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Studying the Factors Affecting the Performance of Stocks by Using the Logistic Regression (Applied Study on Jordan Stock Exchange)

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Abstract:

The use of Multiple Binary Logistic Regression Analysis is considered as a development in data analysis methods, especially in the field of finance and business. Stock markets thought to be one of the important sectors of the economy because they affect it directly or indirectly by providing investing and financing opportunities. Making investment decisions that are related to the acquisition of shares for investment requires the use of the available financial statements correctly. Due to the complexity of forecasting the performance of shares, one of the methods used to analyze the performance of shares is to convert the financial data contained in the annual financial reports to financial ratios, which are widely used in forecasts of the performance of shares of companies.

In this research, a logistic regression analysis is used to classify the shares' performance of listed companies on the Amman / Jordan stock exchange by constructing a model used to predict the performance of these shares. This research provides an effective investment tool to make the right decision regarding the purchase or sale of shares as well as to take corrective decisions in a timely manner. A sample of (62) Jordanian companies was adopted and (8) independent variables were studied to explain the dependent variable. Financial ratios have been adopted to determine the value of each variable whether the dependent variable or the independent variables. Finally, the research concluded with a number of conclusions and recommendations.

Keyword: Stock Exchange, Multiple Regression, Binary Model.

الملخص:

يعتبر استخدام تحليل الانحدار اللوجستي الثنائي المتعدد بمثابة تطور في طرق تحليل البيانات ، خاصة في مجال التمويل والأعمال. يُعتقد أن أسواق الأسهم من القطاعات المهمة في الاقتصاد لأنها تؤثر عليه بشكل مباشر أو غير مباشر من خلال توفير فرص الاستثمار والتمويل. يتطلب اتخاذ قرارات الاستثمار المتعلقة بالاستحواذ على الأسهم للاستثمار استخدام البيانات المالية المتاحة بشكل صحيح. نظرًا لتعقيد التنبؤ بأداء الأسهم ، فإن إحدى الطرق المستخدمة لتحليل أداء الأسهم هي تحويل البيانات المالية الواردة في التقارير المالية السنوية إلى نسب مالية ، والتي تستخدم على نطاق واسع في تنبؤات أداء أسهم شركات.

في هذا البحث، تم استخدام تحليل الانحدار اللوجستي لتصنيف أداء أسهم الشركات المدرجة في بورصة عمان / الأردن من خلال بناء نموذج يستخدم للتنبؤ بأداء هذه الأسهم. يوفر هذا البحث أداة استثمار فعالة لاتخاذ القرار الصحيح فيما يتعلق بشراء أو بيع الأسهم وكذلك لاتخاذ القرارات التصحيحية في الوقت المناسب. تم اعتماد عينة قوامها (62) شركة أردنية ودراسة (8) متغيرات مستقلة لشرح المتغير التابع. تم اعتماد النسب المالية لتحديد قيمة كل متغير سواء كان المتغير التابع أو المتغير المستقل. واختتم البحث بعدد من الاستنتاجات والتوصيات .

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الكلمات المفتاحية: البورصة، الانحدار المتعدد، نموذج ثنائي.

پوختە:

بەکارهێنانی شیکاری پاشەکشەی لۆجستیکی دووانەیی فرەیی وەک پێشکەوتنێک لە شێوازەکانی شیکاری داتادا سەیر دەکرێت، بە تایبەت لە بواری دارایی و بازرگانیدا. بازارەکانی بۆرسە وا بیردەکرایەوە کە یەکێکە لە کەرتە گرنگەکانی ئابووری، چونکە ڕاستەوخۆ یان ناڕاستەوخۆ کاریگەرییان لەسەری هەیە بە ڕەخساندنی دەرفەتی وەبەرهێنان و دارایی. بڕیاردانی وەبەرهێنان کە پەیوەندی بە بەدەستهێنانی پشکەوە هەیە بۆ وەبەرهێنان پێویستی بە بەکارهێنانی دروستی بەیاننامە دارایییەکانی بەردەستە هەیە. بەهۆی ئاڵۆزی پێشبینیکردنی ئەدای پشکەکان، یەکێک لەو ڕێگایانەی کە بۆ شیکردنەوەی ئەدای پشکەکان بەکاردەهێنرێت بریتییە لە گۆڕینی ئەو زانیارییە دارایانەی کە لە ڕاپۆرتە دارایی ساڵانەدا هاتووە بۆ ڕێژەی دارایی، کە بە شێوەیەکی بەرفراوان لە پێشبینیکردنی ئەدای پشکەکانیدا بەکاردەهێنرێت کۆمپانیاکان.

لەم لێکۆڵینەوەیەدا، شیکارییەکی پاشەکشەی لۆجستیکی بەکاردێت بۆ پۆلێنکردنی ئەدای پشکەکانی کۆمپانیا لیستکراوەکان لە بۆرسەی عەممان / ئوردن بە دروستکردنی مۆدێلێک کە بەکاردێت بۆ پێشبینیکردنی ئەدای ئەم پشکانە. ئەم توێژینەوەیە ئامرازێکی کاریگەری وەبەرهێنان دابین دەکات بۆ بڕیاردانی دروست سەبارەت بە کڕین یان فرۆشتنی پشکەکان هەروەها بڕیاردانی چاکسازی لە کاتی خۆیدا. نمونەیەک لە (٦٢) کۆمپانیای ئوردنی وەرگیرا و (٨) گۆڕاوە سەربەخۆکان لێکۆڵینەوەیان لەسەر کرا بۆ ڕوونکردنەوەی گۆڕاوە وابەستەکراوەکە. ڕێژەی دارایی وەرگیراوە بۆ دیاریکردنی بەهای هەر گۆڕاوێک جا گۆڕاوە وابەستە بێت یان گۆڕاوە سەربەخۆکان. لە کۆتاییدا توێژینەوەکە بە کۆمەڵێک دەرەنجام و پێشنیار کۆتایی هات.

کلیلە وشە: ئاڵوگۆڕی کۆگا، دووبارە بوونەوەیەکی هەمەجۆر، مۆدێلی دوانی.

1-0 *Introduction:*

In many economic and social studies, the dependent variable is qualitative rather than quantitative, which does not meet the assumptions and requirements of regression models [2]. Accordingly, the need arose to search for alternative statistical methods that allow dealing with such variables. Hence, the use of Multiple Binary Logistic Regression is considered to be an evolution in data analysis methods, especially in the field of finance and business. Stock markets are important sectors of the economy because they directly and indirectly affect the national economy. Also, they have an important role in the development process because they provide investment and funding opportunities. Making investment decisions to acquire shares for investment require the use of the available financial statements correctly. Due to the complexity of the stock's performance forecasting, one of the methods used to analyze the performance of stocks is to convert the financial statements contained in the annual reports to financial ratios, which became widely used in predicting the stock's performance of companies [3] ,[10].

In this research, logistic regression is used to classify stock's performance of listed companies in the Jordanian Stock Exchange by constructing a model used to predict the performance of these stocks. The research's problem can be determined by answering the following questions:

- What are the variables that have a significant impact on the stock's performance in the Jordanian market and what is their predictive ability?
- What is the order of these variables in terms of importance in predictability?

The aim of the research is to use logistic regression for the purpose of constructing a statistical model that can predict the performance of stocks in the Jordanian market. Also, its goal is to identify

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the variables that have a significant effect on the performance of stocks, and to rank these variables according to their importance.

The importance of research is that it provides an effective investment tool to make decisions regarding the ownership or sale of stocks. In addition, it helps in taking corrective decisions in a timely manner. The spatial limit of the research is the Hashemite Kingdom of Jordan, Amman stock exchange market. The chronological limit of the research is the comparison between years 2015 and 2014. Also, the research studied a total of 62 companies that were listed in the Amman stock exchange market by finding ratios and indicators.

The research depends on the descriptive and the Inference analysis methods by applying the foundations of the statistical theory that is represented by the logistic analysis.

The important literature review is:

Dutta (2015),[4] examined the "stock performance forecasting in the Indian stock market using logistic regression" by using logistic regression and various financial ratios as independent variables to investigate the indicators that significantly affect the performance of active stocks traded in the Indian stock exchange market. The study sample consisted of 30 companies with large market capitalization over a period of four years. The study concluded that the method of logistic regression helps the investor to form an opinion on which stocks to invest. Eight financial ratios were assigned (to a rating of 74.6%) in two categories ("good" or "weak") based on the rate of return. The financial ratios used are:

1. Percentage change in net sales (NS).
2. Sales / Net Asset (SAN).
3. Price / cash return per share (PECEPS).
4. Price / Book Value (PEBV).
5. Price / earnings per share (PE).
6. Sales (BPIDT).
7. Cash price / earnings per share (CEPS).
8. Book value (BV).

Again, in a study done by (Al-Farhoud, 2014),[5] logistic regression is used to study the variables affecting the performance of stocks in the Kuwaiti stock exchange market by providing an effective investment tool for potential investors and relevant parties to make appropriate investment decisions for the acquisition or sale of stocks, as well as take corrective actions towards their situation in a timely manner. The results of this study showed that the logistic regression model is fully efficient in predicting the performance of stocks in the Kuwait stock exchange market. Financial ratios with a significant effect on the performance of stocks in the Kuwaiti market were determined according to their relative importance. The model that was built has a rating of 74.2% while the value of (R^2) is 35%.

In 2012, a study done by (Abbas, 2012)[1] “the use of the logistic regression model in predicting functions with qualitative economic variables” examined the importance of logistic regression in the process of predicting functions with qualitative economic variables in order to eliminate the problems

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facing the method of the least squares, such as; (statistical and conceptual) problems. The aim of this study is to identify the problems faced by researchers when trying to apply the general least squares method model for the purpose of modeling the relationship between independent variable and binary dependent variable, and to examine the suitability of the logistic regression model to model the relationship between independent variables and binary dependent variables. This study found that there are some problems that arise from the application of the ordinary least squares method (OLS), especially when the regression model includes a qualitative variable. Also, the use of the binary responsive logistic regression model (1, 0) is more realistic and gives logical results that are consistent with the theory behind the studied phenomenon. In addition, the logistic regression model requirements regarding the dependent variable are simple.

In another study, (Chanem, 2011),[6] studied the forecasting of stock performance in the Indian market using multiple logistic regression. In this study, financial ratios were used as test criteria to forecast the performance of stocks in the stock market, and they were divided into three categories (weak, medium, and good) based on market rate of return and stock inequality. The multiple logistic regression model was used with seven financial ratios, and the results showed a high forecasting accuracy of 56.8%. It can be concluded that the use of logistic regression model can enhance the stock prices predictability for investors and help them to form an opinion on the stocks to be invested.

1-1: *Logistics Regression*:

Logistic regression is a statistical method used to examine and document the relationship between the dependent variable (Qualitative) and one or more independent variables of any kind (Quantitative or Qualitative). The logistic regression is based on the assumption that the dependent variable (y) that we are interested in is considered as a binary variable that takes the value (1) with probability (P) and value (0) with probability (1-P):[3] ,[5] ,[7] ,

$$E(y1x) = P(y = 1) = P \dots\dots\dots\dots\dots\dots (1)$$

Thus, the value of the right side would be limited between (1, 0), and the model is not applicable from the regression point of view. To solve this problem, we introduce an appropriate mathematical variable on the dependent variable (y):

$$0 \leq P \leq 1$$

Thus, the ratio $(\frac{\mathrm{P}}{1-\mathrm{P}})$ Is a positive value (∞, 0), explicitly:

$$0 \leq \frac{P}{1-P} \leq \infty$$

By taking the natural logarithm we get:

$$-\infty \leq \ln\left(\frac{P}{1-P}\right) \leq \infty \dots\dots\dots\dots\dots\dots (2)$$

Thus, the regression model can be written in the case of one independent variable:

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$$ln\left(\frac{P}{1-P}\right) = b_0 + \quad b_1 \quad x_1 \dots\dots\dots\dots\dots\dots (3)$$

If there is more than one independent variable, the model be:

$$ln\left(\frac{P}{1-P}\right) = b_0 + \sum_{i=1}^{n} b_j \quad x_{ij} \dots\dots\dots\dots\dots\dots (4)$$

$$j = 1,2, \dots, k$$

$$i = 1,2, \dots, n$$

Equation (4) above represents the logistic regression model. The following transformation $ln\left(\frac{P}{1-P}\right)$ is called (Logit Transformation). [8] ,[9] .

Logistics regression is a model that takes the form of a logistic function as in figure (1), and it is used to predict the probability of a particular event by documenting the data in a logistic curve

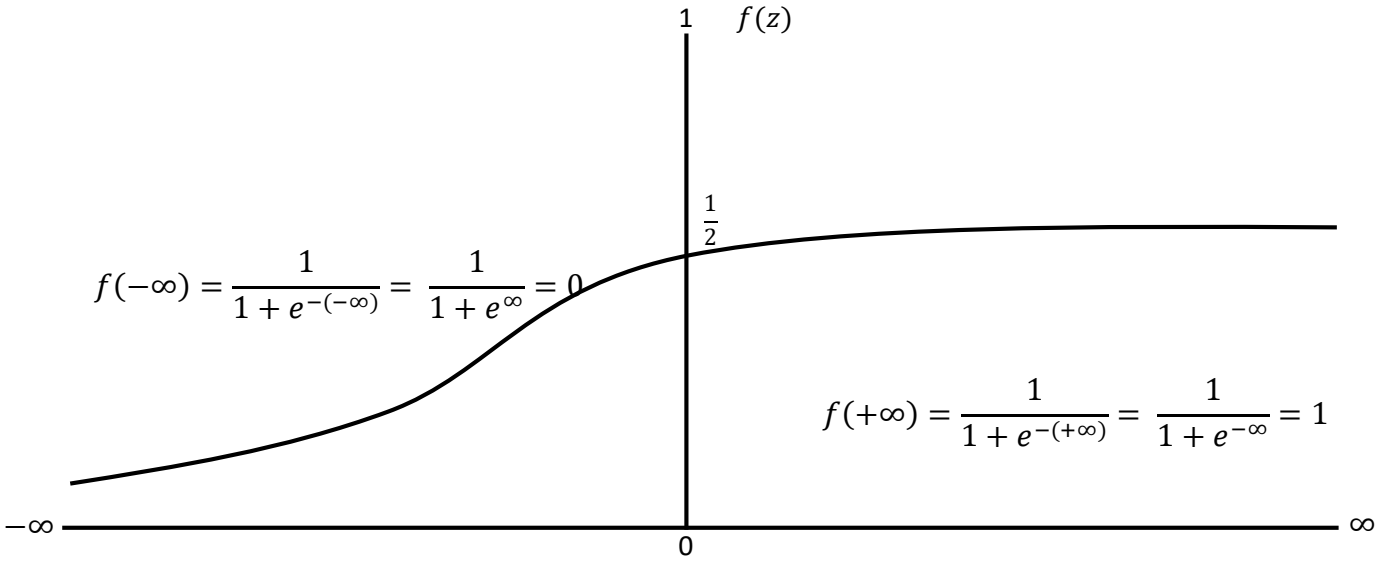

Figure 1: Logistics function

The regression in the figure above is based on the logistic curve that takes the formula as in the following equation:

Range

$$0 \le f(z) \le 1$$

$$P = \frac{e^{a+bx}}{1+e^{a+bx}} = \frac{1}{1+e^{a+bx}} \dots\dots\dots\dots\dots\dots (5)$$

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Instead of the straight line equation $y = b_0 + b_1 x + e$ which made this subject of regression called logistic regression. One of the features of logistic regression analysis is that it arranges the effect of independent variables, allowing the researcher to conclude that one variable is stronger than the other variable. Also, the logistic regression does not require the independent variables to follow the normal distribution nor the relationship with the dependent variable to be a linear relationship. [11] ,[12].

1-2: *The Practical Part*:

1-2-1: *The Data of the Research*:

Data from the Jordan stock exchange market for the years 2014-2015 were adopted and the financial ratios of the companies were calculated to determine the independent variables. The following table shows the independent variables and they are 8 variables.

Table 1 The independent variables

The Independent Variable	The Details	The Value
X1	Return on equity.	Gives (1) if 2015 is greater than ≥ 2014. Gives (0) if 2015 is < less than 2014.
X2	Debt ratio.	
X3	Book value of the stock.	
X4	Cash dividends per stock.	
X5	Dividend payout ratio.	
X6	Stock payout.	
X7	Market price ratio per stock to its book value.	
X8	Price-earnings ratio.	

On the other hand, the dependent variable (y) represents the performance of the stock, which is a binary variable:

y = 1

The above is correct when the stock performs well, or there was a good investment opportunity; if the return on equity is greater than or equal to the market rate of return for that year.

y = 0

The above is correct when the stock performs badly, or there was a bad investment opportunity; if the return on equity is less than the market rate of return for that year.

1-2-2: *Statistical Analysis*:

The SPSS software package was used. Table (2) shows the descriptive data of the sample.

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Table 2 Case Processing Summary

Unweighted Cases[a]		*N*	*Percent*
Selected Cases	*Included in Analysis*	62	100.0
	Missing Cases	0	.0
	Total	62	100.0
Unselected Cases		0	.0
Total		62	100.0

a.If weight is in effect, see classification table for the total number of cases.

Table (2) above shows the data used in the analysis.

Table (3) includes the number of repetitive cycles of the Log Likelihood function derivatives to obtain the lowest -2 Log Likelihood logarithm function. In other words, it is used to obtain the optimal estimation of the derived parameters of the model;

2- Log Likelihood function.

Table 3: Iteration History (a,b,c,d)

Iteration		-2Log likelihood	Constant	X1(1)	X2(2)	X3(3)	X4(4)	X5(5)	X6(6)	X7(7)	X8(8)
Step	1	68.172	.780	.243	-1.332-	-1.237-	-1.371-	1.008	.419	.508	-.547-
	2	67.323	.951	.253	-1.709-	-1.519-	-1.920-	1.297	.812	.636	-.698-
	3	67.291	.972	.251	-1.775-	-1.563-	-2.109-	1.359	.980	.655	-.730-
	4	67.291	.972	.251	-1.778-	-1.565-	-2.123-	1.363	.993	.656	-.732-
	5	67.291	.972	.251	-1.778-	-1.565-	-2.123-	1.363	.993	.656	-.732-

In the fifth cycle of the derivative, we obtained the lowest probability of the maximum value (-2Log likelihood = 67.29). We stopped at this cycle because the change in the parameters (b_1, b_2, ..., b_8) became less than 0.001. In fact, the change in the estimated parameters became very slow after the third cycle as shown in table (3). Therefore, it can be said that the optimal estimations of the parameters in the cycles (3, 4, and 5) are similar with very small differences, and we stopped at the fifth cycle and considered its coefficients to be the best result that could be obtained for the parameters. Thus, (-2Log likelihood) is at its lowest end at this cycle.

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Table (4) summarizes the parameters of the optimal model obtained in the fifth cycle of Table (3). Table (4) contains all estimated parameters of the model (Constant b0, b1, b2, b3, ..., b8), the standard error for each parameter, the Wald statistic for each parameter of the model, the number of degrees of freedom, and the significance of the parameters that will be explained later.

Table 4 The variables in the equation.

		B	*S.E.*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I... Lower*	*95% C.I. for Upper*
Step	X1(1)	.251	.797	0.99	1	.753	1.286	.270	6.128
	X2(1)	-1.778-	.725	6.022	1	.014	.169	.041	.699
	X3(1)	-1.565-	.770	4.131	1	.042	.209	.046	.946
	X4(1)	-2.123-	1.523	1.942	1	.163	.120	.006	2.370
	X5(1)	1.363	1.220	1.248	1	.264	3.907	.358	42.668
	X6(1)	.993	1.608	.381	1	.537	2.699	.115	63.125
	X7(1)	.656	.652	1.013	1	.314	1.928	.537	6.920
	X8(1)	-.732-	.785	.869	1	.351	.481	.103	2.241
	constant	.972	1.262	.593	1	.441	2.643		

a. Variable(s) entered on step 1: x1, x2, x3, x4, x5, x6, x7, and x8.

The (Goodness of Fit) test is used to test the adequacy and quality of the whole model. In the case of the logistic model, the (Log Likelihood Ratio) which follows the distribution of the (Chi-Square x^2) is used according to the following:

$$x^2 = \quad 2[log_e\, l_0 - \ log_e\, l_1] \dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

Where

L_1 = the value of the Likelihood function containing (i) variable.

L_0 = the value of the Likelihood function containing (i - 1) variable.

Furthermore, the value of (x^2 = 15.471) is significant at the level of significance of α, where α = 10%. Table (5) shows that the model is significant at α = 0.10

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Table 5 Omnibus tests of model coefficients.

		Chi-Square	*df*	*Sig.*
Step 1	*Step*	*15.471*	*8*	*.051*
	Block	*15.471*	*8*	*.051*
	Model	*15.471*	*8*	*.051*

Moreover, table (6) represents a nonparametric test of the quality of the model. It depends on the statistical calculation of (x^2) of the difference between observed values and expected values. This test is proposed by (Hosmer and Lemeshow) using (x^2) distribution to detect the deviations of the logistic model. The statistics of this test consists of Observed Statistics that are not based on a theoretical model, and Expected Statistics that are calculated from the estimates of the logistic model. The statistical calculation (x^2) for the quality of documentation (Contingency Table) is calculated as showed in table (6).

Table 6 Contingency table for (Hosmer and Lemeshow) test.

		y = 0		*y = 1*		
		Observed	*Expected*	*Observed*	*Expected*	*Total*
Step 1	1	6	5.619	0	.381	6
	2	5	5.081	1	.919	6
	3	4	4.618	2	1.382	6
	4	1	1.414	1	.586	2
	5	5	6.986	5	3.014	10
	6	5	3.969	1	2.031	6
	7	3	2.420	1	1.580	4
	8	6	3.822	1	3.178	7
	9	2	2.661	4	3.339	6
	10	1	1.410	8	7.590	9

The statistical calculation x^2 of the (Contingency Table) is calculated from the binary dependent variable (y) sums with the estimated probability sums. The table is constructed from the intersection of the dependent variable (y) sums with sums of estimated probabilities. From table (7), it is noted that the value of (H- Statistics = 7.378); thus, the null hypothesis (H0) is accepted, where Sig = 0.496 and *df* = 8. This confirms the documentation quality of the entire model. This is confirmed by the large and clear correlation in table (6) of the column (y = 1, y = 0) between the actual and the estimated values.

Table 7 Hosmer and Lemeshow

Step	*Chi-Square*	*df*	*Sig.*
1	*7.378*	*8*	*.496*

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Table (8) shows the percentage of the overall rating to the two classification groups to which it (77.7 = 62/(12+36)) belongs, where 14 observations were classified incorrectly.

Table 8 Classification table.

			Predicated	
		y		
	observed	0	1	*Percentage Correct*
Step 1	0	36	2	94.7
	1	12	12	50.0
			Overall Percentage	77.7

a. The Cut Value is .500

1-2-3*: The Results*:

Note in table (4) that column (B) contains the parameters of the model in Log-odds units, and the equation of the logistic model that was built:

$$\ln\left(\frac{P}{1-P}\right) = 0.972 + 0.25x1 - 1.778x2 - 1.565x3 - 2.123x4 + 1.363x5 + 0.993x6 + 0.565x7 - 0.732x8 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

The results shown in table (5) indicate that the independent variables that have a significant effect on the performance of the Jordanian stock exchange market (p-value < 0.05) are reliable by (95%): X_2, X_3

In other words, these variables are important in interpreting the performance of stocks in the Jordanian stock exchange market, and the values of the parameters respectively are:

B_2=-1.778---Exp= o.169 odds ratio *B_3=-1.565----Exp=0.209 odd ratio*

- The variable (X_2), which represents the debt ratio, occupied the first place in effecting the stock performance dependent variable (Y). The parameter of this variable (b_2 = -1.778), which showed a substantial significance over the dependent variable at a level of significance (α = 0.05) for a degree of freedom (*df* = 1) with a statistic (Wald stat = 6.022), and a standard error of (SE = 0.797).
- The variable (X_3), which represents the book value of the stock, occupied the second place in terms of its importance in effecting the adopted variable (Y). The parameter of this variable (b_3 = -1.565), which showed a substantial significance over the dependent variable at a level of significance (α = 0.05) for a degree of freedom (*df* = 1) with a statistic (Wald stat = 4.131).
- The other independent variables (X_1, X_4, X_5, X_6, X_7, and X_8) were not significant.

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1-3: Conclusions and Recommendations:

The main conclusions and recommendations of the research can be summarized as follows:

1. The aim of the research was achieved by build a statistical model that can predict the performance of stocks in the Jordanian stock exchange market.
2. The financial ratios (independent variables) that have a significant effect on the performance of stocks in the Jordanian stock exchange market represented

   X_2 = debt ratio.
   X_3 = book value per stock.

3. The classification rate of the model that was built was (77.7%), noticing that the performance rating of the companies in question is classified into (good) and (poor).
4. The nonparametric test, which was suggested by Hosmer and Lemeshow and is based on the difference between the observed and expected values, proved the quality of the model that was built.
5. The importance of providing financial data for companies and facilitating it for the purpose of research.
6. Expanding the use of logistic regression since it is considered as an effective method for measuring stock performance.

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