A RATIO-BASED EQUATION FOR OPERATING LEVERAGE

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ABSTRACT

The degree of operating leverage (DOL) is most often expressed using percentage changes in profits and sales or dollar values for prices, quantity, variable and fixed costs. We propose a formula that does not rely on percentage changes or dollar values, relying instead on financial ratios that reflect the cost-profit structure and allows students to have a better grasp of what variables drive the degree of operating leverage. This presentation of DOL demonstrates that both the fixed cost ratio as a percentage of sales and profit margin are drivers of the degree of operating leverage.

INTRODUCTION

The degree of operating leverage (DOL) is a ratio describing the additional operating income expected with a change in the units of output. Thus knowing the operating leverage of a company provides an important analytic tool for planning and forecasting, as well as for understanding past performance. However, procedures for calculating DOL typically emphasize its role in understanding past performance by using the historical data of a company, either in percentage or dollar value form to calculate DOL. This note frees DOL from these dollar-based forms, relying instead on financial ratios, specifically the fixed cost ratio as a percentage of sales and the profit margin. This note shows the derivation of the ratio-based form of DOL and provides illustrations of how it could be used in the classroom to provide students with more useful insights about the role of DOL in financial management.

APPROACHES TO OPERATING LEVERAGE

Operating leverage is useful in assessing corporate strategies, forecasting future performance, and comparing companies within an industry. However, contemporary accounting textbooks give little guidance in these strategic uses of degree of operating leverage within a company. The power of DOL for the manager is often hidden in textbooks by a perfunctory, descriptive presentation that obscures the underlying fundamental connections between costs, margins, and sales. In four widely-used management accounting textbooks four different versions of DOL are presented; however, all of them require historical data, often selecting GAAP-based numbers that are subject to impact by non-recurring items (Garrison, Noreen, and Brewer, 2006;Hilton, 2008; Horngren et al., 2007; Potter et al., 2006).   None of these formulations allows the direct use of ratios, as developed in this article.

Outside of textbooks, degree of operating leverage has interested researchers in such diverse literatures as the academic finance literature (Dugan and Shriver, 1992, Ryan, 1997, Lord, 1998), professional economic articles (Berner, 2002), and accounting education literature (Blocker and Chen, 2004). The emphasis in academic literature has been the association of operating leverage and systematic risk from the perspective of external stakeholders. Likewise Berner (2002) gives a macro perspective explaining difficulties throughout the U.S. economy in the 2000s based on the deleterious effects on profit from increased operating leverage. Only the teaching materials *The ALLTEL Pavilion Case: Strategy and CVP Analysis* look at operating leverage from the perspective of the manager who actually has access to specific data on variable vs. fixed costs, but the case examines operating leverage only qualitatively (low vs. high). Thus this note makes a contribution to management accounting and financial management literatures.

DERIVATION OF A RATIO-BASED DEGREE OF OPERATING LEVERAGE

The following steps demonstrate a derivation of a ratio-based definition of the degree of operating leverage. The degree of operating leverage can be expressed as:

$$DOL = \frac{\%\Delta\, Profit}{\%\Delta\, Sales} \qquad (1)$$

An alternative version very common in textbooks is:

$$DOL = \frac{(P-V)\,Q}{(P-V)\,Q - F} \qquad (2)$$

Where:

P = price
V = variable cost per unit
Q = quantity
F = fixed cost

Multiply Q by P and V, as indicated, and divide the result and F by PQ:

$$DOL = \frac{\dfrac{PQ}{PQ} - \dfrac{VQ}{PQ}}{\dfrac{PQ}{PQ} - \dfrac{VQ}{PQ} - \dfrac{F}{PQ}} \qquad (3)$$

Defining VQ/PQ as vc (variable cost as a percentage of total revenue) and F/PQ as fc (fixed cost as a percentage of total revenue, after simplification, the formula is

$$DOL = \frac{1 - vc}{1 - vc - fc} \qquad (4)$$

Defining m as profit margin such that m + vc + fc = 1, the numerator is equal to profit margin (m) plus fixed cost on sales (fc) and the denominator is equal to profit margin (m).

$$DOL = \frac{m + fc}{m} \qquad (5)$$

Simplifying:

$$DOL = 1 + \frac{fc}{m} \qquad (6)$$

DOL is a direct function of fixed cost margin and an inverse function of profit margin. Thus this equation provides an alternate way to calculate DOL that identifies relationships not previously included in academic treatments of DOL.

ILLUSTRATION OF USING A RATIO-BASED EQUATION

This section provides a numerical example comparing a data-based approach and a ratio-based approach to DOL using a simple, three-period model. Assume that the company has $1,000 in sales in period 1, a profit margin of 10%, variable costs of 70%, and fixed costs of 20% (see Table 1). Then in period two, sales increase by 5%, and a sales increase of 5% is projected for period 3. Income in period 1 is $100 (Sales of $1,000 – Variable Cost of $700 – Fixed Cost of $200). Income in period 2 is $115 (Sales of $1,050 – Variable Cost of $735 – Fixed Cost of $200). Although sales increased by 5%, profits increased by 15%. Variable cost as a percentage of total revenue (vc) is 30% in each period, but fixed cost as a percentage of total revenue (fc) changes from 20% ($200 / $1,000) to 19.% ($200 / $1,050), and profit margin changes from 10% ($100/$1,000) to 11.5% ($115/$1,000).

Using equation (1), DOL is computed to be 3 (15% / 5%). Since equation (1) is based on percentage changes between two periods, it can only be computed once at the end of period 2. Using equation (6), DOL is 3 for period 1 (1+20%/10%) and 2.7 (1+19.05%/10.95%) for period 2. These values are the same as those that would be computed using equation (2) based on the underlying detailed information of price, variable cost per unit, quantity, and fixed cost. However, the benefit of using equation 6 is that DOL can be computed from the summary ratio information alone.

This difference in the DOL calculated from a data-based method and a ratio-based method can be evaluated by applying them to a common application of leverage, -- forecasting. DOL is used to forecast the change in profit from a given change in sales by multiplying the profit in the current period by 1 + percentage change in sales and DOL. To forecast the change in profits from a 5% growth in sales from period 2 to period 3, DOL based on equation (1) and equation (6) have different results. Using equation (1), forecasted profit in period 3 would be

$132.25 (115 * (1+ 5% * 3)); using equation (6), forecasted profit in period 3 is 130.75 (115 *(1+ 5%*2.74)).   When the forecasted income statement is created (see Table 1), the more accurate forecasting can be credited to the equation (6) ratio-based DOL. The equation (1) DOL calculated using the relative changes in sales and profits does not forecast the change in profits accurately.   Thus, the ratio-based DOL presented here is both less data-intensive and more accurate in forecasting.

TABLE 1
CALCULATION OF THE DEGREE OF OPERATING LEVERAGE
Panel A: Illustration of Income Statement Data

	Income Statement			Horizontal Analysis		Vertical Analysis		
	Period 1	Period 2	Forecasted Period 3	From Period 1 to Period 2	From Period 2 to Period 3	Period 1	Period 2	Period 3
Sales	1,000	1,050	1,102.50	5.00%	5.00%	100.00%	100.00%	100.00%
Variable Cost	700	735	771.75	5.00%	5.00%	70.00%	70.00%	70.00%
Fixed Cost	200	200	200.00	0.00%	0.00%	20.00%	19.05%	18.14%
Total Cost	900	935	971.75	3.90%	3.93%	90.00%	89.05%	88.14%
Profit	100	115	130.75	15.00%	13.70%	10.00%	10.95%	11.86%

NOTE: In period 1 sales are $1,000, variable cost is 70%, fixed cost is 20%, and profit margin is 10%. Sales increase by 5% from period 1 to period 2. Sales are projected to increase by 5% from period 2 to period 3.

Panel B: Degree of Operating Leverage

	Period 1	Period 2
Data-based DOL	--*	3.00
Ratio-based DOL	3.00	2.74

*A data-based DOL can't be calculated until there is data about a change in sales.

Data-based DOL: Equation (1) $DOL = \dfrac{\%\Delta\, Profit}{\%\Delta\, Sales}$

Ratio-based DOL: Equation (6) $DOL = 1 + \dfrac{fc}{m}$, where fc is fixed cost as a percentage of sales and m is profit as a percentage of sales.

DISCUSSION ABOUT USING A RATIO-BASED DEGREE OF OPERATING LEVERAGE

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The ratio-based degree of operating leverage makes clear that DOL has a direct relationship with the fixed cost margin and an inverse relationship with profit margin. Thus,

when using the ratio-based DOL as the primary presentation of the concept of the DOL, the following issues can be readily addressed:

1. How can a company influence its DOL? Decreasing the level of fixed costs for a level of sales, increases DOL However, as the overall profit margin improves, decreasing variable costs, DOL decreases.

2. How is short-term company performance associated with DOL? In the short run, as sales increase, fixed cost becomes less relevant, compared to variable cost, and profit margin increases. As a result, DOL decreases.

3. What is the role of fixed costs in DOL? In the presence of unlimited capacity, as fixed cost declines in consecutive periods, DOL will tend to be equal to the value of one. Likewise, if there are no fixed costs, as in long run analysis, DOL will tend to the value of one.

4. How is DOL associated with business risk? If the fixed cost ratio as a percentage of sales increases, then DOL increases. Having more relative fixed costs, increases the variability of profit and thus affects business risk.

5. How would you characterize the ratio fc/m? This composite ratio can be thought of as the operating leverage multiplier that identifies the power available to increase the profits of the company.

This note presents a formulation for DOL that is new to the accounting literature and useful for classroom presentation of the concept. By using ratios, the formula itself provides insights into the underlying nature of DOL and makes it a valuable tool for understanding company performance and planning strategically for future company performance.

NOTE: In period 1 sales are $1,000, variable cost is 70%, fixed cost is 20%, and profit margin is 10%. Sales increase by 5% from period 1 to period 2. Sales are projected to increase by 5% from period 2 to period 3.

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