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IMPACT OF CAPITAL STRUCTURE ON BUSINESS PERFORMANCE OF ENERGY COMPANIES LISTED ON VIETNAM STOCK MARKET

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A B S T R A C T

The article assesses the impact of capital structure on the performance of energy enterprises listed on the Vietnamese stock market, with data of 35 energy enterprises from 2012 to 2020 through using the XGB (Extreme Gradient Boosting) algorithm in python-based machine learning along with techniques to extract general insights from a machine learning models such as Xgboost feature importance and Shap (Shapley additive explanation). Research results show that enterprises with large capital size (SIZE) operate less efficiently, while enterprises with large net fixed assets over total assets (GROW) operate more efficiently. It is important for energy enterprises to reduce long-term debt (LDR), increase short-term debt (LDR) and reduce total debt to total assets (TDR) to maintain optimal capital structure while ensuring liquidity (LIQ) to improve business performance.

1. INTRODUCTION

Along with the deep integration into the world economy, the activities of Vietnamese enterprises have made strong development steps, promoting their great role in the overall development of the Vietnamese economy after the economic crisis period. Energy is one of the key economic sectors of the country that needs to be facilitated in order to ensure energy security as well as socio-economic development of the country (ADB, 2016). Vietnam as a party to the Paris Convention on greenhouse gas emissions, Vietnam is committed to sustainable energy development, environmental protection through the application of clean energy, renewable energy and efficiency technologies. Therefore, the energy industry is a topic of interest and

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selected for research in the context of a deeply and widely integrated economy.

Building an optimal financial health through capital structure is essential for businesses in Vietnam in general and businesses in the energy sector in particular. A financing decision to establish a capital structure affects firm performance through the generation of agency costs (Jensen and Meckling, 1976). Therefore, firms using a reasonable capital structure not only minimize risk but also bring optimal value to the business, along with the argument that the benefit from the tax savings due to debt may be lower financial distress costs with a developing country like Vietnam. Therefore, the choice of capital structure has a great influence on the business performance of the enterprise. The study has conducted empirical research on 35 energy enterprises listed on the Vietnamese stock market, in order to evaluate the operation situation and recommend the optimal capital structure for Vietnamese energy enterprises (Modigliani, & Miller, 1958; Myers, 2001).

This research consists of five arts: introduction, literature review, methodology, results and recommendations for the Vietnamese energy companines.

2. LITERATURE REVIEW

Le and Phan (2017) conducted a study impact of capital structure on the performance of listed non-financial enterprises in Vietnam in the period 2007-2012. These enterprises are classified into 11 industries according to the ICB (Industry classification benchmark) standard, excluding businesses in the banking, insurance and financial industries, the models used include: Pool OLS, FEM, REM and generalized method of moments (GMM). Variables measure performance include: Tobin'Q, ROA, ROE, capital structure variables (mainly using the ratio of total debt to book value of total assets and the ratio of total debt to market value of total assets). Research results found a negative correlation between capital structure and performance in these enterprises.

Amin and Jamil (2015), study the effect of capital structure on the performance of 7 listed cement companies in Bangladesh. The study uses panel data for 15 years from 2001-2015. The REM model is used to estimate the relationship between debt and firm performance. The results show a positive relationship between short-term debt to total debt and performance as measured by ROA and ROE.

Toraman et al (2013) studied the effect of capital structure on profitability of 28 manufacturing companies in Borsa, Turkey. The data is taken from the financial statements of manufacturing companies from 2005 to 2011. Research results show that short-term debt to total assets and long-term liabilities to total assets have a negative relationship with ROA. There is a positive relationship between operating income to finance expenditure and financial activities, there is no relationship between total debt to equity ratio and ROA.

Sheikh and Wang (2013) conducted a study with a dataset of 240 non-financial enterprises in Pakistan, which are listed on the Karachi stock exchange and classified into 8 different industries. The research used Pool OLS, FEM, REM regression models and Hausman test to choose between FEM and REM models. Research results confirmed the negative relationship between capital structure (TDR, LDR, SDR) and operating efficiency (ROA), LDR is positively correlated with performance (measured by market price ratio to book value).

Salim and Yadav (2012), study used the panel data for sample of 237 Malaysian companies listed on the Bursa Malaysia Stock Exchange from 1995 to 2011. The data is divided into 6 sectors: construction, consumer products, industrial products, crops, real estate, trade and services. The results showed corporate performance measured by ROA, ROE, EPS has a negative relationship with short-term debt (STD), long-term debt (LTD), total debt (TD). In addition, there is a positive relationship between growth and performance for all sectors. Tobin's Q has a positive relationship between short-term debt (STD) and long-term debt (LTD).

Soumadi and Hayajneh (2012) used OLS model to examine the impact of capital structure on performance. The research sample includes 76 enterprises (53 industrial enterprises and 23 enterprises) in the period from 2001 to 2006 listed on the Amman, Jordan stock market. Research results showed that financial leverage has a negative impact on firm performance. At the same time, a new finding on the impact of financial leverage on the efficiency of high-borrowed and low-borrowed firms. The results serve as a premise for firms to balance when using loans.

Khan (2012) studies the relationship between capital structure and business performance of construction enterprises listed on Karachi stock exchange from 2003-2009. The research results show that financial leverage measured by short-term debt to total assets has a negative impact on business performance measured ROA, GM and Tobin's Q. The relationship between financial leverage and performance measured by ROE is negative but not significant. Asset size has no significant relationship with ROA and GM but negative and significant relationship with Tobin's Q.

The study of Shubita and Alsawalhah (2012) studied the influence of capital structure on the profitability of companies listed on Amman stock exchange. Data are collected from 39 companies in the listed industry in the period from 2004 to 2009. Research results found a negative relationship between the ratio of short-term debt to total assets and ROE but has a positive relationship

with the variable of size and revenue growth rate. The study also showed that ROE has a negative relationship.

Through a review of domestic and foreign scientific researches, there have been many studies on the impact of capital structure on performance of enterprises in many different industries with different research methods but no research has been done using machine learning algorithms for the Vietnamese energy industry. Therefore, the issues continue to be studied to give more empirical evidence.

3. RESEARCH METHODOLOGY

After reviewing empirical research models in developing and developed countries along with other related studies, the author applies the model and research method of Khan (2012) and combined with the study of Soumadi and Hayajneh (2012) for the similarity of studying in a developing country. Observational data is 35 energy industry enterprises from 2012 to 2020 used in this study.From there, the author gives a model: $Y_{i,t} = \alpha_i + \beta_i X_{i,t} + \gamma_i X_{i,t} + \varepsilon_{i,t.}$

Specific models implemented include:

$$\mathbf{ROA_{it} = \alpha_0 + \beta_1(SDR_{it}/\ LDR_{it}/\ TDR_{it}) + \gamma_1 SIZE_{it} + \gamma_2 GROW_{it} + \gamma_3 TANG_{it} + \gamma_4 LIQ_{it} + \varepsilon_{it}} \quad (1)$$

$$\mathbf{ROE_{it} = \alpha_0 + \beta_1(SDR_{it}/\ LDRi_{t}/\ TDR_{it}) + \gamma_1 SIZE_{it} + \gamma_2 GROW_{it} + \gamma_3 TANG_{it} + \gamma_4 LIQ_{it} + \varepsilon_{it}} \quad (2)$$

$$\mathbf{TQ_{it} = \alpha_0 + \beta_1(SDR_{it}/\ LDR_{it}/\ TDR_{it}) + \gamma_1 SIZE_{it} + \gamma_2 GROW_{it} + \gamma_3 TANG_{it} + \gamma_4 LIQ_{it} + \varepsilon_{it}} \quad (3)$$

ROA_{it} is the after-tax profit on total assets of company i in year t. ROE_{it} is the after-tax return on equity of company i in year t. TQ_{it} is the ratio of market value of equity plus book value of total debt divided by book value of total assets of company i in year t. SDR_{it} is the short-term debt to total assets of company i in year t, LDR_{it} is the long-term debt to total assets of company i in year t, TDR_{it} is the total debt to total assets of company i in year t. $SIZE_{it}$ is the total assets of company i in year t. $GROW_{it}$ is the net fixed asset value to total assets of company i in year t. $TANG_{it}$ is the total asset growth variable. LIQ_{it} is the liquidity ratio. ε_{it} is the error.

The research is done on Python 3.6.8 programming language. along with libraries and machine learning algorithms. The model is performed through the following steps:

Step 1: Perform descriptive statistics, clean data.

Step 2: Find an algorithm that fits the model and data, based on the python programming language.

Step 3: Determine the model's performance and reliability, find the resulting visualization.

4. RESEARCH RESULTS

Current status of capital structure and the relationship between capital structure and business performance of energy enterprises listed on Vietnam stock market

The enterprise capital structure for the period 2012-2022 is shown in table 1 (Source: Summary statistics in Python).

Table 1. Enterprise capital structure for the period 2012-2020.

YEAR	2012	2013	2014	2015	2016	2017	2018	2019	2020
TDR	54.1%	53.5%	51.6%	49.7%	46.6%	45.0%	44.2%	43.2%	42.1%
LDR	24.1%	22.2%	20.8%	21.5%	20.3%	18.3%	16.0%	16.6%	16.7%
SDR	30.1%	31.2%	30.8%	28.2%	26.2%	26.7%	28.2%	26.6%	25.4%

The results show that the capital structure of energy enterprises in the period from 2012 to 2019 has gradually decline of total debt ratio: from 54.1% (in 2012) to 42.1% (in 2020). Of which, long-term debt decreased from 24.1% (in 2012) to 16.7% (in 2020); Short-term debt also tends to decrease over the years, specifically from 30.1% (in 2012) to 25.4% (in 2020), in total debt, the proportion of short-term debt has a higher proportion than long-term debt. This ratio of total debt is relatively high, but it is also safe because these businesses want to make good use of financial leverage.

Next, the enterprise efficiency in the period 2012 – 2020 is shown in table 2 (Source: Summary statistics in Python).

Table 2. Enterprise efficiency in the period 2012-2020

YEAR	2012	2013	2014	2015	2016	2017	2018	2019	2020
ROA	68.1%	67.3%	61.5%	67.0%	63.2%	60.8%	69.5%	74.2%	66.2%
ROE	7.2%	9.1%	8.5%	8.3%	9.9%	11.6%	12.1%	8.4%	11.8%
TQ	11.0%	5.5%	13.7%	12.7%	8.8%	16.3%	7.0%	13.5%	22.1%

Calculation results show that ROA and ROE increase in the period from 2012 to 2020, in which ROA in every year is larger than ROE. This proves that the financial leverage used by energy enterprises has increased profitability for shareholders. Particularly, the Tobin'Q Index (TQ) has fluctuated over the years, with the highest

increase in 2020 (22.1%), this is the year the Vietnamese stock market experienced explosive growth in the past decade and was the lowest in 2013 (5.5%). In general, the energy sector is quite efficient.

The relationship between capital structure and business performance of enterprises is shown in Figure 1.

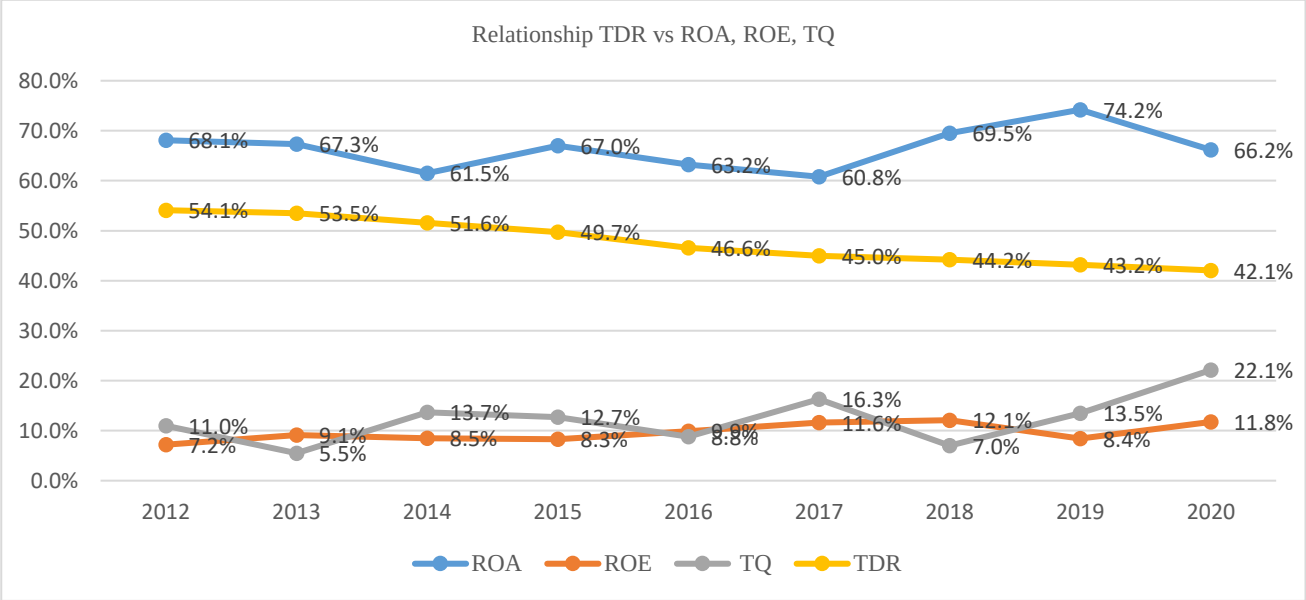


Figure 1. The relationship between capital structure and business performance of enterprises

The chart shows that in the period 2012 to 2020, capital structure with the representative variable TDR and business performance of energy enterprises have a correlation but it is not clear. Therefore, this problem will be clarified by specific machine learning algorithms in the next section.

Algorithm used and model results

Figure 2 show the data before Robust Scalser.

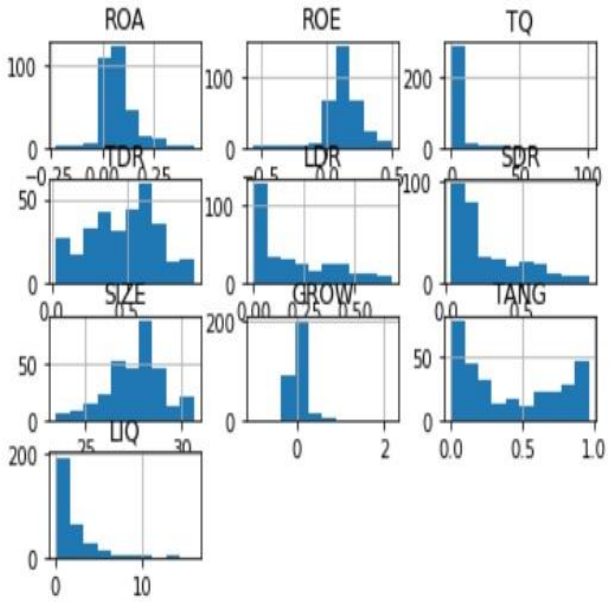


Figure 2. Data before Robust Scaler

Because the data has many outliers and is not balanced among variables, it has been normalized using the Robust Scaler method, after normalizing the data as follows in Figure 3.

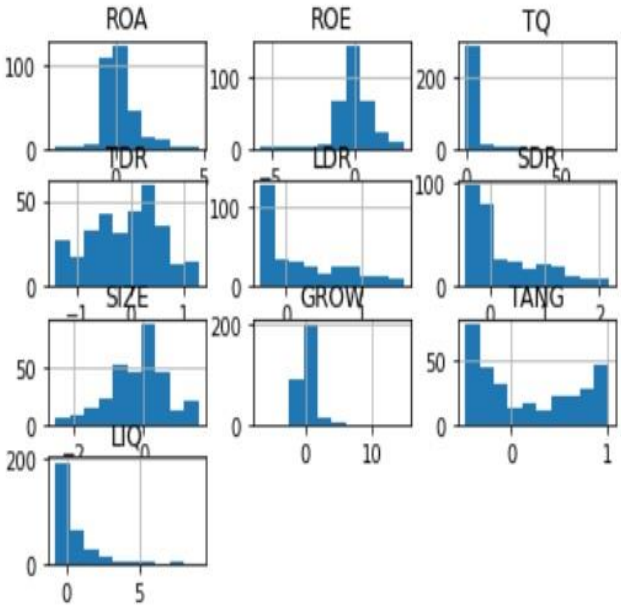


Figure 3. Data after Robust Scaler

Data after normalization by Robust Scaler method is more balanced for building model.

Table 3 shows descriptive statistics of variables in the research sample.

Table 3. Descriptive statistics of variables in the research sample

	ROA	ROE	TQ	TDR	LDR	SDR	SIZE	GROW	TANG	LIQ
count	315.000000	315.000000	315.000000	315.000000	315.000000	315.000000	315.000000	315.000000	315.000000	315.000000
mean	0.214462	-0.006661	1.653253	-0.090143	0.198441	0.269270	-0.157261	0.190835	0.168641	0.500539
std	1.026230	1.007839	6.171435	0.661866	0.559691	0.667650	0.811588	1.558765	0.515632	1.409759
min	-3.418004	-5.642918	-0.788788	-1.417227	-0.344876	-0.461422	-2.537436	-6.735000	-0.477927	-0.757557
25%	-0.393832	-0.498980	-0.280536	-0.589544	-0.338926	-0.253678	-0.663642	-0.410416	-0.316126	-0.248781
50%	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
75%	0.606168	0.501020	0.719464	0.410456	0.661074	0.746322	0.336358	0.589584	0.683874	0.751219
max	4.713022	2.925942	74.937504	1.289174	1.565591	2.161094	1.575959	14.676413	1.017142	9.121830

On the basis of the database has been cleaned and normalized to apply to suitable algorithms.

Some algorithms used such as Multiple linear regression, Polynomial linear regression, SVM, Ada boost regression give bad results, model performance is not high (R Square from 41.22% to 63.14%). The algorithm that gives good results with high model performance is XGBoost regression (R Square from 74.47% to 90.99%).

Table 4 shows the results of train and test XGBoost regression.

Table 4. Results of train and test XGBoost regression

ROA

```
X_XG_train,X_XG_test,y_XGa_train,y_XGa_test = train_test_split(X_XG,y_XGa,test_size=0.2)
xgb_model1 = xgb.XGBRegressor(n_estimators=100)
model_XGBoost1 = xgb_model1.fit(X_XG_train,y_XGa_train)
y_XGa_pred = model_XGBoost1.predict(X_XG_test)
print('R^2 train: ',model_XGBoost1.score(X_XG_train,y_XGa_train))
print('R^2 test: ',model_XGBoost1.score(X_XG_test,y_XGa_test))
mse = mean_squared_error(y_XGa_test, y_XGa_pred)
print("MSE: %.2f" % mse)
print("RMSE: %.2f" % (mse**(1/2.0)))
```

```
R^2 train:  0.9999982014035304
R^2 test:  0.8801310879192886
MSE: 0.12
RMSE: 0.34
```

ROE

```
X_XG_train,X_XG_test,y_XGe_train,y_XGe_test = train_test_split(X_XG,y_XGe,test_size=0.2)
xgb_model2 = xgb.XGBRegressor(random_state=42)
model_XGBoost2 = xgb_model2.fit(X_XG_train,y_XGe_train)
y_XGe_predE = model_XGBoost2.predict(X_XG_test)
print('R^2 train: ',model_XGBoost2.score(X_XG_train,y_XGe_train))
print('R^2 test: ',model_XGBoost2.score(X_XG_test,y_XGe_test))
mseE = mean_squared_error(y_XGe_test, y_XGe_predE)
print("MSE: %.2f" % mseE)
print("RMSE: %.2f" % (mseE**(1/2.0)))
```

```
R^2 train:  0.9999934278056396
R^2 test:  0.7446816827593683
MSE: 0.28
RMSE: 0.53
```

Tobin'Q

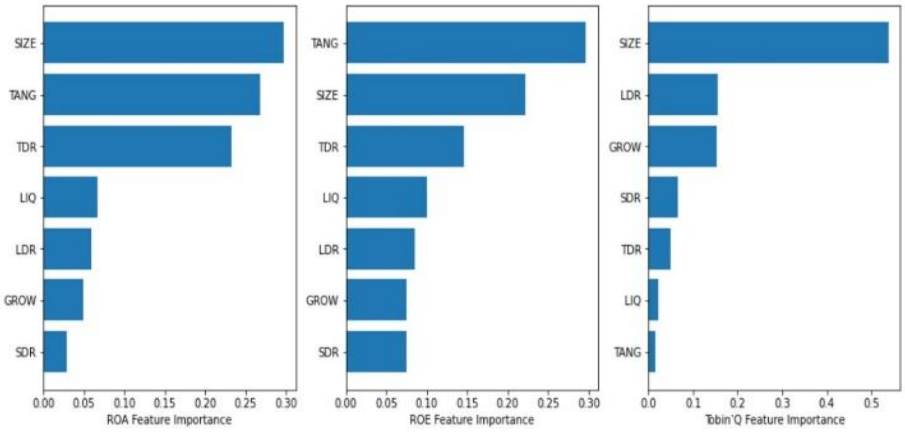
```
X_XG_train,X_XG_test,y_XGt_train,y_XGt_test = train_test_split(X_XG,y_XGt,test_size=0.2)
xgb_model3 = xgb.XGBRegressor(random_state=42)
model_XGBoost3 = xgb_model3.fit(X_XG_train,y_XGt_train)
y_XGt_predT = model_XGBoost3.predict(X_XG_test)
print('R^2 train: ',model_XGBoost3.score(X_XG_train,y_XGt_train))
print('R^2 test: ',model_XGBoost3.score(X_XG_test,y_XGt_test))
mset = mean_squared_error(y_XGt_test, y_XGt_predT)
print("MSE: %.2f" % mset)
print("RMSE: %.2f" % (mset**(1/2.0)))
```

```
R^2 train:  0.9999994808725654
R^2 test:  0.9099000032952504
MSE: 3.45
RMSE: 1.86
```

Source: XGBoost for Regression in python

The model results through XGBoost regression algorithm in table 4 show that the model performance is quite high, the difference between train and test is not much (ROA and Tobin'Q are better than ROE), and Mean Squared Erorr (MSE) and Root coefficients mean squared error (RMSE) is quite low.

Next, we identify impact factors (feature_importances). Feature_importances from model results are shown in Figure 4, Figure 5, Figure 6 and Figure 7.



Source: Xgboost Feature Importance in python

Figure 4. Feature_importances from model results

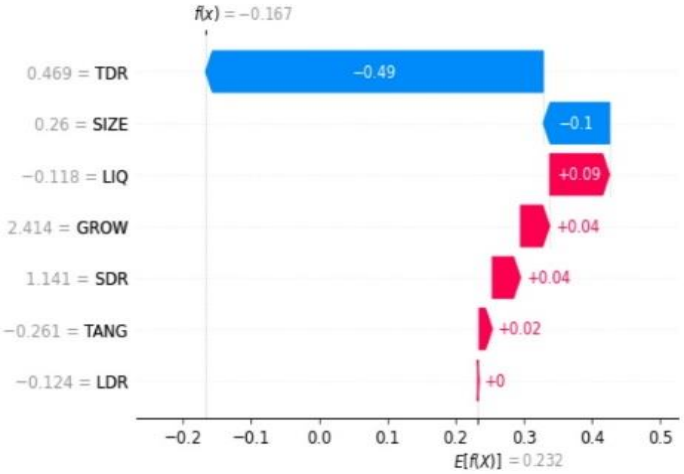


Figure 5. ROA shap values

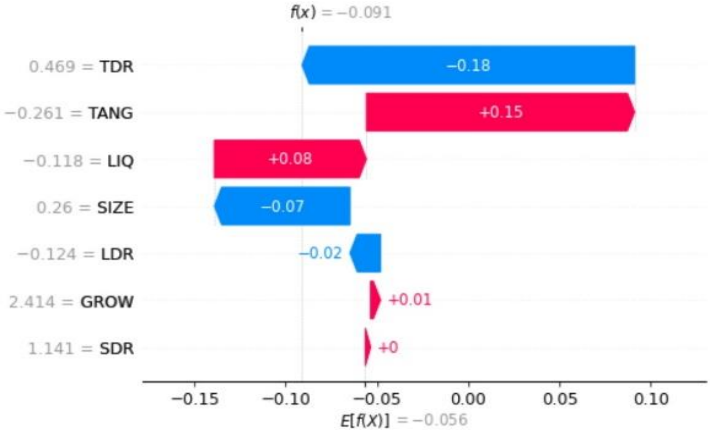


Figure 6. ROE shap values

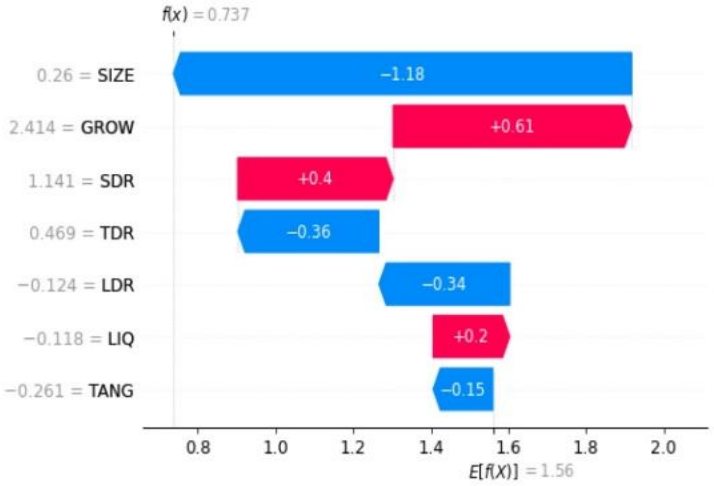


Figure 7. Tobin'Q shap values

The results from the algorithm show that there is similarity in feature_importances for ROA and ROE, features SIZE, TANG, TDR are very important for ROA, ROE means SIZE, TANG, TDR significantly affect ROA and ROE , while LIQ, LDR, GROW, SDR features have less impact. In addition, Tobin'Q's feature_importances are slightly different from ROA and ROE, features SIZE, LDR, GROW have a big impact on Tobin'Q, while features SRD, TDR, LIQ, TANG have a negligible impact on Tobin' Q.

5. CONCLUSION AND SOME RECOMMENDATIONS

Conclusion

Research results show the enterprise with debt capital structure will be leverage to increase the profitability ratio for owners. The result of model found that there is a positive impact of the group of control variables GROW, TANG and LIQ on firm performance, only the SIZE variable has a negative effect, this result is contrary to the research results of Soumadi et al. Hayajneh (2012); Amin and Jamil (2015); Le and Phan (2017). Thus, large-scale Vietnamese energy enterprises have not taken the advantages of scale and network and capital efficiency in business activities.

For the group of explanatory variables, LDR, TDR have opposite effects, this result is similar to studies in developing countries such as: Salim and Yadav (2012); Le and Phan (2017), but there is a difference in SDR that has a positive impact on business performance, because the average ratio of total debt of enterprises in the energy industry is about 47.8%, the ratio of short-term debt accounts for about 28.2% and about 19.6% is long-term debt. Short-term debt is used more due to low cost, loan procedure is simpler, equity capital ratio required in the project is lower and consistent with the actual situation in Vietnamese commercial banks is the limitation of capital sources for long-term credit.

Recommendations for businesses in the energy industry

Firstly, adjust the capital structure in the direction of increasing short-term debt (SDR), reducing long-term debt (LDR) and reducing total debt to total assets (TDR) to improve business performance.

(1) For short-term debt (SDR): enterprises need to rebalance their capital structure by term and access short-term debt financing sources through interest rates and

non-interest rates funds, but it is necessary to avoid relying too much on debt, ensure liquidity (LIQ) and determine the maximum level of leverage.

(2) For long-term debt (LDR): enterprises need to reduce the proportion of long-term debt and invest in fixed assets, such as equipment, warehouses, factories... to increase net fixed asset value to total assets (GROW), while creating quality products that satisfy customer needs.

Accessing long-term funding through credit institutions, but relying on loans will face many limitations in diversifying long-term capital sources to ensure optimal capital structure for businesses; In addition, enterprises can issue bonds, but they need to have operational capacity to make profits, ensure debt repayment and interest expenses for investors, especially long-term reputation when operating.

Secondly, other funding sources in the direction of risk control. Enterprises need to find other sources of funding such as retained earnings, additional shares issuance. Or when a business uses debt, it will help increase value, but increasing equity helps the business avoid risks. Therefore, a combination of debt and equity is required to ensure safety and improve corporate value.

Thirdly, enterprises with large capital scale (SIZE) need to take the advantages of scale and network along with improving the efficiency of capital using to improve the firm's performance.

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