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Improving Predictive Ability of Financial Ratios: The Application of Log Transformation

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Abstract

This study aimed to investigate whether log transformation can help improve predictive ability of financial ratios in Thailand context. Four DuPont-based financial ratios of 104 (using 3 years data), 93 (using 5 years data), and 81 (using 8 years data) Thai large capitalization listed companies are used in this study. Applying yearly data, the four ratios included net profit margin, total asset turnover, equity multiplier, and return on equity. The study period is between 2012 and 2019, totaling 8 years. Statistics used included mean, standard deviation, skewness, kurtosis, logarithm, and multiple regression. The findings suggest that log transformation can significantly improve predictive ability of financial ratios. Therefore, financial researchers and/or financial analysts should initially examine whether financial ratios are normally distributed before testing hypothesis. Also, the researchers and/or the analysts should not overlook financial ratios as a comprehensive financial tool to help maximize stockholders' wealth.
Keywords: Financial Ratios, Log Transformation, Improving Predictive Ability

Introduction

Data transformation in this study means transforming skewed original data to normal data before testing hypothesis using parametric statistics (Manikandan, 2010). Data transformation assists researchers in several fields of research in dealing with sample observations that do not meet the assumption of normality distribution. Previous studies have shown that some parametric statistics (for instance, simple regression, multiple regression, logit regression and so on) are robust when this violation of the assumption is eliminated (Osborne, 2010). According to Ercegovac et al., (2000) and Osborne (2010), either square root transformation, log transformation, or Inverse transformation are employed by researchers to rescale skewed sample observations into normally distributed sample observations before running parametric tests.

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Log transformation, a long-standing practice for data transformation, is widely used by researchers to eliminate and/or decrease skewness of sample observations (Curran-Everett, 2018; West, 2022). Evidently, data transformation is commonly applied in clinical fields of research, for instance, the studies of FENG et al., (2014); Mai and Mirarab (2021); Peterson and Cavanaugh (2019). When it comes to data transformation, most clinical researchers have used log transformation to make sample observations better fit the assumptions of parametric statistics and also to prevent misinterpretation of test results. Besides clinical researchers, researchers in other fields of study are used log transformation when employing parametric statistics in their studies.

In economics and finance research, some sample observations (for instance, gross domestic product (GDP), interest rates, inflation rates, exchange rates, financial ratios and so on) cannot be controlled. As a result, the observations are likely to be skewed or not normally distributed. Along with applying panal data (both time series data and cross section data) approach, reserachers in this field must ensure that the assumption of normality distribution is met before running parametric statistics. For instance, Tien (2021) applied log tranformation to reduce skewed GDP and inflation into normally distributed GDP and Inflation before running regression model. Hoang and Nguyen Thi (2020) transformed macroeconomic factors, such as exchange rates, interest rates, GDP, and so on into log data before running vector regression model or VAR model. Amin et al., (2021) used log of real exchange rate, log of oil price, and log of consumer price index before running a parametric statistics to test their hypothesis. Finally, Tuvadaratragool (2022) transformed net profit margin, total asset turnover, equity multiplier, and return on equity into log data to investigate whether DuPont-based ratios can signal return on equity inAs Thailand context.

In financial management, the utmost responsibility of financial managers is to maximize stockholders' wealth. Stockholders' wealth can be measured by market capitalization. The larger a company's market capitalization, the more stockholders' wealth maximization. According to the Stock Exchange of Thailand, large market capitalization companies are listed in SET 50 and SET 100. Since DuPont analysis has been extensively used to measure companies' financial profitability and/or financial performance, this study applies DuPont-based financial ratios of Thai large capitalization listed companies. As the DuPont-based financial ratios derived from financial statements cannot be controlled, the observations are likely to be not normally distributed. Moreover, parametric statistics was used in this study to ensure a robust result. Thus, to meet the parametric statistics' assumption of normality distribution, the log transformation is required. Finally, this study will help confirm whether net profit margin, total asset turnover, and equity multiplier (the three components of return on equity, being known as the DuPont analysis) are still reliable as a comprehensive financial tool to measure financial profitability of Thai companies.

Objective

The objective of this study is to investigate whether log transformation can help improve predictive ability of financial ratios in Thailand context.

The research hypothesis is as followed:

H_0: Log transformation cannot help improve predictive ability of financial ratios in Thailand context.

H_1: Log transformation can help improve predictive ability of financial ratios in Thailand context.

Literature Review

Why do researchers need to perform data transformation?

As mentioned before, data transformation is a useful tool in quantitative research using either time series data or cross-sectional data, particularly, clinical research. Since the researchers need a robust outcome so parametric tests were applied to test their hypothesis. Manikandan (2010) stated that one of the key assumptions of inferential statistics is that the observations should be normally distributed. This is consistent with Bland and Altman (1996). Before analysis and interpretation, researchers should ensure that the observations used are not skewed or normally distributed. In practice, the major problem for non statistical researchers is how they know the observations used are skewed.

There are a number of statistical techniques used to observe skewness. For instance, Altman and Bland (1996) noted that a histogram and/or a scatter diagram can indicate whether the observations used are skewed or not. Also, researchers can look at mean and standard deviation to examine skewness of the observations. If the standard deviation is bigger than twice the mean, the observations tend to be skewed (Altman & Bland, 1996). However, Hair Jr. et al., (2010), and Aminu and Shariff (2014) applied skewness and kurtosis to test normality distribution. Kline (2011, cited in Aminu and Shariff, 2014) stated that the absolute values of skewness more than 3 and kurtosis more than 10 indicate that the observaitions are not normally distributed or skewed. As a result, Aminu and Shariff (2014) employed this criteria to test the skewness of their observations.

Once skewness of the obseravtions is found, an appropriate transformation should be applied to convert it into a normal distribution or a nearly normal distribution. This lead to the next question.

Which types of data transformation is appropriate to use?

According to Ercegovac et al., (2000) and Manikandan (2010), it can be inferred that there are several types of data transformation such as square root, inverse square root, reciprocal, logarithm, and the like. Osborne (2010) noted that square root can be applied for every values, except for negative values. Likewise square rool, logarithm is another transformation being used in extensive fields of science. In sum, a logarithm is the power a base number must be raised to in order to get the original number (Osborne, 2010).

Like Osborne (2010), West (2022) stated that square root is appropriate for the observations having values either positive or zero, but not negative numbers. He noted that the observations have no zero values, reciprocal or logarithm is more suitable. Also, he mentioned that log transformation has been used to reduce skewness of the observations' values. This consistent with Manikandan (2010).

Curran-Everett (2018) noted that even thought logarithm has been widely used by researchers and scientists, some are skeptical whether logarithm can help reduce skewness of the observations' numbers. Given that, he conducted his study entitled explorations in statistics: the log transformation in 2018. He found that log transformation is able to rescale the skewed numbers of the observations into a normal distribution. According to aforementioned studies, log transformation will be used in this study.

Why DuPont Analysis is widely used as a comperhensive financial tool to measure stockholders' wealth?

The DuPont analysis was introduced in the early 20th century by a management of the DuPont Corporation to investigate financial profitability of the company (Tuvadaratragool, 2022; Turner et al., 2015; Warrad & Nassar, 2017). The DuPont analysis mainly focuses on return on equity and its components. Return on equity's components include net profit margin, total asset turnover, and equity multiplier. Net profit margin represents profitability; total asset turnover represents efficiency; and equity multiplier represents financial leverage. The DuPont analysis is not only used to investigate financial profitability, but also used as a financial tool in signalling a company's future earnings. There are a number of researchers using the DuPont analysis in their studies, for example, Chang et al., (2014), Hao and Choi (2019), Kim (2016), Padake and Soni (2015), and Sheela and Karthikeyan (2012). Theoretically, DuPont analysis is a framework for investigating financial profitability of companies, which mainly focuses on return on equity. It is indisputable that a higher financial profitability leads to stockholders' wealth maximization. Being one of profitability rations, return on equity has been widely used and mentioned in financial research since the introduction of DuPont analysis. According to the DuPont analysis framework, return on equity consists of three financial ratios, that is, net profit margin, total asset turnover, and equity multiplier. Given this, net profit margin, total asset turnover, and equity multiplier are independent variables, whilst return on equity is dependent variable. The measurement level of both independent and dependent variables is ratio. This helps explain why this study focuses only on return on equity, net profit margin, total asset turnover, and equity multiplier.

Methodology

Like other secondary data-based research, this study used accounting information, that is, net profit margin, total asset turnover, equity multiplier, and return on equity derived from the Stock Exchange of Thailand. Applying yearly data, the four financial ratios of 104 (using 3 years data), 93 (using 5 years data), and 81 (using 8 years data) Thai large market capitalization companies were used in this study. According to a concept of triangulation in research, this study triangulates the study period into three periods, that is, a 3-year data representing a short-term study period, a 5-year data representing a middle-term study period, and an 8-year data representing a long-term study period. The key reasons for the study period triangulation are not only to increase the number of observations, but also to enhance the credibility and reliability of the study findings. The whole study period was between 2012 and 2019, totaling 8 years, before COVID-19 pandemic. Given this, total observations consisted of 2,592 (4 ratios * 81 firms * 8 years). The four financial ratios (or the observations) were collected from the companies' financial statements on the website of The Securities and Exchange Commission, Thailand (www.sec.or.th). Statistics used included mean, standard deviation, skewness, kurtosis, logarithm, and multiple regression.

Results

To provide details of the observations used in this study, descriptive statistics are presented as followed.

Table 1 Descriptive Statistics of Net Profit Margin

Financial Ratio	Years	Mean	Standard deviation
	3	18.02	22.90
Net Profit Margin (NPM) (%)	5	17.17	21.74
	8	16.20	20.42

Table 1 shows that 3-year, 5-year, and 8-year means of the companies' NPM were 18.02, 17.17, and 16.20, respectively. The 3-year, 5-year, and 8-year standard deviation of the companies' NPM were 22.90, 21.74, and 20.42, respectively. In sum, during the specified period, mean of the companies' NPM was between 16.20 and 18.02, while standard deviation of the companies' NPM was between 20.42 and 22.90.

Table 2 Descriptive Statistics of Total Asset Turnover

Financial Ratio	Years	Mean	Standard deviation
	3	0.83	2.08
Total Asset Turnover (TAT) (x)	5	0.80	1.61
	8	0.84	1.47

Table 2 illustrates that 3-year, 5-year, and 8-year means of the companies' TAT were 0.83, 0.80, and 0.84, respectively. The 3-year, 5-year, and 8-year standard deviation of the companies' TAT were 2.08, 1.61, and 1.47, respectively. In sum, during the specified period, mean of the companies' TAT was between 0.80 and 0.84, while standard deviation of the companies' TAT was between 1.47 and 2.08.

Table 3 Descriptive Statistics of Equity Multiplier

Financial Ratio	Years	Mean	Standard deviation
	3	3.87	7.18
Equity Multiplier (EM) (x)	5	3.73	4.96
	8	3.93	4.08

Table 3 depicts that 3-year, 5-year, and 8-year means of the companies' EM were 3.87, 3.73, and 3.93, respectively. The 3-year, 5-year, and 8-year standard deviation of the companies' EM were 7.18, 4.96, and 4.08, respectively. In sum, during the specified period, mean of the companies' EM was between 3.73 and 3.93, while standard deviation of the companies' EM was between 4.08 and 7.18.

Table 4 Descriptive Statistics of Return on Equity

Financial Ratio	Years	Mean	Standard deviation
	3	15.03	13.90
Return on Equity (ROE) (%)	5	15.46	12.36
	8	15.47	13.17

Table 4 shows that 3-year, 5-year, and 8-year means of the companies' ROE were 15.03, 15.46, and 15.47, respectively. The 3-year, 5-year, and 8-year standard deviation of the companies' ROE were 13.90, 12.36, and 13.17, respectively. In sum, during the specified period, mean of the companies' ROE was between 15.03 and 15.47, while standard deviation of the companies' ROE was between 12.36 and 13.90.

Next, distribution of the observations needs to be checked before running multiple regression. As mentioned earlier, normality distribution can be checked by looking at a histogram and/or a scatter diagram and/or looking at mean and standard deviation to examine skewness of the observations. This study uses mean and standard deviation to examine both skewness and kurtosis of the observations. Theoretically, skewness value and kurtosis value of 0 (zero) represent a normal distribution (Ghasemi & Zahediasl, 2012). However, this study applies an absolute value of skewness less than 3 and an absolute value of kurtosis less than 10 as an acceptable range of normality distribution suggested by Aminu and Shariff (2014).

Table 5 Skewness and Kurtosis of the Observations before Transformation

Financial Ratios		3 years	5 years	8 years
NPM	Skewness	3.13	3.08	4.19
	Kurtosis	20.44	18.09	26.97
TAT	Skewness	8.93	7.64	6.87
	Kurtosis	86.17	66.52	54.96
EM	Skewness	8.74	6.60	3.80
	Kurtosis	83.51	52.84	19.02
ROE	Skewness	0.37	0.23	0.10
	Kurtosis	11.35	6.87	6.67

Table 5 illustrates that 3-year, 5-year, and 8-year NPM, TAT, and EM are positively skewed because the skewness values were between 3.08 and 8.93, which is larger than 3. Moreover, 3-year, 5-year, and 8-year NPM, TAT, and EM have heavy tails or outliers because the kurtosis values were between 18.09 and 86.17, which is noticeably higher than 10. However, the skewness values of 3-year, 5-year, and 8-year ROE were nearly 0 (zero), considering nearly normal distribution. Also, kurtosis values of 5-year, and 8-year ROE were in the acceptable range, except the 3-year value.

Obviously, distribution of the observations, except ROE, considerably violates the preliminary assumption of multiple regression. To show that data transformation is necessary when this violation happens, multiple regression using the skewed original data was run.

Table 6 An Analysis of Multiple Regression before Transformation

Multiple regression (Enter)	3 years	5 years	8 years
	B	B	B
Constant	0.079*	0.081*	0.100*
NPM	0.199*	0.272*	0.318*
TAT	0.008	0.013	0.010
EM	0.008*	0.004	-0.001
Durbin-Watson	1.923	1.931	1.913
R^2	0.243	0.245	0.233
F	10.683	9.604	7.803
p-value of F	0.000	0.000	0.000

Note: B = Unstandardized Coefficients B,* = 0.05, the dependent variable: ROE

Table 6 shows that, during the specified periods, there is no autocorrelation problem among the observations of NPM, TAT, and EM as the Durbin-Watson values are near 2. R^2 represents a proportion that the independent variables can explain the dependent variable in a regression model. According to R^2, approximately 24.50 per cent proportion that a combination of NPM, TAT, and EM can statistically explain and/or predict ROE. The F values were between 7.803 and 10.683, indicating a relative low ratio of explained variance to unexplained variance. However, p-values of F indicate that at least one independent variable can statistically explain and/or predict ROE.

According to B values, both NPM and EM can statistically predict ROE in 3-year model, while only NPM can statistically predict ROE in both 5-year model, and 8-year model. The multiple regression models can be written as followed.

3-year based model:

ROE predicted = 0.079 + 0.199(NPM) + 0.008(EM) ... (1)

5-year based model:

ROE predicted = 0.081 + 0.272(NPM) ... (2)

8-year based model:

ROE predicted = 0.100 + 0.318(NPM) ... (3)

As mentioned earlier, the distribution of the observations violates a basic assumption of multiple regression. According to (1), (2), and (3) equations, if researchers jump to conclusion and/or interpretation, they might be misled by the results above. Subsequently, they might underestimate an ability of the DuPont analysis, a long-standing financial technique.

Having presented the results of the before-transformation multiple regression models, log transformation is performed to ensure that distribution of the observations is normally distributed and/or nearly normally distributed. Again, this study applied an acceptable range of normality distribution used by Aminu and Shariff (2014), that is, an absolute value of skewness less than 3 and an absolute value of kurtosis values less than 10.

Table 7 Skewness and Kurtosis of the Observations after Transformation

Financial Ratios		3 years	5 years	8 years
NPM	Skewness	-0.83	-0.49	-0.67
	Kurtosis	1.12	0.41	0.78
TAT	Skewness	0.13	0.01	-0.22
	Kurtosis	0.76	0.32	0.29
EM	Skewness	1.81	1.53	1.31
	Kurtosis	6.15	3.50	1.47
ROE	Skewness	-1.95	-1.16	-0.42
	Kurtosis	8.39	4.82	2.63

Table 7 illustrates that, after transformation, skewness values of NPM, TAT, EM, and ROE in the period of 3 years, 5 years, and 8 years were in the acceptable range of normality distribution adopted in this study, which is between 3 and -3. In addition, during the specified periods, the kurtosis values of NPM, TAT, EM, and ROE were in the acceptable range of normality distribution adopted in this study, which is between 10 and -10. Apparently, most values of skewness and kurtosis after transformation are noticeably moving close to 0 (zero), compared to the values in table 5 above. This can be inferred that the observations are normally distributed.

Having presented the results of log transformation, multiple regression analysis of after-transformation observations is performed.

Table 8 An Analysis of Multiple Regression after Transformation

Multiple regression (Enter)	**3 years** B	**5 years** B	**8 years** B
Constant	-0.035	0.011	-0.157
NPM	0.965*	1.006*	0.919*
TAT	0.913*	0.970*	0.883*
EM	0.833*	0.932*	0.830*
Durbin-Watson	2.243	1.983	1.913
R^2	0.950	0.939	0.928
F	612.055	437.476	302.903
p-value of F	0.000	0.000	0.000

Note: B = Unstandardized Coefficients B, * = 0.05, the dependent variable: ROE

Table 8 shows that, during the specified periods, there is no autocorrelation problem among the observations of NPM, TAT, and EM as the Durbin-Watson values are near 2. According to R^2, the combination of NPM, TAT, and EM can predict ROE up to 95 per cent, a significant increase of explanation/prediction when compared to 24.50 per cent in table 6. Therefore, H_0 is rejected. The F values are between 302.903 and 612.055, indicating that the regression model has a considerably high ratio of explained variance to unexplained variance. Also, p-values of F indicate that at least one independent variable can statistically explain and/or predict ROE.

According to B values, NPM, TAT, and EM can statistically predict ROE in 3-year model, 5-year model, and 8-year model, which is consistent with the DuPont analysis approach. The multiple regression models can be written as followed.

3-year based model:

$$\ln(\text{ROE predicted}) = 0.965\ln(\text{NPM}) + 0.913\ln(\text{TAT}) + 0.833\ln(\text{EM}) \quad \ldots (4)$$

5-year based model:

$$\ln(\text{ROE predicted}) = 1.006\ln(\text{NPM}) + 0.970\ln(\text{TAT}) + 0.932\ln(\text{EM}) \quad \ldots (5)$$

8-year based model:

$$\ln(\text{ROE predicted}) = 0.919\ln(\text{NPM}) + 0.883\ln(\text{TAT}) + 0.830\ln(\text{EM}) \quad \ldots (6)$$

Discussion

The objective of this study is to investigate whether log transformation can help improve predictive ability of financial ratios in Thailand context. According to the results above, there are at least 6 dimensions that can be discussed as followed.

1) The results of this study confirm that financial ratios (or longitudinal data) tend to be skewed because they cannot be controllable. To enhance the credibility and reliability of the financial study findings, all skewed financial ratios must be transformed. Otherwise, financial researchers might be misled by the results.

2) Evidently, before transformation, only NPM can 24.50 percent explain the movement of ROE of the companies (a 5-year data). However, after applying log transformation, a combination of NPM, TAT, and EM can up to 95 percent explain the movement of the companies' ROE, considering a significant increase of explanation/prediction. The results confirm the theory of DuPont analysis, that is, NPM, TAT, and EM are the key components of ROE of the companies.

3) Log transformation can significantly reduce positively skewed observations to nearly normal distribution. This is consistent with the studies of Aminu and Shariff (2014), Manikandan (2010), and West (2022).

4) This study brings theory of DuPont analysis, a long-standing financial tool, into practice. In business finance or financial management, it is said that ROE composes of NPM, TAT, and EM. This study confirms that a combination of NPM, TAT, and EM can significantly explain and/or predict ROE. This is consistent with the studies of Kim (2016), Padake and Soni (2015), and Sheela and Karthikeyan (2012).

5) Prediction ability of financial ratios can be considerably improved by applying data transformation if the observations are not normally distributed. This is consistent with the study of Curran-Everett (2018).

6) For non-statisticians, normality distribution of observations can be measured by looking at values of skewness and kurtosis as suggested by Aminu and Shariff (2014).

Suggestion

Like clinical practice researchers, financial researchers need a robust outcome because their works involve stakeholders, for instance, stockholders, investors, creditors, managers, regulators, and the like. Given that, it is necessary that parametric tests are used in their studies. Since the parametric tests have preliminary assumptions, particularly normality distribution, researchers must initially check whether observations are normally distributed or not. Misinterpretation of the results can occur if researchers are not aware of normality distribution of observations.

In case that observations are not normally distributed, data transformation is essential before analysis. Finally, log transformation can help positively skewed observations better meet the normality distribution assumptions of parametric tests. Therefore, the results of this study are applicable to different types of research applying a parametric test and striving for a robust outcome.

Limitation

The limitations of this study are as follows:

1) Financial data were collected from the top 100 market capitalization companies listed on the SET 100 index constituents, considered to be less informative.

2) The study period is between 2015 and 2019 (a five-year study period) before COVID 19 pandemic broke out.

3) This study concentrated on the biggest market capitalization companies in Thailand only, considered to be limited its generalizability.

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