استعمال نموذج انحدار توبت لتحديد أثر بعض المتغيرات في الاستقرار المالي للبنوك

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المستخلص :

ان الوصول الى الاستقرار المالي وتحقيقه يساهم في استقرار الاسعار وكذلك المساهمة في خفض معدلات التضخم ، لذلك لابد من تحليل مؤشرات الاستقرار المالي حيث يساعد ذلك البنوك على اتخاذ التدابير اللازمة وتجنب الوقوع في المخاطر المالية المصرفية. ان البيانات التي تصف الاستقرار المالي قد تكون خاضعة للرقابة من جهة اليمين أو اليسار أو من كلا الجانبين لذلك وفي ضوء التقدم التكنلوجي الحاصل فقد برز نموذج انحدار توبت(Tobit) مؤخرًا كأداة إحصائية مهمة في العديد من التحليلات الإحصائية والذي بدوره يتعامل مع البيانات الخاضعة للرقابة. لذا فأن الهدف من هذا البحث هو دراسة نموذج انحدار توبت في الكشف عن أهمية وأولوية العوامل المؤثرة على الاستقرار المالي لكونه من البيانات الخاضعة للرقابة من الجهة اليسرى ، حيث تم تطبيقه على بعض المصارف العراقية وهي: مصرف الائتمان والمصرف التجاري الخليجي للفترة من (2004 - 2022)، تم بيان دور اربع نسب مالية في تأثيرها على الاستقرار المالي للمصرف وتمثلت هذه النسب بالنسبة الى اجمالي الاصول بالاتي (نسبة رأس المال العامل، نسبة الارباح المحتجزة، نسبة اجمالي حقوق المساهمين و نسبة الارباح قبل الفوائد والضرائب). من نتائج التحليل تبين أن نموذج توبت مناسب لمثل هذا النوع من البيانات ، ووجد أن نسبة الأرباح قبل الفوائد والضرائب إلى إجمالي الأصول هي النسبة المالية التي تؤثر بشكل كبير على الاستقرار المالي لكلا المصرفين.

الكلمات المفتاحية: نموذج توبت، البيانات المر اقبة، الاستقرار المالي.

Using a Tobit regression model to determine the impact of some variables on the financial stability of banks

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Abstract :

Reaching and achieving financial stability contributes to price stability as well as contributing to reducing inflation rates. Therefore, financial stability indicators must be analyzed, as this helps banks to take the necessary measures and avoid falling into banking financial risks. The data that describes financial stability may be censored from the right, left, or from both sides. Therefore, in light of the technological progress that has occurred, the Tobit regression model has recently emerged as an important statistical tool in many statistical analyses, which in turn deals with censored data. Therefore, the aim of this research is to study the Tobit regression model in revealing the importance and priority of the factors affecting financial stability, as it is from the data controlled from the left side, as it was applied to some Iraqi banks, namely: the Credit Bank and the Gulf Commercial Bank for the period from (2004 - 2022). The role of four financial ratios in their impact on the financial stability of the bank was explained, and these ratios were represented in relation to total assets as follows (working capital ratio, retained earnings ratio, total shareholders' equity ratio, and earnings before interest and taxes ratio). From the results of the analysis, it was shown that the model Tobit is appropriate for such type of data, and finds that the ratio of earnings before interest and taxes to total assets is the financial ratio that most influences the financial stability of both banks.

Key words: Tobit Model, Censored Data, Financial Stability

1. Introduction

The financial stability of banks is a primary goal that has increased interest in it over the decades. In the context of the economic policies of various countries of the world, realizing the importance of financial stability reduces the occurrence of financial crises that have a significant impact on economic growth. Financial safety has become one of the most important matters, especially after the financial crisis in 2008, as it contributes to price stability and continues to reduce and maintain inflation rates, and achieving stability helps banks take the necessary measures to avoid banking and financial risks and correct the financial and administrative conditions that threaten financial stability [8].

The study and analysis of financial stability is one of the important topics that requires models for treatment and analysis, and one of these models is the Tobit model, which is one of the regression analysis models that has been widely used in economic research., where the Tobit model is considered one of the most appropriate models to use. when the dependent variable is censored. Wide and varied practical applications have been developed using the Tobit model in various financial or other fields, the most important of which can be mentioned:

Study of (Fadel and Taher,2010)[3] the Tobitt model was used to identify some variables and to show the extent of their influence on increasing or decreasing the number of sperms in men, as they are responsible for pregnancy in women. (Meshal,et.al.2017)[6] Were studied the determinants of the value of bank loans, which are considered one of the most important banking services provided by banks in any country. The Tobit model was used in comparison with the least squares method to reveal the most important factors affecting bank loans. (Meshal,et.al.,2018)[7] In this study, the Tobit model was applied to the censored data from the left side to determine the determinants of profit distribution among some companies competing in stock trading in Iraq. The study used some companies traded on the Iraqi Stock Exchange for the years between 2005-2015. (Raz and Samira,2020)[9] The Tobitt model was used to study the factors affecting blood pressure in patients with renal failure. Data were collected from 300 patients. It was found that age and urea were more effective than other factors included in the study. (Ismael,2021)[4] He studied how to improve the Tobit model by removing irrelevant variables from the final model based on Bayesian method. (Jassam,et.al.,2022)[5] A1 The study aimed to use the Tobit

model in evaluating the marketing efficiency of the dry onion crop in the city of Salah al-Din, Iraq. It was found that the Tobit model is very suitable for the data under study.

In this paper, the Tobit model was applied to analyze the impact of some financial ratios on the financial stability of some Iraqi banks for the periods (2004-2022).

2. Tobit Regression

For each type of data, there must be an optimal model that fits with it. Therefore, in the event that the data that describes the phenomenon is censored from the right or left side, or both sides, in this case, the use of classical regression models leads to biased and inconsistent estimated parameters, so it is necessary to select a model in this case, the Tobit regression model is the most suitable model, which was proposed by James Tobin 1985 [10]. Whereas, through Tobit model, the effect of a group of explanatory variables on the response variable is evaluated, in which the response variable is specified. The Tobit model is very suitable for estimating random effects models, as there are no additional problems except how to deal with the circumstances surrounding the phenomenon [7].

2.1 Tobit Models

There are different types of Tobit model, depending on the place and time of censorship. Tobit models can be illustrated as below [6][1].

If the data is censored from the left with zero, the Tobit model is as follows:

$$Z_i^* = \beta^t X_i + e_i \qquad \text{...(1)}$$

$$Z_i = \begin{cases} Z_i^* & if\ Z_i^* > 0 \\ 0 & if\ Z_i^* \leq 0 \end{cases} \qquad \text{...(2)}$$

Whereas Z_i and Z_i^* represent the dependent variables with $Z^* \sim N(X\beta, \sigma^2)$ which independent identically distribution (i.i.d). X_i: vector of explanatory variables, β: parameters vector of the model, e_i represent the random error.

If the data is censored from the left with a certain restriction a_L, then the model is as follows:

$$Z_i = \begin{cases} Z_i^* & if\ Z_i^* > a_L \\ a_L & if\ Z_i^* \leq a_L \end{cases} \quad ...(3)$$

The Tobit model for the censored data from the right with a certain restriction a_U is as follows:

$$Z_i = \begin{cases} Z_i^* & if\ Z_i^* < a_U \\ a_U & if\ Z_i^* \geq a_U \end{cases} \quad ...(4)$$

In general, the comprehensive equation for both cases when the data is censored from the right and the left at the same time, so the Tobit model is as follows:

$$Z_i = \begin{cases} Z_i^* & if\ a_L < Z_i^* < a_U \\ a_L & if\ Z_i^* \leq a_L \\ a_U & f\ Z_i^* \geq a_U \end{cases} \quad ...(5)$$

2.2 Estimation of Tobit Model

There are many methods for estimating the function of the Tobit model, the most important and most used of which is the maximum likelihood method, as shown below.

If the control limit is (a), then the likelihood function has the form[6]:

$$L = \prod_{i=1}^{n} pr(Z_i^* < a)^{(1-d_i)} \quad ...(6)$$

Then

$$L = \prod_{i=1}^{n} \{pr(Z_i^* > a) f(Z_i^* | Z_i^* \geq a)\}^{d_i} \quad ...(7)$$

To simplified the equation (7) we do the following:

$$pr(Z_i^* < a) = pr(\beta^t X_i + e_i < a)$$

$$= pr\left(\frac{\beta^t X_i + e_i}{\sigma^2} < \frac{a}{\sigma^2}\right)$$

$$= pr\left(\frac{e_i}{\sigma^2} < \frac{a - \beta^t X_i}{\sigma^2}\right) = \emptyset\left(\frac{a - \beta^t e_i}{\sigma^2}\right) \quad ...(8)$$

When $a = 0$ then

$$pr(Z_i^* < a) = \emptyset\left(\frac{-\beta^t X_i}{\sigma^2}\right) = 1 - \emptyset\left(\frac{\beta^t X_i}{\sigma^2}\right) \quad ...(9)$$

$$pr(Z_i^* \geq a) = 1 - \emptyset\left(\frac{a-\beta^t X_i}{\sigma^2}\right) \quad ...(10)$$

Then we conclude the following

$$pr(Z_i^* > a) = \emptyset\left(\frac{\beta^t X_i}{\sigma^2}\right) \quad ...(11)$$

$$f(Z_i^* | Z_i^* \geq a) = \frac{1/\sigma \emptyset(Z_i^* - \beta^t X_i)/\sigma_u}{pr(Z_i^* > a)} \quad ...(12)$$

Therefore, write the likelihood function for the censored normal distribution according to the formula below [9].

$$L = \prod_{i=1}^{n} \left[\frac{1}{\sigma}\ \emptyset\left(\frac{Z_i - X_i\beta}{\sigma}\right)\right]^{d_i} \left[1 -\ \emptyset\left(\frac{X_i\beta}{\sigma}\right)\right]^{1-d_i} \quad ...(13)$$

By taking the logarithm, the resulting final function will be in the form:

$$ln\ L = \sum_{i=1}^{n} d_i \left(-ln\sigma + ln\emptyset\left(\frac{Z_i - X_i\beta}{\sigma}\right)\right) + (1 - d_i) ln\left(1 -\ \emptyset\left(\frac{X_i\beta}{\sigma}\right)\right) \quad ...(14)$$

Where $(\emptyset)$ represents the probability density function of the normal distribution.

For the purpose of testing the goodness of fit of the model, the likelihood function is used. In addition, the quality and significance of the model are tested through the Chi-square test, and this will be explained in the applied aspect.

3. Application

3.1 Description of The Data

The study is based on the hypothesis that the impact of some factors on the financial stability of some banks, where the data was taken from the annual reports issued by the Central Bank of Iraq for the years (2004-2022) for each of the credit and gulf commercial banks. The data was represented by four financial ratios considered as explanatory variables and one dependent variable Z representing the value

of the financial stability of the bank in each year. The financial ratios included in the study were as follows:

X_1: The ratio of working capital to total assets.

X_2: The ratio of retained earnings to total assets.

X_3: The ratio of total shareholders' equity to total assets.

X_4: The ratio of earnings before interest and taxes to total assets.

Based on the study of Altman[2], if the value of Z is less than 1.1, the bank is financially unstable and is at risk of bankruptcy. Therefore, in this paper, the control limit of the Tobit model on the left side was made equal to 1.1, in order to exclude the years in which the bank was failing and exposed to bankruptcy.

3.2 Results for The Analysis

From the Tables 1 and 2 below show descriptive statistics related to the Credit and Gulf Commercial Banks. Descriptive statistics show an overview of the work with the minimum, maximum, average, standard deviation, and variance for each of the variables included in the study. We notice through the values related to the variance that the dispersion within the explanatory variables was very small.

Table(1): Descriptive statistics for the independent and dependent variables for the credit bank

	Minimum	Maximum	Mean	Std. Deviation	Variance
X1	0.05215	0.65163	0.3833811	0.19126386	0.037
X2	0.00400	0.09745	0.0424505	0.03029153	0.001
X3	0.09370	0.66184	0.3933863	0.19032076	0.036
X4	0.00610	0.06117	0.0255158	0.01626591	0.000
Z	0.68320	5.40080	3.2262263	1.45653719	2.122

Source prepared by the researcher.

Table(2): Descriptive statistics for the independent and dependent variables for the Gulf Commercial Bank.

	Minimum	Maximum	Mean	Std. Deviation	Variance
X1	0.12758	0.51480	0.2983468	0.12694656	0.016
X2	0.00076	0.06901	0.0252228	0.01820748	0.000
X3	0.17105	0.60136	0.3776621	0.12925666	0.017
X4	0.00021	0.08556	0.0294895	0.02398881	0.001
Z	1.43150	4.97780	2.8489416	1.14774707	1.317

Source prepared by the researcher.

Tobit regression model was applied to show the effect of the ratios included in the study on the financial stability of the bank. By using Stata program(V.15), the results are presented in Tables (3) and (4) below for each Credit and Gulf Commercial banks.

Table(3): Results of Tobit regression model for Credit bank

Z	Coef.	Std.Err.	t	p>|t|	[95% Conf. Interval]	
X1	10.1343	1.1118	9.11	0.000***	7.7644	12.5041
X2	3.4348	0.4363	7.87	0.000***	2.5047	4.3649
X3	-2.5890	1.1044	-2.34	0.033*	-4.9430	-0.2350
X4	6.6263	0.6415	10.33	0.000***	5.2589	7.9937
Cons.	0.0388	0.0432	0.90	0.383	-0.0532	0.1309
/sigma	0.02711	0.00465		0.017202	0.03702	

(*) is significant with 0.05 level, (***)is significant with 0.01 level.

Source prepared by the researcher.

From the results in table(3) with regard to the credit bank, we note that the ratio of working capital to total assets and the ratio of earnings before interest and taxes to total assets, have a significant direct effect, That is, an increase of one unit for each of them leads to an increase in the stability of the bank by a percentage of 10.1343 and 6.6263 respectively. while for the ratio of total shareholders' equity to total assets it has a significant opposite effect, Therefore, an increase of one unit leads to a decrease in the stability of the bank by a percentage -2.5890 . In table (4) for the Gulf Commercial Bank, we find that the ratio of earnings before interest and taxes to total assets had the largest direct significant effect equal to

34.2781, but the ratio of retained earnings to total assets it also had a significant effect, but in an inverse manner, as shown in the results of the both tables(3) and(4).

Table(4): Results of Tobit regression model for Gulf Commercial bank.

Z	Coef.	Std.Err.	t	p>|t|	[95% Conf. Interval]	
X1	1.0619	2.7785	0.38	0.708	-4.8603	6.9842
X2	-33.2178	13.2247	-2.51	0.024**	-61.4057	-5.0298
X3	8.1950	2.7828	2.94	0.010**	2.2634	14.1266
X4	34.2781	10.1329	3.38	0.004***	12.6801	55.8760
Cons.	-0.7358	0.5162	-1.43	0.175	-1.8361	0.3644
/sigma	0.4455	0.7227	0.2915	0.5996		

(**) is significant with 0.05 level, (***)is significant with 0.01 level.

Source prepared by the researcher.

The results in Table (5) show measures that the fit of Tobit's model to the data of both banks. Through the results, we notice that the value of both R squared and Log likelihood was good, we note that the values of R were (0.9699) and (0.9409), respectively, for both banks, and these values are very close to one, and this indicates the good fit of the model. Through the probability value of the Chi-square test, which is equal to(Prob>Chi2=0.00), which is less than the level of significance (0.01). From the above this indicates the suitability of the Tobit model for this type of monitored data.

Table(5): A summary of the fit of the Tobit regression model for both credit and Gulf Commercial banks.

	Credit Bank	Gulf Commercial bank
Chi2	141.44	134.93
Prob>Chi2	0.0000	0.0000
Log likelihood	37.2091	31.5996
R^2	0.9699	0.9409

Source prepared by the researcher.

4. Conclusions

Financial failure is one of the negative phenomena that banks may be exposed to and lead to their exit from the market. The study concluded that the Tobit model is in good harmony with the censored data of financial stability, where it was found that the estimated Tobit model is a significant model, and we also find that the most influential ratios on the financial stability of the credit bank are the ratio of working capital to total assets, as it was directly affecting, and the ratio of earnings before interest and taxes to total assets was the most influential on the financial stability of Gulf Commercial Bank, with respect to the rest of the factors have been explained in section 3.2 in detail.

We recommend that banks pay attention to the ratio of earnings before interest and taxes to total assets, because it is the ratio that most affects the financial stability of the bank. From the foregoing, we recommend financial institutions, including banks, to use mathematical and statistical models to predict financial failure, as well as to study the causes that lead to it, in order to take the necessary measures and address them.

References

1- Amemia,T.(1985). Tobit Models. Advanced econometrics. Cambridge, Mass: Harvard University Press. p. 384. ISBN 0-674-00560-0. OCLC 11728277.

2- Altman,E.I.(1968). Financial Ratios, discriminant analysis and the prediction of corporate bankruptcy. The journal of Finance,XXIII(4),pp.559-609.

3- Fadhel,H.H and Taher,R.D.(2010). Study of the variables affecting the increase in the number of active sperms using Tobit model. Journal of Economic and Administrative Sciences, V.16, N. 59, p. 179-184.

4- Ismael,A.H.(2021). Inference with Gamma and Inverse Gamma Prior Densities in Tobit Regression Problem with a Practical Application. Master Thesis, College of Administration & Economics / University of Al-Qadisiyah, Iraq.

5- Jassam,Q.T; Abd Al-majeed,A.T. and Ali,E.H.(2022). An Economic Analysis Of Some Factors Affecting In Marketing Efficiency Of Dry Onion Crop Using The Tobit Regression Model. Iraqi Journal of Agricultural Sciences ,:53(1):180-186.

6- Meshal,H.O.; Ali,S.M. and Bahar,K.M. (2017). Tobit Regression Analysis Applied on Iraqi Bank Loans. American Journal of Mathematics and Statistics, 7(4): 179-182 DOI: 10.5923/j.ajms.20170704.06.

7- Meshal,H.O.; Bahar,K.M. and Ali,S.M. (2018). Tobit Regression Model to Determine the Dividend Yield in Iraq. LUMEN Proceedings 3 | NASHS2017. DOI: 10.18662/lumproc.nashs2017.30.

8- Naeem,S.J.; Aqil,A.A. and Mustafa,M.I. (2019). Impact of quantitative (indirect) instruments of monetary policy on some indicators of financial stability in Iraq for the period (2003-2016). Journal of Economics and Administration Sciences, Vol. 25, No .110, pp.354-370.

9- Raz,M.H. and Samira,M. (2020). Using Tobit Model for Studying Factors Affecting Blood Pressure in Patients with Renal Failure. UHD Journal of Science and Technology, Vol,4, Issue 2.

10- Tobin,J. (1958). Estimation of Relationships for Limited Dependent Variables. *Econometrica*, Vol. 26, No. 1, pp. 24-36.