RIDGE REGRESSION ANALYSIS ON THE INFLUENTIAL FACTORS OF FDI IN IRAQ

Ali Sadiq Mohommed BAGER [1]
Bahr Kadhim MOHAMMED [2]
Meshal Harbi ODAH [3]

ABSTRACT
Foreign direct investment is considered one of the most effective factors in the growth and development of states and an indicator of the economic ability to accommodate developments towards global mechanism and the field of the multi-national companies in the movement of commodities and services. This paper deals with an important topic, studying the obstacles with which foreign direct inflow investment is faced with in Iraq. The study of the obstacles is accompanied by the problem of linear multiplicity, which will be addressed through building a statistical model by using the method of applied ridge regression. The results of the analysis showed that there are four variables with a clear effect on the FDI, and ridge regression is the best method to be applied in case of a multicollinearity problem in financial and economic data, which often are associated with each other.

KEYWORDS: *foreign direct investment, ridge regression model, ridge parameter, multicollinearty problem.*

JEL CLASSIFICATION: *A13, C24*

1. INTRODUCTION

Foreign Direct Investment (FDI) is defined as a company investing in projects outside the borders of the motherland with the aim of exerting some influence on the operations of those projects (Ietto, 2012). The United Nations Conference on Trade and Development knows that such an investment involves a long-term relationship that reflects permanent interests and the ability to manage between a company within the homeland (the country of the investee company) and a company or production unit in another country (the recipient country of the investment) (UNCTAD, 2012). This type of investment contributes to raising the efficiency of the economy through its implications in developing the capabilities of individuals and enhancing the financial assets in the host country, in addition to contributing to the increase of the factors of production and the transfer of technology, this way raising the efficiency and skills of the labor force through training and rehabilitation (Ashwini, 2003). This type of production also increases the administrative and management expertise of project management and the introduction of various production programs that may not be included in such local investments, as well as finding a state of economic interdependence of the host country with global production networks. Metwally (2004) presented a study regarding the impact of interest rates and the rate of economic growth on the attraction of total foreign investment for each of the three Middle Eastern countries: Egypt, Jordan, and Oman. The results showed

[1] Muthanna University, Department of Statistics and Econometrics, Iraq, nader.ali62@yahoo.com.
[2] University of AL-Qadisiyah, Department of Statistics and Econometrics, Iraq , baherm@yahoo.com.
[3] Muthanna University, Department of Statistics and Econometrics, Iraq, m.algelidh@gmail.com.

positive impact of foreign direct investment on the process of GDP growth and increased quantities of goods and services exported to these countries. Zekos (2005) investigated the role of foreign direct investment in the development of the digital economy in countries that have taken the required measures to liberalize the economy and concluded that foreign direct investment pushed to improve the position of companies and development of efficiency of performance and worked to accelerate the movement of capital and the importation in the field of work of multinational enterprises.

Gilmore et al. (2003) also studied the factors influencing foreign investment, such as incentives, level of satisfaction of managers, political stability, low wages and cultural level on foreign investment from Ireland and Bahrain, and consequently found no significant impact on attracting foreign investment.

As a result, developing countries including Iraq, due to their economic conditions (lack of financial resources, lack of expertise, deterioration of organizational and administrative situation, narrow export base, low savings rates, local limited investment, low GDP growth rates) are seeking to encourage foreign direct investment and stimulate them to help expand the local economy base by increasing productivity through the establishment of new systems and mechanisms that encourage investment activity and remove many restrictions and barriers to the movement of foreign capital (David,1985).

This paper is organized as follows: after the introduction, in the second chapter we will present the research objective and hypothesis methodology. In the third chapter, we will present the Ridge regression model. In chapter 4 we will illustrate the sample study. In chapter 5 we will make the analysis of the study results. In the end, a brief conclusion is included in section 6.

2. RESEARCH OBJECTIVE, HYPOTHESIS METHODOLOGY

The aim of this research is to use Ridge regression in order to identify variables that have a significant role in influencing foreign direct investment in Iraq, where the foreign direct investment (FDI) is the focus of international competition. Countries compete for foreign investments and provide incentives and exemptions in order to win over the investors.

The research hypothesis consists of the fact that foreign direct investment has an important and positive role and would help to promote the economic reality in Iraq.

The methodology of the research is based on the descriptive methodology and the statistical method of statistical analysis of the data in order to address it statistically and come up with clear recommendations and knowledge of the most important factors that would affect foreign direct investment in Iraq. Also, we will use the Ridge regression method to address the multicollinearty problem, along with the study of factors affecting the inflow of foreign direct investment in Iraq, where the FDI is considered a dependent variable and a set of major economic indicators are considered explanatory variables. For data analysis, an efficient algorithm was used in programming (R).

3. RIDGE REGRESSION MODEL

The ordinary squares method (OLS) used to estimate the multiple linear regression model is as follows:

$$\underline{Y} = X\underline{\beta} + \underline{\varepsilon} \qquad (1)$$

where:

$\underline{Y}$: a vector represents the variable response observations of the class $(N \times 1)$

X: the matrix represents the observations of the explanatory variables of the class $(N \times p)$

$\underline{\beta}$: vector parameters are estimated from the class $(p \times 1)$

$\underline{\Sigma}$: random error vector of class $(N \times 1)$ is considereb by assuming $E(e) = 0\ ,\ Var\ (e) = I_{\sigma^2}$
For estimation the (OLS) method is used according to the following formula:

$$\hat{\beta}_{OLS} = (\acute{X}X)^{-1}\acute{X}Y \qquad (2)$$

If there are multicollinearity problems, the estimated parameters of the linear model ($\hat{\beta}$) and variance will be unrepresentative to the studied phenomenon, which requires treatment by using one of the methods of addressing the multicollinearity problems. In this case the Ridge regression method is used.

The Ridge regression method (RR) adds a small positive constant (K) to the main diagonal elements of the information matrix $(X'X)$ (Hoerl et. al.,1976). This positive value decodes the links between the explanatory variables, reducing the variance of estimated parameters, at the expense of some biases. Also, the mean square error for ridge regression is less than the mean square error for ordinary least square method. The ridge regression method (RR) can be written as follows (Hoerl et. al.,1981):

$$\hat{\beta}_{RR} = (\acute{x}x + kI_n)^{-1}\acute{X}Y \qquad (3)$$

where:
$k > 0$: Ridge parameter
In **:** identity matrix.
If the value of (k=0) applies, the ridge regression method of the convert is ordinary least square method. We note from the equation (3) that the value of (k) is added to the main diagonal elements of the information matrix $(\acute{x}x)$ and for the chosen value (K), there are several methods, including the iterative method on which this paper focused (Kibria, 2003). The initial value (K) is determined using the following formula:

$$K_0 = \frac{m\hat{\sigma}^2}{\hat{\beta}'_{ols}\hat{\beta}'_{ols}} \qquad (4)$$

$$(k_0)k_1 = \frac{m\hat{\sigma}^2}{\hat{\beta}'_{R(K_0)}\hat{\beta}_{R(K_0)}}$$

$$(k_1)k_2 = \frac{m\hat{\sigma}^2}{\hat{\beta}'_{R(K_1)}\hat{\beta}_{R(K_1)}}$$

where"
m: number of the variable
$\hat{\sigma}^2$: mean square error.
This process has to reach the stability of the estimated parameters. If the estimated parameters are stabilized despite the difference in values (k), the value of the variance inflation factor is close to one. A value (k) is then adopted at the stability point.

4. SAMPLE STUDY

The context of the Iraqi market is considered and in this situation the main factors that affect the FDI are thought to be the same in some regions as opposed to other regions, where they may be a lot of different. The actual situation in Iraq from the perspective of available data is considered. Data has been obtained from the Ministry of Finance, the 2015 Annual Bulletin. The data is interpreted with the following considerations: the variable is represented by the inflow of foreign direct investment is considered the dependent variable (y), and there 6 statistical indexes chosen as explanatory variables. The variables are the following:
(a) Y: Foreign direct investment (measured in percent %)
(b) X1: Infrastructure (measured in million Iraqi dinars)

(c) X2: Economic growth rate (measured in percent %)
(d) X3: Rate of Inflation (measured in percent %)
(e) X4: Privatization (measured in million Iraqi dinars)
(f) X5: Size of market (measured in million Iraqi dinars)
(g) X6: The quality of labor force (the proportion of college students of every 10000 people) in 2015.
We used programming R packages (MASS) for the analysis of the phenomenon data.

5. ANALYSIS OF STUDY RESULTS

The test Kaiser-Meyer-Olkin (K-M-O) was used to determine the sufficiency of the data. The K-O-M condition was that the minimum acceptable score is 0.5 for the sample size to be sufficient. Note that the value of the K-M-O statistic in this sample was (0.813). 0.813 is more than 0.5, so the size is sufficient.

5.1. Multicollinearity problem test

In order to determine the variables influencing the inflow of foreign direct investment in Iraq, the Ridge regression model is composed by the response variable, which represents the inflow of foreign direct investment, and the independent variables as listed above. The regression model was tested on the studied phenomenon in order to identity the econometrics problems, more precisely the multicollinearity problem. The model under study suffers from multicollinearity problem. The causative variables were identified by using the Variance Inflation Factor (VIF) which measures the inflation of the parameter estimates for all explanatory variable in the model (Farrar & Glauber, 1967).

Table 1. Values of the Variance Inflation Factors (VIF)

Variables	x1	x2	x3	x4	x5	x6
VIF	237.2265	134.1332	8.7147	110.6251	7.4114	39.3134

Source: produced by the author, using the programing R packages for Statistical Computing

VIF is a measurement of variance inflation factor: if VIF is more than (10), then this means the variables suffer from inflation in the variance of their parameters variables and are the cause of the multicollinearity problem.

From table 1, we can see that the independent variables (X_1, X_2, X_4, X_6) have VIF greater than (10). In this case, the four variables are the cause of the multicollinearity problem.

5.2. Ridge regression analysis

Ridge regression analysis is based on the estimation of the model parameters when there is a multicollinearity problem between the explanatory variables. The ridge regression coefficients are (k), for which we used the method of Hoerl et al. (1975) in order to identify the value of ridge parameter in accordance with formula 4. The result was k = 0.165763.

From Table 2, it can be observed that at the value of (k=0) the same estimators as in the ordinary least squares are obtained. When changing the values of the estimators, we observe their stability as the value of k moves away from zero. Also, the results show that the level of the variance inflation factors (VIF) for the explanatory variables is: $X_1 = 0.1377$, $X_2 = 0.0832$, $X_3 = 0.4866$, $X_4 = 0.4236$, $X_5 = 0.4847$, $X_6 = 1.1017$.

Table 2. Variance Inflation Factor Section $k = 0.165763$

k	x1	x2	x3	x4	x5	x6
0	237.2265	134.1332	8.7147	110.6251	39.3134	7.4114
0.1	11.9681	18.8898	7.0301	17.9527	8.2527	6.1769
0.2	6.6824	7.9689	2.7605	9.0054	6.2222	5.8753
0.3	4.5027	4.4548	1.6049	5.5547	5.0759	4.9463
0.4	3.2968	2.8689	1.0823	3.8083	4.2699	3.4864
0.5	2.54	2.0141	0.7912	2.7888	3.6588	2.627
0.6	2.0275	1.499	0.6092	2.1376	3.1772	2.0686
0.7	1.662	1.1637	0.4868	1.6948	2.7884	1.6809
0.8	1.391	0.9328	0.4001	1.3792	2.4689	1.3988
0.9	1.1838	0.7667	0.3362	1.1461	2.2026	1.186
0.165763	0.1377	0.0832	0.4866	0.4236	1.1017	0.4847

Source: produced by the author, using the programing R packages for Statistical Computing

By comparing it with other values in the table, it seems to be the best value to be selected, provided the lowest values for VIFs. We can observe through the same table the variance inflation factor (VIF) showing that the ridge parameter value has significantly contributed to the decrease in the level of the value VIF for all the explanatory variables.

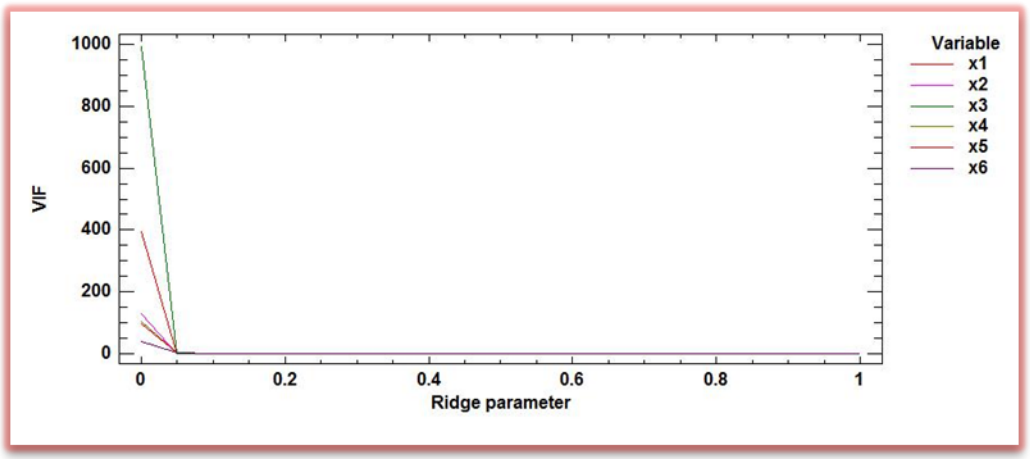

Figure 1. Variance Inflation Factor with y

Source: produced by the author, using the programing R packages for Statistical Computing

As shown in Figure 1., we found the dependent variables for ridge regression analysis with variance inflation factor. We note the stability of the value of (VIF) to all the variables at the value of (K =0.165763).

According to the results from table 3, the final outcome shows that there are four significant variables. The significant factors for FDI are those where the p-value is a measurement of statistical significance less than (0.05). The following factors are identified:

(a) The coefficient (x1) -infrastructure - is significant from a statistical point of view and the variable has a positive relationship with FDI. This is consistent with economic logic. This means that when there is an increase in Infrastructure by one unit, an increase in the FDI appears.

(b) The coefficient (x2) - economic growth rate - is significant from statistical point of view and the variable has a positive relationship with FDI. This means that if there is an increase in economic growth rate by 1%, an increase in the FDI follows.

(c) The coefficient (x3) - rate of inflation- is non-significant from statistical point of view in the response variable according to the studied data.
(d) The coefficient (x4) - privatization - is significant from statistical point of view and the variable has a positive relationship with FDI. This is consistent with economic logic. This shows that an increase in privatization by one unit leads to an increase in the FDI.
(e) The coefficient (x5) - size of market - is non-significant from statistical point of view in the response variable according to the studied data.
(f) The coefficient (x6) - the quality of labor force - is significant from statistical point of view and the variable has a positive relationship with FDI. This is consistent with economic logic, meaning that an increase in the quality of labor force by one unit leads to an increase in the FDI.

Table 3. Estimator ridge regression

Independent Variable	Regression coefficient	Standard error	t-value	Pr > |t|	VIF
Intercept	102426.8				
x1	12.05426	3.330226	2.021618	0.00346	0.1377
x2	11.54196	2.694152	2.389668	0.00014	0.832
x3	11.11553	7.103215	1.564859	0.5467	0.4866
x4	1715.262	717.7826	3.619652	0.0002	0.4236
x5	4316.969	5815.67	0.7423	0.06030	1.1017
x6	2664.022	1317.767	4.284079	0.0000	0.4847
R-Squared	0.8672				

Source: produced by the author, using the programing R packages for Statistical Computing

The explanatory robust of the model is (R^2=86 %), which means that 86% of the changes in the FDI values is explained by the changes in each of the variables infrastructure, economic growth rate, privatization and the quality of labor force, while 14 % of the variables are due to other factors that may not be quantified within the estimated model.

6. CONCLUSIONS

The hypothesis proved to be correct by determining the most important factors that affect foreign direct investment in Iraq, having an impact on the economic reality and development of the country. After addressing this problem of relationships between the explanatory variables expected to impact the flow of foreign direct investment through the use of the Ridge regression method, the study demonstrated results by estimating the equation of the model as follows:
(a) X1: The indicator's symbol is positive, which in line with the expectations meaning that the impact of infrastructure on FDI is positive. However, in the selected factors, the infrastructure index ranked fourth, which may be due to infrastructure construction in Iraq are relatively in line in recent years with economic growth and the hard investment environment is satisfied. Compared with other variables, it isn't the primary consideration factor. However, this does not mean that the investment environment is not able to further expand in order to attract foreign investment.
(b) X2; the actual FDI flows and economic growth rate have significant positive correlation, in line with the economic logic, meaning that increase in economic growth leads to an increase in foreign direct investment (FDI) in the host countries. This index was on the third place.
(c) X4: privatization as indicator had a positive relationship with FDI and was consistent with economic logic, showing that privatization contributes to increasing economic efficiency in the country concerned, leading to attracting more savings. It was second as rank.
(d) X6: the quality of labor force factor was the first and is the most influential factor affecting FDI in Iraq, having a positive relationship with FDI and being the most important resource in the

optimization and upgrading of industrial structure and economic development, foreign investment enterprises in Iraq.

It has been shown through the analysis of the results that the Ridge regression model has proven its ability to address the muliticolinearty problem well. This is one of the econometric methods used to address the problem of linear multiplicity that occurs between variables in economic and financial data because they are correlated with each other in most cases.

REFERENCES

Ashwini, J. (2003). *How does the black market exchange premium affect foreign direct investment*. Stanford University, 1

David, G. S. (1985). *Foreign direct investment in developing countries, finance and development*. March, 1.

Farrar, D. E. & Glauber, R. R. (1967). Multicollinearity in regression analysis: the problem revisited. *The Review of Economic and Statistics*, 92-107.

Gilmore, A., O'Donnell, A., Carson, D., & Cummins, D. (2003). Factors influencing foreign direct investment and international joint ventures: A comparative study of Northern Ireland and Bahrain. *International Marketing Review*, *20*(2), 195-215.

Hoerl, A. E. & Kennard, R. W. (1981). *Ridge regression, advances, algorithms and applications*. American Sciences Press.

Hoerl, A. E., Kannard, R. W. & Baldwin, K. F. (1975). Baldwin, Ridge regression: some simulations. Communications in Statistics. *Theory and Methods*, 105-123.

Hoerl, A. E. & Kennard, R. W. (1976). Ridge regression: Iterative estimation of the biasing parameter. *Communications in Statistics*, A5, 77-88.

Ietto-Gillies, G. (2012). *Transnational corporations and international production: concepts, theories and effects*. Edward Elgar Publishing.

Kibria, B.G. (2003). Performance of some new ridge regression estimators. *Communications in Statistics-Simulation and Computation, 2003.32* (2), 419-435.

Metwally, M. M. (2004). Impact of EU FDI on economic growth in Middle Eastern countries. *European Business Review*, *16*(4), 381-389

UNCTAD, G. (2012). World investment report: Towards a new generation of investment policies. *Unite Nations. New York and Geneva*. unctad.org/en/PublicationsLibrary/wir2012_embargoed_en.pdf

Zekos, G. (2005). Foreign direct investment in a digital economy. *European Business Review*, *17*(1), 52-68.