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A Modern Theory to Analysis of Break-Even Point and Leverages with Approach of Financial Analyst

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Abstract
In financial management, leverage is an overly explored key concept to a variety of instances involving analysis of operational and financial fixed costs. And in the present work, the greater emphasis is placed on corporate leverage (including operating, financial, and combined leverages) and its connection to other financial indicators.This paper, adopting a quantitative approach and following a mathematical line of argument, conducts a fairly exhaustive financial analysis of leverages and break-even points (BEPs) and their implications for other financial indicators. The theories and the associated formulas, aided by practical examples for better illustration of the concepts, have been initially proposed by Meysam Kaviani (2014), aiming to expand on the existing corporate finance theories.
Keyword: Break-Even Point, Leverages, Financial Analyst

Introduction

Evidently, the leverage is a widely applied concept which by no means is limited to finance and business. However, in so far as it concerns the financial and business environment, leverage serves as a key operating and/or financial performance indicator. In particular, it measures the impact of borrowed funds on operating income (OI), and on the firm's overall return. Notably, leverage-related concepts have been subject to many debates and investigations for decades in the course of which a variety of definitions have been developed by scholars of the field.

Degree of operating leverage (DOL) is defined as percentage of changes in OI relative to percentage of changes in sales (Watson & Brigham, 1969), and Degree of Financial Leverage (DFL) is described as percentage of changes in net profit relative to percentage of changes in OI (Blazenko, 1996). Further definitions of DFL suggest it as the ratio of total debt to total asset (Ferri & Jones, 1979; Remmers et al, 1974), and ratio of total long-term debt to total asset. In addition, other definitions of DOL applied earlier view it as the ratio of fixed asset to total asset (Ferri & Jones, 1979), and the ratio of fixed operating costs to total costs (Brigham, 1995). And finally, Degree of Combined Leverage (DCL), which is made up of operating and financial leverages, is defined in terms of percent changes in net income (net profit) to percent changes in sales.

Financial analysis is a process which provides the users with information on operational and financial features of the enterprise. In this paper, more emphasis is placed on the underlying relationships between leverage ratios and certain financial indicators which are supposed to convey significant information content to the users. Current study, following a quantitative design, based on a number of financial assumptions worked out through algebraic modeling, expands on financial analysis and interpretation of the critical interrelations between the understudy variables.

Degree of Operating Leverage

DOL is an indicator which measures the effect of a given change in sales on earnings before interest and taxes (EBIT) or Operating Income (OI) and reflects the role of corporate fixed costs. In other words, DOL represents the effect of changes in sales on operating income as a result of making certain amount of fixed costs in operation of the business (Robinson et al, 2008). DOL is the Degree to which a firm's costs of operation are fixed as opposed to variable. A firm with high operating costs compared to a firm with a low DOL, and hence relatively larger changes in EBIT with respect to a change in the sales revenue (Ross and et al, 2002).

Profit making companies are likely to make use of DOL, because at high earnings, and in presence of DOL, operating income grows at a higher rate (Robinson et al, 2008). DOL is calculated by the following formulas:

$$DOL = \frac{\Delta EBIT\%}{\Delta Q\%} \quad (1)$$

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

Where,
Q: Quantity of product sold
P: Selling price per unit
V: Variable cost per unit
F: Fixed operating cost

Here the important question arises as what is the cause of the change in DOL and increased operating risk? Given relation (2), the increase of fixed operating costs seems to be the immediate cause of the increase in DOL. This is further elucidated in the example presented below.

Example – Given the following information, and using formulas (1) and (2), DOL is to be calculated.

Period	Units Sold	Total Variable Costs	Fixed Costs	Total Costs	Total Revenue	Operating Income (Loss)
Initial of Period	40,000	80,000	50,000	130,000	160,000	30,000
End of Period	60,000	120,000	50,000	170,000	240,000	70,000

Selling price per unit = 2
Variable cost per unit = 4

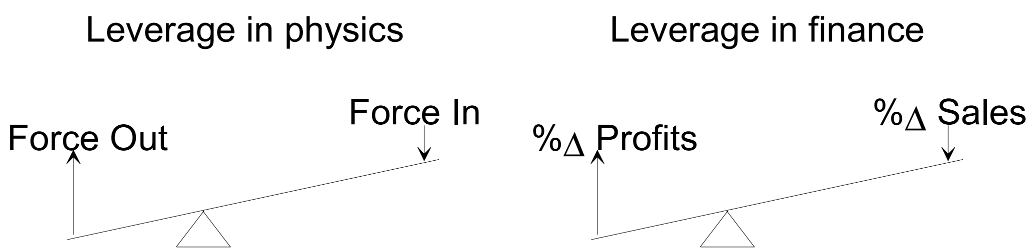
$$DOL = \frac{\dfrac{70{,}000 - 30{,}000}{30{,}000}}{\dfrac{60{,}000 - 40{,}000}{40{,}000}} = \frac{\dfrac{40{,}000}{30{,}000}}{\dfrac{20{,}000}{40{,}000}} = 2.66$$

Using formula (1), DOL value becomes 2.66, implying that 1% change in sales brings about 2.66% mutation in the corresponding EBIT (i.e. 2.66 x 1% = 2.66%). Now, if we look for the solution via the second formula (formula (2)), of the Q's, which one ought to be replaced in the formula? As we see in formula (2), to solve the problem, Q_1 is to be replaced in the formula. But, we may ask why Q_1? Quite expectedly, the ones who prove formula (1) would think of Q_1 as the answer. However, we primarily look here for the logic underlying leverages and its implication for finance. Thus, given formula (2), DOL becomes 2.66.

$$DOL = \frac{40{,}000\ \ (4 - 2)}{40{,}000\ \ (4 - 2) - 50{,}000} = \frac{80{,}000}{30{,}000} = 2.66$$

❖ ***M. Kaviani's theory on Degree of Operating Leverage***

As long as fixed costs remain unchanged, there will be no change of leverage. Notwithstanding, fixed costs in the long run will necessarily undergo changes, giving rise to changes in leverage, as a consequence. It should be noted that in physics, a lever is propped by a fixed body or mass called fulcrum. The higher the fulcrum is, the greater the applied force by lever becomes in shifting the object. In finance, fixed costs play the role of fulcrum. Hence, changes of fixed costs in each period induce greater changes in leverage Degree. However, if with an increase of fixed operating costs no significant earnings are realized, then operating risks are expected to rise.



In the example above, for a change in the number of sold product from 40,000 to any other quantity, the leverage will be the same (2.66), in which case EBIT as the product of percent changes in sales times leverage will mutate accordingly. Suppose the number of sold items increases from 40,000 to 100,000. According to formula (1), the same initially calculated leverage (i.e. 2.66) would apply.

Period	Units Sold	Total Variable Costs	Fixed Costs	Total Costs	Total Revenue	Operating Income (Loss)
Initial of Period	40,000	80,000	50,000	130,000	160,000	30,000
End of Period	100,000	200,000	50,000	250,000	400,000	150,000

Selling price per unit = 2
Variable cost per unit = 4

$$DOL = \frac{\frac{150{,}000 - 30{,}000}{30{,}000}}{\frac{100{,}000 - 40{,}000}{40{,}000}} = \frac{\frac{120{,}000}{30{,}000}}{\frac{60{,}000}{40{,}000}} = 2.66$$

As you see, given the constant fixed costs, changes in sales quantity of any magnitude do not lead to any alteration in leverage.

❖ ***Implications of M. Kaviani's note***

- An increase of fixed costs, theoretically, is expected to influence EBIT and the eventual expected return, hence, in case of operational inefficiency the firm is exposed to higher operational risk;
- Given the inevitable changes of fixed costs in the long run, such development might also be effectuated by a reduction of the fixed operating costs which play a lesser role in production, such as elimination of fixed advertisement and marketing costs at certain points in the product life cycle (e.g. when product is enjoying a widely recognized brand name), or selling of the machinery the maintenance of which is no longer justifiable, given its production capacity and value added relative to its depreciation expenses; and
- Fulcrum, in corporate finance, is identified with fixed operating and financial costs.

Margin of safety (MS) and its connection with leverage

Margin of safety refers to the amount of sales in excess of BEP which is an indication to the level of profit making. Margin of safety is the difference between actual sales (projected sales) and sales at BEP. This difference at operating and combined break-even points varies. As we know, at operating BEP, EBIT, and at combined BEP, Earnings per Share (EPS) or the net profit belonging to equity shareholders assume zero value which are found by equations (3) and (4).

$$Q_1^* = \frac{F}{P - V} \qquad (3)$$

$$Q_2^* = \frac{F + I + \frac{PD}{1-t}}{P - V} \qquad (4)$$

Where, Q_1 and Q_2 represent operating break-even point and combined or total break-even point, respectively; PD denotes preferred shareholder dividend; I is Interest expense, and $I + \frac{PD}{1-t}$ is referred to as fixed financial costs.

And margin of safety is obtained as follows:

MS = Actual sales – Sales at BEP

Example – Given the information below, we want to calculate operating and combined BEPs, and margin of safety (price in USD and tax rate is 20%).

Q: Quantity of product sold
P: Selling price per unit
V: Variable cost per unit
F: Fixed operating cost

Selling price per unit: 800	Variable cost per unit: 300
Fixed operating costs: 5,500,000	Interest expense: 50,000
PD: 40,000	Quantity of product sold: 11,400 Unit

$$Q_1^* = \frac{5{,}500{,}000}{800 - 300} = 11{,}000$$

$$Q_2^* = \frac{5{,}500{,}000 + 500{,}000 + \frac{40{,}000}{1 - .2}}{800 - 300} = 11{,}200$$

MS based on operating BEO = 11,400 – 11,000 = 400 Unit
MS based on combined BEP = 11,200 – 11,000 = 200 Unit
If the sale amount is reduced to 400 and 200 units, respectively, EBIT and net profit is a zero. Since DFL measures changes of EPS relative to change of OI, DFL, according to formulas (6) and (7) is as follow:

$$DFL = \frac{\Delta EPS\%}{\Delta EBIT\%} \qquad (6)$$

$$DFL = \frac{Q\ (P - V) - F}{Q\ (P - V) - F - \left[I + \frac{PD}{1 - t}\right]} = \frac{EBIT}{EBIT - \left[I + \frac{PD}{1 - t}\right]} \qquad (7)$$

$$DFL = \frac{11{,}400(800 - 300) - 5{,}500{,}000}{11{,}400(800 - 300) - 5{,}500{,}000 - \left[50{,}000 + \frac{40{,}000}{1 - .2}\right]} = 2$$

It follows that 1% change in EBIT induces 2% changes in EPS.

❖ ***M. Kaviani's note on DFL and MS***

Based on the concepts discussed earlier, in this section, profiting from mathematical relations, another formula of DFL is presented whereby the role of financial analysis of the extracted data from margin of safety is discussed.
If numerator and denominator of formula (7) are divided into contribution margin per unit (CM = P – V), DFL formula becomes as follows:

$$DFL = \frac{\frac{Q\ (P - V) - F}{(P - V)}}{\frac{Q\ (P - V) - F - \left[I + \frac{PD}{1 - t}\right]}{(P - V)}} = \frac{Q\ - \frac{F}{(P - V)}}{Q\ - \frac{F - I - \frac{PD}{1 - t}}{(P - V)}} = \frac{Q\ - \frac{F}{(P - V)}}{Q\ - \left[\frac{F + I + \frac{PD}{1 - t}}{(P - V)}\right]} \qquad (8)$$

As we see, the numerator is margin of safety based on operating BEP and the denominator gives MS for total BEP. Hence, DFL is calculable by formula (8) as follows:

$$DFL = \frac{11{,}400 - 11{,}000}{11{,}400 - 11{,}200} = 2$$

Given formula (8), numerator of MS by operating BEP is always greater than denominator of MS by combined BEP, and only when fixed financial costs are zero, the two indicators equal one another in which case DFL is 1.

❖ ***Implications of the note***

It suggests that

- A high MS value by operating BEP is desirable when it covers operating income from fixed financial costs, because companies with a high BEP-based MS falling short of covering for fixed financial costs, despite their low operating risk, are exposed to high financial risks which would result in reduced earnings for ordinary shareholders, signaling that corporate managers are moving away from the main goal of financial management (i.e. maximization of shareholder wealth).
- The companies with high MS on combined BEP enjoy a higher payment power in fixed financial costs, and are better protected against financial and operating (Total risk).

DFL and financial BEP
Financial BEP is the amount EBIT at which net profit becomes zero and is calculated through by the following formula:

$$\text{Financial BEP} = \quad EBIT = I + \frac{PD}{1-t}$$

❖ ***M. Kaviani's note on DFL and its connection to combined BEP***
If financial BEP is indicated as EBIT*, then DFL can be expressed as follows:

$$DFL = \frac{EBIT}{EBIT - EBIT^*} \qquad (10)$$

If ahead of the above statement you were asked to find financial BEP for a case where EBIT and company EBIT at combined BEP was 100,000 and 200,000 USD, respectively, what would be your answer? Bearing in mind that EPS both at combined and financial BEPs is zero, it follows that at BEP quantity of sales (Q), EBIT is equal to financial BEP, and hence DFL can be found in the following terms:

$$DFL = \frac{200{,}000}{200{,}000 - 100{,}000} = 2$$

Let's give another example which is calculable by relation (10). Suppose DFL = 2 and EBIT at combined BEP = 100,000 are given. EBIT at corporate actual sales is as follows:

$$2 = \frac{EBIT}{EBIT - 100{,}000} \rightarrow 2EBIT - 200{,}000 = EBIT \rightarrow EBIT = 200{,}000$$

❖ ***Implications of the note***
➢ Financial BEP is defined as EBIT at combined BEP;
➢ For earnings before interest and tax at combined BEP (EBIT*) greater than actual earnings before interest and tax (EBIT), DFL becomes greater than 1;
➢ For EBIT* at combined BEP smaller than actual EBIT, DFL assumes a negative value; and
➢ For EBIT* at combined BEP equal to actual EBIT, DFL becomes infinite.

DFL and Times Interest Earned Ratio
In financial analysis, Times Interest Earned Ratio is among the DFL group of ratios (debt management) which measures corporate solvency regarding Interest expense.
DFL is related to the extent to which a firm relies on debt financing rather than equity. Measures of DFL are tools in determining the probability that the firm will default on its debt contracts. The more debt a firm has, the more likely it is that the firm will become unable to fulfill its contractual obligations. In other words, too much debt can lead to a higher probability of insolvency and financial distress (Ross and et al, 2002). In other words, DFL arises from the use of debt in the firm's capital structure. A levered firm must make fixed interest payments regardless of its revenues. Fixed interest payments cause the percentage change in net income to be greater than the percentage change in EBIT, magnifying the cyclicality of a firm's revenues. Thus, returns on highly levered stocks should be more responsive to movements in the market than the returns on stocks with little or no debt in their capital structure.
A reduced times interest earned ratio is viewed as a signal of higher financial risk. This ratio (Times Interest Earned Ratio) presumes the remainder of earnings after deduction of production, operating, and administration costs from the corporate sales are spent for loan interest payment. Banks prefer to lend firms whose earnings are far in excess of interest payments. Therefore, analysts often calculate the ration of earnings before interest and taxes (EBIT) to interest payment (Richard et al, 2001).

$$\text{Times Interest Earned} = \frac{EBIT}{I} \qquad (11)$$

❖ ***M. Kaviani's note on the relationship of DFL with Times Interest Earned Ratio***
In explaining the relationship between Times Interest Earned Ratio and DFL according to relation (7), we dispense with use of preferred stocks supposing firm has not made use of preferred stock in its financial structure. Thus, the formula below applies.

$$DFL = \frac{EBIT}{EBIT - I}$$

Numerator and denominator are divided by Interest expense (I):

$$DFL = \frac{\frac{EBIT}{I}}{\frac{EBIT - I}{I}} = \frac{\frac{EBIT}{I}}{\frac{EBIT}{I} - \frac{I}{I}} = \frac{\frac{EBIT}{I}}{\frac{EBIT}{I} - 1} \qquad (12)$$

From the above formula, it follows that at a higher solvency for interest payment; the firm is less exposed to financial risk or has a lower DFL. Now, if at an earlier time you were asked to give DFL of a firm with Times Interest Earned Ratio of 4, what would be your answer? You would undoubtedly find it a challenging question demanding some reflection on the matter. However, according to formula (12), at the above interest payment ratio, DFL comes up to 1.33.

$$DFL = \frac{4}{4-1} = 1.33$$

Thus, against an increase in the mentioned ratio, there is a corresponding reduction in corporate DFL and financial risk.

$$DFL = \frac{5}{5-1} = 1.25$$

❖ ***Implications of the note***

- Firms with higher Times Interest Earned Ratio are exposed to smaller financial risk;
- Financial analysts, when output of Times Interest Earned Ratio is known, would easily calculate DFL.

Margin of safety percentage (MS %), contribution margin ratio (CMR)[1], and Operating Profit Margin (OPM)

MS% concept regards BEP as a function of changes in actual sales in percent. Hence, given operating BEP, MS% is calculated as follows:

$$MS\% = \frac{Q - \frac{F}{(P-V)}}{Q} \qquad (13)$$

MS% is inversely related or complementary to DOL. In DOL formula ($DOL = \frac{Q(P-V)}{Q(P-V)-F}$), dividing numerator and denominator by contribution margin per unit (P–V), we arrive at formula (13):

$$\%MS = \frac{1}{DOL}$$

Or

$$DOL = \frac{1}{\%MS}$$

MS% is calculable as follows:

$$MS\% = \frac{Q(P-V)-F}{Q(P-V)} \qquad (14)$$

A greater MS% coincides with a smaller operating risk corresponding to reduction of DOL. We also know that EBIT is computable as the product of MS times contribution margin (as CM = P – V), or as product of MS% times total contribution margin (as TR – TVC).

EBIT=MS × CM

[1] Or Contribution Margin Percentage (CM %)

$$EBIT = MS \times CM = \left[Q - \frac{F}{P-V} \right] \times (P-V) = Q(P-V) - F \qquad (15)$$

$$EBIT = MS\% \times (TR - TVC) = \left[\frac{Q - \frac{F}{P-V}}{Q} \right] \times Q(P-V) = Q(P-V) - F \qquad (16)$$

❖ ***M. Kaviani's note on the relationship among CM%, SM%, and OPM***

We rewrite formula (14) as follows:

$$MS\% = \frac{EBIT}{Q(P-V)}$$

If numerator and denominator in the above equation are divided by total revenue (TR), MS% can be rearranged as the following:

$$MS\% = \frac{EBIT}{Q(P-V)} = \frac{\frac{EBIT}{TR}}{\frac{Q(P-V)}{TR}} = \frac{OPM}{CM\%} \qquad (16)$$

$\frac{Q(P-V)}{TR} = \frac{TR-TVC}{TR}$ is referred to as contribution margin ratio or percentage. CMR or CM% is proportion of sales which in the first place covers fixed costs and the remainder thereof (i.e. 1 – CM %) will be then dispensable as the expected return.

$\frac{EBIT}{TR}$ represents operating profit margin (OPM). It is a profitability ratio which measures sales-based corporate return. Given formula (16), OPM is expressed as follows:

$$OPM = SM\% \times CM\% \qquad (17)$$

Example – What would be OPM of a [illegible]ose actual sales, BEP sales, and CM% are 11,400 units, 11,000 units, and 62.5 percent, respectively?

$$OPM = \frac{11{,}400 - 11{,}000}{11{,}000} \times .625 = .036 \times .625 = .0219$$

❖ ***Implications of the note***

➢ Companies by increasing their contribution margin percentage (CM%) can improve their OPM;

➢ Companies by increasing their margin of safety percentage (MS%) can improve their OPM as well.

DFL, net operating profit after tax (NOPAT), and net income (NI)[1]

Operating profit after deduction of taxes is called net operating profit, whereas by net income (NI), operating profit after deduction of interest and taxes is meant. The two types of profit are, inter alia, applied to calculations of cash flow from operations (CFO) in financial-accounting sense. In the financial sense, for calculation of CFO, Interest expense is not included, i.e. NOPAT is used, while in accounting terms, Interest expenses are held as a kind of operating cost, hence to calculation of CFO, net profit is applied. Therefore, the main difference of NOPAT and PAT lies in Interest expense.

[1] Or profit after tax (PAT)

❖ ***M. Kaviani's note on the relationship between DFL, NOPAT and PAT***

If in the formula of DFL preferred shares are excluded and numerator and denominator thereof are multiplied by (1 – t), we arrive at another formula of DFL in which data associated to NOPAT and PAT are used.

$$DFL = \frac{EBIT}{EBIT - I} \times \frac{1-t}{1-t} = \frac{NOPAT}{PAT} \qquad (18)$$

Considering formula (18), NOPAT can be calculated as follows:

$$NOPAT = DFL \times PAT \qquad (19)$$

Thus, NOPAT refers to a percentage of net profit (to the amount of DFL), so as an increase in DFL finds immediate projection in NOPAT. NOPAT in financial analyses is used for calculation of economic profit or economic value based measures such as economic value added (EVA), refined economic value added (REVA), adjusted economic value added (AEVA), equity economic value added (EEVA), cash value added (CVA), and shareholder value added (SVA).

Example – Given the following information excerpt from income statement, DFL is to be calculated (Tax rate 30%).

X CORPORATION
Income Statement
For the Year Ending December 31, 200X

Sales (on credit) 4,000,000
Less: Cost of goods sold. 3,000,000
Gross profit 1,000,000
Less: Selling and administrative expenses 450,000
Operating Income (EBIT) 550,000
Less: Interest expense 50,000
Earnings before taxes (EBT) 500,000
Less: Taxes 150,000
Profit after taxes (PAT) 135,000

$$DFL = \frac{550{,}000}{550{,}000 - 50{,}000} = 1.1$$

In addition, based on the above information, NOPAT can be calculated as follows:
NOPAT = 550,000 × (1 – 30%) = 385,000

If the above income statement information was not available and you were asked to find NOPAT at DFL = 1.1 and NI = 450000, how would you figure out your answer? In the face of such a challenging question, you would naturally require in-depth thinking.

According to relation (19), NOPAT is calculated as follows, and the answer is the same as we would find using the income statement information.

✓ If DFL = 1, PAT = NOPAT;

✓ At DFL = 1; 10 percent in excess of DFL (1 + .1) constitutes interest to earnings before tax ratio ($\frac{I}{EBT}$), that is:

NOPAT = 1.1 × 350,000 = 385,000

Thus, if prior to this occasion you had been asked to calculated Interest expense at DFL = 1.1 and earnings before taxes or EBT = 500,000, you would have found such information quite challenging. At any rate, according to formula (20), Interest expense, as is given in the income statement, is 50,000 USD.

❖ ***Implications of the note***

➢ NOPAT is a percentage of net income (to the amount of financial leverage);
➢ NOPAT is affected by DFL; and
➢ At DFL = 1, the amount over and above DFL is called $\frac{I}{EBT}$ ratio.

Conclusion

The concepts and theories treated in present work by expanding on the assumed relationships between certain financial indicators and ratios on the one side, and different classes of leverages and BEPs on the other side, aimed to provide financial analysts with a more generic insight into the subject, allowing them in light of the presented concepts to further probe the case from different angles. In addition, the introduced concepts are applicable to situations where there is a lack of necessary and useful information, or when certain data are difficult to retrieve, allowing estimation of the desired values with the pieces of information available to them. Hence, the algebraic modeling and procedures adopted in our financial analysis approach to the critical interrelations between the understudy variables, on the ground of their theoretical value and practical advantages for corporate finance, are expected through wide scale printed and electronic distribution and file sharing to be effectively communicated to financial circles.

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