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USING RIDGE REGRESSION TO ESTIMATE SOME VARIABLES AFFECTING THE IRAQI STOCK EXCHANGE INDEX

Arshed Taha Othman and Mowafaq Muhammed Al-Kassab*

Senior Economic Advisor
Kurdistan Parliament Federal Republic of Iraq
Department of Economics
Salahaddin University
Erbil, Iraq
e-mail: arshadtaha@yahoo.com

Department of Mathematics Education
Faculty of Education
Tishk International University
Erbil, Iraq
e-mail: mowafaq.muhammed@tiu.edu.iq

Abstract

Ridge regression method is one of the most widely used methods for solving the multicollinearity problem as an alternative to the Ordinary Least Squares (OLS) when there is a collinearity between the explanatory variables, the presence of multicollinearity will produce unreliable result in the estimates of the parameters of OLS. Due to

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*Corresponding author

such a reason, this study aims to use the new version of the ridge regression to estimate the coefficients of some important economic variables as a real application. A numerical example of stock market index and macroeconomic variables in Iraq is employed using both methods aimed at to investigate the relationship of the variables in the presence of multicollinearity in the data set. The variables of interest are the index of Iraqi Stock Exchange (ISE), the Prices of Crude Oil (POC) and Gold (POG), and the Global Inflation Rates (GIR). Depending on the mean squares error criterion, the results show that the new version of the ridge regression procedure is able to estimate the model and produce reliable results by reducing the effect of multicollinearity in the data set.

1. Introduction

The stock market index acquires great importance as it represents the movement of the market, reflects the totality of the changes that occur to it, and the market is described through the movement of its index up, down and stability and the movement of the market index in developed countries with developed financial markets often expresses the economic movement of that country, and its interpretation is due to the fact that the calculation of the market index depends on the prices of the shares of registered companies operating in that market, from here, the changes in the stock market index are carried out through the movement of shares in the market. This is related to the performance of the company and its activity on the one hand, and on the other hand, it governs the forces of supply and demand. On the shares of a specific company or group of companies, whether it is the activity or performance of companies or the practice and performance of investors, the factors of the international financial environment and the changes that occur to them have a role in the movement of the stock market index, and this is what we will address in this work.

The research aims to test the impact of changes in some economic variables in the international financial environment (the global prices of crude oil, gold prices and the inflation rates of the US dollar) in the stock

market index (the general index of shares). Sixty (60) monthly observations are selected for each of the index of Iraqi Stock Exchange (ISE) (as a dependent variable) and the prices of crude oil and gold, and the global inflation rates (as independent variables) for the period from January 2010 to December 2014. A set of statistical tools are used to test this relationship; the multiple linear regression model is the most important. In regression analysis, when two or more regressed variables are linearly related, it is called *multicollinearity*. Multicollinearity problem tends to produce estimates that are unstable, having wrong sign coefficients, raises the value of the variance of the coefficient estimates and it makes it more difficult to specify the correct model. Therefore, alternative methods have been proposed to overcome the problem of multicollinearity. Ridge regression method is introduced (Horel and Kennard [7]), to overcome the problem of multicollinearity. The new ridge regression parameter method introduced by Al-Kassab and Al-Awjar [1] is used to estimate the regression parameters.

This paper is organized as follows: The literature review is presented in Section 2. Section 3 describes the data and the models used. Discussion and results are given in Section 4. Finally, the concluding remarks are presented in Section 5.

2. Literature Review

Financial markets are one of the basic indicators of development in any country, just as financial markets play a pivotal role in creating stability for the financial system and achieving the efficiency of the financial market, and there are a group of local and international factors that directly or indirectly affect the performance of this market. The performance indicators of Arab financial markets are affected by such changes, especially the Iraqi market for securities, and the variables that frame the relationship between the international financial environment, including the variables that have been discussed that could have an impact on the performance of stock markets, including crude oil prices, gold prices, and the inflation rates. It has been observed that the fluctuation of global crude oil prices indicates that all

sectors and economic activities will be affected by this. Historically, a group of researchers has indicated that sharp fluctuations in crude oil prices have a reflexive effect on the growth of financial markets. Filis et al. [5] have tested the temporal discrepancy in the correlation between stock market prices and oil prices in the countries that import crude oil (the United States, Germany and the Netherlands) and export it (Brazil, Mexico and Canada). Upon testing the above hypothesis, the results of the correlation showed no difference in the correlation relationship of financial markets in exporting countries than in oil-importing countries. Jones and Kaul [8] presented an analysis and test of the reaction of international stock markets to oil shocks. The two authors justified this by the current and expected real changes in cash flows and expected returns. The study has shown that changes in oil prices have impacts on production and stocks, and that the precedence of oil prices in their relationship has shown the nature of changes in stock prices in response to oil shocks. Ready [9] discussed the study of changes in oil prices and then categorized those changes with the aim of determining the nature of the effects and relationships between changes in oil prices and changes in stock prices, and then the expected returns. He classified these changes into shocks and positive effects on stock returns and to negative effects through negative correlations between those prices and their changes and their effects on the stock markets, and then prices and returns. Arouri and Fouquau [3] have tested the short-term relationships between oil prices and the money markets of the Gulf Cooperation Council states. The study assumed that the Gulf countries are the main player in the global energy market and this makes their stock markets vulnerable to the price shocks of crude oil. Throughout its history, gold maintained its function as a means of exchange, and after the Bretton Woods system, the US dollar remained pegged to gold until 1971 when the United States was prevented from converting dollars into gold directly (Sujit and Kumar [11]). Bilal et al. [4] studied the long-term relationship test between gold prices, the Karachi Stock Exchange and the Bombay Stock Exchange (BSE), adopted a set of statistical methods, the most important of which was the Granger Causality to measure the

relationship in the long run. The long-term relationship between gold prices and the stock prices of the financial market, using the monthly data from July 1 2005 to February 2011, and the results of the joint complementarity test indicated that there is no long-term relationship between the monthly average of gold prices and the stock index. While the study indicated that there is a strong relationship in the long-term when using the Granger causation, and it proved that there is a relationship between the stock index and the average price of gold, and that there is no causal relationship between the average price of gold and the Karachi Stock Exchange and stock indices. Gencer and Musoglu [6] studied the fluctuations that occur between gold prices and the prices of government stocks and bonds in the Turkish financial market. The study used the Bekkgarch model to assess the fluctuations that occur and the relationship between those changes for the period from 2006 to 2013, and the study period was characterized by being severe. Sinton [10] dealt with the determination of the joint complementarity relationship and the causal relationship between the independent variables, namely (gold prices and the exchange rate) in the adopted variable, which is the Jakarta Stock Exchange Index (Indonesia Stock Exchange) for the period from January 2, 2004 to December 30, 2013. The important thing is that there is a use of an investment portfolio and a diversification of investment and of different types of securities. Usman and Adejare [12] dealt with the relationship between inflation and the performance of the stock market in Nigeria, and they tested the relationship to find out the effect of inflation on the performance of the capital market, using data for the period 1970 to 2010, and the data were analyzed according to variables such as the rate of inflation, and market capitalization, all equity index, market size, market turnover, and GDP, the impact of inflation on the performance of the Nigerian capital market has been weak. The relationship has shown deviation from a prior expectation and a positive relationship between inflation and market size, and that there is a negative relationship between inflation and the performance of the capital market. The result indicates that the Central Bank of Nigeria has to design and implement policy tools that

will keep inflation at a reasonably low level and a level that does not have an impact on the real value of stock returns.

3. Data and Model

The data of macroeconomic variables represented by the index of Iraqi Stock Exchange (ISE) (the response variable as a dependent variable y), the prices of crude oil (X_1), the prices of gold (X_2) and the global inflation rates (X_3) refer to explanatory variables (as independent variables). The macroeconomics variables can be indicators to Iraqi's economy that might affect the stock market movement. Sixty monthly measurements are selected for each of the index of Iraqi Stock Exchange (ISE) (Y), the prices of crude oil (X_1), the price of gold (X_2), and the global inflation rates (X_3) for the period January 2010 to December 2014.

Methods

Multiple linear regression is a well-known method of analyzing the relationship between dependent and independent variables. The mathematical equation for this regression is:

$$y = X\beta + e. \quad (3.1)$$

The Ordinary Least Squares (OLS) estimator is:

$$\hat{\beta}_{OLS} = (X^T X)^{-1} X^T Y, \quad (3.2)$$

where $\hat{\beta}_{OLS}$ is the unbiased estimate of β . The least squares estimator works with some assumptions such as linearly independent identically distributed errors with mean zero and constant variance, homoscedasticity. The problem of multicollinearity in the method of Ordinary Least Squares (OLS) leads to unstable estimates, and causes the false sign of the coefficients, increases the variance of the estimates and makes the determination of the correct model more difficult. Therefore, alternative methods have been proposed to overcome the problem of multicollinearity.

The ridge regression method introduced by Horel and Kennard [7] aims to overcome the problem of multicollinearity. This method is obtained by adding a small positive number, $k \geq 0$ to the diagonal elements of the matrix $X^T X$. Thus the regression estimators will be:

$$\hat{\beta}_R = (X^T X + kI_p)^{-1} X^T Y, \quad (3.3)$$

where $k \geq 0$ is known as the ridge (or the biased) parameter and is estimated from the studied data. A new method which depends on the eigenvalues and the eigenvectors of the matrix $X'X$ for finding the ridge parameter k when it is a constant or a matrix is suggested in Al-Kassab and Al-Awjar [1].

For the case when k is a constant, the vector of the estimated regression coefficients is:

$$\hat{\beta}_R^* = (X^T X + \hat{k}_R I_p)^{-1} X^T Y, \quad (3.4)$$

where

$$\hat{k}_R = \frac{1}{\sum_{i=1}^p \lambda_i^2} [\lambda^T X^T Y - \lambda^T (X^T X) \lambda],$$

λ is the vector of the eigenvalues. And for the case when $k(K^*)$ is a diagonal matrix whose elements are either the diagonal elements or the vector matrix of the matrix $X^T X$, the estimated regression coefficients are:

$$\hat{\beta}_R^* = (X^T X + K^*)^{-1} X^T Y. \quad (3.5)$$

Based on the mean squares error criterion and on comparison of this method with many other methods used by several researchers (Al-Kassab and Al-Awjar [1]) as well as through simulation technique using the Monte Carlo method (Al-Kassab and Al-Awjar [2]), it is concluded that this method for the case of K^* diagonal matrix is the best.

4. Results and Discussions

Table 1 illustrates the descriptive analysis of all variables used in this study. It can be seen that most variables provide similar results of measures of center that are mean and median values. It can be said that there is no peculiar observation that might affect these measures except for POG with a slight difference between the values of the mean and median and this occurred because of the non-homogeneity of the data. This result is supported by the slight larger value in standard error of the mean. The result shows that POC has negative skewness.

Table 1. Descriptive analysis of variables

Variables	(y) ISE	(X ₁) POC	(X ₂) POG	(X ₃) GIR
Mean	113.45	97.67	1428.1	1.998
Median	115.79	102.41	1365.0	1.750
Standard error of the mean	1.92	1.64	26.1	0.104
Kurtosis	-0.67	0.12	-1.31	-0.13
Skewness	0.10	-0.98	0.23	0.87

The presence of multicollinearity is investigated using correlation and it is presented in Table 2 and Figure 1. The high dependency among POC, POG and GIR can be seen from the results. Thus, the parameter estimation methods that encounter the multicollinearity problem need to be employed to achieve the aim of the study.

Table 2. Correlation analysis of explanatory variables

Explanatory variables	ISE	POC	POG
POC	0.642*		
POG	0.785*	0.595*	
GIR	0.229	0.411*	0.498*

* indicates the presence of multicollinearity with the P -value > 0.05

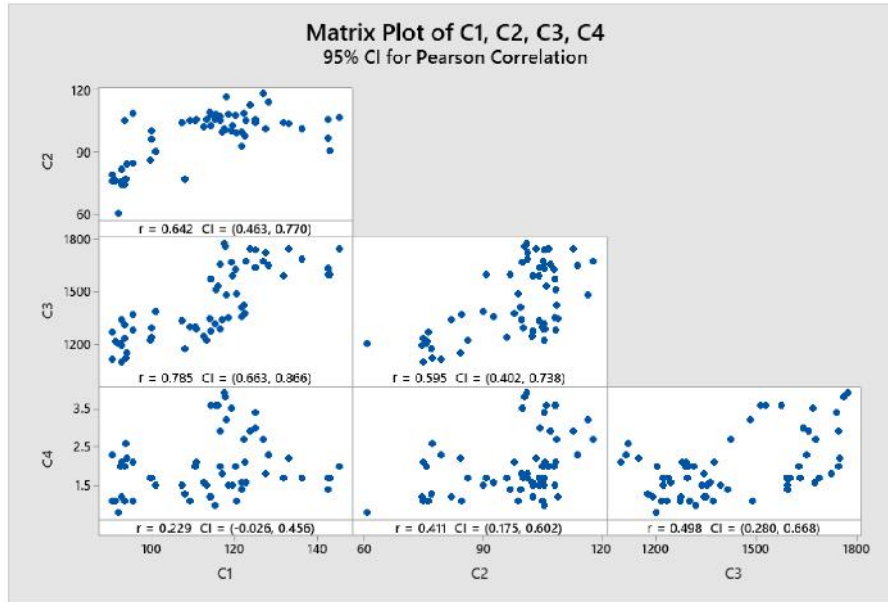


Figure 1. Correlation plot of explanatory variables, where C1 represents ISE, C2 represents POC, C3 represents POG, and C4 represents GIR.

The predicted regression model using ordinary least squares (OLS) method is:

$$\text{ISE} = 0.3172 \text{ POC} + 0.7273 \text{ POG} - 0.2636 \text{ GIR}$$

with $R^2 = 71.39\%$ and $F = 46.59$ ($p < 0.05$).

The predicted regression model using the new version of the ridge regression method is:

$$\text{ISE} = 2.306 \text{ POC} - 0.31 \text{ POG} - 0.56 \text{ GIR}$$

with $R^2 = 95.3\%$ and $F = 378.717$ ($p < 0.05$).

A comparison between the two methods with respect to MSE, R^2 , and F -values is given in Table 3.

Table 3. The results of estimation procedures

Method of estimation	Parameter	Coefficient	MSE	R^2	F -value
OLS	POC	0.3172	0.3014	71.39%	46.5
	POG	0.7273			
	GIR	-0.2636			
Proposed ridge regression	POC	2.306	0.04949	95.3%	378.717
	POG	-0.31			
With $K = (-0.54 \ 0.006 \ 0.008)^T$	GIR	-0.56			

The results of estimation of Ordinary Least Squares (OLS) and the proposed method are shown in Table 3. Both methods provide same result and it can be seen that the two methods provide significant results for all parameters indicating that all variables affect the stock market movement. But the result of the proposed method, however, yields significant more efficient than the OLS. This is due to the value of F (378.717) which is highly significant indicating good fitting of the regression model than OLS (46.59). In comparison to R^2 and MSE values, the new version of the ridge regression method provides largest value whereby the sum squared of errors is minimized by the values of k rather than in OLS. Thus, the suggested method is able to estimate the model in the presence of high dependency of variables in the model.

5. Conclusions

This study proposes a ridge regression estimator as in Al-Kassab and Al-Awjar [1] to solve the problem in regression analysis in the presence of high dependency among explanatory variables for the real data application. The proposed method is applied to investigate the relationship between macroeconomic variables and stock market movement. Although the estimation method of OLS and proposed method provide almost similar results, it is shown that the proposed method of estimation is able to produce consistent results as existing methods of estimation in the presence of multicollinearity in the data.

The study has concluded that the variables prices of oil and gold are linked to a direct relationship with the value of the Iraqi Stock Exchange (ISE) and there is a clear effect of these variables on stock prices. The modified R^2 value is approximately 95% which means that the independent variables account for 95% of change in the dependent variable. The existence of positive relationship between crude oil prices and monthly stock market indicators means that higher oil prices support the market index through the increase in the public spending, which in turn affects the volume of goods and services sold by these companies and increase their profitability. It is clear that the inflation rates are more influential in the dependent variable compared with oil and gold prices, as well as it is negatively related, which means that stocks are not among the assets that provide protection against inflation risks in the Iraqi financial market.

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