Introduction

The gravity model, which is known as the Stewart-Zipf hypothesis, was first formulated in 1941 by a physicist named John Stewart at Princeton University. He presented the concept of social physics when he noticed that the Newtonian law of migration could be applied to the distance of his students home towns. About the same time, a sociologist named Zipf developed some of the same concepts and used relationships that differ from Stewart's use of the demographic concepts. Re applied an empirical analysis and tested the validity of Stewart's hypothesis.

Generally, the gravity concept in the basic model was largely mechanical. It has no behavioral underpinnings. Later economists have adopted the idea of basic gravity model and added to it some behavioral components. They suggested that many other factors, economic and noneconomic, are important in determining interregional migration flows. These factors include income, employment, unemployment, urbanization, education, and amenities.

The present study has more than one objective. First, it reviews and discusses the development of gravity models. Second, it represents an econometric application to a developing economy that has appropriate data on internal migration for a sufficient number of regions. Third, it estimates the magnitude and tests the importance of some factors that are believed to affect decisions to migrate from one place to another in Egypt. Finally, it estimates the elasticity of migration for the Egyptian economy as a whole and for each individual region in the country.

The paper is set up as follows. The second section provides the theoretical foundation of the gravity models. The data and some related issues are discussed in section 3. Section 4 shows and explains the empirical results. The paper concludes in section 5 with a summary and assessment of the findings.

11- Theoretical Approach

The basic gravity model is defined by J. Stewart as a constant (G) times the product of two cities population divided by the square of the distance between the two cities, His definition is written as follow:

$$F=G\frac{P_iP_j}{D_{ij}^2} \qquad (1)$$

where

F = Gravitational Force.
G = Constant.
P_i = Population of city i.
P_j = Population of city j.
D_{ij} = Distance from i to j.

The relationship shown in equation (1) states that gravitational force is directly related to origin and destination population size and inversely related to the square of distance. Later, the square was dropped and the expression was written as:

$$F= G\frac{P_iP_j}{D_{ij}^{\alpha}} \qquad (2)$$

Stewart argues that if the gravitational force declines with distance, then migration from one place to another must decline with distance. Therefore, he substituted migration from area (i) to (j) for the gravitational force variable:

$$M_{ij} = G\frac{P_iP_j}{D_{ij}^{\alpha}} \qquad (3)$$

This relationship indicates that migration from area (i) to (j) is a function of population of (i), population of (j), and distance between (i) and (j).

By taking logs of both sides in equation (3) we get:

$$\ln M_{ij} = \ln G + \ln p_i + \ln P_j - \alpha \ln D_{ij} \qquad (4)$$

The implicit assumption in this formulation of the original gravity model is that population parameters are both unitary elastic. This means if population increases by 1 percent in either region (i) or (j), the flow of people between (i) and (j) will increase by 1 percent. Clearly this assumption is highly restrictive because population elasticities are subject to empirical tests.

Assuming that the population parameters are estimatable, then the gravity model could be written as:

$$M_{ij} = G \frac{P_i^{\beta_1} P_j^{\beta_2}}{D_{ij}^{\alpha}}$$

or in double-log form:

$$\ln M_{ij} = \ln G + \beta_1 \ln p_i + \beta_2 \ln P_j - \alpha \ln D_{ij} \qquad (5)$$

This means the hypothesis of unitary elastic population parameters ($\beta_1=\beta_2=1$) could be directly tested rather than implicitly constrained. Generally, economists expected that migration flows to be directly related to the size of relevant origin and destination populations:

$$\frac{\partial M_{ij}}{\partial P_i} > 0, \frac{\partial M_{ij}}{\partial P_j} > 0$$

This expectation is due to the following reasons:

1- Population size proxies the size of the labor market[1]. Larger labor markets have more job opportunities, and also a wider variety of jobs. Therefore, large labor markets are expected to be attractive to migrants.

2- Areas with large population size are expected to experience high out - migration rates, because larger areas have larger pools of potential migrants.

3- The larger is the population of origin or destination area, the greater is the probability that any given number of persons will have migrated between the areas in the past. This argument arise from the migrant stock concept which reflects the fact that current migrants follow past migrants[2]. The more people who migrated between two areas in the past, the more likely are the flows to be larger in the present because past migrants are expected to provide information to potential migrants, help to make the social transition easier, and provide temporary shelter and food until the migrant can find a job.

In the context of the literature on human capital investment, economists argue that distance is one of the major determinants of migration. It is expected that migration flows decline with distance:

$$\frac{\partial M_{ij}}{\partial D_{ij}} < 0$$

In order to rationalize this expectation, (Greenwood 1997,P666) suggested the following reasons:

1- Distance serves as a proxy for the economic costs (money costs) of moving from one place to another. These economic costs include out-of- pocket transportation cost and opportunity costs associated with migration. Both kinds of economic costs are expected to rise with distance. The opportunity costs rise with distance in the sense that longer moves require more time, which means greater foregone earnings.

2- Distance also serves as a proxy for the noneconomic costs incurred by a migrant when moving from one place to another. The noneconomic costs are psychic costs that entail moving a way from relatives and friends. The psychic costs usually tend to rise with distance and therefore, migration flows from one place to another are expected to decline with distance.

3- Information tends to decline with distance in part due to the fact that the cost of obtaining a given quantum of information rises with distance.

Later, economists have introduced the Modified Gravity models. They suggested that many other economic and noneconomic variables are important in determining interregional migration flows. The typical migration function in the modified gravity model could be written as follows:

$$M_{ij} = G\ D_{ij}^{\alpha}\ P_i^{\beta_1}\ P_j^{\beta_2}\ Y_i^{\beta_3}\ Y_j^{\beta_4}\ U_i^{\beta_5}\ U_j^{\beta_6}\ E_i^{\beta_7}\ E_j^{\beta_8}\ \ldots.\ e$$

or in double-log form:

$$\text{In } M_{ij} = \text{In } G + \alpha \text{ In } D_{ij} + \beta_1 \text{ In } P_i + \beta_2 \text{ In } P_j + \beta_3 \text{ In } Y_i + \beta_4 \text{ In } Y_i + \beta_5 \ln U_i + \beta_6 \ln U_j + \beta_7 \text{ In } E_i + \beta_8 \text{ In } E_j + \ldots + e$$

where

M_{ij} = Migration volume (or rate) from region (i) to (j).
P_i (P_j) = Population of region i (j).
Y_i (Y_j) = Income or wage rate of region i (j).
U_i(U_j) = Unemployment rate of region i (j).
E_i (E_j) = Education level in region i (j).

G = Constant term.

e = Random errors.

As in the basic gravity model, the longer the distance between two areas, the lower the migration rates from any given origin. Also, the greater the population size of origin and destination areas, the higher the migration rates from any given origin and to any given destination.

Economists expect income of both the origin and the destination to play an important role in the individual's decision to migrate. People are expected to move away from relatively low income to relatively high-income places. This means, ceteris paribus, the greater the income level of region (1) relative to (i), the higher the migration flow from (i) to (1). Another important variable that economists expect to be a major determinant of migration flows is unemployment rate of both origin and destination areas. Higher unemployment rates encourage out - migration from region (i) and discourage in - migrate to region (j). Also, another variable that is expected to have a noticeable influence on the migrant's decision function is the education level of both origin and destination areas. Higher levels of education in region (i) tend to reduce the importance of traditions and family ties among individuals in the region. This leads to higher migration flows from region (i) to other regions. On the other hand, higher education levels in destination region (j) means more employment opportunities and better employment information. This attract people to migrate from other regions to region (j), therefore, ceteris paribus, both origin and destination level of education are expected to have a positive impact on migration flows.

Finally, it should be noted that many other economic and noneconomic variables could be included in the above migration flow equation.

III- Data Analysis

Egypt is one of few developing countries that have appropriate data on internal migration for a sufficient number of regions. In 1979, and for the first time in Egypt, a household sample survey on internal migration was conducted by the Central Agency for Public Mobilization and Statistics (CAPMAS). The main objective was to uncover internal migration differentials and characteristics of migrants in Egypt. It has a cross-classification of the population by place of birth and place of current usual residence. Therefore, inter-governorate lifetime migration flows can be identified and studied. The spatial unit employed in this study is the governorate, which is the highest administrative division of the country. There are 26 governorates in Egypt. Each governorate will be considered as origin (i) and each of the other 25 governorates will be treated as destination J). This means there will be 650 migration flows (26x25).

Table (1) reports the in-, out-, and net migration rates of all individuals for each Egyptian governorate. The in - migration rate is defined as the number of individuals born in other governorates and enumerated in governorate (i) divided by governorate (i) population size in 1986. The out-migration rate is defined as the number of individuals born in governorate (i) and enumerated in other governorates divided by governorate (i) population size in 1986. The net-migration rate is defined as the number of in-migrants minus the number of out - migrants divided by the population size of the governorate in 1986.

There were 12 governorates had in-migration rates of population above the national average rate. On the other hand, 14 governorates had out migration rates of population above the national average rate. The migrant's highest contribution to regional population was in Red Sea and Suez. These two governorates are considered the most attractive places for migrants in Egypt. Approximately one third of these two governorates total population is contributed by in- migrants from other governorates. On the other hand, the migrants lowest contribution to regional population was in Quena, Sohag, and Fayoum. These governorates are considered the least attractive places for migrants in Egypt.

There were three governorates that experienced high out-migration rates. These governorates are Suez, Menoufia and Wadi Gedid. Each of these governorates lost a significant number of their population as out- migrants relative to other governorates. The lowest out- migration rates were for Matrouh and Alexandria (2.55% and 3.67% respectively).

The same table shows that 15 of the 26 Egyptian governorates had net out- migration of people, and the other 11 had net in- migration. The top two governorates in net out-migration of people are Menoufia and Sohag, with rates of –14.21% and –11.08% respectively. While the top two governorates in net in-migration rates of people were Red Sea and Suez, with rates of 24.21% and 17.81% respectively.

Finally, it is worth mentioning that the 26 governorates used in this study represent the whole population of Egypt. Therefore, the movement of people within the country is expected to behave as a closed system. This argument is supported by the result that there is a zero net migration in total Egypt, as shown in table (1).

Table (1)

In-, Out, and Net Migration Rates of Egyptian Population in 1986

Governorate	IMR	OMR	NMR
Cairo	19.73	9.25	1048
Alexandria	13.92	3.67	10.25
Port- Said	18.03	9.99	8.05
Suez	33.28	15.46	17.81
Domiat	3.08	9.50	-6.42
Dakahlia	1.57	8.01	-6.45
Sharkia	2.18	7.35	-5.17
Qulyoubia	13.17	5.41	7.75
Kafr El-Sheikh	1.92	3.73	-1.81
Gharbia	2.68	7.48	-4.79
Menoufia	1.76	15.96	-14.21
Behira	3.09	4.24	-1.15
Ismailia	21.00	8.45	12.55
Giza	18.71	3.97	14.74
BeniSweif	1.50	7.16	-5.66
Fayoum	1.37	6.10	-4.74
Almenia	1.52	4.26	-2.74
Assiut	1.61	10.13	-8.52
Sohag	1.35	12.34	-11.08
Ouena	1.20	9.52	-8.32
Aswan	7.94	8.68	-0.74
Red Sea	35.42	11.21	24.21
Wadi Gedid	10.52	15.19	-467
Matrouh	9.32	2.55	6.77
N.Sina	6.43	6.32	0.11
S.Sina	22.21	8.99	13.22
Total Egypt	**7.54**	**7.54**	**0**

In order to use the Egyptian census data (CAPMAS) to estimate the two gravity models, the variables have been defined in the following way:

M_{ij} = Number of individuals born in governorate (i) and enumerated in governorate (j) in 1986 divided by the total population of governorate (j) in 1986.

D_{ij} = Distance in Kilometers between representative cities in governorates (i) and (j).

Yi(Yj)= Annual percapita income of workers in governorate i (j) in 1986.

U_i (U_j) =Rate of unemployment in governorate i (j); that is the ratio of unemployment level prevailing in governorate i (j) in 1986 to the labor force of the same governorate in 1986.

E_i (E_j) =Percentage of population ten years old and over who are literate with a minimum of university degree in governorate i (j) in 1986.

IV- Empirical Results

The basic model of gravity shown in equation (5) has been estimated by least squares using a double logarithmic form, where all data have been transformed to logarithms(3). The parameter estimates and their associated t - ratios as follow:

$$M_{ij} = -5.830 \quad - 0.728D_{ij} + 0.676P_i + 0.620P_j$$

$$(-5.604) \quad (-10.999) \quad (16.567) \quad (15.189)$$

$$R^2=0.61 \qquad F = 332.175$$

The estimation results of the basic gravity model show that the variables of distance and population of origin and destination gevernorates do a very good job in explaining migration from one governorate to another. The coefficient of multiple determination (R^2) is 0.61, and all of the parameter estimates are highly significant at better than the one- percent level.

The result of negative and significant distance coefficient in the migration equation means that moving costs, which distance is proxy, are an important deterrent to migration between Egyptian governorates. The greater the distance between governorates (i) and (j), the lower is likely to be the number of persons moving from (i) to (j). This finding strongly supports many earlier studies concerned with developed and less developed countries that found distance as the major determinant of the spatial allocation of migrants(4).

Distance elasticity measures the percentage change in migration flow from governorate (i) to (j) that results from a one-percent change in the distance between (i) and (j)(5). The coefficient of distance in the above migration equation suggests that a one percent increase in the distance between governorate of origin (i) and destination (j) results in (-0.728) decrease in migration flow from (i) to (j) The estimated elasticity of the distance variable in this study is similar to the findings of Greenwood and Sweetland (1972) and Sahota (1969). In studying the determinants of internal migration, Greenwood and Sweetland (1972) have found a distance elasticity of (-0.70) for the United States, Sahota has found it (-0.79) for Brazil. Another study by Greenwood (1969) estimated a distance elasticity of (-1.06) for Egypt. Comparing Greenwood's estimate of distance elasticity and the estimate of distance elasticity in this study (-0.728), we find a noticeable decline in elasticity over time in Egypt. This decline could be attributed to the following reasons: (1) The transportation and communication systems are improved and expanded over time. (2) Education and income levels of people rose over time, which lower moving costs.

The parameter estimates of population of both the origin and destination variables are positive, as expected, and highly significant. This suggests that the populations of both the origin and destination governorates are important determinants of governorate migration in Egypt. These results are consistent with Greenwood's (1969) conclusion that migrants in Egypt come from and go to governorates with large population. The elasticities of population of both the origin and the destination are less than one and quite similar. The response of migration to both origin and destination population is inelastic. A one percent increase in population of origin (destination) governorate results in 0.68 (0.62) percent increase in migration flow from (i) to (j).

The modified gravity model shown in equation (6) also has been estimated by least square method using the double-logarithm form. The parameter estimates and their associated t-ratios are shown in table (2). The coefficient of multiple determination (R^2) is reasonably high (0.66). All of the parameter estimates except that of Y_i and E_i are significant at better than the one- percent level.

The empirical results of the modified gravity model are consistent with those of the basic model for both the distance and population variables. The coefficient of distance variable is negative and highly significant and the coefficient of both population of origin and destination variables are positive and highly significant. This finding supports the previous result that distance and population of both the origin and the destination are major determinants of inter - governorate migration in Egypt. When economic variables are included the relative size of distance and origin population coefficients have decreased while the destination population coefficient has increased.

Table (2)

Gross Inter- governorate Migration of Egyptian population: Logarithmic Regression Coefficients and t- ratios*

Equation / Variable	M_{ij}	
	Coefficient	T-ratios
D_{ij}	0.694	(-10.481)
P_I	0.496	(9.663)
P_j	0.803	(15.640)
Y_I	0.202	(1.062)
Y_j	-0.673	(-3.540)
U_I	1.066	(5.600)
U_j	-1.101	(-5.784)
E_I	0.058	(0.370)
E_j	0.373	(2.393)
Constant	-2.884	(-1.034)
R^2	0.66	--
F- stat	141.075	--

* Numbers in parenthesis show the t- ratios.

The variable of income of both the origin and destination has a poor performance in the migration equation. The parameter estimates of the income variable for both origin and destination are of the opposite sign. These study findings concerning the income variable are consistent with some other studies such as Greenwood (1981). Both studies do not support several earlier studies that suggest that income is a major determinant of migration in both developed and less- developed countries.

Unemlopyment rate of both the origin and the destination is a significant determinant of inter- governorate migration in Egypt. Ceteris paribus, people tend to go to governorates with low unemployment rates and move out from governorates with high unemployment rates. The response of migration to origin and destination unemployment is similar. A one- percent increase in unemployment rate of origin (destination) results in about 1.0 percent increase (decrease) in migration flow from origin governorate (i) to destination governorate (j).

The parameter estimates of both the origin and the destination education variables have the anticipated positive sign, and are significant only for the destination education variable. These results indicate that the higher the destination governorate education level the greater the rate of in - migration to this governorate.

In studying the determinants of internal migration in the United States, Greenwood (1972) argues that the factors that influence internal migration from regions are likely to differ in importance. Therefore, migration elasticities are expected to differ between regions within the country. He suggested the desegregation of data in order to treat each region separately. Following Greenwood, the data have been disaggregated and each of the 26 Egyptian governorates was treated as an origin to analyze migration from each governorate to the other 25 governorates. This disaggregation will lead to one elasticity parameter for each governorate, and this result in 26 sets of elasticities.

In order to apply this procedure to the basic and modified gravity models, the independent variables in equations (5) and (6) should refer only to the destination governorates. The equations would be rewritten as follow:

$$M_{ij} = \alpha + \beta_1 D_{ij} + \beta_2 P_j + e \qquad (7)$$

$$M_{ij} = \alpha + \beta_1 D_{ij} + \beta_2 P_J + \beta_3 Y_j + \beta_4 U_j + \beta_5 E_j + e \qquad (8)$$

Both equations were estimated by least squares using the double-logarithmic form. Table (3) shows the parameters estimate for the basic gravity model and table (4) shows the estimate for the modified model. The performance of the distance and population of destination variables was good for each governorate in both models, while the performance of the other variables in the modified model is good for some governorates and poor for others. Therefore, the analysis of migration will be based on the results of basic gravity model shown in table (3). The coefficients of multiple determination (R_s^2) are presented in the last column of the table. The R_s^2 range from the highest of 0.83 (Domiat governorate) to lowest of 0.14 (North Sina governorate). Greenwood (1972) argues that the high degree of variability in the R^2_s could be explained in large part by the relative importance of distance in explaining migration. The distance variable has an expected negative sign for each governorate and it is significant except for one governorate (South Sina). The distance elasticity ranges from -0.36 (Giza) to -1.58 (Wadi Gedid). The estimated elasticity coefficient of different governorates reflects a high degree of regionalily. Some governorates are characterized by their low distance elasticity. Such governortes are Giza, Cairo, Alexandria, Suez, and Sohage. Other governorates are characterized by their high distance elasticity. Such governorates are Wadi Gedid, Aswan and Domiat. These results suggest that the more accessible a given governorate (j) to other governorates, the smaller the distance elasticity from governorate (j).

The destination population variable has an expected and significant sign for each governorate except for one governorate (South Sina) where the sign is negative but not significant. The distination population elasticity ranges from 0.07 (Matrouh) to 0.92 (Sohag). Since elasticity is positive and less than one for each governorate, therefore, the response of migration to destination population is inelastic for all Egyptian governorates.

Table (3)
Gross out-Migration by Governorate: The Basic Gravity Model

Var. / Govern.	D_{ij}	P_i	R^2
Cairo	-0.61[a]	0.54[a]	0.74
Alexandria	-0.38[a]	0.71[c]	0.63
Port- Said	-0.06[a]	0.69[a]	0.78
Suez	-0.44[b]	0.52[a]	0.48
Domiat	-1.41[a]	0.83[a]	0.83
Dakahlia	-1.15[a]	0.46[a]	0.69
Sharkia	-1.14[a]	0.33[c]	0.58
Qulyoubia	-0.93[a]	0.45[a]	0.71
Kafr El-Sheikh	-1.16[a]	0.56[a]	0.70
Gharbia	-0.96[a]	0.63[a]	0.74
Menoufia	-1.14[a]	0.55[a]	0.72
Behira	-1.08[a]	0.52[a]	0.65
Ismailia	-0.91[a]	0.56[a]	0.67
Giza	-0.36[a]	0.75[a]	0.78
BeniSweif	-0.95[a]	0.65[a]	0.60
Fayoum	-0.93[a]	0.73[a]	0.68
Almenia	-0.75[b]	0.64[a]	0.55
Assiut	-0.76[a]	0.77[a]	0.60
Sohag	-0.40[b]	0.92[a]	0.58
Ouena	-1.02[b]	0.58[a]	0.32
Aswan	-1.33[a]	0.87[a]	0.54
Red Sea	-1.50[b]	0.48[a]	0.36
Wadi Gedid	-1.58[a]	0.28[b]	0.27
Matrouh	-1.23[c]	0.07[c]	0.17
N.Sina	-1.09[c]	0.24[c]	0.14
S.Sina	-1.91	-0.03	0.22

(a) Indicates absolute $t \leq 96$. (b) Indicates absolute $1.69 \leq$.
(c) Indicates absolute $1.29 \leq t < 1.96$.

Table (4)
Gross out-Migration by Governorate: The Modified Gravity Model

Var. / Govern.	D_{ij}	P_i	Y_i	U_i	E_i	R^2
Cairo	-0.67[a]	0.64[a]	-0.88[c]	-0.38	0.12	0.77
Alexandria	-0.40[a]	0.92[a]	-0.93[c]	-1.03[b]	-1.018	0.71
Port- Said	-0.87[a]	0.76[a]	0.21	-0.50	0.87[b]	0.84
Suez	-0.10[a]	0.54[a]	-0.76	-0.23	1.46[a]	0.62
Domiat	-1.22[a]	0.81[a]	0.27	0.27	0.58	0.84
Dakahlia	-0.89[a]	0.62[a]	2.14[b]	-0.38	0.63	0.76
Sharkia	-1.03[a]	0.69[a]	0.23[a]	-1.84[b]	-0.01	0.66
Qulyoubia	-0.69[a]	0.82[a]	-0.65[c]	-0.66	0.70	0.83
Kafr El-Sheikh	-1.05[a]	1.09[a]	-0.01[c]	-2.84[a]	0.32	0.87
Gharbia	-0.91[a]	1.02[a]	-0.00[c]	-2.15[a]	0.04	0.84
Menoufia	-1.05[a]	0.96[a]	-0.75[c]	-2.20[a]	0.12	0.82
Behira	-1. 7[a]	0.88[a]	-1.18[c]	-2.13[a]	-0.50	0.79
Ismailia	-0.84[a]	0.78[a]	-0.19[c]	-1.27[a]	0.38	0.75
Giza	-0.30[c]	0.83[a]	-0.35[c]	-0.30	0.22	0.79
BeniSweif	-0.79[a]	0.96[a]	-1.67[a]	-1.60[a]	0.23	0.73
Fayoum	-0.85[a]	0.95[a]	-1.32[b]	-1.14[c]	0.15	0.75
Almenia	-0.81[b]	0.90[a]	-1.48[a]	-1.53[a]	-0.35	0.72
Assiut	-0.97[a]	0.97[a]	-0.70	-1.35[b]	0.24	0.68
Sohag	-0.39[c]	1.05[a]	-1.10	-0.73[c]	-0.14	0.62
Ouena	-1.08[b]	0.82[a]	-1.77[c]	-1.43[c]	0.02	0.45
Aswan	1.97[a]	1.24[a]	-1.25[a]	-2.27[a]	0.56	0.71
Red Sea	-1.51[c]	0.48[a]	-0.27	-0.11	0.36	0.37
Wadi Gedid	-2.56[a]	1.05[a]	0.73	-4.12[a]	-0.87[c]	0.63
Matrouh	-0.93[c]	0.35	-0.57	1.50[c]	0.02	0.28
N.Sina	-0.54[a]	0.27	-0.63	-0.25	2.21[b]	0.33
S.Sina	-1.72	-0.14	-2.09[b]	-1.27	1.32	0.35

(b) Indicates absolute $t \leq 1.96$. (b) Indicates absolute $1.69 \leq 1.96$.

(c) Indicates absolute $1.29 \leq t < 1.96$.

V- Summary and Conclusion

This study is considered one of the few applications of the gravity and modified gravity models to the Egyptian economy. It estimates the magnitude and tests the importance of some factors that are believed to affect decisions to migrate from one place to another. Moreover, it estimates the elasticity of migration for the Egyptian economy as a whole and for each individual governorate. This study results are expected to be important to the policy makers who are interested in encouraging (or discouraging) migration to or from particular governorates in Egypt.

Data analysis of this study shows that the most attractive places for migrants in Egypt are Red Sea and Suez governorates, whereas the least attractive places are Quena, Sohag, and Fayoum.

The empirical results of the basic gravity model show that distance is an important deterrent to migration between Egyptian governorates. It suggest that a one percent increase in the distance between governorate of origin (i) and destination (j) results in (-0.728) decrease in migration flow from (i) to (j). This conclusion is similar to these of related studies that dealt with distance elasticities of some developed and developing economies. Moreover, populations of both the origin and destination governorates are found to be major determinant of inter-governorate migration in Egypt. The response of migration to both origin and destination populations are found to be inelastic.

The modified gravity model empirical results are consistent with those of the basic model for both the distance and population variables. In addition to this conclusion, unemployment rate of both the origin and the destination is a significant determinant of intergovenorate migration. Migrants tend to go to governorates with low unemployment rates and move out from governorates with high unemployment rates.

This study expected that factors that influence migration from governorates differ in importance. Therefore, data have been disaggregated in order to treat each governorate separately. The performance of the distance and population of destination variables was good for each governorate in both models. It has been found that distance elasticity ranges from (-0.36) for Giza governorate to (-1.58) for Wadi Gedid governorate. The results suggest that the more accessible given governorate to other governorates, the smaller the distance elasticity of migration from that governorate. Finally the response of migration to destination population is found to be inelastic for all Egyptian governorates.

Footnotes

(1) Of course, population size is not the best measure of job opportunities and there are better measures such as changes in employment and unemployment rates.

(2) The estimated coefficients of the migration equation will be biased if the researcher did not account for the fact that current migrants follow past migrants, for more details see (Greenwood 1969, P.189):

(3) Greenwood (1997) suggested the use of double logarithmic form in estimating gravity models because it yields reasonably good fits and the coefficients obtained from it can be directly interpreted as elasticities.

(4) See, for example, Greenwood (1969, 1971, 1972), Beals et el. (1967), Greenwood and Sweetland (1972).

(5) Greenwood argues that the distance elasticity typically ranges between (-0.2) to (-2.0), depending upon the population subgroup under study, the type of migration flow studied ... etc (1997, P667).

References

(1) Beals, R.E; Levy, M.B; Moses, L.N (1967), Review of Economics and Statistics, 49, PP.480-6.

(2) CAPMAS (1978), Census of Population and Housing, 1976, Ref. No.93-111510-1978.

(3) CAPMAS (1979), Preliminary Results of Samples Survey of Internal Migration Differentials, Cairo, Ref No (90-1400- 79).

(4) CAPMAS (1991), Census of Population, Housing and Establishment, 986, Second Volume, Ref. No. 873/91/CAC, ARE.

(5) Greenwood, M.J (1969) "The Determinants of labor migration in Egypt". Journal of Regional Science 9:283-290.

(6) Greenwood, M.J (1969) "An Analysis of The Determinants of Geographic Labor Mobility In The United States". The Review of Economics And Statistics. Vo. LI, No.2, May 1969.

(7) Greenwood, M.J (1971), "A Regression Analysis of Migration to Urban Areas of A less Developed Country: The Case of India," Journal of Regional Science, Vol.11, No.2, PP.253-62.

(8) Greenwood, M.J. and Sweatland (1972), "The Determinants of Migration Between Standard Metropolitan Statistical Areas". Demography, Vol.9, No.4, PP.665-681.

(9) Greenwood, M.J. (1981). Migration and Economic Growth in the U.S. New York: Academic Press.

(10) Greenwood M. 3. Michael (1997) "Internal Migration In Developed Countries"Handbook of population and Family Economics, Volume lB. Edited by M.R. Rosenzweig and 0. Stark.

(11) Isard, Walter (1967) "Methods of Regional Analysis: An Introduction to Regional Science." The M. I. T. Press.