Estimation the spatial Durban regression model for anemia patients sample in some region of Al-Karkh/ Baghdad

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ABSTRACT

The study of economic and health spatial phenomena is of great importance in research, where an added and important variable is studied, which is the spatial variable, because of this the Durban spatial regression model is an important models in applications for many phenomena and the research aims to estimate the Durban spatial regression model using the ordinary and modified spatial contiguity matrix under the Rook criterion using the parametric estimation methods represented by the maximum likelihood method, as this model was described to study the relationship between the dependent variable (Y_i) represented by the ratio of hemoglobin in the blood and the explanatory variables represented by (Marital status, menstrual cycle for more than seven days, bleeding during the menstrual cycle, pregnancy or childbirth during the life period and the number of total loads) under the effect of spatial contiguity. Among the most important conclusions that were reached is the emergence of significant effects of some explanatory variables on the dependent variable (Y_i), also show that the modified spatial contiguity matrix (M*) is better than the ordinary spatial contiguousness matrix (M) when estimating the Durban spatial regression model in representing the data and that the estimated values of the dependent variable (Y_i) are close to the real values of the same variable.

Keywords: Durban spatial regression model, Spatial contiguity matrix, Rook neighboring Criteria, Maximum Likelihood.

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1. Introduction:

In recent years, there has been a great interest by researchers in the topic of analyzing spatially approved data, especially in spatial economic measurement models, as these models are concerned with studying the spatial effects between the units' observations of the studied phenomena. When studying any of the economic, agricultural, health, social and other phenomena, the spatial influences that are associated with them must not be ignored,[2] therefore, ignoring spatial effects may lead to inaccurate results, so when using statistical methods in spatial analysis of any phenomenon without taking into account the nature of spatial data and its characteristics derived from the spatial location, this will affect the results of the statistical analysis, therefore, the spatial effects have a clear effect on the economic measurement model, which is called the spatial economic measurement, which represents the scientific method for analyzing the economic spatial chains. [1] In this research, the Durban spatial regression model was used, whose features were estimated through the use of the maximum likelihood method, and this model describes the relationship between the response variable (dependent) and the explanatory variables under the Rook spatial contiguity criterion of the spatial adjacent matrix. The aim of this research is to estimate the spatial Durban regression model by using the maximum likelihood method, which describes the relationship between the dependent variable represented (by the ratio of hemoglobin in the blood) and the explanatory variables represented (marital status, menstrual cycle for more than seven days, bleeding during the menstrual cycle, pregnancy or childbirth during the life period and the number of total loads) for anemia under the Rook spatial contiguity criterion of the ordinary and modified spatial contiguity matrices (M, M*).

2. Spatial contiguity criterion and matrices:

The Rook contiguity criterion, which is one of the spatial contiguousness criteria was used in the formation of the spatial contiguity matrix as the method of this criterion depends on the common points between the regions as it takes all directions of contiguity i.e. from the right, left, front and back, meaning that the two areas adjacent in any direction give one value, and the two areas that do not contiguous are given a value of zero, and that this matrix has a clear effect in building the spatial regression model. [4] For example, if we had the following scheme:

The first region	The second region
Third region	Fourth region
Fifth region	Sixth region

Figure (1) represents the diagram of the contiguity of regions

So it is possible to find the matrix of spatial contiguity of style the Rook contiguity criterion which is denoted by the symbol (M) of the scheme is note that the first region is adjacent to the second and third regions while it is not contiguous with the other regions, represented by the fourth, fifth and sixth regions, while the third region is adjacent to the first, fourth and fifth regions and does not contiguous with the second and sixth regions and so on for the rest of the regions, so the contiguity matrix will take the following form:

$$M = \begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

The matrix M is called the ordinary spatial contiguous matrix which is used in the estimation of the Durban spatial regression model under the Rook contiguity criterion. [4]

And through the ordinary spatial contiguity matrix M can be found the modified spatial contiguity matrix which is denoted by the symbol M* as it is calculated according to the following formula: [6]،[9].

$$M^* = \frac{M_{ij}}{\sum_{j=1}^{n} M_{ij}} \qquad \dots (1)$$

That is each of the values of any row of the ordinary spatial contiguity matrix M is divided by the row sum as shown in the matrix below:

$$M^* = \begin{bmatrix} 0 & 1/2 & 1/2 & 0 & 0 & 0 \\ 1/3 & 0 & 1/3 & 1/3 & 0 & 0 \\ 1/3 & 0 & 0 & 1/3 & 1/3 & 0 \\ 0 & 1/3 & 1/3 & 0 & 0 & 1/3 \\ 0 & 0 & 1/2 & 0 & 0 & 1/2 \\ 0 & 0 & 0 & 1/2 & 1/2 & 0 \end{bmatrix}$$

3. Spatial model:

The general spatial regression model is as follows: [10]

$$\underline{Y} = \theta M_1 \underline{Y} + X\underline{\beta} + \underline{u} \qquad \dots (2)$$

$$\underline{u} = \rho M_2 \underline{u} + \underline{\varepsilon}$$

$$\underline{\varepsilon} \sim N(0, \sigma^2 I_n)$$

Whereas: $\underline{Y}$ represents the vector of dependent variable with dimension nx1, θ represent the spatial dependence parameter, $M_1\underline{Y}$ represents the dependent variable vector spatially lagging in the dimension nx1, X represents the matrix of explanatory variables of dimension n x k+1, β represents the parameters vector of dimension nx1, $\underline{u}$ represents the vector of spatially correlated random errors of dimension nx1, ρ represents the error spatial correlation parameter, $\underline{\varepsilon}$ represents the vector of unobserved errors of dimension nx1and $\underline{\varepsilon} \sim N(0, \sigma^2 I_n)$, n represents the sample size, k represents the number of explanatory variables M_1 represents the spatial contiguity matrix between observations M_2 the spatial contiguity matrix represents the distance of the observations from the city center and can be $(M_1 = M_2 = M)$ where M represents what is defined for the matrix M_1.

Through Formula (2) it is possible to write the Durban Spatial Regression Model (SDM) as follows:[8]

$$\underline{Y} = \theta M\underline{Y} + H\underline{\beta} + \underline{\varepsilon} \qquad \ldots (3)$$

Where: $H = [\ X \ \ MX^* \ ]$

$\underline{\beta} = [\ \underline{\beta}_1 \ \ \underline{\beta}_2\ ]$

X represents the matrix of explanatory variables with dimensions (nxk + 1) and X^* represents the matrix of explanatory variables with dimensions (nxk) and $\underline{\beta}_1$ represents the parameter vector without the matrix of spatial contiguity with dimension (k+1x1), $\underline{\beta}_2$ represents the parameter vector in the presence of the matrix of spatial contiguity of dimension (kx1).

4. Maximum likelihood method:

Estimating the two vectors of model parameters $\underline{\beta}_2$، $\underline{\beta}_1$ and other parameters σ^2 ،θ, we using the maximum likelihood method. It is one of the important and commonly used methods for estimating the parameters of a regression model. The Method capabilities have good properties and can be used by making the logarithm of the likelihood function at its maximum. This method was used to estimate the spatial dependence parameter θ and the vectors of the parameters $\underline{\beta}_1$ ، $\underline{\beta}_2$ for the Durban spatial regression model defined in formula (3) when the random error variable has a known probability distribution.

The likelihood function is as follows:

$$L(Y; \underline{\beta}, \theta, \sigma^2) = \left(\frac{1}{2\pi\sigma^2}\right)^{\frac{n}{2}} |A| \exp\left\{-\frac{1}{2\sigma^2}\left[(A\underline{Y} - H\underline{\beta})' (A\underline{Y} - H\underline{\beta})\right]\right\} \qquad \ldots (4)$$

Where: $A = (I - \theta M)$

By taking the natural logarithm of both sides of the above formula, (4) we get:

$$\ln L(Y; \underline{\beta}, \theta, \sigma^2) = -\frac{n}{2}\,\mathrm{Ln}\,2\pi - \left(\frac{n}{2}\right)\mathrm{Ln}(\sigma 2) + \mathrm{Ln}|A| - \frac{1}{2\sigma^2}[(AY - H\beta)'(AY - H\beta)] \quad \dots (5)$$

By making the partial differentiation with respect to and $\underline{\beta}$, σ^2 and setting them equal to zero we get:

$$\underline{b}_{ML} = (H'\,H)^{-1}\,H'A\,Y \qquad \dots (6)$$

$$\underline{b}_1 = (\,H'\,H)^{-1}\,H'\,Y$$
$$\underline{b}_2 = (H'\,H)^{\,-1}H'\,MY$$
$$\hat{\sigma}^2_{ML} = (e1 - \theta\,e2)'\,(e1 - \theta\,e2)\,/\,n \qquad \dots (7)$$
$$e_1 = Y - H\underline{b}_1$$
$$e_2 = MY - H\underline{b}_2$$
$$e = e_1 - \theta\,e_2$$

As for the spatial dependence parameter θ it can be found by substituting formula (7) into formula (5) and knowing the maximum likelihood function as follows: [11]

$$\ln L(\theta) = -\frac{n}{2}\ln 2\pi - \left(\frac{n}{2}\right)\ln[(e_1 - \theta e_2)'\,(e_1 - \theta\,e_2)\,/\,n] + \ln|A| - \frac{n}{2} \quad \dots (8)$$

$$\ln L(\theta) = C - \left(\frac{n}{2}\right)(\,\ln[(e_1 - \theta\,e_2)'\,(e_1 - \theta\,e_2)] + \ln|\,I - \theta\,M\,| \quad \dots (9)$$

where:

$$C = -\frac{n}{2}\ln 2\pi - \frac{n}{2}\ln(n) - \frac{n}{2}$$

5. Moran's test for spatial dependability:

The Moran's test statistic was used to detect spatial dependability between regions that is the presence of spatial autocorrelation between values, since the spatial autocorrelation coefficient was used to measure the similarity between adjacent phenomena, when the values of one of the variables in one place are correlated with the values of the same variable in another neighboring place this shows autocorrelation between the two variables. [6] If the value of the coefficient of Moran's test which close to the integer one, then this indicates the existence of a spatial correlation, and that the formula for the Moran statistic I is as follows: [6], [5]

$$I = \left(\frac{n}{\sum_{i=1}^{n}\sum_{j=1}^{n} y_{ij}}\right)\frac{(e'Me)}{e'e} \qquad \dots (10)$$

Where e is the vector of the regression residuals.

both (Cliff and Ord) proved that the convergent distribution of the Moran test I corresponds to the standard normal distribution after making an adjustment to the Moran statistic I by subtracting the mean and dividing by the standard deviation, [3] so we assume that:

$$G = I - X(X'X)^{-1}X \qquad \dots (11)$$

$$E\,(I) = \left(\frac{n}{S}\right)tr(GM)/(n-k) \qquad \dots (12)$$

$$V(I) = \left(\frac{n}{S}\right)^{2}[tr(GMGM') + tr(GM)^{2} + (tr(GM))^{2}]/d - E(I)^{2} \qquad \dots (13)$$

$$d = (n-k)(n-k+2)$$

$$Z_I = [I - E(I)]/V(I)^{1/2} \qquad \dots (14)$$

The formula (14) used to see the existence of spatial dependence.[7] The calculated Z_I value is compared with the tabular Z value at a given level of significance and under the null hypothesis that there is a spatial dependence against the alternative hypothesis that there is no spatial dependence.

6. Application Part :

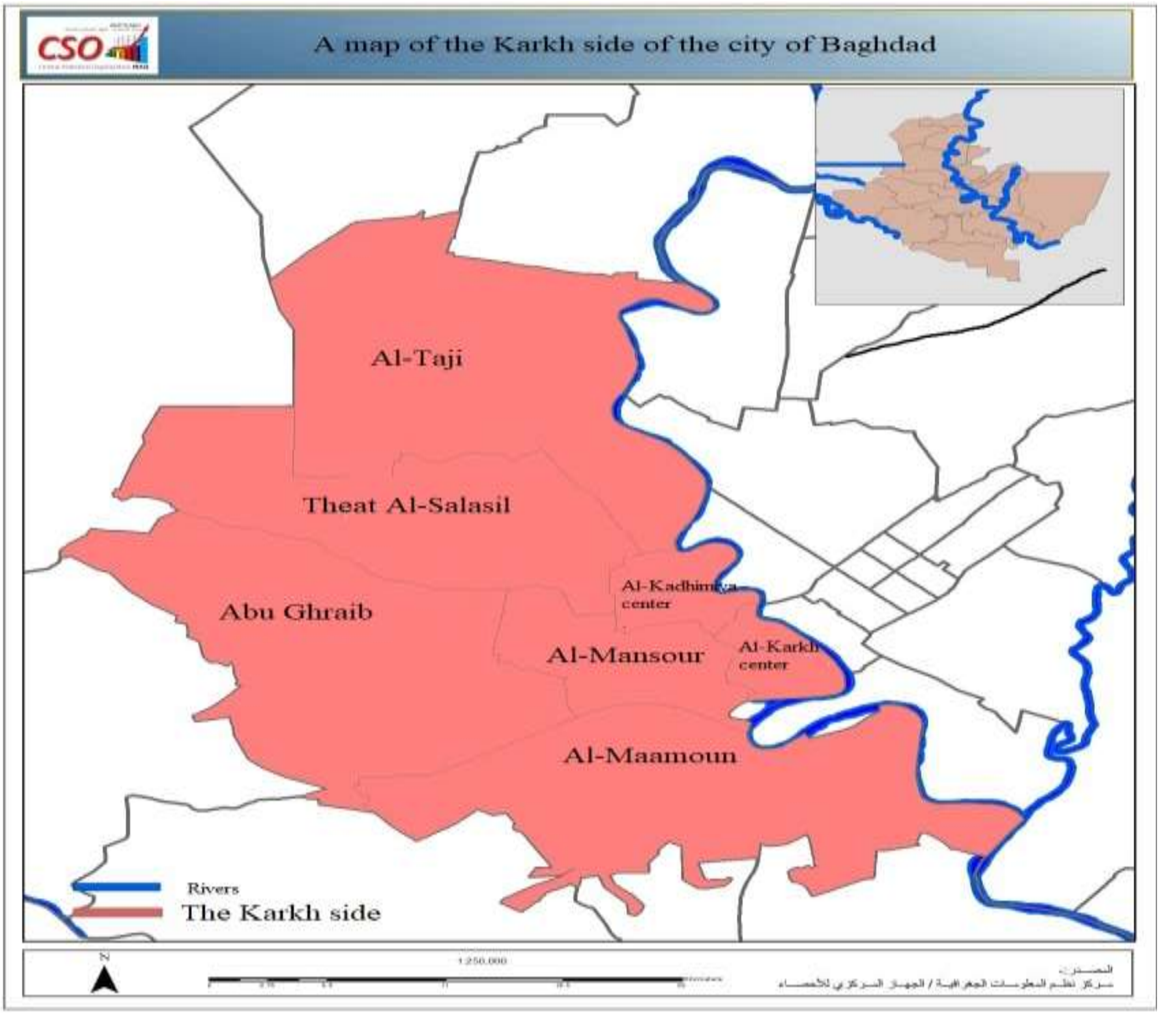
Despite the achievements of the health side and its associated hospitals and its support in providing medical supplies from doctors, nurses, other cadres and health supplies, but there is an important matter, which is how to reduce diseases and their spread between areas that have a direct impact on human life, as well as the impact of contiguity of regions around the spread of disease in this research the focus was on the spatial aspect i.e. The spatial contiguity to know their effect on the spread of diseases between regions to know the distribution of transmissible diseases infections and to build a spatial model to predict anemia, as this aspect included estimating the Durban spatial regression model by using the two matrices of ordinary and modified spatial contiguousness (M, M*) under the criterion of Rook contiguity and according to formula (3), And by using the spatial data collected by taking a random sample of 98 patients from patients with anemia, according to the geographical regions of the Karkh side in Baghdad governorate from the hospitals of the Baghdad Health Department / Ministry of Health, Iraq They were collected from the records and drums of each patient, as well as the assistance of the Central Bureau of Statistics of the Ministry of Planning in designing a map that includes the Karkh areas according to their administrative division. Where the data collected was described by the following variables The hemoglobin ratio in the blood was used for anemia patients, which is the dependent variable (Y), Also, five explanatory variables were used with their levels after agreement on them with the specialist doctors, and as shown in Table (1) below :

Table (1)

shows the explanatory variables with their description and levels

Explanatory variables	Description of explanatory variables	Code of explanatory variables
X_1	Marital status 1. married 2. not married	0 1
X_2	menstrual cycle for more than seven days 1. yes 2. no	0 1
X_3	bleeding during the menstrual cycle 1. yes 2. no	0 1
X_4	pregnancy or childbirth during the life period 1. yes 2. no	0 1
X_5	the number of total loads	-

As the data in the above table were obtained through a questionnaire for women of childbearing age, the number of cases studied in this research was 98 cases, which included all seven areas of the Karkh side of Baghdad governorate according to the administrative division and knowledge as follows: The first region represents Al-Karkh center, the second region represents Al-Mansour, the third region represents the Al-Kadhimiya center, the fourth region represents Al-Maamoun, the fifth region represents the Theat Al-Salasil, the sixth region represents the center of Abu Ghraib, the seventh region represents Al-Taji. Figure (2) represents a map of the Karkh side of the city of Baghdad, in which the seven regions are divided according to the administrative division:



by using Matlab the study model test was performed in formula (3) using the Z_I Moran test in formula (14) to detect spatial dependence and according to the following hypotheses:

$H_0: \theta = 0$ There is no spatial dependence
$H_1: \theta \neq 0$ There is spatial dependence

From Table (2) which shows the results of the Moran test and according to the above hypothesis it is found that the value of the Z_I Moran test statistic is 1.9849 when using the ordinary spatial contiguity matrix M and that its P-Value is equal to 0.00001 which is less than the significance level 0.05 and also equal to 9.2416 when using a matrix The modified spatial contiguity M* and that its P-value is equal to 0.00001, which is less than the significance level 0.05, and this indicates the significance of the test, meaning that there is a spatial dependence between the Karkh regions of Baghdad governorate.

Table (2) shows the values of the Moran test formula

Matrix type	Moran value (Z_I)	P-Value For the Moran's (Z_I) test
M	1.9849	0.04716
M*	9.2416	0.00001

The data were analyzed according to the ordinary spatial contiguity matrix M of dimension (98 x 98) by using the maximum likelihood method in estimating the parameters of the Durban Spatial Regression Model (SDM) in formula (3) and under the criterion of Rook contiguity shown in Table (3), as these parameters were tested using the F and t tests the significance value of the two tests was extracted and compared with the significance level of 0.05, so we note that the value of the F-test is equal to 225.29 and that its P-value is equal to 0.00001 and it is less than the significance level 0.05 and this indicates that the differences are significant, i.e. There is at least one of the explanatory and representative variables (marital status, menstrual cycle for more than seven days, bleeding during the menstrual cycle, pregnancy or childbirth during the life period, the number of total loads) that has a significant effect on the dependent variable Y, which is the ratio of hemoglobin in the blood. As for the t-test, it was found that the value of the test parameter b_0 is equal to 5.4727 and its P-Value is equal to 0.00001 and it is less than the significance level 0.05, and this indicates that the value of the parameter $b_0$is positive and significant.
In the absence of the ordinary spatial contiguity matrix M, the test value of the estimated parameter b_1 is -2.1274 and its P-value is 0.036096 It is less than the level of significance 0.05 and this is an indication that the variable X_1 which represents the marital status has a significant effect on the dependent variable Y which represents the Ratio of hemoglobin in the blood, as for the value of the test of the estimated parameter b_2 it is equal to 0.2796 and its P-value is equal to 0.780412 which is greater than the level of significance 0.05 and this is an indication that the variable X_2 which represents the menstrual cycle for more than seven days has a non-significant effect on the dependent variable Y which represents the ratio of hemoglobin in the blood, thus for the rest of the other explanatory variables that is the variable X_3 which represents bleeding during the menstrual cycle it has a significant effect on the dependent variable Y. The two variables X_4, X_5 which represent (pregnancy or childbirth during the life period, the number of total loads) have a non-significant effect on the dependent variable Y. In the case of the ordinary spatial contiguity matrix M the value of the test parameter b_6 estimated is 2.3014 and its P-value is equal to 0.02365 and it is less than the significance level 0.05 and this is an indication that the variable X_6 which represents the marital status has a significant effect on the dependent variable Y which It represents the Ratio of hemoglobin in the blood, and the test value of the estimated parameter b_7 is equal to -1.9980 and its P-value is equal to 0.048669 which is less than the level of significance 0.05 and This is an indication that the variable X_7 which represents the menstrual cycle for more than seven days, has a significant effect on the dependent variable Y

which represents the Ratio of hemoglobin in the blood, and so on for the rest of the other explanatory variables that is the variable X_8 which represents bleeding during the menstrual cycle which has a significant effect on the dependent variable Y. As for the variable X_9 which represents pregnancy or childbearing during the life period, it has a non-significant effect on the dependent variable Y and finally the variable X_{10} which represents the number of total loads has a significant effect on the dependent variable Y. We note from Table (3) that the value of the spatial dependence parameter θ of the Durban regression model when using the ordinary spatial contiguity matrix M is equal to 0.4587 which has an indication of the strength of the spatial dependence, and also through Table (3) we notice that the value of the coefficient of determination R^2 is equal to 0.5642 This indicates that 56% of the differences in the ratio of hemoglobin in the blood under the spatial effects are caused by the explanatory variables.

Table (3) represents the values of the parameters of the Durban spatial regression model estimated by the method of maximum likelihood ML using matrix M, t-test values, F and other indicators (θ, R^2, (RMSE))

Parameters vector $\underline{\beta}$	Parameters estimated using the method of maximum likelihood using M	Parameter value	T-test value	P-Value for t-test	F test value	Parameter value θ	The coefficient of determination value R^2	RMSE
β_0	b_0	22.3504	5.4727	0.00001	225.29	0.4587	0.5642	0.0438
$\underline{\beta}_1$ without M	b_1	-2.1543	-2.1274	0.036096				
	b_2	0.3145	0.2796	0.780412				
	b_3	-2.3655	-2.5040	0.014042				
	b_4	-2.7832	-1.8180	0.072319				
	b_5	-0.2948	-0.3127	0.755747				
$\underline{\beta}_2$ with M	b_6	2.0468	2.3014	0.023627				
	b_7	-1.2104	-1.9980	0.048669				
	b_8	-2.2768	-2.1091	0.037661				
	b_9	1.4516	1.5204	0.13184				
	b_{10}	0.6538	2.6058	0.010691				

After estimating the parameters of the Durban spatial regression model (SDM) in formula (3) and according to the ordinary spatial contiguity matrix M under the criterion of Rook contiguity shown in table (3) above the values of the dependent variable Y (the ratio of hemoglobin in the blood) symbolized by the symbol $\hat{\mathrm{Y}}$ for the spatial Durban regression model shown in table (4) and figure (3) below were estimated as it shows the real and estimated values of the dependent variable Y which is divided according to the seven regions of the Karkh side in Baghdad governorate.

Table (4) shows the real and estimated values of the dependent variable Y of the Durban spatial regression model using the ordinary spatial contiguity matrix M under the criterion of Rook Contiguity

Regions	S	The real values of Y	Estimated values of Y	Regions	S	The real values of Y	Estimated values of Y	Regions	S	The real values of Y	Estimated values of Y
Al-Karkh center	1	5.2	8.7258		34	14.4	8.4279		67	7.8	7.2850
	2	10.4	6.7577		35	5.3	4.9513		68	13.9	8.6485
	3	14.4	14.1692		36	4.3	7.9684		69	2.2	3.8085
	4	13.8	14.4837		37	5.3	6.0623		70	13.7	9.9650
	5	3.8	9.0403		38	2.2	6.0623	Abu Ghraib center	71	9.7	11.2928
	6	12.4	8.3888		39	3.9	6.3571		72	11.9	13.9531
	7	12.6	11.4058		40	5.3	6.0426		73	20.2	11.2928
	8	20.5	9.0403	Al-Maamoun	41	3.7	9.7500		74	13.5	13.9531
	9	3.9	9.0205		42	13.1	11.8208		75	13.2	12.8843
	10	3.3	7.9715		43	14.9	11.5063		76	13.8	11.5875
	11	13.8	13.4347		44	13	8.2415		77	12.7	11.5875
	12	3.7	13.4347		45	3.6	9.4553		78	12.5	13.6583
Al-Mansour	13	13.4	10.8573		46	4.2	8.7010		79	13	12.9041
	14	20.8	16.0060		47	13.7	11.8208		80	13.4	11.5875
	15	11.4	10.8573		48	4.2	9.7500		81	3.2	11.2928
	16	3.9	9.8083		49	7.8	9.7500	Al-Taji	82	14.1	11.3129
	17	13.5	12.9281		50	13	11.8208		83	3	10.2441
	18	4.4	9.0540		51	20.1	14.6040		84	12.3	9.6819
	19	10.2	12.1738		52	12.8	11.0665		85	3.3	7.4388
	20	3.3	7.5258		53	2.2	10.3123		86	12.9	8.9474
	21	12.1	12.1738		54	11.2	8.6813		87	11.7	11.3129
	22	12.6	12.1738		55	20.3	8.7010		88	20.3	14.5359

	23	3.9	13.2228		56	14	11.8208		89	13.1	9.9964
	24	12.1	10.8573	Al-Salasil	57	7.2	6.8452		90	12.8	8.9276
	25	15.4	10.8573		58	4.2	8.3537		91	3.4	9.9964
	26	13.9	12.1738		59	13.2	9.9650		92	7.3	11.3129
	27	14.1	12.9281		60	11.3	9.9650		93	14.1	8.1734
	28	13.7	8.5945		61	11.8	11.0140		94	7.2	8.9474
	29	13.1	10.8573		62	8.4	11.1172		95	5.3	12.3619
	30	9.4	10.1031		63	12.5	12.2887		96	12.3	9.7016
Al-Kadhimiya Center	31	9.3	5.6028		64	11.5	13.0430		97	11.5	12.0671
	32	3	6.0623		65	8.6	10.6995		98	12.6	9.2421
	33	12.7	7.3591		66	11.3	13.4827				

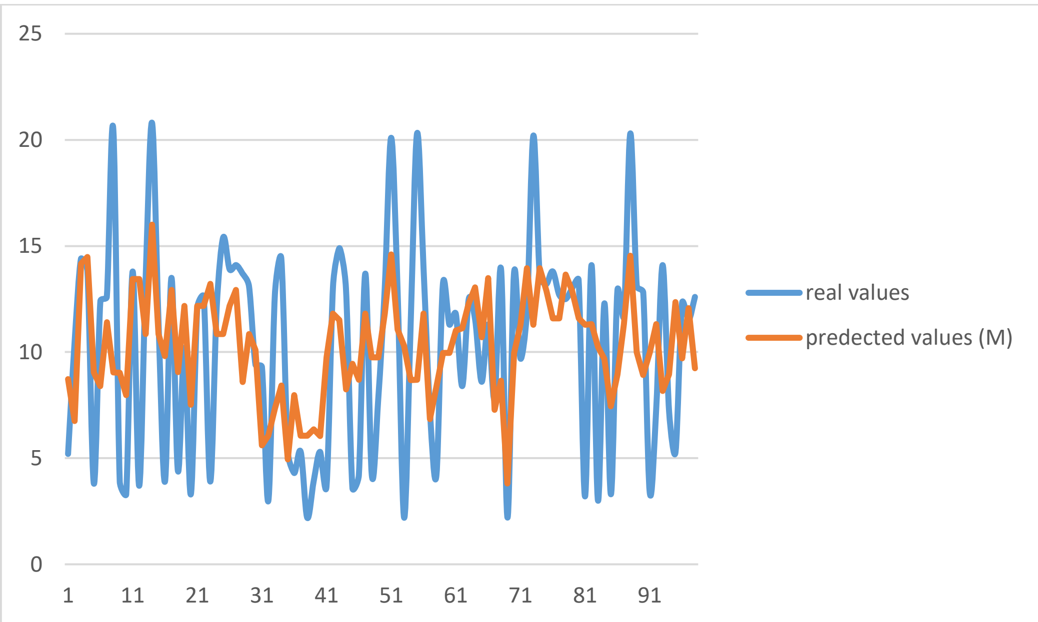


Figure (3) shows the real and estimated values of the dependent variable (Y), which represents the percentage of hemoglobin in the blood using the ordinary spatial contiguity matrix M under the criterion of Rook Contiguity Also, the data were analyzed according to the modified spatial contiguity matrix M* of dimension (98 × 98) by using the method of maximum likelihood in estimating the parameters of the Durban spatial regression model (SDM) in formula (3) and under the criterion of Rook contiguity shown in table (5) below, therefore we notice that the value of the F-test is equal to 50.8474 and that its P-value is equal to 0.00001, which is less than the level of significance 0.05, This indicates that the differences are significant that is, there is at least one of the explanatory variables represented (marital status, menstrual cycle for more than seven days, bleeding during the menstrual cycle, pregnancy or childbirth during the life period, the number of total loads) that has a significant effect on the dependent variable Y represented by (the ratio of hemoglobin in the blood). As for the t-test it was found that the value of the parameter test estimated $b_0$is equal to 1.9897 and its P-value is equal to 0.049593 and it is less than the level of significance 0.05, and this indicates that the value of the parameter b_0 is positive and significant. In the absence of the modified spatial contiguity matrix and its P-9920.1M* the value of the estimated parameter test b_1 is equal to - which is less than the significance level 0.05 and 49336value is equal to 0.0 This is an indication that the variable X_1 which represents marital status has a significant effect on the dependent variable Y which represents the ratio of test b_2 is hemoglobin in the blood, while the value of the estimated parameter equal to 0.2201 and its P-value is equal to 0.826281 which is greater than the level of significance 0.05 and this indicates that the variable X_2 which represents the menstrual cycle for more than seven days has a non-significant effect on the dependent variable Y Which represents the ratio of hemoglobin in the blood, and so for the rest of the other explanatory variables that is the variable X_5 which represents the number of total loads that have a non-significant effect on the dependent variable Y, As for the two variables X_3, X_4 which represent (bleeding during the menstrual cycle, pregnancy or childbirth during the life period) they have a significant effect on the dependent variable In the case of the value of the estimated parameter the modified spatial contiguity matrix M* test b_6 is equal to 2.0187 and its P-value is equal to 0.04643 and it is less than the significance level 0.05 and this is an indication that the variable X_6 which represents the marital status has a significant effect on the dependent variable Y which is It represents the ratio of hemoglobin in the blood, As for the test 258 and its P-value is 7.2value of the estimated parameter b_7 it is equal to - 80 which is less than the significance level 0.05 and This is an 7600equal to 0. indication that the variable X_7 which represents the menstrual cycle for more than seven days has a significant effect on the dependent variable Y which represents the ratio of hemoglobin in the blood, Thus for the rest of the other explanatory variables That is the variable X_{10} which represents the number of total loads that have a non-significant effect on the dependent variable Y, either the two variables X_8, X_9 which represent (bleeding during the menstrual cycle, pregnancy or childbirth during the life period) they have a significant effect on the dependent variable Y .We notice from table (5) that the value of the spatial dependence parameter of the Durban regression model when using the modified spatial contiguity matrix M^* is equal to 0.6251 which is an indication of the strength of the spatial dependence. Also through table (5) we note that the value of the coefficient of determination R^2 is equal to 0.6832 This indicates that

68% of the differences in the ratio of hemoglobin in the blood under the spatial effects are caused by the explanatory variable

Table (5) represents the values of the parameters of the Durban spatial regression model estimated by the method of maximum likelihood ML using matrix M* t-test values, F and other indicators (θ, R^2, (RMSE))

Parameters vector $\underline{\beta}$	Parameters estimated using the method of maximum likelihood using M	Parameter value	T-test value	P-Value for t-test	F test value	Parameter value θ	The coefficient of determination value R^2	RMSE
β_0	b_0	89.6306	1.9897	0.049593	50.8474	0.6251	0.6832	0.0435
$\underline{\beta}_1$ without M^*	b_1	-0.7198	-1.9920	0.049336				
	b_2	0.2499	0.2201	0.826281				
	b_3	-2.2404	-2.3637	0.020233				
	b_4	-3.1950	-2.0053	0.047902				
	b_5	-0.1292	-0.1364	0.892118				
$\underline{\beta}_2$ with M^*	b_6	2.7591	2.0187	0.046430				
	b_7	-18.4142	-2.7258	0.007680				
	b_8	-140.574	-2.9473	0.004065				
	b_9	84.2002	2.1470	0.034423				
	b_{10}	11.1843	0.6266	0.532473				

After estimating the parameters of the Durban spatial regression model (SDM) in formula (3) and according to the modified spatial contiguity matrix M* under the criterion of Rook contiguity shown in table (5) above The values of the dependent variable Y (the ratio of hemoglobin in the blood), which is symbolized by the symbol $\hat{Y}$ for the spatial Durban regression model shown in Table (6) and Figure (4) below, were estimated, as it shows the real and estimated values of the dependent variable Y, which is divided according to the seven regions of the Karkh side in Baghdad governorate.

Table (6) shows the real and estimated values of the dependent variable Y of the Durban spatial regression model using the modified spatial contiguity matrix M* under the criterion of Rook Contiguity

Regions	S	The real values of Y	Estimated values of Y	Regions	S	The real values of Y	Estimated values of Y	Regions	S	The real values of Y	Estimated values of Y
Al-Karkh center	1	5.2	7.4832		34	14.4	8.8812		67	7.8	8.0578
	2	10.4	5.4531		35	5.3	5.4115		68	13.9	9.1567

	3	14.4	13.0479		36	4.3	8.2907		69	2.2	4.5881
	4	13.8	13.2977		37	5.3	6.6408		70	13.7	10.5481
	5	3.8	7.7331		38	2.2	6.6408		71	9.7	11.8739
	6	12.4	7.0944		39	3.9	6.7701		72	11.9	14.2436
	7	12.6	9.9735		40	5.3	6.5202		73	20.2	11.8739
	8	20.5	7.7331		41	3.7	9.8936		74	13.5	14.2436
	9	3.9	7.6125		42	13.1	12.0048		75	13.2	13.2739
	10	3.3	6.7634		43	14.9	11.7549	Abu Ghraib center	76	13.8	12.0032
	11	13.8	12.4487		44	13	8.4541		77	12.7	12.0032
	12	3.7	12.4487		45	3.6	9.7644		78	12.5	14.1143
	13	13.4	10.2011		46	4.2	9.0446		79	13	13.3946
	14	20.8	15.6365		47	13.7	12.0048		80	13.4	12.0032
	15	11.4	10.2011	Al-Maamoun	48	4.2	9.8936		81	3.2	11.8739
	16	3.9	9.3521		49	7.8	9.8936		82	14.1	11.3868
	17	13.5	12.3123		50	13	12.0048		83	3	10.4171
	18	4.4	8.6323		51	20.1	15.1998		84	12.3	9.7455
	19	10.2	11.5925		52	12.8	11.2850		85	3.3	7.7068
	20	3.3	7.0721		53	2.2	10.5652		86	12.9	9.1464
Al-Mansour	21	12.1	11.5925		54	11.2	8.9240		87	11.7	11.3868
	22	12.6	11.5925		55	20.3	9.0446		88	20.3	15.0517
	23	3.9	12.4415		56	14	12.0048	Al-Taji	89	13.1	9.9954
	24	12.1	10.2011		57	7.2	7.5879		90	12.8	9.0258
	25	15.4	10.2011		58	4.2	9.0275		91	3.4	9.9954
	26	13.9	11.5925		59	13.2	10.5481		92	7.3	11.3868
	27	14.1	12.3123	Al-Salasil	60	11.3	10.5481		93	14.1	8.3060
	28	13.7	8.0418		61	11.8	11.3971		94	7.2	9.1464
	29	13.1	10.2011		62	8.4	12.1018		95	5.3	12.2358

	30	9.4	9.4813		63	12.5	13.1525		96	12.3	9.8662
Al-Kadhimiya Center	31	9.3	6.0503		64	11.5	13.8723		97	11.5	12.1066
	32	3	6.6408		65	8.6	11.1472		98	12.6	9.2756
	33	12.7	7.9116		66	11.3	14.3422				

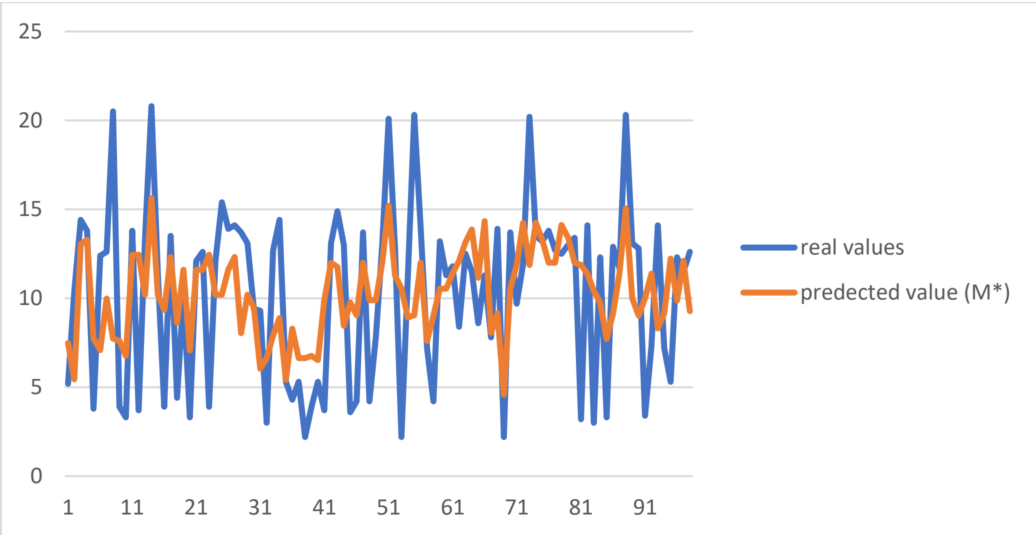


Figure (4) shows the real and estimated values of the dependent variable (Y),which represents the percentage of hemoglobin in the blood using the modified spatial contiguity matrix M^* under the criterion of Rook Contiguity.

7. Conclusions:

1. The value of the F-test of the Durban Spatial Regression Model (SDM) when using the ordinary and modified spatial contiguousness matrices (M , M*) has significant differences meaning that there is at least one explanatory variable that has a significant effect on the dependent variable Y.

2. That in the absence of the ordinary and modified spatial contiguity matrix (M, M*) the value of the t-test for the parameters (b_1, b_3) has a significant effect and this is an indication that the explanatory variables (X_1, X_3) have an effect significant for (Y), while the value of the t-test for the parameters (b_2, b_5) has non-significant effects and this is an indication that the explanatory variables (X_2, X_5) have an effect Is insignificant over (Y).

3 That in the case of the ordinary spatial contiguity matrix (M), the value of the t-test for the parameters (b_6, b_7, b_8, b_{10}) has a significant effect and this is an indication that the explanatory variables (X_1, X_2, X_3, X_5) has a significant effect on (Y) under the spatial effects, while the value of the t-test of the parameter b_9 has a non-significant effect meaning that the variable X_4 has a non-significant effect on (Y).

4. In the case of the modified spatial contiguity matrix (M^*) the value of the t-test for the parameters (b_6, b_7, b_8, b_9) has a significant effect and this is an indication that the explanatory variables (X_1, X_2, X_3, X_4) has a significant effect on (Y) under the spatial effects, while the value of the t-test of the parameter b_{10} has a non-significant effect, meaning that the variable X_5 has a non-significant effect on (Y).
5. The value of the square root of the mean square error RMSE in the case of using the ordinary spatial contiguous matrix M is equal to 0.0438, which is greater than the value of the square root of the mean square error RMSE in the case of using the modified spatial contiguous matrix M* which is equal to 0.0435, and this indicates that the Durban spatial regression model when using the M^* is the best in data representation
6. The drawing shows that the estimated values of the dependent variable Y when using the ordinary and modified spatial contiguity matrices (M, M*) It is an approximation to the real values of the same variable.
7. Show through the value of the coefficient of determination R^2 when using the matrix M that there is 56% of the differences and when using the M* matrix, the percentage of differences is 68% for the dependent variable Y and this is caused by the explanatory variables.
8. In the case of a matrix (M), it appears that the two variables (X_2, X_3) have opposite significant effects, while the two variables (X_1, X_5) have positive significant effects and the variable (X_4) has a non-significant negative effect. In the case of a (M*) matrix, the two variables (X_2, X_3) have negative significant effects, while the two variables (X_1, X_4) have positive significant effects, and the variable (X_5)has a negative negative effect.

8. Recommendations:

1. As future studies, nonparametric and semi-parametric methods are used in estimating the Durban Spatial Regression Model for spatially approved data.
2. Study spatial economic standard models for spatial data, which include economic, social and agricultural phenomena, including health and other phenomena.
3. Conducting a database that includes the health field for the purpose of making things easier for researchers in collecting data for the purpose of conducting an accurate and realistic study, including giving a clear picture in that area.
4. Add another factor which is the time factor with the place factor in the study of the spatial standard models.

9. Sources:

1. Hussein, Saja Muhammad and Akkar, Ahmad Abd Ali, (2019), “Proposing core functions with a two-stage method to estimate the SPSEM model”, Journal of Administration and Economics, Al-Mustansiriya University, Volume (2), Issue (122), pages (529-544).
2. Hussein, Saja Muhammad and Akkar, Ahmed Abd Ali, (2019), “Some Estimation methods for the two models SPSEM and SPSAR for spatially dependent data”, Journal of Economic and Administrative Sciences, University of Baghdad, vol. (25), Issue (113), pages (499-524).

3. Ali, Omar Abdul-Mohsen and Hadi, Sawsan Qasim, (2014),“Spatial Regression Models Estimation for the poverty Rates In the districts of Iraq in 2012”, Journal of Economic and Administrative Sciences, University of Baghdad, Volume (20), Issue (79), Pages (337- 351).
4- Anselin, L. (1988); Spatial Econometrics: Methods and Models; Kluwer Academic, Publishers, Dordrecht, The Netherlands.
5- Anselin, L. and Bera, A. K. (1998); Spatial Dependence in Linear Regression Model With An Introduction to Spatial Econometrics; In: UIlah A, Giles DEA (eds) Handbook of applied economic statisties. Marcel Dekker, New York, pp (237-289).
6- Cameron (2014); Spatial Econometrics Introduction and Reading List; Department of Political Science, Texas.
7- Gan, Jiansheng. (2009); Spatial Combination Interpolation model based on panal data and its empirical study; school of management, Fuzhou university (or Fujian institute of economics and management) Fuzhou 350002, china.
8- Gerolimetto, M., & Magrini, S. (2009). "Nonparametric regression with spatially dependent data". Department of Economics WP, 20- 2009.
9- Lesage ,James P.(1997). Regression Analysis of Spatial Data. Department of Economics University Toledo , pp (83 – 90).
10- Lesage , James P. (1999) . The Theory and Practice of Spatial Econometrics. Department of Economics University of Toledo, Ohio4.
11- Lesage , James P. and Pace, R. K. (2009); Introduction to Spatial Econometrics; Taylor and France Group , pp (45 – 69).

Estimation the spatial Durban regression model for anemia patients sample in some region of Al-Karkh/ Baghdad

تقدير انموذج انحدار Durban المكاني لعينة من مرضى فقر الدم في بعض مناطق الكرخ / بغداد

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المستخلص :

أن دراسة الظواهر الاقتصادية والصحية المكانية لها أهمية بالغة في البحوث حيث تم دراسة متغير مضاف ومهم الا وهو المتغير المكاني، وبسبب ذلك يعد انموذج انحدار ديربن المكاني (Spatial Durban Regression Model) من النماذج المهمة في التطبيقات للعديد من الظواهر، ان هدف البحث هو تقدير معلمات انموذج انحدار ديربن المكاني مستعملا مصفوفتي التجاورات المكانية الاعتيادية والمعدلة في ظل معيار تجاور Rook باستعمال الطريقة المعلمية والمتمثلة بطريقة الامكان الاعظم (Maximum Likelihood Method)، اذ تم توظيف الانموذج لدراسة مرض فقر الدم والذي يبين العلاقة بين المتغير المعتمد Y والمتمثل بنسبة الهيموغلوبين في الدم والمتغيرات التوضيحية والمتمثلة (الحالة الاجتماعية، الدورة الشهرية لاكثر من سبعة ايام، نزف اثناء الدورة الشهرية، حمل او انجاب خلال فترة الحياة، عدد الاحمال الكلية) في ظل اثر التجاور المكاني، ومن اهم الاستنتاجات التي تم التوصل اليها ظهور تأثيرات معنوية لبعض المتغيرات التوضيحية على المتغير المعتمد Y، كما اظهر ان مصفوفة التجاورات المكانية المعدلة M^* هي افضل من مصفوفة التجاورات المكانية الاعتيادية M عند تقدير انموذج انحدار ديربن المكاني في تمثيل البيانات وان القيم التقديرية للمتغير المعتمد Y تكون مقاربة للقيم الحقيقية لنفس المتغير.

الكلمات المفتاحية :

انموذج انحدار ديربن المكاني، مصفوفة التجاورات المكانية، معيار تجاور Rook، طريقة الامكان الاعظم