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Application of Regression Analysis on the Impact of Various Factors on Lenovo Group's Profits

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Abstract: For an enterprise, profitability is the specific performance of business results in each link, one of the important indicators, and the most direct response to its ability to make profits. Lenovo Group has been on the Fortune 500 list continuously, with its total income increasing and ranking rising, but its profit has not maintained growth all the time. Using descriptive statistics, correlation analysis, Unit root test, Johansen Cointegration Test, Granger Causality Test, and Vector Autoregressive Models (VAR), this paper establishes multiple regression equations to analyze the impact of various factors on its profits from 2000 to 2021 and helps Lenovo Group to improve its profitability while maintaining the continuous growth of total revenue.

Keywords: Profitability; Multiple Regression Equations; Profits

1. Introduction

Lenovo Group, founded in 1984, is a large enterprise group with diversified development in the information industry and an innovative international technology company. Lenovo has been the No.1 PC seller in China since 1996. In 2013, Lenovo became the world's largest PC maker by sales. According to Fortune's Global 500 list, Lenovo Group ranked 329 in 2013, up from 370 in 2012, with a turnover of \$34 billion and a profit of \$63.51 billion. In fact, since 2015, Lenovo Group has encountered development difficulties. In 2014, Lenovo reported revenue of \$46.3 billion, which fell for the next two years to \$44.9 billion in 2015 and \$43 billion in 2016, according to Fortune Magazine. In 2017, it recovered to \$45.3 billion, ranking 240th in the Global 500, but recorded a loss of \$189 million (Liu, 2022).

During the period from 2015 to 2020, Lenovo Group's income keeps increasing, but its profit range fluctuates greatly. Lenovo Group has a high asset liability ratio and the financial leverage has strong effect. Its return on equity is far greater than the return on assets.

The regression equation is established in this study using the data of Lenovo Group from 2000 to 2021 to judge the factors affecting the profit of Lenovo Group and to help improve the profit of Lenovo Group. The data mainly include: Total revenue (TR), Assets (ASS), Shareholders' equity (SHE), Profit as a percentage of revenue (PITR), Return on assets (PIAS), and Profit (PI).

2. Profits Status of Lenovo Group

Lenovo Group has the support of national policies. Under the policy call of "making the information industry bigger and stronger", China's political environment is beneficial to Lenovo's internationalization route. Under the normal situation of the epidemic, the acceleration of new infrastructure construction and the outbreak of network economy have brought opportunities to Lenovo. According to IDC data, Lenovo has outstanding advantages in the PC market in the Asia Pacific region. As the data of 2020, Lenovo notebook has always been in the leading position in Asian market, ranking first with 24.3% computer market share (Gou, 2021).



Data Sources: Lenovo Group Financial Market Share Report. Figure 1. Lenovo's market share in China, 2020.

The descriptive statistics is a general term used to describe or summarize the basic situation of observations. It describes how statistical research obtains data reflecting objective phenomena and processes, displays the collected data in the forms of charts, and then obtains the regular quantitative characteristics reflecting objective phenomena through comprehensive generalization and analysis (Shi & Mclarty, 2009). Correlation analysis is to analyze the signs that do have connections in the population, and its main body is to analyze the signs that have causality in the population. It is a process of describing the closeness of the relationship between objective things and expressing it with appropriate statistical indicators (Kang, 2019). The explained variable of this study is PI, and the explanatory variables are TR, ASS, SHE, PITR, PIAS. The descriptive statistics and correlation analysis are shown in Table 1 and Table 2.

The descriptive statistics shows the data are stable and could be use. The correlation analysis shows that ASS, TR and PI are lowly correlated, PIAS, SHE and PI are moderately correlated, PITR and PI are highly correlated, respectively. All the correlation coefficients are significantly different from zero at the 5% level and these data could be further used for unit root test.

	ASS	PI	PIAS	PITR	SHE	TR
Mean	158.6923	5.2027	0.0453	0.0184	32.24	305.6523
Median	98.69	5.105	0.0297	0.0160	36.5	251.975
Maximum	379.91	13.13	0.1859	0.0507	52.28	607.42
Minimum	50.41	-2.26	-0.0341	-0.0152	10.45	132.76
Sum Sq. Dev.	233,587	417.35	0.0603	0.0066	3,662	444,127
Observations	22	22	22	22	22	22

Table 1. The descriptive statistics.

Table 2. Correlation analysis.						
	ASS	PI	PIAS	PITR	SHE	TR
ASS	1					
PI	0.2071	1				
PIAS	-0.3687	0.7187	1			
PITR	-0.2543	0.8313	0.9606	1		
SHE	0.3633	0.5361	0.4218	0.4804	1	
TR	0.9779	0.2851	-0.2735	-0.1728	0.4421	1

3. The Model and the Tests

3.1. Unit Root Test

Unit root test is to check for stationary in the sequence because the existence of unit root is non-stationary time series. Unit root refers to unit root process. It can be proved that the existence of unit root process will lead to the existence of false results in regression analysis (Hepasg, 2021). The absolute values of ADF values of ASS, PI, TR, SHE, PITR and PIAS in Table 3 are less than the critical value under the significance level of 5%. The original assumption that the original sequence has a unit root cannot be rejected, that is, the above variables are unstable. However, all sequences are stationary sequences after the first-order difference. That is, the first-order difference of each variable is a first-order single integer sequence at the significance level of 5%.

Variables	Test type (C, T, K) [*]	ADF-statistic	Test critical value (5% level)	Prob.	Conclusion
ASS	(0, 0, 0)	2.6790	-1.9581	0.9968	Not stable
PI	(C, 0, 0)	-2.9659	-3.0121	0.0548	Not stable
TR	(0, 0, 0)	1.9618	-1.9581	0.9847	Not stable
SHE	(0, 0, 0)	-1.0840	-1.9581	0.2427	Not stable
PITR	(C, 0, 0)	-3.2052	-3.0124	0.0340	Stable
PIAS	(0, 0, 0)	-3.2055	-1.9614	0.0031	Stable
D(ASS)	(C, 0, 0)	-4.4583	-3.0207	0.0025	Stable
D(PI)	(0, 0, 0)	-6.7820	-1.9591	0.0000	Stable
D(TR)	(0, 0, 0)	-3.7435	-1.9591	0.0008	Stable
D(SHE)	(0, 0, 0)	-5.3043	-1.9591	0.0000	Stable

Table 3. Unit root test results for all variables.

* C denotes intercept; T denotes trend; K denotes lag length; D denotes the first-order difference.

3.2. Johansen Cointegration Test

Johansen Cointegration Test determines whether the linear combination of a group of non-stationary sequences has a stable equilibrium relationship. Pseudo regressive a special case is that the trend components of the two time-series are the same. At this time, this common trend may be used to modify the regression to make it reliable. In the real economy, the time series is usually non-stationary. We can make a difference to make it reliable, but this will lose the total long-term information which is necessary for the analysis. Johansen Cointegration Test is used to solve this problem because a long-term equilibrium relationship can be transmitted. If a reliable connection can be found between several variables that seem to have a single random trend, the random trend brought by the unit root can be excluded by introducing this "relatively stable" to adjust the model through the so-called Error Correction Model (Yoo, 1998). The results of Johansen Cointegration Test of each variable are shown in Table 4.

Table 4 shows that when the original hypothesis r = 0, the Trace Statistic are higher than Critical Value at the 5% significance level, and the original hypothesis is rejected at this time; when the original hypothesis is $r \leq 2$, the Trace Statistic is still higher than the Critical Value at the 5% significance level. The original hypothesis is accepted and there are three long-term stable equilibrium relationships among variables at the 5% significance level.

Table 4. Johansen Cointegration Test for the model.

No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob	
None*	0.9075	129.9860	95.7537	0.0000	
At most 1 [*]	0.7739	82.3647	69.8189	0.0036	
At most 2*	0.6855	52.6306	47.8561	0.0167	
At most 3	0.5630	29.4972	29.7971	0.0541	

* denotes significantly different from 0 at 5% level.

3.3. Granger Causality Test

The results Johansen Cointegration Test show that ASS, PI, TR, SHE, PITR and PIAS have long-term stable equilibrium relationships. In order to further verify whether there is causality between these variables,

Granger Causality Test needs to be carried out. Granger Causality Test is a technique for determining whether one time series is useful in forecasting another (Granger, 1969). In the results of Table 5, there is no obvious causal relationship between ASS, TR, SHE, PITR, PIAS and PI.

Null Hypothesis	F-Statistic	Prob.	Result
TR does not Granger Cause PI	0.3877	0.6853	cannot reject
PI does not Granger Cause TR	0.6585	0.5320	cannot reject
ASS does not Granger Cause PI	1.2218	0.3224	cannot reject
PI does not Granger Cause ASS	0.3209	0.7304	cannot reject
SHE does not Granger Cause PI	0.9698	0.4017	cannot reject
PI does not Granger Cause SHE	0.3349	0.7206	cannot reject
PITR does not Granger Cause PI	0.0464	0.9548	cannot reject
PI does not Granger Cause PITR	0.2484	0.7832	cannot reject
PIAS does not Granger Cause PI	0.2147	0.8093	cannot reject
PI does not Granger Cause PIAS	0.9284	0.4167	cannot reject

Table 5. Granger Causality Test for the model.

* denotes significantly different from 0 at 5% level.

3.4. Vector Autoregressive Models (VAR)

Vector Autoregressive Models (VAR) is to establish a model based on the statistical properties of data. It is to construct the model by taking each endogenous variable in the system as a function of the lag value of all endogenous variables in the system to extend the univariate autoregressive model to the "vector" autoregressive model composed of multivariate time series variables. In the time series model, if the model setting and identification are not accurate, the model cannot accurately reflect the dynamic characteristics of the economic system, nor can it be used for dynamic simulation and policy analysis. Therefore, VAR model usually uses the least economic theoretical assumptions and takes the statistical characteristics of time series as the starting point. It usually analyzes the impact and response of the economic system. Since VAR model focuses on describing the dynamic characteristics of economy, it can verify various economic theoretical assumptions and has advantages in policy simulation as well (Moniko, 2011).

In this paper, variables affecting the profits of Lenovo Group are established into a Vector Autoregressive Model as follows:

$$PI = C + \alpha_1 TR + \alpha_2 PIAS + \alpha_3 \frac{SHE(-1)}{ASS} + \alpha_4 PITR$$
(1)

Among this VAR model, PI, TR, PIAS, SHE(-1)/ASS, and PITR represent profit, total income, return on assets, shareholders' equity lagging behind the first period in assets, and profit as a percentage of revenues, C is a constant term, and α_1 , α_2 , α_3 , α_4 are the coefficients of TR, PIAS, SHE(-1)/ASS, and PITR. The VAR model is essentially an n-order difference equation and the solution of the difference equation is a sequence. When the sequence converges, the time series is stable and the model is stable. By understanding the structure of the solution of the difference equation, the difference equation has a convergent solution if and only if the root of the characteristic equation falls in the unit circle. The VAR model established in this study and all unit roots reciprocal is smaller than 1 and falls inside the unit circle (as shown in Figure 2), indicating that the model is stable.

Inverse Roots of AR Characteristic Polynomial



Figure 2. Graph and chart of Vector Autoregressive Model.

3.5. The Multivariable Regression Analysis

The multiple regression analysis refers to a statistical analysis method in which one variable is regarded as a dependent variable and one or more other variables as independent variables, and quantitative relations of linear or nonlinear mathematical models between multiple variables are established and analyzed by using sample data (Anne & Harald, 2011).

According to Table 6, the R-squared is 0.9069 and Adjusted R-squared is 0.8837, both are higher than 0.8. Therefore, the regression analysis equation fits the observed values well and can be used to test the theory. Durbin-Watson stat is 2.0133 (close to 2), this shows that PI has no strong self-correlation. For PI, the higher the TR, the higher PI, so there is significant positive correlation between the two variables. The SHE(-1)/ASS and PI have positive correlation and the probability is higher than 0.05, so there is significant positive correlation with PI, so there is significant positive correlation with PI, so there is significant positive correlation with PI, so there is significant positive correlation between the two variables. PIAS and PI have negative correlation and the probability is higher than 0.05, so there is significant positive that 0.05, so there is low correlation between PI and PIAS. To sum up, this regression model is almost consistent with explained variable and the explanatory variable, so PITR and TR has the greater impact on PI.

Table 6. Estimated equation.							
Variable	Coefficient	Std. Error	t-Statistic	Prob.			
С	-3.3957	1.2605	-2.6939	0.0160			
TR	0.0119	0.0029	4.1515	0.0008			
SHE(-1)/ASS	1.5379	1.8141	0.8478	0.4091			
PITR	396.3459	82.8472	4.7841	0.0002			
PIAS	-59.5692	28.7908	-2.0690	0.0551			
R-squared	0.9069	Mean dependent var		5.2167			
Adjusted R-squared	0.8837	S.D. dependent var		4.5676			
S.E. of regression	1.5578	Akaike info criterion		3.9287			
Sum squared resid	38.8284	Schwarz criterion		4.1774			
Log likelihood	-36.2513	Hannan-Quinn criter.		3.9827			
F-statistic	38.9854	Durbin-Watson stat		2.0133			
Prob(F-statistic)	0						

4. Conclusions

Lenovo Group's net profit growth rate is highly consistent with its operating profit growth rate (Feng, 2021). This paper using multiple regression equations to analyze the relationship between PI, TR, ASS, SHE, PITR and PIAS to find out the greater impact on PI using the financial data of Lenovo Group from 2000 to

2021. The profits status of Lenovo Group is analyzed first followed by descriptive statistics, correlation analysis, unit root test, Johansen Cointegration test, Granger Causality test and Vector Autoregressive Models (VAR) to analyze whether the data are fit to do multiple regression. The results of multiple regression analysis show that all variables have impact on profit and the TR and PITR are the most influence variables. The Lenovo Group is then suggested to improve total income and the profit as a percentage of revenue to make higher profits.

Based on the results of the analysis, this article proposes the following countermeasures for Lenovo to improve profitability:

4.1. Focus on Improving the Quality of Operations

Lenovo should establish a market-oriented and customer-oriented service system, and constantly improve its own technological innovation to actively improve the company's operating products and improve management capabilities. With the fierce competition in the market, the competition between enterprises has gradually shifted from the competition of the external environment to the competition of the internal environment. In the case of homogeneous products, channels, markets, etc., in order to ensure that the enterprise has a high market competitiveness, it will inevitably become the internal business environment of the company. Therefore, enterprises need to create favorable conditions for improving their internal competitiveness: First, continuous improvement of internal management, especially product technology innovation and quality management; The second is to improve the efficiency of internal operations and reduce the company's efficient management costs; The third is to continuously improve the company's sales capacity and create a more perfect market channel.

4.2. Strengthen Capital Risk Management

With the enhancement of Lenovo's operating strength, diversified business strategies have helped it to improve market competitiveness. But in fact, Lenovo's diversified operation also has a situation of capital abuse. For example, PC, mobile phone, software *etc.* should be the most core industry of Lenovo, and the company should invest most of the funds in these industries. For Lenovo, as a multinational company, the development of the IT industry itself needs larger funds. But Lenovo invests capital projects in the real estate industry, decentralizing the capital chain of the main business.

Lenovo should firstly attach importance to and implement the company's strategic planning, formulate a detailed capital use plan for each business cycle, ensure the supply of main business funds, and ensure the normal operation of the company's cash flow according to the company's daily business needs. The second is to improve the financial management ability of Lenovo Company, attach importance to the analysis and evaluation of various indicators, and control the liabilities of the enterprise within a reasonable range. This is followed by increasing the use of assets and strengthening the management of liabilities, accounts receivable, inventories and other aspects to reduce costs. Finally, effective measures are put in place to strengthen the risk management of funds for Lenovo to ensure that capital achieves satisfactory returns on a safe basis.

4.3. Strengthen the Brand Building of Enterprises

Brand is the image endorsement of enterprises in market competition, but also the performance of market competitiveness. The brand of the enterprise is formed after the effective integration of the culture, values, products and services of the enterprise, which is the most important feature that distinguishes it from similar products. After more than 30 years of building, Lenovo brand has created today's global Lenovo brand. Many computer industries attach great importance to the problem of brand building. In the future computer market, brand competition is becoming more and more important. Only products with higher added value can meet the actual needs of consumers, bring more capital accumulation to enterprises, promise the effective operation of the capital chain, and promote the stable development of the entire enterprise. With the continuous fierce competition in the entire computer market and the continuous improvement of consumer maturity, computer development companies pay more attention to brand building. Rather than simply advertising, brand building requires high-quality products, perfect services, scientific planning, appropriate media publicity, and a series of systematic operations to finally achieve the purpose of brand building.

4.4. Improve the Construction of Internal Control

The first is to establish and improve the internal control system within the company, so that all the business operations of the company are under the company's internal control system. The second is to establish a

corporate organizational structure that conforms to internal control, correctly handle the relationship between the board of directors and the board of supervisors, and enable various departments to supervise and promote each other. The third is to strengthen the company's internal audit work, incorporate audit awareness into the company's daily work, make various business activities carry out in accordance with the enterprise system and process, and effectively audit and supervise the finance, capital, and operation of the enterprise. These approaches can improve the financial analysis and evaluation capabilities, improve the efficiency of the use of funds and assets, and establish an operation and management system with profitability as the assessment standard. The fourth is to continuously carry out technological innovation and management innovation according to internal control norms, reduce operating costs, and improve the operating efficiency and profits of enterprises.

The profit level is usually a measure of a certain number of resources and a certain amount of revenue relative to the amount of profit, and profitability can reflect the quality of business performance. Whether investors or potential investors can obtain the guarantee of investment income is also an important basis for creditors to collect principal and interest funds and complete national taxation. Corporate managers, investors, potential investors, creditors and governments are all more focused on profitability, and this is what all companies should actively strive for.

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