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VARIANCE ANALYSIS TO CHANGES IN
RETURN OF INVESTMENT

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VARIANCE ANALYSIS TO CHANGES IN RETURN ON INVESTMENT

Quite a few studies have been made on the need for ROI measures, the associated measurement problems and the major determinants of ROI. The Du Pont chart system enunciated by Kline and Hessler¹ has led researchers to undertake studies on determining the investment base upon which the rate of return to be measured, identifying the managerial uses of ROI and evaluating the limitations of using ROI as a performance criterion. Besides, Robert F. Lusch and William F. Bentz of the University of Oklahoma have developed a simple quantitative technique that isolates factors that lead to the changes in two ROI rates². The technique is useful in financial reporting to shareholders. It can also be used for management planning and control. This paper employs the technique in order to analyse changes or differences in ROI of three units : Delhi Cloth, Hindustan Lever and TELCO.

The variance analysis undertaken in this study is based on interperiod and inter-entity comparisons. Data relating to the above three units for the two years 1978-79 and 1979-80 have been taken from the 'Study of Finances of 101 giant companies' reported by the Economic Times dated May 25, 1981. Through this analysis it is possible to identify the relative effect of differences in profit margin, asset turnover and leverage on return on investment. It helps us to isolate the effect of one or more of the three factors at a time on ROI,

thereby permitting a more meaningful study of changes or differences in ROI.

The ROI Model

The typical return on investment model, in terms of its components is given in Exhibit I.

Exhibit I

Return on Investment Model

$$\frac{NP}{NS} \times \frac{NS}{TA} = \frac{NP}{TA}$$

$$\frac{NP}{TA} \times \frac{TA}{NW} = \frac{NP}{NW}$$

NP = Net Profits

TA³ = Total Assets

NS = Net Sales

NW⁴ = Net Worth

As per the model a company's profit margin is multiplied by its rate of asset turnover and its leverage ratio in order to compute its return on net worth. This model emphasises that the principal financial objective of the form is to earn an adequate return on net worth. The three ways in which it can improve its return on net worth are by increasing its profit margin, by increasing its rate of asset

turnover, or by making use of a high degree of leverage. The three main areas of decision making are therefore margin management, asset management, and leverage management or financial policy.

Return on Asset Analysis

In the first instance the ROI model focuses attention on return on assets as arrived at by multiplying profit margin by the rate of asset turnover. This does not incorporate the leverage factor. This measure may be used in evaluating the performance of individual managers or of particular investment centers. It focuses attention on the rate of return attained on all assets under the control of the manager without taking care of the financial decisions made at a higher organisation level.

Symbolically,

$$R = M \times T$$

where $R =$ return on assets $\frac{\text{net profit}}{\text{assets}}$

$M =$ profit margin $\frac{\text{net profit}}{\text{sales}}$

$T =$ asset turnover $\frac{\text{sales}}{\text{assets}}$

For DCM in the year 1978-79

$$R = 0.022 \times 1.488$$

$$= 0.0327$$

If 1978-79 is taken as period 1 and 1979-80 is taken as period 2 then, for DCM

$$\begin{aligned} R_1 &= M_1 \times T_1 \\ &= 0.022 \times 1.488 \\ &= 0.0327 \end{aligned}$$

$$\begin{aligned} R_2 &= M_2 \times T_2 \\ &= 0.024 \times 1.713 \\ &= 0.0409 \end{aligned}$$

The change in return on assets from 1978-79 to 1979-80 is given by

$$\begin{aligned} R_2 - R_1 &= M_2 \times T_2 - M_1 \times T_1 \\ &= 0.0409 - 0.0327 \\ &= 0.0082 \end{aligned}$$

The expression given above can be partitioned further :

$$\begin{aligned} R_2 - R_1 &= (M_2 - M_1) T_1 + (T_2 - T_1) M_1 + (M_2 - M_1) (T_2 - T_1) \\ &= (0.024 - 0.022) 1.488 + (1.713 - 1.488) 0.022 + \\ &\quad (0.024 - 0.022) (1.713 - 1.488) \\ &= 0.0029 + 0.0049 + 0.0004 \\ &= 0.0082 \end{aligned}$$

The expression given above provides information by which we can measure the effect on ROI of changes in two factors: profit-margin and asset turnover. There are three components to it :

1. The effect on return on assets due to difference in profit margins for a given turnover level is known as the Margin variance. For DCM it is 0.0029.
2. The effect on return on assets due to difference in asset turnover for a given profit margin level is known as the Turnover variance. For DCM, the same is 0.0049.
3. The interaction effect on return on assets due to differences both in profit margin and asset turnover is known as the Joint-Margin-Turnover Variance. For DCM, the same is 0.0004.

The relationship among the two main variances and the joint variance is portrayed in Exhibit 2.

Exhibit 2

Increase in Return on Assets Analysis

Asset Turnover	T_2	Turnover variance $(T_2 - T_1) M_1$ 0.0049	Joint Margin, Turnover Variance $(M_2 - M_1)(T_2 - T_1)$ 0.0004
	T_1	R_1	Margin Variance $(M_2 - M_1) T_1$ 0.0029
		M_1	M_2
		Profit Margin	

The rectangle formed by the interaction of M_1 and T_1 represents DCM's return on total assets for the year 1978-79. During the year 1979-80, both margin and turnover increased leading to the larger rectangle formed by the interaction of M_2 and T_2 . The return on assets for the year 1979-80 is represented by the larger rectangle. The area between the two rectangles shows the overall variance. It has three components described above, viz., the margin variance, the turnover variance and the joint margin-turnover variance.

Return on Net Worth Analysis

It is possible to transform the return on assets analysis to an analysis of return on net worth by the inclusion of an additional leverage variable. If one is interested in knowing the overall performance of a company, the return on net worth is probably the most important measure. It is a measure which reflects the effect of financial policies, besides measuring management's effectiveness in the area of margin management and asset management.

The return on net worth version of ROI model is of immense use to ordinary shareholders as it gives them an idea about the overall profitability of their investment in the company. If the company makes some changes in leverage over time, the effect of that can be evaluated by the trade-off between the resultant return on investment and the risk relating to that investment. Similarly if one is interested in evaluating

the effect of differences in leverage between two corporate units, it can be known through the trade-off between return on investment and the risk associated with that. The variance analysis portrayed in Exhibit 2 can be extended to cover the impact of leverage on the return on net worth. It is possible to undertake a risk-return analysis for different financial policies both at the inter-period and inter-unit level.

The return on net worth measure can be simply obtained by multiplying the return on assets measure by the leverage ratio. Thus, return on net worth is given by the formula

$$R = M \times T \times L$$

where

$$\begin{aligned}
 R &= \text{return on net worth} && \left(\frac{\text{profit}}{\text{net worth}} \right) \\
 M &= \text{profit margin} && \left(\frac{\text{profit}}{\text{sales}} \right) \\
 T &= \text{asset turnover} && \left(\frac{\text{sales}}{\text{assets}} \right), \text{ and} \\
 L &= \text{leverage ratio} && \left(\frac{\text{assets}}{\text{net worth}} \right)
 \end{aligned}$$

The DCM's return on net worth for the year 1978-79 is given by

$$\begin{aligned}
 R_1 &= M_1 \times T_1 \times L_1 \\
 &= 0.022 \times 1.488 \times 2.781 \\
 &= 0.091
 \end{aligned}$$

Similarly for the year 1979-80,

$$\begin{aligned} R_2 &= M_2 \times T_2 \times L_2 \\ &= 0.024 \times 1.713 \times 2.725 \\ &= 0.111 \end{aligned}$$

The change in DCM's return on net worth from the year 1978-79 to 1979-80 will be given by

$$\begin{aligned} R_2 - R_1 &= M_2 \times T_2 \times L_2 - M_1 \times T_1 \times L_1 \\ &= 0.111 - 0.091 \\ &= 0.020 \end{aligned}$$

The overall variance given above can be broken into the following seven components

$$\begin{aligned} R_2 - R_1 &= (M_2 - M_1) T_1 L_1 + (T_2 - T_1) M_1 L_1 + (L_2 - L_1) T_1 M_1 + \\ &\quad (M_2 - M_1) (T_2 - T_1) L_1 + (M_2 - M_1) (L_2 - L_1) T_1 + \\ &\quad (T_2 - T_1) (L_2 - L_1) M_1 + (M_2 - M_1) (T_2 - T_1) (L_2 - L_1) \end{aligned}$$

These seven components explain the overall change in DCM's return on net worth from 1978-79 to 1979-80. The respective variances are :

1. Margin Variance

$(M_2 - M_1) T_1 L_1$: This gives an idea about the extent of change in return on net worth arising because of change in profit margins.

In order to compute Margin Variance, one must keep turnover and leverage constant. For DCM, the margin variance between 1978-79 and 1979-80 is equal to $(0.024 - 0.022) (1.488) (2.781) = 0.008$.

2. Turnover Variance

$(T_2 - T_1) M_1 L_1$: This explains the changes in net worth arising because of changes in turnover. It is necessary to hold margin and leverage constant. For DCM, the Turnover Variance for the same period is equal to $(1.713 - 1.488) (0.022) (2.781) = 0.013$.

3. Leverage Variance

$(L_2 - L_1) T_1 M_1$: The influence of change in the leverage variable on return on net worth is depicted by leverage variance. The turnover and margin variables are kept constant. For DCM the leverage variance for the same period is equal to $(2.725 - 2.781) (1.488) (0.022) = -0.002$.

4. Joint Margin-Leverage Variance

$(M_2 - M_1) (L_2 - L_1) T_1$: This shows the effect of interaction between changes in margin and leverage on return on net worth by keeping turnover constant. For DCM, the same is equal to $(0.024 - 0.022) (2.725 - 2.781) (1.488) = -0.0001$.

5. Joint Margin-Turnover Variance

$(M_2 - M_1) (T_2 - T_1) L_1$: This shows the impact of interaction between changes in margin and turnover on return on net worth by keeping leverage constant. For DCM, it is equal to $(0.024 - 0.022) (1.713 - 1.488) (2.781) = 0.001$.

6. Joint Turnover-Leverage Variance

$(T_2 - T_1) (L_2 - L_1) M_1$: This shows the effect of interaction in changes in turnover and leverage on return on net worth, by keeping margin constant. For DCM, the same is equal to $(1.713 - 1.488) (2.725 - 2.781) (0.022) = 0.0003$.

7. Joint Turnover Leverage-Margin Variance

$(T_2 - T_1) (L_2 - L_1) (M_2 - M_1)$: This shows the effect of interaction in changes in turnover, leverage and margin in return on net worth. For DCM, the same is equal to $(1.713 - 1.488) (2.725 - 2.781) (0.024 - 0.022) = 0.000$.

It is not possible to make a graphic representation of the above variances arising because of the interaction effects. The two comparisons made are of inter-period and inter-unit type. The three units for which the different variances have been computed are DCM, Hindustan Lever and TELCO. The period is as usual 1978-79 to 1979-80.

Variance Analysis of Return on Net Worth

Inter period Comparisons	R ₂ - R ₁		Margin		Turnover		Leverage		Margin Turnover		Turnover Leverage		Leverage Margin		Margin Leverage	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
DCM (1978-79 Vs. 1979-80)	0.020	100	0.008	40.0	0.013	65.0	(0.002)	(10.0)	0.001	5.0	0.000	0.0	0.001	0.0	0.000	0.0
Hindustan Lever (1978-79 Vs 1979-80)	0.076	100	0.079	104.0	(0.009)	(11.8)	0.008	10.5	(0.005)	(6.6)	(0.001)	(0.6)	0.004	5.3	0.000	0.0
TELCO (1979-79 Vs 1979-80)	(0.026)	N/A	(0.028)	N/A	(0.031)	N/A	0.041	N/A	0.003	N/A	(0.006)	N/A	(0.005)	N/A	0.001	N/A
<u>Inter-Unit Comparisons</u>																
DCM Vs Hindustan Lever	0.114	100	0.135	118.4	0.011	9.6	(0.019)	(16.7)	0.014	12.3	(0.002)	(1.8)	(0.023)	20.2	(0.002)	(1.8)
TELCO Vs DCM	(0.059)	N/A	(0.068)	N/A	0.121	N/A	(0.062)	N/A	(0.048)	N/A	(0.043)	N/A	0.024	N/A	0.017	N/A
TELCO Vs Hindustan Lever	0.057	100	0.055	96.5	0.153	268.4	(0.080)	(140.0)	0.049	86.0	(0.071)	(124.6)	(0.026)	(45.6)	(0.023)	(40.3)

Let us analyse the results. For DCM, there is an improvement in profit margin on sales, which would have increased ROI by 0.008 points, if both turnover and leverage are kept constant. However, Turnover has also increased, which would have increased ROI by 0.013 points if margin and leverage are kept constant. The interaction between Margin and turnover keeping leverage constant has also led to an increase in ROI by 0.001 points. Leverage, however, has decreased slightly leading to a net increase in ROI by approximately 0.020 points (0.008 + 0.013 + 0.001 - 0.002).

For Hindustan Lever the overall improvement in ROI by 0.076 points is explained by an increase in margin by 0.079, in leverage by 0.008, and the interaction effect between margin and leverage by 0.004. Part of this increase is offset by decrease in turnover by 0.009 and the interaction effect of decrease in Margin-turnover and Leverage-turnover. The net result is $(0.079 + 0.008 + 0.004 - 0.009 - 0.005 - 0.001) = 0.076$. It includes the joint, margin, leverage, turnover variance.

It is interesting to note that both for DCM and Hindustan Lever the joint variances are negligible in relation to the effects on ROI caused by the changes in three main variables : profit-margin, asset turnover and leverage. The joint variances for DCM are unusually small because of relatively small changes in leverage variable.

When the comparison is made at the inter-unit level, we find that the difference between DCM and Hindustan Lever's return on net worth is 0.114 points. In terms of components this is explained by difference in profit margins (0.135 points), turnover (0.011 points), and leverage (-0.019 points). These are the significant differences. Though the combined effect on ROI because of differences in margin and turnover totals to 0.146 points, the net overall difference in ROI is only of 0.114 points.

The variance analysis given above can be used to find out the effect on ROI that would result because of a specified change in leverage. On the other hand one can find out how much changes in leverage are required in order to get a specified increase in ROI. The same sort of relationship can be drawn with profit margin and asset turnover as well.

It is also possible to find out the best way in which ROI can be improved. The significance of each of the variables; profit margin, asset turnover, and leverage can be tested. However, each of these means has a cost associated with it which can be compared with the resultant benefits. The variance analysis helps us to undertake such a cost benefit analysis.

The variance analysis given above can be undertaken for an extended period of ten to twelve years for a particular unit. The year to year changes in ROI taking place in that unit vis-a-vis that of

industry can be analysed in terms of its different components. Significant deviations may be detected. This would facilitate planning and control of future operations. One can also extend the analysis for units competing in the same industry. One can compare its own performance with the performance of the competing units. It is possible to undertake a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis based on this.

The variance analysis of this nature can be used for external reporting to shareholders and financial community. The factors behind change in ROI can be identified. At the same time, it can be used for management planning and control.

Conclusion

This paper applies the Variance analysis approach developed by Robert F. Lusch and William F. Bentz for analysing changes in return on investment of three units : DCM, Hindustan Lever and TELCO. It identifies the different factors that explain the difference or change in two ROI rates. Both an inter-period and inter-unit comparison have been made. The analysis is useful for purposes of financial reporting to shareholders. It can also be used for management planning and control.

1. C.A. Kline and Howard L. Hessler, "The Du Pont Chart System for Appraising Operating Performance", NACA Bulletin, August 1952.
2. Robert F. Lusch and William F. Bentz, "A Variance Approach to Analysing Changes in Return on Investment," Management Accounting, NACA, February 1979.
3. In place of Total Assets, the study employs the figures of "Total Capital employed" which is given by the Net Fixed Assets, inventory and all other assets excluding advance payment of taxes.
4. Paid-up capital and all free reserves including taxation reserve, accumulated balance of debenture redemption reserves, sinking funds and surplus, loss carried forward.