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Mathematical Methods in Determining Spatial Development Priorities for The Industrial Sector at The Level of The Iraqi Governorates: A Study of Quantitative Measures to Determine Investments in Industrial Urbanization

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Abstract

The levels of development exhibit significant disparities across countries and even among different parts of the same governorates. The major focus of many planners and decision makers was to investigate and analyze the regional variation in development levels. The study aims to examine the regional disparities in investment within the industrial sector throughout the governorates of Iraq. This analysis is not just based on quantitative indicators but also takes into account the specific investment requirements of each governorate. To overcome this issue, we do the following actions: A mathematical model is constructed to elucidate the regional differences in investment amongst governorates. This model uses factor analysis to quantify the association between various variables studied. Utilize the Ridge Regression Model to assess the influence of the factors on the geographical distribution of investment. The study aimed to determine the allocation of investment in the industry sector among the Iraqi governorates. The priorities for distribution were as follows: "Al-Muthanna", "Missan", "Wasit", "Salahuddinni", "Thi-Qar", "Diala", "Kerbala", "Kirkuk", "Al-Qadisiya", "Al-Anbar", "Al-Najaf", "Babil", "Nineueh", "Basrah", and Baghdad. This allocation aimed to achieve a balanced regional development. The value of the challenge coefficient (R^2= 0.84 and the correlation coefficient) (R= 0.91), indicates the strength of the effect of the economic variables on the investment sector. This value is the spatial distribution of industrial investments among the governorates, and this is confirmed by the decrease in the value of (MSE) as it reached 3319.41, which confirms the increase in the efficiency of the model at (k= 0.016).

Keywords: Industrial Sector, Industrial Urbanization, Mathematical Methods

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1. Introduction

Throughout history, people have turned to mathematics as a tool for understanding and solving issues. Countless fields rely on mathematics as a tool because it offers a formal foundation for studying and simulating complicated systems. People from many areas of life may benefit from the development of logical thinking, problem-solving abilities, and mental discipline [1].

Commonly referred to be the "key of technology" these days. Anyone hoping to make a difference in the creation of new technologies or to work in sectors dependent on technology must have a solid background in mathematics. From the first stages of the Industrial Revolution to the current Fourth Industrial Revolution (4IR), mathematics was an essential tool [2].

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 ISSN: 2073-9524
Page:1-16

Critical design and the theoretical construction of the different factory machinery and improvements to production processes were both aided by mathematics during the First Industrial Revolution. The steam engine, an essential component of the first industrial revolution, owes much of its success to mathematical calculations [3].

Additionally, the telegraph, railway, and steamship were all heavily reliant on mathematical tools and procedures throughout the Second Industrial Revolution for their creation and development. Product development procedures, including mass manufacturing techniques and the creation of interchangeable components, also benefited from its use [4].

In addition, the third industrial revolution relied heavily on mathematics for the development of computer systems and automated processes in several sectors, including manufacturing. To create intelligent decision-making systems, it was necessary to create and implement mathematical models and algorithms for processing and analyzing data and optimizing processes [5].

Mathematical tools are used in development planning to elucidate economic phenomena by illustrating the interconnections among variables in the examined phenomenon. Mathematical functions are used to derive estimated outcomes of the interaction between variables. The use of mathematical and statistical techniques has significantly advanced the development of a comprehensive theoretical framework for cosmic events [6].

Mathematics is now an integral component in validating theories across several scientific disciplines. In Iraq, there is a lack of specialized research on the implementation of sports methodologies that have been officially endorsed by the local authority. Hence, this research aims to examine the correlation between aspects of attraction and investment, with the objective of identifying variables that have a role in attracting and securing investments, using a factor analysis approach [7].

The geographical distribution of investments is assessed using a linear regression model to determine the influence of these factors. To achieve balanced spatial development, it is necessary to determine the magnitude of development priority between the governorates. This may be done by using the preceding two models to create development poles. The industrial sector was selected because of its fundamental role in the economic and social development of emerging nations, such as Iraq. This research is the first study of the expected mathematical models that can describe the relationship between Mathematical Methods in Determining Spatial Development Priorities and the nature of the Industrial Sector in Iraq.

Spatial development refers to the attainment of an optimal spatial arrangement of economic activities, ensuring that the degree of development in any given location is conducive to efficient and effective economic growth. In other words, they depict the geographical and spatial dimensions of economic progress. Therefore, achieving balanced spatial development involves establishing a framework for the allocation of investment projects in a manner that is not just reliant on economic considerations [8].

Reliance on these economic considerations results in the promotion of development in the established development centers while perpetuating underdevelopment in other parts of the nation. Therefore, achieving balance in growth entails the harmonious integration of many centers of development. The primary objective of spatial development is to establish equilibrium among different areas, ensuring convergence in average income and level of life, while also mitigating unplanned movement patterns [9].

The objective of spatial development is to concentrate industry in certain areas and evenly distribute services, therefore decreasing unemployment and enhancing the level of economic activity to elevate the growth rate. The spatial development objectives' priority differs among regions. In one location, the primary objectives may revolve around augmenting the average per capita income, but in another region, the emphasis is in enhancing the level of services offered to that area [10].

This study is considered the first of its kind, according to the researcher's knowledge, to use different mathematical models, whether in analyzing the spatial variation of industrial sector investment in the Iraqi governorates or using the Ridge Regression model in measuring the impact of the studied variables on the spatial distribution of industrial sector investments.

2. Literature Review

The word encompasses a wide range of mathematical approaches to solving issues with practical industrial applications. I would say that IM is more of a mathematical mode of operation than a distinct area or subfield due to the breadth of mathematics that it may cover. Brian Wetton said it concisely in his 2013 CAIMS-Mprime Industrial Mathematics Prize lecture: "Industrial mathematics is mathematics that industry is willing to pay for (26).

Employing applied mathematicians in industry has several advantages. Financial optimization abilities are crucial. Mathematics can help engineers analyze and solve technological difficulties. We can utilize mathematical models to comprehend certain processes' physics, chemistry, and biology. Understanding may improve process efficiency. Financial savings may be substantial [11].

Applied mathematicians in engineering and science must be multidisciplinary. This means they must have scientific broad knowledge and be able to provide mathematical representations of practical difficulties. Although mathematics is a universal language, applied mathematicians may connect with scientists from many fields [3].

After setting up and validating the basic mathematical model, the applied mathematician must be willing to follow other scientists' recommendations on which physical variables are significant and which research avenues to pursue. Traditional applied mathematics students learn mathematical procedures and practice them on standard mathematical problems. The initial phase of mathematical modeling simplifying or expressing a practical situation for mathematical analysis—is harder to teach. Writing problems well takes years of experience.

2.1. Mathematical Methods

The analysis of the relationship between polarization and investment is based on several theoretical and mathematical methods, which we will explain in Fig. 1 as follows:

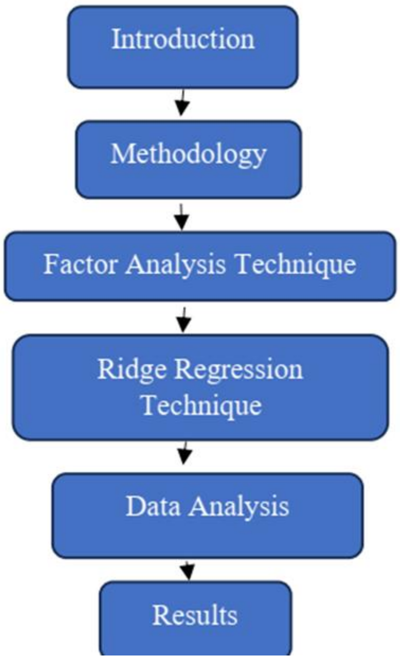

Fig. 1 The methodology Flowchart

2.1.1. Factor Analysis Model

Factor analysis is a statistical technique that is used to explain the variation among observable variables that are connected, by using a smaller number of unseen variables known as factors. For instance, it is plausible that the fluctuations in six known variables mostly correspond to the fluctuations in two unseen (latent) variables [11].

Factor analysis aims to identify common patterns of variation in response to underlying, unobservable factors. Factor analysis is a statistical method where the observed variables are represented as linear combinations of possible factors, along with "error" terms. This means that factor analysis may be seen as a specific instance of errors-in-variables models [12].

A major reason for factor analytic approaches is that they may decrease a dataset's variables by revealing their interdependencies. It may assist with data sets with many observable variables that represent fewer underlying/latent factors. It is one of the most prominent inter-dependency strategies used to uncover latent factors that establish commonality in each group of variables with systematic interdependence [13].

If we assume that there are (P) variables, and that each variable is $(X_{j,j} = 1,2,3,\cdots,P)$, then it can be expressed in terms of (m) of hypothetical factors $(F_L, L = 1,2,3,\cdots,m)$ as in the following equation:

$$X_j = a_{j1}F_1 + a_{j2}F_2 + a_{jL}F_L \dots + a_{jm}F_m + U_j \quad (1)$$

And,

$$X_j = \sum_{L=1}^{m} a_{jL}F_L + U_j \quad (2)$$

Where P represents the number of variables $(j = 1,2,3,\cdots,P)$ is the index of variables, M represents the number of common factors $(L = 1,2,3,,\cdots,m)$ and factor index $(P > m)$, a_{jL} represents the (loading) factor of the variable (j) in the extracted factor (L) and is called (factor loadings), $(F_1,\cdots,F_m)$ represents the factors that are extracted from solving the factor analysis model. The number of these factors is less than the number of variables, and they are called (common factors), U_j is the factor representing the specificity of the variable (j) in creating the phenomenon, that is, the amount of variance that is not explained by any factor in the equation [14].

The commonness value of the variable (X_j) is the sum of the squares of the loadings of that studied variable (h_j) which can be represented as follows:

$$h_j^2 = a_{j1}^2 + a_{j2}^2 + \cdots + a_{jp}^2 \quad (3)$$

In the condition that the variable x represented with error terms as follows:

$$X_i = a_{i1}F_1 + a_{i2}F_2 + \cdots + a_{im}F_m + e_i \quad (4)$$

One of the characteristics of (h_j^2) is that it is positive and lies between zero and one $0 \le h_j^2 \le 1$. Since the prevalence values (h_j^2) represent the percentage of variance explained by the factors for each variable, its variance is according to the following equation [15]:

$$U_j = 1 - h_j^2 \quad (5)$$

Where U_j is the variance of the commonness values, $j = 1,2,\cdots,p$.

2.1.2. Basic Assumptions of Factor Analysis

1) First hypothesis

The variables explaining the phenomenon have a noticeable correlation between (J, J') and the direct effect of any variable can be calculated by calculating the covariates according to the following equation:

$$r_{JJ'} = a_{J1}a_{J'1} + a_{J2}a_{J'2} + \cdots + a_{Jp}a_{J'p} \quad (6)$$

2) Second hypothesis

The hypothesis states that there is a relationship between a group of variables and that these relationships result from common factors that affect them. From these factors, the standard value for each observation can be represented assuming the presence of m factors. Under this hypothesis, we have three types of variation:

- Common Variance, symbolized by (h_{j2}).
- Error Variance, symbolized by (e_{j2})
- Specific Variance, symbolized by (S_{j2}).

2.1.3. Methods of Factor Analysis Model

There are multiple ways to solve the factor model, the most important of which are the following:

- Principal factor Method
- Minor method
- Maximum liquidity method
- Image method

We will briefly touch on the theoretical aspects of the principal factor method adopted in the analysis.

1) Principal factor method

This method is based on the analysis of the main components after making some modifications to them, as the coefficients of the factors are extracted sequentially, so the coefficients of the first factor are extracted.

(F1) which is characterized by the largest common value of the variables, then we extract the coefficients of the second factor.

(F2) which represents the largest value of the residual commonness of the remainder of the correlation matrix, and we continue the same method until extracting all the coefficients for the required factors.

There were several criteria for determining the number of important factors. In 1960, Kaiser [16] concluded that the number of factors is equal to the number of base (sample) values whose value is greater than one and calculated from the original correlation matrix. After that, the significance of the loadings of the variables on each factor is tested. The most used test is the test presented by Banks and Burt, where they used the standard error of the loadings to determine the significance of the loadings, and it is calculated according to the following formula:

$$S_{ajt} = S_{r_{x_i}y_i}\sqrt{\frac{P}{P+1-t}} \tag{7}$$

Whereas $S_{r_{x_i}y_i}$ is the significant tabular value of the correlation coefficients, P is the number of variables in the set, t is the rank of the variable in the extraction process.

2) Linear regression model/ridge regression

The linear regression method is one of the most important standard methods used in all studies. It aims to estimate the linear mathematical relationship that links two or more variables to each other. Hence, multiple linear regression is concerned with expressing the relationship between the dependent variable and several explanatory variables, with the availability of certainty. There is a causal relationship between them. The letter regression method is one of the estimation alternatives when there is a linear relationship between the explanatory variables of the general model.

Character regression proposed this method. To address the problem of multicollinearity, this can be summed up by adding a small quantity (positive $K > 0$) to the diagonal elements of the correlation matrix between the explanatory variables $(X'X)$ before inverting it, and define the resulting expression as follows:

$$\hat{B}_{RR} = \left(X'X + KI_P\right)^{-1} X'Y \tag{8}$$

The term $\hat{B}_{RR}$ is called the ordinary ridge regression estimator, and the factor K has been defined as follows:

$$K < \frac{\sigma^2}{\alpha_{max}} \tag{9}$$

The term α_{max} can be defined as the following:

$$\alpha_{max} = \max(v_i, B)^2\,, I = 1,2,3,\cdots p \tag{10}$$

Whereas $(v_i, I = 1,2,3,\cdots p)$ represent the eigenvectors in the matrix $(X'X)$, B represents a vector of estimated parameters. Values for (K) can be found as follows:

$$MSE\left(\hat{B}_{RR}\right) < MSE\left(\hat{B}_{LS}\right) \tag{11}$$

and,

$$\sigma^2 \sum \frac{1}{\lambda} \tag{12}$$

It is not possible to determine the optimal value for k precisely, but several studies presented in the statistical literature have presented methods for choosing this value, including the following:

- Ridge trace: The approach introduced by Hoerl and Kennard in 1970, utilizes a graphical display to see the impact of altering the value of K on a collection of estimators $(R.R)$. Each estimator is represented by a distinct line, allowing for straightforward interpretation. This approach gives us the ability to get insights into the behavior of each estimator and its characteristics. Select a constant value for (k) that ensures the estimators remain stable across all estimators. Nevertheless, I find fault with this approach since the selected number for (k) is not the only option available [2].

- Simulation technique: Simulation refers to the endeavor of generating precise representations of a system without implementing that system. This is often achieved by using mathematical and statistical models, utilizing a computer, and then replicating that system under situations of uncertainty. Simulation approaches are used to establish the ideal value for (k) considering the dependence of (K) on the unknown values of B and σ^2. One such method, presented by Hoerl, Kennard, and Baldwin in 1975, suggests adopting the mean as the optimal value for (k) within this approach. The harmonic value of (ki) is determined using the following equation:

$$K = \frac{\sigma^2}{\alpha_i} \tag{13}$$

Which equal to the following:

$$K_H = \frac{1}{P}\sum\frac{1}{K_i} = \frac{\sum\alpha_i^2}{p\sigma^2} = \frac{\alpha'\alpha}{p\sigma^2} = \frac{B'B}{p\sigma^2} \tag{14}$$

Where:

$$K_H = \frac{p\sigma^2}{B'B} \tag{14}$$

Because the values of B and σ^2 are unknown values, they are therefore replaced with estimated values as follows:

$$K = \frac{\sigma^2}{\alpha_i} \tag{15}$$

and,

$$K_H = \frac{p\sigma^2}{\hat{B}_{LS}\hat{B}_{RS}} = \frac{p\sigma^2}{\alpha'\alpha^2} \tag{16}$$

This parameter makes the MSE as low as possible when it is $X'X = I$ that is when they are perpendicular.

3. Mathematical Models and Variables

Quantitative tools are used to facilitate economic research and ascertain the determinants that attract investments. Furthermore, the process of assessing the impact of industrial investments on geographical distribution necessitates the identification of fundamental factors and the collection of data, in line with the study methodology. The researcher obtained data on economic factors from the Ministry of Planning and Development Cooperation, namely the Central Agency as shown in the table **1**. The sources used for data include the Regional Planning Authority, the Economic Department, the Government Investment Program, and interviews with select officials, I will apply a mathematical process according to the following equation:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_7, X_8, X_9, X_{10}) \tag{16}$$

Whereas Y is the volume of investment allocations to the industrial sector by the governorate for the year 2020. The economic variables affecting the spatial distribution function of industrial sector investments (polarization factors) are represented by the following table:

Table 1: The variables and their meaning in this study

X_1	The GDP value of the industrial sector per governorate for the years (2014-2020).
X_2	The sum of the average numbers of industrial establishments (large, medium, and small) for each governorate for the years (2014-2020).
X_3	Total average number of workers in the large, medium, and small industrial facilities for each governorate for years (2014-2020).
X_4	The sum of the average value of wages and benefits for establishments (large, medium, and small) for each governorate for the years (2014-2020).
X_5	Total average value of industrial production for large establishments medium and small for each governorate for the years (2014-2020).
X_6	The sum of average values of industrial production requirements for establishments (large, medium) and small ones (for each governorate) (2014-2020).
X_7	Electrical energy received by each governorate (megawatt-hour) and according to estimates for the period (2014-2020).
X_8	Average amount of net water received for each governorate cubic meter for years (2014-2020).
X_9	Health level, measured by the average number of hospital beds for the years (2014-2020) for each governorate.
X_10	Percentage of urban population to total population for each governorate for the year. (2014-2020)

3.1. Factor Analysis Model to Analyze the Relationship of Polarization Factors to Investments

To determine the most important factors for attracting industrial investments, the data collected by the researcher was entered into the computer, using the ready-made application (SPSS). To identify the most important variables affecting the spatial distribution of industrial investments, the correlation matrix for the studied variables was calculated according to the Newman-Pearson formula as shown in Table 2.

We note from the matrix of correlation coefficients above that the correlation is relatively weak between the size of investment allocations and the variables affecting their attraction, except for the variables (X_1, X_3, X_4, X_8, X_{11}). The highest correlation between the size of investment allocations and the educational level (0.69). Regarding the value of the correlation coefficients between the polarization factors studied, we note from the table above that they are strong.

It is very good, as the variable value of the gross domestic product of the industrial sector by governorate (X_2) achieved the highest correlation subject to the rest of the factors in other polarizations, the highest correlation was between it and the variable average wages and benefits (X_4), which amounted to about (0.54), while the lowest correlation was between it and the quantity of pure water received.

For each governorate, it was about (0.17), the lowest value of the correlation coefficients was between the amount of net water received for each governorate with the other variables, as it ranged between (0.17-0.93). To analyze the correlations for the Variables affecting the polarization of industrial investments (spatial distribution of investment allocations). Spatial distribution of investment allocations (by the principal factors method (P.F.A.)).

It is essential to ascertain the number of primary variables that account for most of the difference in the geographical distribution of investments across the governorates under investigation. Determine the fundamental value of the correlation coefficient matrix by considering the proportion of variance attributed to each element and the total variance contributed by all factors. The results we obtained reveal that there are two fundamental factors influencing the spatial distribution of investments. These factors are characterized by a base value exceeding one and their significance in attracting and consolidating industrial investments at the governorate level varies depending on their respective importance and impact.

4. Results and discussion

To choose the appropriate regression function for the studied data to measure the

 ISSN: 2073-9524
Page:1-16

relationship between polarization factors (explanatory variables) and the spatial distribution of investment allocations (dependent variable), and using the ready-made application (StatRad) and relying on the data that takes the shape of the spread points for each factor of polarization versus investment allocations was drawn Industrial, as it became clear that there is an increasing linear relationship between polarization factors and industrial investment allocations as explained in the table **2**.

Table 2: Simple correlation coefficient matrix for industrial investment model variables

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Y	1	0.47	0.69	0.19	0.18	0.54	0.36	0.61	0.82	0.80	0.40
X_1		1	0.55	0.81	0.89	0.69	0.41	0.52	0.74	0.71	0.23
X_2			1	0.47	0.54	0.23	0.22	0.27	0.32	0.11	0.70
X_3				1	0.65	0.17	0.19	0.42	0.41	0.82	0.46
X_4					1	0.39	0.60	0.73	0.74	0.82	0.06
X_5						1	0.70	0.38	0.79	0.17	0.93
X_6							1	0.21	0.88	0.39	0.54
X_7								1	0.73	0.25	0.22
X_8									1	0.71	0.82
X_9										1	0.26
X_{10}											1

So, the linear function was adopted to represent the above relationship after identifying the most important economic indicators of the spatial distribution of investments (polarization factors), as explanatory variables, influencing the polarization and concentration of industrial investments (dependent variable), and given that the explanatory variables are strongly related to each other according to the results of the matrix of correlation coefficients between the polarization factors that were calculated previously, which is considered a preliminary indicator of the existence of the problem of multicollinearity.

In Table 1, which is considered a preliminary indicator of the presence of the problem of multicollinearity among the explanatory variables, and for the purpose of confirming the existence of this problem, some tests were conducted for the problem of multicollinearity, including the determinant of the correlation matrix is equal to comparing the extracted value of the square (x^2) with the tabular one with a degree of freedom (55) at a significance level (5%), we notice that the extracted value is larger than the tabulated one, and this is further evidence of the existence of the problem of multicollinearity between the explanatory variables.

To address this problem to obtain estimates close to reality (the variance of the estimate is as small as possible) for the parameters of the regression model for the relationship between polarization factors and industrial investment allocations, the ridge regression method was used. Using the ready-made statistical application (NCSS), the best value for (NCSS) was determined k within the range (1-0) through the graph shown in Fig. 1 that the vertical line (---) represents the best value (k) which is equal to (0.0151), which is the value at which the factor value (10) (is equal to or less than the variance inflation factor (VIF).

Using the iterative method, the optimal value of (k) was obtained from the first iteration, equal to the value we obtained using the graphical display method as shown in Table **3**. It gave the best estimate of the parameters of the letter regression model with the lowest (MSE) and the highest (R^2), in addition to the probability of error for the entire model being (R^2) (003), and this is the smallest possible error we obtained. Considering this, the results of the estimated model for the spatial distribution function of industrial investments were as in Table 2.

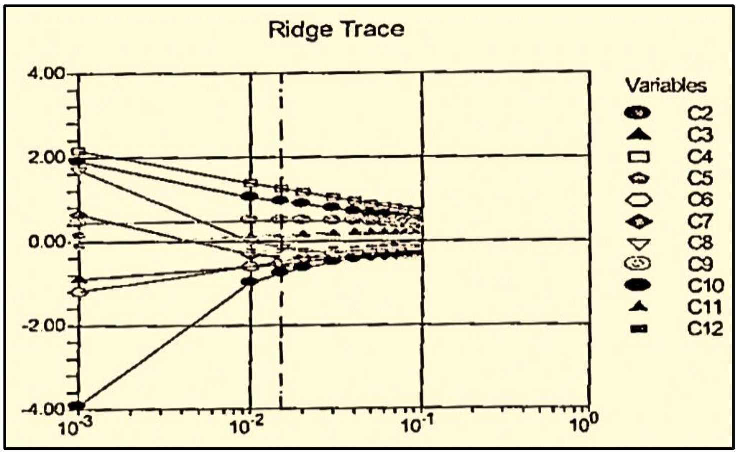

Fig. 2. Image of the NCSS statistical application to determine the best K value [9]

Table 3: Results of the relationship between industrial investment allocations and a set of explanatory variables

	B_0	B_1	B_2	B_3	B_4	B_5	B_6	B_7	B_8	B_9	B_{10}
Estimate Beta	2437	-0.270	0.946	274	18329	-0.612	-0.511	-4279	0.2671	-1.888	5710
T	-	1.66	1.5	1.6	1.72	-0.83	-0.79	-1.1	2.16	-1.52	0.35
VIF	-	10	9.3	9.8	5.2	10	6.6	7.2	1.2	6.3	3.8
$R^2 = 0.84$			F =16.67			MSE = 3319.41			R = 0.91		
$\hat{Y} = 2437 + 0.270X_1 - 694.946X_2 + 2684.5236X_3 + 1.736X_4 - 0.413X_5 - 0.392X_6 - 2.265X_7 + 0.278X_8 - 97486X_9 + 532.3629X_{10}$											

It is noted from the results of estimating the regression model that the relationship is direct and very strong between the variable, (industrial investment allocations) and the explanatory variables represented by (the value of the gross domestic product of the industrial sector by governorate, the number of industrial establishments, the number of employers, and the value of wages and benefits, the value of industrial production, and the value of production requirements. The electrical energy received per governorate, the quantity of pure water, the health and educational levels, as well as the ratio of the urban population to the total population of the governorate. The value of the multiple correlation coefficient reached) ($R = 0.91$) and the value of the corrected coefficient of the determination reached ($R^2 = 0.84$). This means that (86%) of the changes occurring in the volume of investment allocations at the governorate level are due to these variables, which play an important role in the spatial distribution of allocations.

Industrial investment opportunities for each governorate, and that 14% of the changes or deviations in the adopted variable are due to the error limit. The value of (MSE) was low using the method ($R.R$) methodology, when the value of ($k = 0.0151$) became ($MSE =$ 3319.41), which confirms the increase in the efficiency of the model after excluding the multicollinearity problem. That is, the model error values fall within the confidence limits. This is

ISSN: 2073-9524
Page:1-16

demonstrated through comparison. The (F) test showed the significance of the regression model, with an accuracy level of (70%). The (t) test also showed the significance of most of the explanatory variables with a confidence level of (92%).

As for the values of the estimated parameters, we note that the value of (B_2) for (the average number of establishments), shows that the increase in the number of industrial establishments in the governorate, this leads to a decrease in the volume of investment allocations directed towards it by the amount of (9469 billion dinars), but it is known that the increase in the number of industrial establishments in the governorate which helps attract industrial investments to that governorate, which has a workforce with different skills and marketing, financial and technical services, in addition to the advantages of industrial interconnection.

The only explanation for the negative linear relationship between the rise in the number of industrial enterprises and the decline the size of investment allocations is that there are factors. It has a clear impact on the trends and content of spatial development, and one who traces the pattern of spatial distribution of industrial investment allocations during the 1970s and after can easily sense the presence of this trend in industrialization policy. It was widespread in Iraq, which was characterized by a major and apparent characteristic, which is the spread of industrialization and directing it to the governorates where it was not available.

It has one large industrial project, as is observed in the governorates of (Wasit, Karbala, Maysan, Dhi Qar, Erbil, Sulaymaniyah, Al-Muthanna, Diyala, and Al-Qadisiyah), and in the past two years the expansion has been limited in Baghdad governorate, even if there are other governorates, such as: (Basra, Nineveh, Anbar, Babylon, and Salah al-Din), The industrialization process continued and it acquired a larger proportion of industrial investments. This explanation of the negative linear relationship between the number of industrial establishments and the volume of investment allocations can apply to the relationship between the value of production and the volume of investment allocations. It is noted that increasing the value of industrial production and the value of production supplies and electrical energy received by each governorate by one unit leads to a decrease in the volume of allocations. Industrial investment amounted to (361200, 451200 and 301482 billion dinars, respectively.

The negative inverse relationship between urbanization indicators represented by each of the health levels (the number of beds in hospitals) and the ratio of the urban population to the total population of the governorate and the size of investment allocations for each governorate, while we expected the relationship to be positive and direct, based on the direct relationship between urbanization and industrialization.

The economic analysis therefore indicates that the governorates that have a high level of industrialization are the ones that are increasing. The proportion of urban population, which are the governorates in which the largest number of health service facilities are available. In addition, one of the features of the current industrialization policy is avoiding the concentration of industrial investments in areas with high levels of industrialization and urbanization and moving towards the less industrialized and urbanized governorates to achieve balanced spatial development.

The other important results produced by the regression model for the industrial sector are: the positive direct relationship between each population (the value of gross domestic product, the number of employees, the value of wages and benefits, and the amount of net water received, in addition to the educational level) for each governorate and the volume of industrial investment allocations. These are all very logical results, as it cannot be determined any industrial activity or increase in volume thereof activity in any governorate is without the availability of the minimum level of domestic product.

The number of employers, and the quantity of net water for industrial purposes and human consumption, also apply at the national level Providing educational services in every governorate, and thus it seems clear that the process of industrialization and the supply and construction of the main structures go side by side and are moving in a It is clear towards the less developed governorates and after the letter regression model was estimated. $(R.R)$ To measure the effect of polarization factors on the spatial distribution of industrial investments, the estimated values of investment allocations $(\hat{Y})$ were calculated for each governorate, and the random error values were calculated as shown in the table **4**.

The values of the estimated industrial investment allocations $(\hat{Y})$ and the error values $(\hat{e})$ mean that if the importance of the variables included in the model was taken into account when estimating the size of the investment allocations for each of the governorates, the sizes of those allocations would become the norm Investment and not as it was allocated. The difference between what was allocated and what should be allocated is represented by the error value (e), as the governorates of (Baghdad, Basra, Nineveh, Diyala, Karbala, Al-Muthanna, Al-Qadisiyah, Dhi Qar, and Wa Set and Maysan) require industrial investments higher than what was allocated for it, while the governorates of (Anbar, Salah al-Din, Tamim, Babel, Najaf, and Maysan), more industrial investments were allocated to them than necessary in light of the potential.

Table 4: The amount of actual and estimated investment allocations and error values for the industrial sector according to governorates

Name of the governorate	Actual investment allocations = Y	Discretionary investment allocations = $\hat{Y}$	The amount of random error is $e = Y - \hat{Y}$
Baghdad	65125578	164799460	1573885-
Nineveh	114581844	116957400	1236548-
Basra	48476934	52096680	2277545-
Anbar	67084242	54733200	2519745-
Salahaddin	62187582	43144660	1651040
Kirkuk	2448330	32215444	2142920
Diyala	2448330	1858127-	4306457
Babylon	87660548	14866400	-11718070
Najaf	24972966	74658830	11601720
Karbala	489666	17769200	6303765
Double	489666	13075560	-11485890
Al-Qadisiyah	1468998	16663800	-15074130
Dhi Qar	61958664	9147140	-6578142
Maysan	489666	8499574	-7340910
Wasit	1028986	3297583	-2607917

5. Limitation

Several basic factors control the allocation of investment funds and the extent of success that the industrial sector in Iraq can achieve in the period between 2014 and 2020. They were not studied in this research due to the difficulty of measuring them and measuring their effects. It is also difficult to measure the extent of investment success in the industrial sector if these factors do not exist. The entry of terrorism into Iraq in 2014 and the fall of a third of Iraq under the control of terrorist gangs is considered one of the most important factors that curbed investment in the industrial sector. Therefore, our study is a study of what is available and can be measured.

The researcher believes that a more detailed study is necessary that takes into account the impact of political and social terrorism on Iraqi society. Iraq is a country not only governed by traditional laws that are made in the Iraqi parliament and judiciary. Rather, Iraqi society is subject to historical, sectarian,

ISSN: 2073-9524
Page:1-16

and cultural factors that cannot be ignored, overlooked, or nullified in the context of creating modern society. The second most important factor is financial and administrative corruption, which the researcher could not point out because it is difficult to measure the percentages of money stolen from investment projects allocated to the industrial sector. The researcher realizes that the reader, by his knowledge of Iraqi society, that the rate of corruption exceeds that of any neighboring regional society, due to the accumulation of circumstances that cannot be discussed in this research.

6. Conclusions

Based on the study and analysis shown above, the following key findings were reached: The factor analysis findings revealed the following polarization variables, listed according to their relevance, as the key polarization determinants for the distribution of industrial investments:

- Governorate-specific GDP for the industrial sector.
- Average pay and benefits, average production value, average employee count.
- An average number of industrial enterprises.
- Each governorate got electrical electricity.
- The number of hospital beds.
- Average value of production inputs.
- Student/school ratio. Urban population ratio compared to the governorate total population.
- Amount of clean water for each governorate.
- According to Peirce, there is a weak or average correlation between each factor of polarization and industrial investment allocations. The factor of the number of workers employed in industry had the highest correlation coefficient with allocations (0.62), while the ratio of students to the number of schools had the lowest correlation coefficient.
- The relationships between the polarization factors were quite strong, except for the pure water component and the other polarization factors. The spatial distribution of industrial investment allocations by the governorate is influenced by two main factors, which account for 90% of the total variance.
- The industrial investment foundations factor is the most significant, accounting for 82% of the variance in the second year (0.19). These characteristics must be the driving forces underlying the geographical dispersion of investments in industrial cities across governorates.
- The results of estimating the parameters of the studied explanatory variables (polarization factors) according to the regression method showed the strength of the relationship and correlation between the economic explanatory variables and the sizes of the allocations. It was fruitful, as it reached the value of the challenge coefficient ($R^2 =$ 0.84 and the correlation coefficient) ($R =$ 0.91), which indicates the strength of the effect of the economic variables òòadeya This is in the spatial distribution of industrial investments among the governorates, and this is confirmed by the decrease in the value of (MSE) as it reached 3319.41,
- which confirms the increase in the efficiency of the model at ($k =$0.016). Considering the results, we obtained from the factor analysis model and the letter regression model about. By choosing a scale of spatial development priorities between the governorates, and after conducting a difference test, we find that there are no significant differences between the two scales.
- If the preceding findings are to be believed, there has been a dramatic uptick in focus on Iraq's industrial sector at the governorate level. This is due in large part to the fact that Mr. Sudan's administration has placed a premium on reviving dormant projects, increasing funding for industrial investment, and resuming previously suspended projects.

Recommendation

The most important step is creating a framework for developing planning methodologies at the governorate level and strengthening the coordination mechanism between planning agencies in the governorates and sectoral ministries, which leads to increasing the efficiency of the process of preparing, following up, and implementing development plans at the national levels. In addition, spatial growth across governorates guarantees that spatial development is one of the most visible aims of the reform program that strives to achieve sustainable development. The research calls on the specialized executive authorities (Ministry of Planning and Development Cooperation) to accept the study findings, making them one of the primary sources in determining the geographical scale of investment distribution priorities, to achieve balanced development.

In the industrial sector, it is better to prioritize the recommended hierarchy based on the findings of the global study. The need to establish a statistical base at the level of each governorate in the country, including complete and detailed data on the economic, social, and environmental structure of each governorate, to provide sound statistical information that contributes to improving the plan's ability to draw and adopt the investment objective, diagnose and address defects. Spatial development must be made a basic approach in reform programs to support long-term development in Iraq, to laying the groundwork for complementary development between the countryside and the city by including investment allocations no less quantitative and qualitative than those directed to the city, thereby establishing the countryside as a development pole.

The financial planning of the federal budget of the Republic of Iraq operates in accordance with central directives and is based on the objectives of the general plan of the state. The initial appropriation of the budget, both its current parts, is for directives to strengthen the investment structure of the industrial sector in the governorates. In addition to activating the investment effort in the planning budgets of the public sector. Therefore, it works to organize unified schedules for current and investment spending, prepare instructions, controls, and powers to dispose of the amounts approved in the budget and coordinate them considering the directions specified for them.

Conflict of interest

There are no conflicts of interest regarding the publication of this manuscript.

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