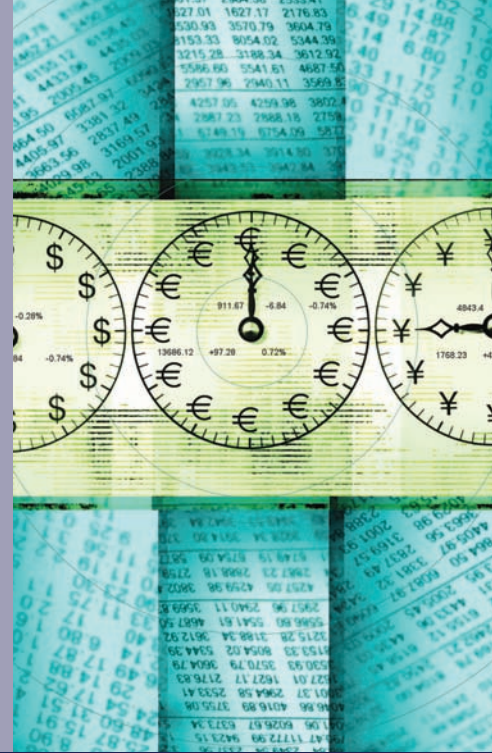


WEB EXTENSION 15A

Degree of Leverage



This Extension explains how operating and financial leverage interact.

DEGREE OF OPERATING LEVERAGE (DOL)

The **degree of operating leverage (DOL)** is defined as the percentage change in operating income (or EBIT) that results from a given percentage change in sales:

$$\text{DOL} = \frac{\text{Percentage change in EBIT}}{\text{Percentage change in sales}} = \frac{\frac{\Delta \text{EBIT}}{\text{EBIT}}}{\frac{\Delta Q}{Q}} \quad (15A-1)$$

In effect, the DOL is an index number that measures the effect of a change in sales on operating income, or EBIT.

DOL can also be calculated by using Equation 15A-2, which is derived from Equation 15A-1:

$$\begin{aligned} \text{DOL}_Q &= \text{Degree of operating leverage at Point Q} \\ &= \frac{Q(P - V)}{Q(P - V) - F} \end{aligned} \quad (15A-2)$$

or, based on dollar sales rather than units:

$$\text{DOL}_s = \frac{S - VC}{S - VC - F} \quad (15A-2a)$$

Here Q is the initial units of output, P is the average sales price per unit of output, V is the variable cost per unit, F is fixed operating costs, S is initial sales in dollars, and VC is total variable costs. Equation 15A-2 is normally used to analyze a single product, such as IBM's PC, whereas Equation 15A-2a is used to evaluate an entire firm with many types of products, where "quantity in units" and "sales price" are not meaningful.

Equation 15A-2 is developed from Equation 15A-1 as follows. The change in units of output is defined as ΔQ . In equation form, $\text{EBIT} = Q(P - V) - F$, where Q is units sold, P is the price per unit, V is the variable cost per unit, and F is the total fixed costs. Since both price and fixed costs are constant, the change in EBIT is $\Delta \text{EBIT} = \Delta Q(P - V)$. The initial EBIT is $Q(P - V) - F$, so the percentage change in EBIT is

$$\% \Delta \text{EBIT} = \frac{\Delta Q(P - V)}{Q(P - V) - F}$$

The percentage change in output is $\Delta Q/Q$, so the ratio of the percentage change in EBIT to the percentage change in output is

$$\text{DOL}_Q = \frac{\frac{\Delta Q(P - V)}{Q(P - V) - F}}{\frac{\Delta Q}{Q}} = \left[\frac{\Delta Q(P - V)}{Q(P - V) - F} \right] \left[\frac{Q}{(\Delta Q)} \right] = \frac{Q(P - V)}{Q(P - V) - F} \quad (15A-2)$$

Applying Equation 15A-2a to data for an illustrative firm, Hastings Inc., at a sales level of \$200,000 as shown in Table 15A-1, we find its degree of operating leverage to be 2.0:

$$\begin{aligned} \text{DOL}_{\$200,000} &= \frac{\$200,000 - \$120,000}{\$200,000 - \$120,000 - \$40,000} \\ &= \frac{\$80,000}{\$40,000} = 2.0 \end{aligned}$$

Thus, an $X\%$ increase in sales will produce a $2X\%$ increase in EBIT. For example, a 50% increase in sales, starting from sales of \$200,000, will result in a $2(50\%) = 100\%$ increase in EBIT. This situation is confirmed by examining Section I of Table 15A-1, where we see that a 50% increase in sales, from \$200,000 to \$300,000, causes EBIT to double. Note, however, that if sales decrease by 50%, then EBIT will decrease by 100%; this is again confirmed by Table 15A-1, as EBIT decreases to \$0 if sales decrease to \$100,000.

Note also that the DOL is specific to the initial sales level; thus, if we evaluated DOL from a sales base of \$300,000, it would be different from the DOL at \$200,000 of sales:

$$\begin{aligned} \text{DOL}_{\$300,000} &= \frac{\$300,000 - \$180,000}{\$300,000 - \$180,000 - \$40,000} \\ &= \frac{\$120,000}{\$80,000} = 1.5 \end{aligned}$$

In general, if a firm is operating at close to its break-even point, the degree of operating leverage will be high, but DOL declines the higher the base level of sales is above break-even sales. Looking back at the top section of Table 15A-1, we see that the company's break-even point (before consideration of financial leverage) is at sales of \$100,000. At that level, DOL is infinite:

$$\begin{aligned} \text{DOL}_{\$100,000} &= \frac{\$100,000 - \$60,000}{\$100,000 - \$60,000 - \$40,000} \\ &= \frac{\$40,000}{0} = \text{undefined but } \approx \text{infinity} \end{aligned}$$

When evaluated at higher and higher sales levels, DOL progressively declines.

DEGREE OF FINANCIAL LEVERAGE (DFL)

Operating leverage affects earnings *before* interest and taxes (EBIT), whereas financial leverage affects earnings *after* interest and taxes, or the earnings available to common stockholders. In terms of Table 15A-1, operating leverage affects the top section, whereas financial leverage affects the lower sections. Thus, if Hastings decided to use more operating leverage, its fixed costs would be higher than \$40,000, its variable cost ratio would be lower than 60% of sales, and its EBIT would be more sensitive to changes in sales. *Financial leverage takes over where operating leverage leaves off, further magnifying the effects on earnings per share of changes in the level of sales.* For this reason, operating leverage is sometimes referred to as *first-stage leverage* and financial leverage as *second-stage leverage*.

The **degree of financial leverage (DFL)** is defined as the percentage change in earnings per share that results from a given percentage change in earnings before interest and taxes (EBIT), and it is calculated as follows:

$$\begin{aligned} \text{DFL} &= \frac{\text{Percentage change in EPS}}{\text{Percentage change in EBIT}} && \text{(15A-3)} \\ &= \frac{\text{EBIT}}{\text{EBIT} - I} \end{aligned}$$

Equation 15A-3 is developed as follows:

1. Recall that $\text{EBIT} = Q(P - V) - F$.
2. Earnings per share are found as $\text{EPS} = [(\text{EBIT} - I)(1 - T)]/N$, where I is interest paid, T is the corporate tax rate, and N is the number of shares outstanding.
3. I is a constant, so $\Delta I = 0$; hence, ΔEPS , the change in EPS, is

$$\Delta \text{EPS} = \frac{(\Delta \text{EBIT} - \Delta I)(1 - T)}{N} = \frac{\Delta \text{EBIT}(1 - T)}{N}$$

TABLE 15A-1 Hastings Inc.: EPS with Different Amounts of Financial Leverage (Thousands of Dollars, except Per Share Figures)**I. Calculation of EBIT, Total Assets = \$200,000**

Probability of indicated sales	0.20	0.60	0.20
Sales	\$100.00	\$200.00	\$300.00
Fixed costs	40.00	40.00	40.00
Variable costs (60% of sales)	60.00	120.00	180.00
Total costs (except interest)	<u>\$100.00</u>	<u>\$160.00</u>	<u>\$220.00</u>
Earnings before interest and taxes (EBIT)	<u>\$ 0.00</u>	<u>\$ 40.00</u>	<u>\$ 80.00</u>

II. Situation if Debt/Assets (D/A) = 0%

EBIT (from Section I)	\$ 0.00	\$ 40.00	\$ 80.00
Less interest	<u>0.00</u>	<u>0.00</u>	<u>0.00</u>
Earnings before taxes (EBT)	\$ 0.00	\$ 40.00	\$ 80.00
Taxes (40%)	<u>0.00</u>	<u>(16.00)</u>	<u>(32.00)</u>
Net income	<u>\$ 0.00</u>	<u>\$ 24.00</u>	<u>\$ 48.00</u>
Earnings per share (EPS) on 10,000 shares ^a	<u>\$ 0.00</u>	<u>\$ 2.40</u>	<u>\$ 4.80</u>
Expected EPS		\$ 2.40	
Standard deviation of EPS		\$ 1.52	
Coefficient of variation		0.63	

III. Situation if Debt/Assets (D/A) = 50%

EBIT (from Section I)	\$ 0.00	\$ 40.00	\$ 80.00
Less interest (0.12 × \$100,000)	<u>12.00</u>	<u>12.00</u>	<u>12.00</u>
Earnings before taxes (EBT)	(\$ 12.00)	\$ 28.00	\$ 68.00
Taxes (40%; tax credit on losses)	<u>4.80</u>	<u>(11.20)</u>	<u>(27.20)</u>
Net income	<u>(\$ 7.20)</u>	<u>\$ 16.80</u>	<u>\$ 40.80</u>
Earnings per share (EPS) on 5,000 shares ^a	<u>(\$ 1.44)</u>	<u>\$ 3.36</u>	<u>\$ 8.16</u>
Expected EPS		\$ 3.36	
Standard deviation of EPS		\$ 3.04	
Coefficient of variation		0.90	

Note:

^aThe EPS figures can also be obtained using the following formula, in which the numerator amounts to an income statement at a given sales level laid out horizontally:

$$\text{EPS} = \frac{(\text{Sales} - \text{Fixed costs} - \text{Variable costs} - \text{Interest})(1 - \text{Tax rate})}{\text{Shares outstanding}} = \frac{(\text{EBIT} - 1)(1 - T)}{\text{Shares outstanding}}$$

For example, with zero debt and sales = \$200,000, EPS is \$2.40:

$$\text{EPS}_{D/A=0} = \frac{(\$200,000 - \$40,000 - \$120,000 - 0)(0.6)}{10,000} = \$2.40$$

With 50% debt and sales = \$200,000, EPS is \$3.36:

$$\text{EPS}_{D/A=0.5} = \frac{(\$200,000 - \$40,000 - \$120,000 - \$12,000)(0.6)}{5,000} = \$3.36$$

The sales level at which EPS will be equal under the two financing policies, or the indifference level of sales, S_1 , can be found by setting $\text{EPS}_{D/A=0}$ equal to $\text{EPS}_{D/A=0.5}$ and solving for S_1 :

$$\begin{aligned} \text{EPS}_{D/A=0} &= \frac{(S_1 - \$40,000 - 0.6S_1 - 0)(0.6)}{10,000} \\ &= \frac{(S_1 - \$40,000 - 0.6S_1 - \$12,000)(0.6)}{5,000} = \text{EPS}_{D/A=0.5} \\ S_1 &= \$160,000 \end{aligned}$$

By substituting this value of sales into either equation, we can find EPS_1 , the earnings per share at this indifference point. In our example, $\text{EPS}_1 = \$1.44$.

4. The percentage change in EPS is the change in EPS divided by the original EPS:

$$\frac{\left(\frac{\Delta\text{EBIT}(1 - T)}{N}\right)}{\left(\frac{(\text{EBIT} - I)(1 - T)}{N}\right)} = \left[\frac{\Delta\text{EBIT}(1 - T)}{N}\right] \left[\frac{N}{(\text{EBIT} - I)(1 - T)}\right] = \frac{\Delta\text{EBIT}}{\text{EBIT} - I}$$

5. The degree of financial leverage is the percentage change in EPS over the percentage change in EBIT:

$$\text{DFL} = \frac{\left(\frac{\Delta\text{EBIT}}{\text{EBIT} - I}\right)}{\left(\frac{\Delta\text{EBIT}}{\text{EBIT}}\right)} = \left(\frac{\Delta\text{EBIT}}{\text{EBIT} - I}\right) \left(\frac{\text{EBIT}}{\Delta\text{EBIT}}\right) = \frac{\text{EBIT}}{\text{EBIT} - I} \quad (15A-3)$$

6. This equation must be modified if the firm has preferred stock outstanding.

Applying Equation 15A-3 to data for Hastings at sales of \$200,000 and an EBIT of \$40,000, the degree of financial leverage with a 50% debt ratio is

$$\begin{aligned} \text{DFL}_{s=\$200,000, D=50\%} &= \frac{\$40,000}{\$40,000 - \$12,000} \\ &= 1.43 \end{aligned}$$

Therefore, a 100% increase in EBIT would result in a $1.43(100\%) = 143\%$ increase in earnings per share. This may be confirmed by referring to the lower section of Table 15A-1, where we see that a 100% increase in EBIT, from \$40,000 to \$80,000, produces a 143% increase in EPS:

$$\% \Delta \text{EPS} = \frac{\Delta \text{EPS}}{\text{EPS}_0} = \frac{\$8.16 - \$3.36}{\$3.36} = \frac{\$4.80}{\$3.36} = 1.43 = 143\%$$

If no debt were used, the degree of financial leverage would by definition be 1.0, so a 100% increase in EBIT would produce exactly a 100% increase in EPS. This can be confirmed from the data in Section III of Table 15A-1.

COMBINING OPERATING AND FINANCIAL LEVERAGE: DEGREE OF TOTAL LEVERAGE (DTL)

Thus far, we have seen that (1) the greater the use of fixed operating costs as measured by the degree of operating leverage, the more sensitive EBIT will be to changes in sales, and (2) the greater the use of debt as measured by the degree of financial leverage, the more sensitive EPS will be to changes in EBIT. Therefore, if a firm uses a considerable amount of both operating and financial leverage, then even small changes in sales will lead to wide fluctuations in EPS.

Equation 15A-2 for the degree of operating leverage can be combined with Equation 15A-3 for the degree of financial leverage to produce the equation for the

degree of total leverage (DTL), which shows how a given change in sales will affect earnings per share. Here are three equivalent equations for DTL:

$$DTL = (DOL)(DFL) \quad (15A-4)$$

$$DTL = \frac{Q(P - V)}{Q(P - V) - F - I} \quad (15A-4a)$$

$$DTL = \frac{S - VC}{S - VC - F - I} \quad (15A-4b)$$

Equation 15A-4 is simply a definition, while Equations 15A-4a and 15A-4b are developed as follows:

1. Recognize that $EBIT = Q(P - V) - F$, and then rewrite Equation 15A-3 as follows:

$$DFL = \frac{EBIT}{EBIT - I} = \frac{Q(P - V) - F}{Q(P - V) - F - I} = \frac{S - VC - F}{S - VC - F - I} \quad (15A-3a)$$

2. The degree of total leverage is equal to the degree of operating leverage times the degree of financial leverage, or Equation 15A-2 times Equation 15A-3a:

$$DTL = (DOL)(DFL) \quad (15A-4)$$

$$= (\text{Equation 15A-2})(\text{Equation 15A-3a})$$

$$= \left[\frac{Q(P - V)}{Q(P - V) - F} \right] \left[\frac{Q(P - V) - F}{Q(P - V) - F - I} \right]$$

$$= \frac{Q(P - V)}{Q(P - V) - F - I} \quad (15A-4a)$$

$$= \frac{S - VC}{S - VC - F - I} \quad (15A-4b)$$

Applying Equation 15A-4b to data for Hastings at sales of \$200,000, we can substitute data from Table 15A-1 into Equation 15A-4b to find the degree of total leverage if the debt ratio is 50%:

$$\begin{aligned} DTL_{\$200,000, 50\%} &= \frac{\$200,000 - \$120,000}{\$200,000 - \$120,000 - \$40,000 - \$12,000} \\ &= \frac{\$80,000}{\$28,000} = 2.86 \end{aligned}$$

Using Equation 15A-4, we get the same result:

$$DTL_{\$200,000, 50\%} = (2.00)(1.43) = 2.86$$

We can use the degree of total leverage (DTL) number to find the new earnings per share (EPS_1) for any given percentage increase in sales ($\% \Delta \text{Sales}$), proceeding as follows:

$$\begin{aligned} EPS_1 &= EPS_0 + EPS_0[(DTL)(\% \Delta \text{Sales})] && \text{(15A-5)} \\ &= EPS_0[1.0 + (DTL)(\% \Delta \text{Sales})] \end{aligned}$$

For example, a 50% (or 0.5) increase in sales, from \$200,000 to \$300,000, would cause EPS_0 (\$3.36 as shown in Section III of Table 15A-1) to increase to \$8.16:

$$\begin{aligned} EPS_1 &= \$3.36[1.0 + (2.86)(0.5)] \\ &= \$3.36(2.43) \\ &= \$8.16 \end{aligned}$$

This figure agrees with the one for EPS shown in Table 15A-1.

The degree of leverage concept is useful primarily for the insights it provides regarding the joint effects of operating and financial leverage on earnings per share. The concept can be used to show the management of a business, for example, that a decision to automate a plant and to finance the new equipment with debt would result in a situation wherein a 10% decline in sales would produce a 50% decline in earnings, whereas with a different operating and financial leverage package, a 10% sales decline would cause earnings to decline by only 20%. Having the alternatives stated in this manner gives decision makers a better idea of the ramifications of alternative actions.¹

¹The degree of leverage concept is also useful for investors. If firms in an industry are ranked by degree of total leverage, an investor who is optimistic about prospects for the industry might favor those firms with high leverage, and vice versa if industry sales are expected to decline. However, it is very difficult to separate fixed from variable costs. Accounting statements simply do not make this breakdown, so an analyst must make the separation in a judgmental manner. Note that costs are really fixed, variable, and "semi-variable," for if times get tough enough, firms will sell off depreciable assets and thus reduce depreciation charges (a fixed cost), lay off "permanent" employees, reduce salaries of the remaining personnel, and so on. For this reason, the degree of leverage concept is generally more useful for thinking about the general nature of the relationship than for developing precise numbers, and any numbers developed should be thought of as approximations rather than as exact specifications.