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Break even analysis for incentive based profit system in producer-distributor supply chain system

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Abstract

In a typical linear break even analysis, the Break Even Volume (BEV) is determined as the ratio of the total fixed cost and the difference between the total variable cost per volume (UVC) and the unit selling price (USP). Basically, this is feasible for traditional systems where the USP is greater than UVC. But in incentive based profit system adopted by most big companies for their distributors, where the distributor's profitability is tied to his/her productivity rather than the price recovery factor, USP = UVC, and profit is based on the incentive obtained (which is a function of sales volume). The paper develops a BEV for such system, running a sensitivity analysis of the system. It was found that the BEV maintains a linear relationship with the total fixed cost, with a slope of the inverse of the product of USP and percentage of sales volume given as incentive/bonus. But for the USP and incentive plan (percentage of sales volume given as incentive/bonus) the BEV shares a negative power relationship.

Keywords: Incentive Based Profit System, Break Even volume (BEV), profitability, productivity.

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1. INTRODUCTION

Break-even point is the threshold of sales or revenues that must be generated, above which a business venture will become economically feasible. It is the point at which the system neither makes profit nor suffers loss. Breakeven analysis is also known as cost-volume-profit analysis. It was introduced in the 19th century, and its concept has been used, enhanced, adjusted, and extended in a bid to reduce or correct for its limitations so it can be applied to more and more business situations. Despite its limitations, it continues to be one of the best ways to focus on the relationship between these three: cost, volume, and profitability [1].

The objective of setting up all businesses is to earn profit from the business activities. And, while conducting the business activities, the organization incurs certain costs which are broadly categorized under fixed costs and variable costs. Breakeven analysis is also helpful in calculating margin of safety which is the cushion before an organization starts incurring losses [2]. So, understanding the break-even point (BEP) is crucial for businesses to determine the minimum sales volume needed to cover costs. It could be used for analyzing the potential profitability of expenditure in a sales-based business, determine pricing strategy, identify cost reduction opportunities and set realistic production or sales targets.

Hess [3] introduced this concept in management in form of costs, receipts, and profits chart. The findings revealed significant insights into the manufacturing landscape of the early 20th century, indicating that effective management of capital and operational costs directly correlated with enhanced profit margins. It is widely used by production managers and management accountants. It categorizes production costs into "variable" (costs that change when the activity level changes) and those that are "fixed" (costs not directly related to the volume of production or activity level). It is typically calculated for a linear system, in order for businesses to determine under certainty the profitability of selling or producing a proposed product, as opposed to attempting to modify same for an existing product.

Profitability is significantly impacted on by:

Sales, Costs of production and volume. In the course of a study drawn from 42 Block factories within Kaduna Metropolis, it was found that Cost has negative significant effect on Profit at 1% level of significance, while Sales Volume has positive significance effect on Profit of Block factories within Kaduna Metropolis at 5% level of significance. However, Sales has positive insignificant impact on Profit. The study concluded that Cost and Sales Volume have significant impact, while Selling Price has insignificant impact on profit. Training and enlightenment on the BEP concept and its components was also recommended as some selected block industries within Kaduna Metropolis applied BEP concept in their operations, whereas others are ignorant of the concept [4].

There exists some real life scenario that operates beyond the confines of some of the assumptions or constraints of traditional linear BEA, which also needs the application of the BEA. Although various modifications have been considered in time past: analysis of the case with semi-fixed cost [5]; the applicability of BEA under non deterministic cost behaviour scenario [6];development of dynamic break-even analysis techniques that account for nonlinear cost behaviours [7], there is need for further exploration of possible modifications and application of this important concept.

Its application has since been extended to accommodate various systems with some variation from the traditional linear function of breakeven point equation. As early as 1979, Morse & Posey [8] evaluated the effect of income taxes in Break-even analysis. Several authors have studied the application of the analysis on: curvilinear system [9-14] and systems under uncertainty [15-18].

Kim & Lee [19] applied BEA in the transportation industry, Optimizing break-even points under nonlinear cost conditions, while Martinez & Silva [20] did same in renewable energy projects with nonlinear cost functions. Similarly, curvilinear break-even analysis has been employed in analysis of automotive industry [21] and construction industry [22].

These recent researches found various extension of the application by adjusting the model to accommodate the pertinent factors and parameters of the system under study. Laitinen [23], shows the potency of BEA in handling financial distress prediction by extending the traditional version of BEA to take into account some important characteristics of system. Just as [23] extended the application of BEA to payment default prediction in small scale firms, this paper develops a modified version of the model that will suit producer-distributor supply chain incentive based profit system, especially commission incentive based profit system, creating simulations to predict the impact of this incentive structures on the break-even point and overall profitability of a distribution system.

In the context of distribution systems, incorporating incentive-based profit mechanisms adds complexity but can also enhance performance and motivation among stakeholders. Incentive-based profit models introduce performance-based rewards, aligning the interests of distributors with the company's goals. These incentives can include bonuses, commissions, and profit-sharing schemes, which are designed to motivate distributors to achieve higher sales and efficiency. While bonus schemes offer financial rewards when distributors achieve specific sales targets, which are often set above the break-even point, the profit-sharing models distribute a portion of the company's profits to distributors based on their contribution to sales. This model fosters a sense of ownership and long-term commitment among distributors. The above submission justifies the extension of BEA to such producer-distributor supply chain system.

2. Modification of the traditional Linear Break-Even Analysis for Incentive Based Profit System

The traditional linear break-even analysis is based on the use of linear total revenue and total cost relationships. The sum of the variable and fixed costs is compared with sales revenue in order to determine the level of sales volume, sales value or production at which the business makes neither a profit nor a loss (the "break-even point"). When the following assumptions apply; Selling prices remains constant at all sales level, linear relationship exist between sales volume and costs, all associated costs could be clearly classified into fixed cost and variable cost, production / purchase and sales quantities are equal, and no other factors will influence the variable cost except the quantity (i.e. activity level), then Break-even analysis will become a veritable tool for decision making.

Where TR represents the total revenue of the firm, USP the price per unit of its product sold, V indicates its volume of sales (which is assumed to be equals volume of output), FC indicates the total fixed cost of production and UCP been the Unit Cost Price.

$$TR = USP \times V \qquad (1)$$

Total cost (TC) takes the form:

$$TC = FC + UCP \times V \qquad (2)$$

Breakeven point occurs when:

$$TR = TC \qquad (3)$$

Substituting equation 1 and 2 in equation 3:

$USP \times V = FC + UCP \times V$ (4)

Thus,

$BEV = FC / (USP - UCP)$ (5)

Here, other things been equal, the above equation implies that the break-even volume of sales will be greater, when the total fixed cost or the unit cost price is increased, or both increased, and when unit selling price of its product is reduced. The above is true only when USP is greater than UCP. At a point when USP = UCP we have undefined BEV, and when USP < UCP, an unrealistic (negative volume) value of BEV is obtained.

The distributor in the producer-distributor supply chain incentive based profit system supplies or distributes the product to the customers at same price purchased from the producer or the source. This helps the company in price control, avoiding undue price inflation. The major objective of most business is to make profit and to maximize this desirable function (profit) under some set of constraints. The system described above, makes profit from sales of incentive package (in form of the company product(s)), which is given at the end of a specified period, and it is a function of the sales volume within the period. This incentive plan is productivity oriented. It calls for more sales, and profit is tied to sales volume and not selling price.

The following assumptions were made while developing the model for calculating BEV for the producer-distributor supply chain incentive based profit system:

i. The USP =UVC for Incentive-Based Profit system
ii. No variable cost on the incentive system
iii. All the purchased products are sold. Purchased Vol.=sales vol.
iv. Profit source is from sales of incentive, which is equal to the product of i% of total sales volume and unit selling price at the study period.

Where,

USP =Unit Selling Price

UVC =Unit Variable Cost (function of Purchased cost)

BEV =Break Even Volume

i% =incentive Function = % of Sales Volume collected as Incentive

Incentive = i% of Sales Volume

TC =Total Cost =TVC +TFC

TVC =Total Variable cost

TFC =Total Fixed Cost

TR =Total Generated Revenue =(USP ×Sales Volume +Incentive x USP)

SV =Sales Volume

PV =Purchase Volume

At breakeven point, TR = TC, and for the incentive-based profit system, USP = UCP,

Thus,

$TR=(USP \times SV) +(USP \times Incentive)$ (6)

$=(USP \times SV) +(USP \times i\% \times SV)$ (7)

$=USP \times SV(1+i\%)$ (8)

$TC=(UVC \times PV)+ TFC$ (9)

Assuming at the study period, $PV = SV = vol$ i.e. no shortage or Inventory, or having after sales analysis. Thus at Breakeven point;

$USP \times Vol.(1 + i\%)=UVC \times Vol.+ TFC$ (10)

Then, $BEV = TFC/[USP + (i\% \times USP) - UVC]$ (11)

Since in the considered incentive based profit system, $UVC = USP$

Thus the BEV for the system is given as:

$BEV = TFC/(i\% \times USP)$ (12)

From equation 12, it is clear that the BEV (on the side of the distributor) in such system depends on the total fixed cost, the incentive plan, and the unit selling price (which is same as the unit purchase/cost price). Reduction in BEV, which sometimes translates to shorter payback period, is desirable. It is achieved by reducing the total fixed cost, increasing the unit selling price, improving the incentive plan or some form of combination of the three alternatives.

3. Results and Discussion

The BEV was differentiated with respect to the three factors that contributed to the value of the BEV (as seen in equation 12), and the following differential equations were obtained.

$$\frac{\partial BEV}{\partial TFC} = \frac{1}{A}(\text{Where A} = i\% * USP) \quad (13)$$

$$\frac{\partial BEV}{\partial i\%} = -B(i\%)^{-2}(\text{Where B} = TFC/USP) \quad (14)$$

$$\frac{\partial BEV}{\partial USP} = -C(USP)^{-2}(\text{Where C} = TFC/i\%) \quad (15)$$

From the differential equation developed above for the system, it was found that the BEV has a linear relationship with the total fixed cost, with a slope of the inverse of the product of USP and percentage of sales volume given as incentive/bonus. The USP and incentive plan (percentage of sales volume given as incentive/bonus) shares a negative power relationship with the BEV. The following results were obtained from the simulation of the behaviour of the system as the three factors changes.

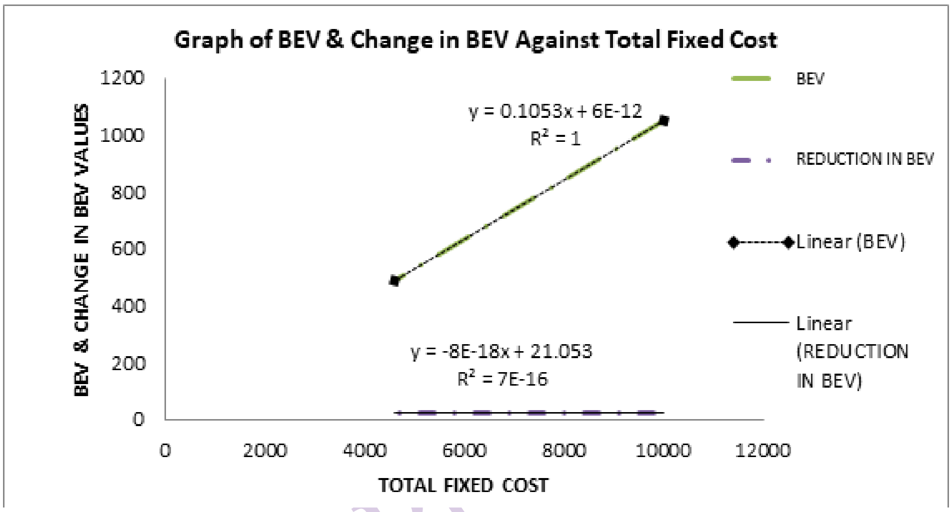

Figure 1: Graph of BEV & Change in BEV against Total Fixed Cost

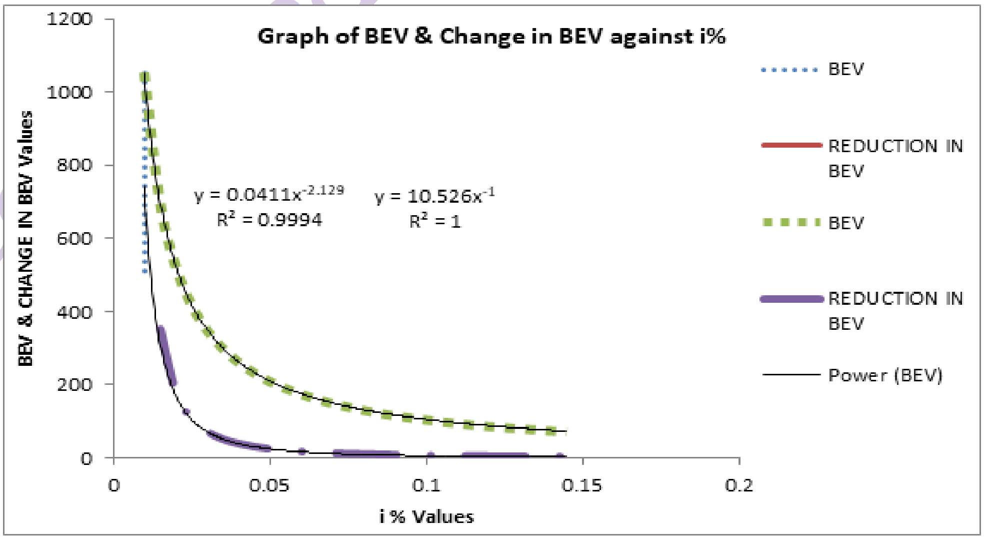

Figure 2: Graph of BEV & Change in BEV against i%

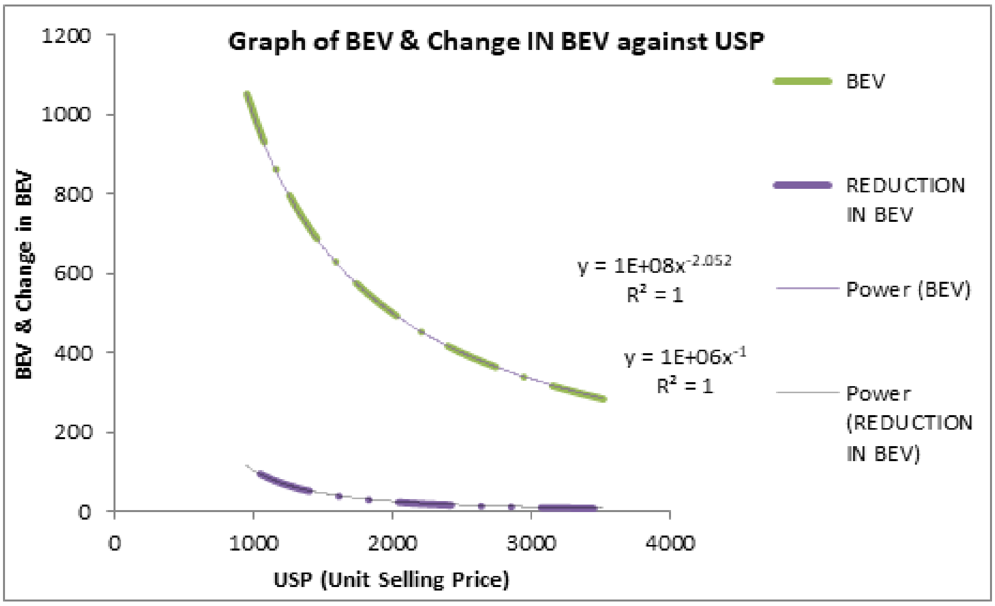

Figure 3: Graph of BEV & Change in BEV against USP

Also, analysis of the rate of change of BEV with respect to the three factors were run for the system studied (with TFC = 10,000, i% = 0.01 & USP = 950), by evaluating the change in BEV over 10% change in the various factors.USP and i% gave same result of 9.091% (≈ 9 %) while TFC gave 9.9999% (≈ 10%). This suggests the need to focus more on the reduction of TFC. The following models in table 1 were developed that describe the relationship between the BEV and the USP, i%, and TFC.

Table 1: Models that describes the BEV and its reduction with respect to the 3 components of the system

	BEV		CHANGE IN BEV	
TFC	$y=0.105x-2e^{-12}$	$R^2=1$	$y=21.05$	$R^2 = 9E-16$
USP	$y=1e^6\ x^{-1}$	$R^2 = 1$	$y=1e^8\ x^{-2.05}$	$R^2 = 1$
I%	$y=10.52x^{-1}$	$R^2 = 1$	$y=0.041x^{-2.12}$	$R^2 = 0.999$

4. Conclusion

The paper develops a model for computing BEV for an incentive based profit system in producer-distributor supply chain system. The developed model shows that the BEV is a function of the total fixed cost, the unit Selling price and the percentage of sales volume given as incentive for the system studied. It was found that the BEV has a linear relationship with the total fixed cost, with a slope of the inverse of the product of USP and percentage of sales volume given as incentive/bonus. But with the USP and incentive plan (percentage of sales volume given as incentive/bonus), the BEV shows a negative power relationship. The rate of change of BEV with respect to the three factors were analyzed for the system (with TFC = 10,000, i% = 0.01 & USP = 950), by evaluating the change in BEV over 10% change in the various factors, USP and i% gave same result of 9.091% (≈ 9 %) while TFC gave 9.9999% (≈ 10%). This suggests the need to focus more on the reduction of TFC, which is in line with productivity enhancement technique.

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