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THE EFFECT OF SOME MACROECONOMIC VARIABLES ON STOCK MARKET MOVEMENT IN IRAQ

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Abstract

Regarding the effect of macroeconomic variables such as money supply and interest rate on stock prices, the efficient market hypothesis

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suggests that competition among the profit-maximizing investors in an efficient market will ensure that all the relevant information currently known about changes in macroeconomic variables are fully reflected in current stock prices, some of these relevant information (explanatory variables) may have interrelation (collinearity). In regression analysis, multicollinearity refers to a high strength correlation among the explanatory variables. Thus, the ordinary least squares (OLS) are unreliable because of the violation of the independence assumption of the explanatory variables. The high dependency in explanatory variables will cause huge value in the standard errors of parameter estimates and thus, OLS is no longer appropriate to be employed in modeling the data. The most popular method used to overcome this problem is ridge regression. A numerical example of stock market price and macroeconomic variables in Iraq is employed using both methods to investigate the relationship of the variables in the presence of multicollinearity in the data set. The variables of interest are consumer price index (CPI), gross domestic product (GDP), base lending rate (BLR), and money supply (M1). The obtained findings show that the ridge regression method can estimate the model and produce reliable results by reducing the effect of multicollinearity in the data set. It is concluded that there is a relationship between macroeconomic variables (CPI, GDP, BLR and M1) and stock prices in the Iraqi stock market ISE, and that these variables account 98.5% of the change in ISE.

1. Introduction

The economic theory suggests that the stock prices should reflect expectations about future corporate performance. The corporate profits generally reflect the level of economic activities. If stock prices accurately reflect the underlying fundamentals, then the stock prices should be employed as leading indicators for future economic activities, and not the other way round. Therefore, the causal relations and dynamic interactions among macroeconomic variables and stock prices are important in the formulation of the nation's macroeconomic policy. As for the effect of

macroeconomic variables such as money supply and interest rate on stock prices, the efficient market hypothesis suggests that competition among the profit-maximizing investors in an efficient market will ensure that all the relevant information currently known about changes in macroeconomic variables are fully reflected in current stock prices so that investors will not be able to earn abnormal profit through prediction of the future stock market movements (Chong and Koh [8]). Mostly, in economics, this relevant information, named explanatory variables, has a linear relationship that affects negatively the stock prices. Multicollinearity refers to a high strength correlation among the explanatory variables in regression analysis. This situation commonly occurs due to a large number of explanatory variables incorporated in the analysis. The ordinary least squares (OLS) method was used to estimate the parameters of these variables. This method is found to be unreliable because of the violation of the independence assumption of explanatory variables. The high dependency in explanatory variables will cause huge value in the standard errors of parameter estimates and thus, OLS is no longer appropriate to be employed in modeling the data.

Several methods of estimation have been suggested in the literature to overcome the multicollinearity problem. The most popular method is ridge regression that has been introduced in Hoerl and Kennard [19, 20]. The ridge regression is proposed by introducing a positive value of k to the diagonal of the matrix $X^T X$ (where X is the matrix of explanatory variables) with the aim of minimizing the biased estimates and mean squared error (MSE) of the model. The k is also known as a *ridge parameter* and there are a variety of methods to estimate k, Duzan and Shariff [9], Kibria [25] and Mansson et al. [27]. Some of them make comparisons with OLS and obtain that ridge estimators outperform OLS and conclude that the generalized ridge regression is the best model among all. On the other hand, an alternative method of the existing ridge method is proposed in Duzan and Shariff [10] where k is estimated by using the coefficient of determination in the regression of an explanatory variable.

This method has shown ability to produce reliable results in existing ridge methods in such a way that the dispersion of the standard error of the parameter estimates can be minimized. Due to this, the method can be applied to financial data. In the financial data, some explanatory variables may be correlated due to high dependency among each other. This problem will have a vital influence on the results of statistical inference in the regression analysis. In a preliminary analysis, the descriptive analysis and the correlation measures are analyzed to describe the data and illustrate the presence of multicollinearity. 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

Several researchers have centered their empirical studies on the relationship between stock market movement and macroeconomic variables which has been intensively examined in both emerging and developed capital markets.

Homa and Jaffee [21], and Hamburger and Kochin [17] found a positive relationship between money supply and stock prices. Their result follows the ideas of real activity economists who argue that if there is an increase in money supply, then money demand increases which is a signal of an increase in economic activity. This increase in economic activity implies higher cash flows, which causes stock prices to rise (Sellin [38]). Lintner [26], Jaffe and Mandelker [23], and Fama and Schwert [11] examined the relationship between inflation and stock prices. Most of these studies test the Fisher hypothesis which predicts a positive relationship between expected nominal returns and expected inflation and their findings are inconsistent with the Fisher hypothesis. They all report a negative linkage between stock returns and inflation. However, Firth [12] observed a positive relationship between nominal stock returns and inflation when studying the relationship between stock market returns and rates of inflation in the United Kingdom.

Grossman and Shiller [15] examined how historical movements can be justified by new information. Using historical data from 1890-1979, they showed evidence that stock price movement can be attributed to real interest rate movement. Ta and Teo [40] had earlier observed a high correlation among six Singapore sector indices in the period 1975 to 1984 and the overall SES market return. Using daily data in examining the relationships, they had concluded that sector returns were highly correlated to each other, although such correlations did not remain stable over time. Sun and Brannman [39] similarly found a single long-run relationship among the SES All-S Equities Industrial and Commercial Index, Finance Index, Hotel Index, and Property Index from 1975 to 1992. Chen et al. [7] investigated the impact of macroeconomic variables on stock prices. They employed seven macroeconomic variables to test the multifactor model in the USA. They found that the consumption market index and oil prices are not related to the financial market while industrial production, changes in the risk premium, and twist in the yield curve are significantly related to stock returns.

Mukherjee and Naka [33] applied Johansen's [24] VECM to analyze the relationship between the Japanese Stock Market and exchange rate, inflation, money supply, real economic activity, long-term government bond rate, and call money rate. They concluded that a co-integrating relation indeed existed and that stock prices contributed to this relation. Maysami and Koh [28] examined such relationships in Singapore. They found that inflation, money supply growth, changes in short- and long-term interest rates, and variations in exchange rates formed a co-integrating relation with changes in Singapore's stock market levels.

Abdalla and Murinde [1] investigated the relationship between exchange rates and stock prices in India, Korea, Pakistan, and the Philippines. They found a unidirectional causality from exchange rates to stock prices in all countries except the Philippines. Mookerjee and Yu [32] reported that not all macroeconomic variables are integrated with stock prices in Singapore. Hashemzadeh and Taylor [18] investigated the direction of causality between the money supply, stock prices, and interest rates in the US. The

relationship between money supply and stock prices is reflected by a feedback system, with money supply explaining some of the observed variations in stock price levels, and vice versa. Causality runs from interest rates to stock prices, but not the other way round.

Gjerdr and Saettem [14] studied the relation between stock returns and macroeconomic variables in Norway. Their results show a positive relationship between oil price and stock returns as well as real economic activity and stock returns. Muradoglu et al. [34] studied the causal relationship between macroeconomic variables and stock returns in nineteen emerging markets. They conducted Granger causality tests for each country on a set of selected macroeconomic indicators. They concluded that a two-way interaction between stock return and macroeconomic variables is derived from the size of the stock markets, and their integration with the world markets, through various measures of financial liberalization.

Maysami and Sim [29-31] employed the error-correction modeling technique to examine the relationship between macroeconomic variables and stock returns in Hong Kong and Singapore (Maysami and Sim [31]), Malaysia and Thailand (Maysami and Sim [29]), and Japan and Korea (Maysami and Sim [30]). Chong and Koh's [8] results were similar: they showed that stock prices, economic activities, real interest rates, and real money balances in Malaysia were linked in the long-run both in the pre- and post-capital control sub-periods. Islam and Watanapalachaikul [22] showed a strong, significant long-run relationship between stock prices and macroeconomic factors (interest rate, bonds price, foreign exchange rate, price-earnings ratio, market capitalization, and consumer price index) during 1992-2001 in Thailand.

Gunasekarage et al. [16] examined the influence of macroeconomic variables on stock market equity values in Sri Lanka, using the Colombo all share price index to represent the stock market and (1) the money supply, (2) the treasury bill rate (as a measure of interest rates), (3) the consumer

price index (as a measure of inflation), and (4) the exchange rate as macroeconomic variables. Abugri [3] studied whether selected macroeconomic indicators like exchange rates, interest rates, industrial production, and money supply in four Latin American countries significantly explain market returns. He reported that the global factors are consistently significant in explaining returns in all the markets. The country variables are found to impact the markets at varying significance and magnitudes.

Ben Naceur et al. [6] examined the macroeconomic determinants of stock market development and found that saving rate, credit to the private sector, the ratio of the value traded to GDP, and inflation change are the important determinants of stock market development. Gay [13] investigated the relationship between stock market index price and the macroeconomic variables of exchange rate and oil price for emerging countries (Brazil, Russia, India, and China) using the Box-Jenkins ARIMA model. He found no significant relationship between respective exchange rates and oil price on the stock market index prices in any of the emerging countries. He concludes that this result suggests that the markets of Brazil, Russia, India, and China exhibit a weak form of market efficiency. Abdul Rahman et al. [2] have studied mutual relationships between selected macroeconomic variables and stock prices in the stock exchange in Malaysia and showed that monetary policy variables have considerable long-term effects on the Malaysian stock exchange.

Xiufang [41] tried to find some evidence on the relationship between stock prices and macroeconomic variables (real GDP, CPI, short-term interest rate) in China Stock Market. His research is aimed to estimate the volatility of each variable using exponential generalized autoregressive conditional heteroscedasticity (EGARCH) and determine the causal relationship between the stock price volatility and macroeconomic variables by using Lag-Augmented VAR (LA-VAR) models. The first finding of this research was that there is no causal relationship between stock price and real GDP volatility. A bilateral causal relationship is found between inflation and stock price volatility. Xiufang [41] also found that there is a unidirectional

causal relationship between stock market volatility and interest rate volatility, with the direction from stock prices to the interest rate. Pal and Mittal [35] examined the long-run relationship between the Indian capital markets and key macroeconomic variables such as interest rates, inflation rate, exchange rates, and gross domestic savings (GDS) of Indians.

Sarbapriya [37] used a simple linear regression model and Granger causality test to measure the relationship between foreign exchange reserves and stock market capitalization in India. The results show that causality is unidirectional, and it runs from foreign exchange reserve to stock market capitalization and that foreign exchange reserves have a positive impact on stock market capitalization in India. Prempeh [36] empirically examined the impact of some macroeconomic variables on stock price volatility in the Ghana Stock Exchange (GSE) using annual time series data over the period of 1990-2014. The macroeconomic variables used in this study are inflation rate, real gross domestic product growth rate, and interest rate. The Granger causality test was employed to determine the causal link between stock prices and macroeconomic variables in Ghana. The results of the Granger causality test showed that at a 10% significance level, real domestic product rate Granger causes stock price, but the stock price does not Granger cause real domestic product rate. However, the other variables: inflation rate and interest rate do not Granger cause stock prices.

3. Data and Model

The data of macroeconomic variables represented by interest rate (base lending rate) (BLR, X_1), inflation (consumer price index) (CPI, X_2), gross domestic product (GDP, X_3), monetary supply (M1, X_4), and stock price are of interest in this study. The macroeconomic variables refer to explanatory variables which can be indicators of Iraqi's economy that might affect the stock market movement. As such, the response (dependent variable) is the stock price index (Iraq Stock Exchange) (ISE, y) with the length of the study being 16 years (2004-2019).

Methods

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

$$y = X\beta + e. \tag{3.1}$$

The ordinary least squares (OLS) estimators are:

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

where $\hat{\beta}_{OLS}$ is the unbiased estimator of β. The least-squares estimator works with some assumptions such as linearity independent identically distributed, errors with mean zero and constant variance, and 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 Hoerl and Kennard [19, 20] 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 $X^T X$, where X is the matrix of the explanatory variables. Thus, the regression estimators will be:

$$\hat{\beta}_R = (X^T X + k\, I_P)^{-1} X^T Y, \tag{3.3}$$

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 by Al-Kassab and Al-Awjar [5].

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

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

where

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

and λ represents the vector of the eigenvalues.

For the case $k(K^*)$ as the diagonal matrix whose elements are either the diagonal elements or the vector matrix of the matrix $X^T X$, the estimated regression coefficients are:

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

Based on the mean squares error criterion and on comparing this method with many other methods that are used by several researchers (Al-Kassab and Al-Awjar [5]) through simulation technique using the Monte Carlo method (Al-Kassab and Al-Awjar [4]), it could be concluded that this method for the case K^* diagonal matrix is the best.

4. Results and Discussion

Table 1 presents the summary of descriptive statistics for the selected dependent and independent variables under study examining 16 observations of all the variables to estimate the following statistics. The mean describes the average value in the series and the standard error of the mean measures the dispersion or spread of the average.

Table 1. Descriptive analysis of variables

Variables	(Y) ISE	(X_1) BLR	(X_2) CPI	(X_3) GDP	(X_4) M1
Mean	253.1	14.494	9.25	1.56316E + 11	53043351
Median	119.1	14.225	2.55	1.76197E + 11	65048051
Standard error of the mean	61.9	0.502	4.06	17238374854	6917099
Kurtosis	–0.88	1.82	2.87	–1.16	–1.51
Skewness	0.91	1.48	1.78	–0.47	–0.49

It can be said that there is no peculiar observation that might affect these measures except for ISE and CPI. This result is supported by slightly larger values in standard error.

The presence of multicollinearity investigated using correlation is presented in Table 2 and Figure 1. The GDP and CPI are related to interest rates from an economic point of view. Similar results are also observed for M1, CPI and GDP. 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	(Y) ISE	(X_1) BLR	(X_2) CPI	(X_3) GDP
(X_1) BLR	–0.424			
(X_2) CPI	–0.375	–0.137		
(X_3) GDP	0.404	–0.273	–0.660*	
(X_4) M1	0.586*	–0.413	–0.670*	0.962*

*Indicate the presence of multicollinearity with the p-value < 0.05

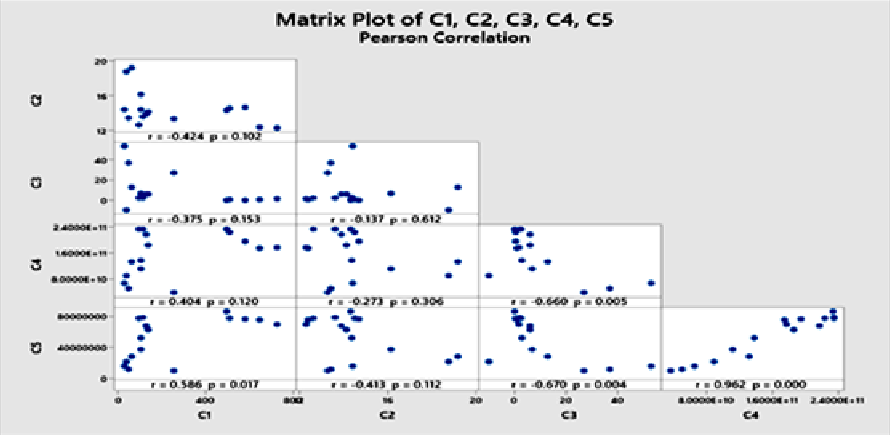

Figure 1. Correlation plot of explanatory variables, where C1 represents ISE, C2 represents BLR, C3 represents CPI, C4 represents GDP and C5 represents M1.

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

$$\text{ISE} = 0.209\,\text{BLR} + 0.124\,\text{CPI} - 2.459\,\text{GDP} + 3.121\,\text{M1}$$

$$\text{with } R^2 = 69.86\% \text{ and } F = 6.37\ (p = 0.007)$$

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

$$\text{ISE} = -0.104\,\text{BLR} + 0.464\,\text{CPI} + 0.205\,\text{GDP} + 0.434\,\text{M1}$$

$$\text{with } R^2 = 98.51\% \text{ and } F = 182.02\,(p = 0.007).$$

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	BLR	0.209	0.4111	69.86%	6.37
	CPI	0.124			
	GDP	–2.46			
	M1	3.12			
Proposed ridge regression with $K = (0.049856\ -0.232780\ 0.070136\ 0.127707)^T$	BLR	–0.10367	0.0202950	98.51%	182.02
	CPI	0.463702			
	GDP	0.204848			
	M1	0.43709			

The results of the estimation of ordinary least squares (OLS) and the proposed method are shown in Table 3. Both methods provide the same result, and the two methods provide significant results for all parameters indicating that all variables affect the stock market movement. In fact, the second model is more efficient than the first one economically, since the relationship between ISE and the BLR is negative and ISE with GDP is positive, also the result of the proposed method, however, yields significantly more efficiency than the OLS. This is due to the value of F (182.02) which is highly significant indicating good fitting of the regression model than OLS (6.37). In comparison to R2 and MSE values, the new

version of the ridge regression method provides the largest value whereby the sum squared of errors is minimized by the values of k rather than in OLS. Thus, the suggested method can estimate the model more accurately in the presence of a high dependency of variables in the model.

5. Conclusions

This study proposes a ridge regression estimator as in (Al-Kassab and Al-Awjar [5]) 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. The proposed method of estimation can produce consistent results as existing methods of estimation in the presence of multicollinearity in the data.

This study has concluded that there is a direct relationship between macroeconomic variables (CPI, GDP, BLR and M1) and stock prices in the Iraqi stock market ISE, and there is a clear effect of these variables on stock prices. The modified R^2 value is approximately 98.5% which means that the independent variables account for 98.5% of the change in the dependent variable. The existence of a negative relationship between ISE and the BLR means that lower BLR supports the market index through the increase in the stock price in ISE. The relationship was positive between M1, GDP and CPI with stock prices in the Iraqi Stock Exchange (ISE). It is because of the increase in domestic production and the increase in consumer prices. These reflect the increase in economic activity that leads to a rise in stock prices.

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