**METHODS OF PROJECT EVALUATIONS**

The following topics will be discussed in this hand out.

Methods of Project evaluations:

Internal Rate of Return – IRR Associated topics to be covered:

NPV vs. IRR

Criticism of IRR

**The Internal Rate of Return (IRR)**

The IRR is the discount rate at which the NPV for a project equals zero. This rate means that the present value of the cash inflows for the project would equal the present value of its outflows.

The IRR is the break-even discount rate. The IRR is found by trial and error.



Where r = IRR

IRR of an annuity:



Where:

**Q (n, r)** is the discount factor **Io** is the initial outlay

**C** is the uniform annual receipt (C1= C2=....= Cn).Example:

What is the IRR of an equal annual income of $20 per annum which accrues for 7 years and costs $120?



= 6

**Net present value vs. Internal rate of return:**

**Independent vs. dependent projects**

NPV and IRR methods are closely related because:

1. both are time-adjusted measures of profitability, and
2. Their mathematical formulas are almost identical.

So, which method leads to an optimal decision: IRR or NPV? a) **NPV vs. IRR: Independent projects**

Independent project: Selecting one project does not preclude the choosing of the other.

With conventional cash flows (-|+|+) no conflict in decision arises; in this case both NPV and IRR lead to the same accept/reject decisions.

Mathematical proof: for a project to be acceptable, the NPV must be positive, i.e.



Similarly for the same project to be acceptable:



Where **R** is the IRR.

Since the numerators Ct are identical and positive in both instances:

* Implicitly/intuitively R must be greater than k (R > k);
* If NPV = 0 then R = k: the company is indifferent to such a project;
* Hence, IRR and NPV lead to the same decision in this case.

b) **NPV vs. IRR: Dependent projects**

NPV clashes with IRR where mutually exclusive projects exist.

Example:

Agritex is considering building either a one-storey (Project A) or five-storey (Project B) block of offices on a prime site. The following information is available:

**Initial Investment Outlay****Net Inflow at the Year End**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Project A |  | -9,500 |  | 11,500 |
|  |  |  |
| Project B |  | -15,000 |  | 18,000 |

Assume k = 10%, which project should Agritex undertake?



* $954.55
* $1,363.64



Both projects are of one-year duration:

**IRRA:** 

$11,500=$9,500(1+R)



= 1.21-1

Therefore **IRRA** = 21%

**IRRB:**  $18,000 = $15,000(1 + RB)



= 1.2-1

Therefore **IRRB** = 20%

Decision:

Assuming that k = 10%, both projects are acceptable because:

NPVA and NPVB are both positive

IRRA > k AND IRRB > k

Which project is a "better option" for Agritex?

If we use the NPV method:

NPVB ($1,363.64) > NPVA ($954.55): Agritex should choose Project B.

If we use the IRR method:

IRRA (21%) > IRRB (20%): Agritex should choose Project A.

**Differences in the scale of investment**

NPV and IRR may give conflicting decisions where projects differ in their scale of investment. Example:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **Years** |  | **0** |  | **1** |  | **2** |  | **3** |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  | Project A |  | -2,500 |  | 1,500 |  | 1,500 |  | 1,500 |  |  |  |
|  |  |  |  |  |  |  |  |
|  | Project B |  | -14,000 |  | 7,000 |  | 7,000 |  | 7,000 |  |  |  |

Assume k= 10%.

**NPVA** = $1,500 x PVFA at 10% for 3 years

* $1,500 x 2.487
* $3,730.50 - $2,500.00
* $1,230.50.

**NPVB** == $7,000 x PVFA at 10% for 3 years

* $7,000 x 2.487
* $17,409 - $14,000
* $3,409.00.

**IRRA =**



= 1.67.

Therefore **IRRA** = 36% (from the tables)

**IRRB =**



= 2.0

Therefore **IRRB** = 21%

Decision:

Conflicting, as:

* NPV prefers B to A
* IRR prefers A to B

**NPV** **IRR**

Project A$ 3,730.50 36%

Project B $17,400.0021%

To show why:

* 1. The NPV prefers B, the larger project, for a discount rate below 20%
	2. The NPV is superior to the IRR
1. Use the incremental cash flow approach, "B minus A" approach
2. Choosing project B is tantamount to choosing a hypothetical project "B minus A".

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  | **0** |  |  | **1** |  | **2** |  | **3** |  |
|  |  |  |  |  |  |  |
| Project B |  | - | 14,000 |  | 7,000 |  | 7,000 |  | 7,000 |  |
|  |  |  |  |  |  |  |
| Project A |  | - | 2,500 |  | 1,500 |  | 1,500 |  | 1,500 |  |
|  |  |  |  |  |  |
| "B minus A" |  | - | 11,500 |  | 5,500 |  | 5,500 |  | 5,500 |  |
|  |  |  |  |  |  |  |  |  |  |  |

IRR"B Minus A" 

= 2.09

= 20%

1. Choosing B is equivalent to: A + (B - A) = B
2. Choosing the bigger project B means choosing the smaller project A plus an additional outlay of $11,500 of which $5,500 will be realized each year for the next 3 years.
3. The IRR"B minus A" on the incremental cash flow is 20%.
4. Given k of 10%, this is a profitable opportunity, therefore must be accepted.
5. But, if k were greater than the IRR (20%) on the incremental CF, then reject project.
6. At the point of intersection,

NPVA = NPVB or NPVA - NPVB = 0, i.e. indifferent to projects A and B. i) If k = 20% (IRR of "B - A") the company should accept project A. This justifies the use of NPV criterion.

**Advantage of NPV:**

It ensures that the firm reaches an optimal scale of investment.

**Disadvantage of IRR:**

* It expresses the return in a percentage form rather than in terms of absolute dollar returns, e.g. the IRR will prefer 500% of $1 to 20% return on $100. However, most companies set their goals in absolute terms and not in % terms, e.g. target sales figure of $2.5 million.

**The timing of the cash flow**

The IRR may give conflicting decisions where the timing of cash flows varies between the 2 projects. Note that initial outlay Io is the same.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
|  |  |  | **0** |  | **1** |  | **2** |
|  |  |  |  |  |
|  | Project A |  | - 100 |  | 20 |  | 125.00 |
|  |  |  |  |  |
|  | Project B |  | - 100 |  | 100 |  | 31.25 |
|  |  |  |  |  |
|  | "A minus B" |  | 0 |  | - 80 |  | 88.15 |
|  |  |  |  |  |  |  |  |
| Assume k = 10% |  |  |  |  |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  |  | **NPV** |  | **IRR** |  |
|  |  |  |  |
| Project A |  | 17.3 |  | 20.0% |  |
|  |  |  |  |
| Project B |  | 16.7 |  | 25.0% |  |
|  |  |  |
| "A minus B" |  | 0.6 |  | 10.9% |  |
|  |  |  |  |  |  |

IRR prefers B to A even though both projects have identical initial outlays. So, the decision is to accept A, that is B + (A - B) = A.

**The horizon problem**

NPV and IRR rankings are contradictory. Project A earns $120 at the end of the first year while project B earns $174 at the end of the fourth year.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  | **0** |  | **1** |  | **2** |  | **3** |  | **4** |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Project A |  | -100 |  | 120 |  | - |  | - |  | - |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | Project B |  | -100 |  | - |  | - |  | - |  | 174 |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Assume k = 10% |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  | **NPV** | **IRR** |  |  |
|  |  |  |  |  |
|  | Project A |  | 9 | 20% |  |  |
|  |  |  |  |  |
|  | Project B |  | 19 | 15% |  |  |
|  |  |  |  |  |  |  |

Decision:

NPV prefers B to A.

IRR prefers A to B.

**METHODS OF PROJECT EVALUATIONS**

The following topics will be discussed in this hand out.

Methods of Project evaluations:

* Payback Period Method
* Discounted Payback Period
* Accounting Rate of Return ARR
* Profitability Index PI

**THE PAYBACK PERIOD (PP)**

The time it takes the cash inflows from a capital investment project to equal the cash outflows, usually expressed in years'. When deciding between two or more competing projects, the usual decision is to accept the one with the shortest payback.

Payback is often used as a "first screening method". By this, we mean that when a capital investment project is being considered, the first question to ask is: 'How long will it take to pay back its cost?' The company might have a target payback, and so it would reject a capital project unless its payback period was less than a certain number of years.

Example 1:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Years** |  | **0** |  | **1** |  | **2** |  | **3** |  | **4** |  | **5** |

Project A1,000,000250,000250,000250,000250,000250,000

For a project with equal annual receipts:



= 4 years Example 2:

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |  |  |
| **Years** |  | **0** |  | **1** |  | **2** |  | **3** |  | **4** |  |
|  |  |  |  |
| Project B |  | - 10,000 |  | 5,000 |  | 2,500 |  | 4,000 |  | 1,000 |  |
|  |  |  |  |  |  |  |  |  |  |  |  |

Payback period lies between year 2 and year 3. Sum of money recovered by the end of the second year = $7,500, i.e. ($5,000 + $2,500)

Sum of money to be recovered by end of 3rd year

* $10,000 - $7,500
* $2,500
* 2.625 years



**Disadvantages of the payback method:**

* It ignores the timing of cash flows within the payback period, the cash flows after the end of payback period and therefore the total project return.
* It ignores the time value of money. This means that it does not take into account the fact that $1 today is worth more than $1 in one year's time. An investor who has $1 today can either consume it immediately or alternatively can invest it at the prevailing interest rate, say 30%, to get a return of $1.30 in a year's time.
* It is unable to distinguish between projects with the same payback period.

\* It may lead to excessive investment in short-term projects.

**Advantages of the payback method:**

* Payback can be important: long payback means capital tied up and high investment risk. The method also has the advantage that it involves a quick, simple calculation and an easily understood concept.

**DISCOUNTED PAYBACK PERIOD:**

Length of time required to recover the initial cash outflow from the *discounted* future cash inflows. This is the approach where the present values of cash inflows are cumulated until they equal the initial investment. For example, assume a machine purchased for $5000 yields cash inflows of $5000, $4000, and $4000. The cost of capital is 10%. Then we have



The payback period (without discounting the future cash flows) is exactly 1 year. However, the discounted payback period is a little over 1 year because the first year discounted cash flow of $4545 is not enough to cover the initial investment of $5000. The discounted payback period is 1.14 years (1 year + ($5000 - $4545)/$3304 = 1 year + .14 year).

**THE ACCOUNTING RATE OF RETURN - (ARR):**

The ARR method also called the return on capital employed (ROCE) or the return on investment (ROI) method of appraising a capital project is to estimate the accounting rate of return that the project should yield. If it exceeds a target rate of return, the project will be undertaken.



Note that net annual profit excludes depreciation. Example:

A project has an initial outlay of $1 million and generates net receipts of $250,000 for 10 years. Assuming straight-line depreciation of $100,000 per year:



= 15%



= 30%

**Disadvantages:**

* It does not take account of the timing of the profits from an investment.
* It implicitly assumes stable cash receipts over time.
* It is based on accounting profits and not cash flows. Accounting profits are subject to a number of different accounting treatments.
* It is a relative measure rather than an absolute measure and hence takes no account of the size of the investment.
* It takes no account of the length of the project.
* It ignores the time value of money.

**The payback and ARR methods in practice:**

Despite the limitations of the payback method, it is the method most widely used in practice. There are a number of reasons for this:

* It is a particularly useful approach for ranking projects where a firm faces liquidity constraints and requires fast repayment of investments.
* It is appropriate in situations where risky investments are made in uncertain markets that are subject to fast design and product changes or where future cash flows are particularly difficult to predict.
* The method is often used in conjunction with NPV or IRR method and acts as a first screening device to identify projects which are worthy of further investigation.
* It is easily understood by all levels of management.
* It provides an important summary method: how quickly will the initial investment be recouped?

**THE PROFITABILITY INDEX – PI:**

This is also known as benefit-cost ratio. It is a relationship between the PV of all the future cash flows and the initial investment. This relationship is expressed as a number calculated by dividing the PV of all cash flows by initial investment.

This is a variant of the NPV method.



Decision rule:

PI > 1; accept the project

PI < 1; reject the project

If NPV = 0, we have:

NPV = PV - Io = 0

PV = Io

Dividing both sides by Io we get:



PI of 1.2 means that the project's profitability is 20%.

Example:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |
|  |  | **PV of CF** |  | **Io** |  | **PI** |  |
|  |  |  |  |  |
| Project A |  | 100 |  | 50 |  | 2.0 |  |
|  |  |  |  |  |
| Project B |  | 1,500 |  | 1,000 |  | 1.5 |  |
|  |  |  |  |  |  |  |  |

Decision:

Choose option B because it maximizes the firm's profitability by $1,500.

**Disadvantage of PI:**

Like IRR it is a percentage and therefore ignores the scale of investment.

The NPV method is preferred over the PI method. This is because PI greater than 1 implies that the Net Present Value of the project is positive. Secondly, NPV clearly states whether to undertake or reject a project or not and return a dollar value by which the economic contribution is made to value of firm. This is not the case with PI which only expresses the relative profitability of projects being considered.

**ADVANCE EVALUATION METHODS**

The following topics will be discussed in this lecture. Advance Evaluation Methods:

* Sensitivity analysis
* Profitability analysis
* Break even accounting
* Break even - economic

**SENSITIVITY ANALYSIS:**

Sensitivity analysis is the study of how the variation in the output of a model (numerical or otherwise) can be apportioned, qualitatively or quantitatively, to different sources of variation.

A mathematical model is defined by a series of equations, input factors, parameters, and variables aimed to characterize the process being investigated. Input is subject to many sources of uncertainty including errors of measurement, absence of information and poor or partial understanding of the driving forces and mechanisms.

This imposes a limit on our confidence in the response or output of the model. Further, models may have to cope with the natural intrinsic variability of the system, such as the occurrence of stochastic events. Good modeling practice requires that the modeler provides an evaluation of the confidence in the model, possibly assessing the uncertainties associated with the modeling process and with the outcome of the model itself. Uncertainty and Sensitivity Analysis offer valid tools for characterizing the uncertainty associated with a model.

**Applications**

Sensitivity Analysis can be used to determine:

1. The model resemblance with the process under study
2. The quality of model definition
3. Factors that mostly contribute to the output variability
4. The region in the space of input factors for which the model variation is maximum
5. Optimal - or instability - regions within the space of factors for use in a subsequent calibration study
6. Interactions between factors
7. Sensitivity Analysis is popular in financial applications, risk analysis, signal processing, neutrals

networks and any area where models are developed.

**Methodology**

There are several possible procedures to perform uncertainty (UA) and sensitivity analysis (SA). The most common sensitivity analysis is sampling-based. A sampling-based sensitivity is one in which the model is executed repeatedly for combinations of values sampled from the distribution (assumed known) of the input factors. Other methods are based on the decomposition of the variance of the model output and are model independent.

In general, UA and SA are performed jointly by executing the model repeatedly for combination of factor values sampled with some probability distribution. The following steps can be listed:

1. Specify the target function and select the input of interest
2. Assign a distribution function to the selected factors
3. Generate a matrix of inputs with that distribution(s) through an appropriate design
4. Evaluate the model and compute the distribution of the target function
5. Select a method for assessing the influence or relative importance of each input factor on the target function.

**PROFITABILITY ANALYSIS**

Successful financial institutions today are able to effectively identify those products, customers, branches, and other factors that impact overall profitability. But discovering what's actually profitable isn't always straightforward. To really understand what's driving bank profitability, you need to be able to drill down into the lowest level of detail, and analyze data with ease and precision.

Profitability is a dynamic, accountable solution for managing customer relationships and measuring performance – providing a complete picture of your organization's profitability. It allows you to analyze your business across unlimited dimensions. Beyond customer profitability, product profitability and organizational profitability, it’s sophisticated, multi-dimensional OLAP environment provides the unique ability to calculate profitability at the account level, drill up and down through every level of the hierarchy, and aggregate up for any reporting or analytical dimension, for improved accuracy and better decision-making.

This flexibility allows you to analyze…

* Customers who are 'at risk'
* Performance of an officer that supports multiple business units
* Business unit performance across a group of branches
* Customer households reported in multiple market segments
* Geographic views that aren't aligned with organizational units
* Product success across a group of market segments
* Origination trends by groups of officers, branches, or by market segment

**BREAK-EVEN ACCOUNTING**

This type of report is not one that is automatically generated by most accounting software, nor is it one that is normally produced by your accountant, but it is an important analysis for you to have and understand. For any new business, you should predict what gross sales volume level you will have to achieve before you reach the break-even point and then, of course, build to make a profit. For early-stage businesses, you should be able to assess your early prediction and determine how accurate they were, and monitor whether you are actually on track to make the profits you need. Even the mature business would be wise to look at their current break-even point and perhaps find ways to lower that benchmark to increase profits. The recent massive layoffs at large corporations are directed at this goal, lowering the break-even point and increasing profits.

**Break-Even Is the Volume Where All Fixed Expenses Are Covered:**

You will start a break-even analysis by establishing all the fixed (overhead) expenses of your business. Since most of these are done on a monthly basis, don’t forget to include the estimated monthly amount of line items that are normally paid on a quarterly or annual basis such as payroll taxes or insurance. For example, if your annual insurance charge is $9,000, use 1/12 of that, or $750 as part of your monthly budget. With the semi variable expense (such as phone charges, travel, and marketing), use that portion that you expect to spend each and every month.

For the purpose of a model break-even, let’s assume that the fixed expenses look as follows:

|  |  |
| --- | --- |
| Administrative salaries | 1,500 |
| Rent | 800 |
| Utilities | 300 |
| Insurance | 150 |
| Taxes | 210 |
| Telephone | 240 |
| Auto expense | 400 |
| Supplies | 100 |
| Sales and marketing | 300 |
| Interest | 100 |
| Miscellaneous | 400 |
| Total | ksh.4,500 |

These are the expenses that must be covered by your gross profit. Assuming that the gross profit margin is 30 percent, what volume must you have to cover this expense? The answer in this case is 15,000—30 percent of that amount is $4,500, which is your target number.

The two critical numbers in these calculations are the total of the fixed expense and the percentage of gross profit margin. If your fixed expense is ksh.10,000 and your gross profit margin is 25 percent, your break-even volume must be ksh.40,000.

**This Is Not a Static Number:**

You may do a break -even analysis before you even begin your business and determine that your gross margin will come in at a certain percentage and your fixed expense budget will be set at a certain level. You will then be able to establish that your business will break even (and then go on to a profit) at a certain level of sales volume. But your pre-start projections and your operating realities may be very different. After three to six months in business, you should compare projections to the real-world results and reassess, if necessary, what volume is required to reach break-even levels.

Along the way, expenses tend to creep up in both the direct and indirect categories, and you may fall below the break-even volume because you think it is lower than it has become. Take your profit and loss statement every six months or so and refigure your break-even target number.

**Ways to Lower Break-Even:**

There are three ways to lower your break-even volume, only two of them involve cost controls (which should always be your goal on an ongoing basis).

1. Lower direct costs, which will raise the gross margin. Be more diligent about purchasing material, controlling inventory, or increasing the productivity of your labor by more cost effective scheduling or adding more efficient technology.
2. Exercise cost controls on your fixed expense, and lower the necessary total dollars. Be careful when cutting expenses that you do so with an overall plan in mind. You can cut too deeply as well as too little and cause distress among workers, or you may pull back marketing efforts at the wrong time, which will give out the wrong signal.
3. Raise prices! Most entrepreneurs are reluctant to raise prices because they think that overall business will fall off. More often than not that doesn’t happen unless you are in a very price-sensitive market, and if you are, you really have already become volume driven.

But if you are in the typical niche-type small business, you can raise your prices 4 to 5 percent without much notice of your customers. The effect is startling. For example, the first model we looked at was the following:

|  |  |  |
| --- | --- | --- |
| Volume | Ksh.15,000 |  |
| direct cost | 10,500 | 70% |
| gross profit | 4,500 |  |

Raising the prices 5 percent would result in this change:

|  |  |  |
| --- | --- | --- |
| Volume | Ksh.15,750 |  |
| direct cost | 10,500 | 67% |
| gross profit | 5,250 |  |

You will have increased your margin by 3 percent, so you can lower the total volume you will require to break even.

**The Goal Is Profit:**

You are in business to make a profit not just break even, but by knowing where that number is, you can accomplish a good bit:

* You can allocate the sales and marketing effort to get you to the point you need to be.
* Most companies have slow months, so if you project volume below break-even, you can watch expenses to minimize losses. A few really bad months can wipe out a good bit of previous profit.
* Knowing the elements of break-even allows you to manage the costs to maximize the bottom line.

Once you have gotten this far in the knowledge of the elements of your business, you are well on your way to success.

The **breakeven point** in economics is the point at which cost or expenses and income are equal - there is no net loss or gain, one has "broken even".

The point at which a firm or other economic entity breaks even is equal to its fixed costs divided by its contribution to profit per unit of output, which can be shown by the following formula:



The break even point is also the point on a chat indicating the time when something has broken even, and is a general term for not having gained or lost something in a process.

The Contribution per Unit can be worked out using

Contribution = Price per Unit - Variable Costs per Unit

The **break even point** for a product is the point where total revenue received equals total costs associated with the sale of the product (TR=TC). A break even point is typically calculated in order for businesses to determine if it would be profitable to sell a proposed product, as opposed to attempting to modify an existing product instead so it can be made lucrative. Break-Even Analysis can also be used to analyze the potential profitability of an expenditure in a sales-based business.

**In unit sales**

If the product can be sold in a larger quantity than occurs at the break even point, then the firm will make a profit; below this point, a loss. Break-even quantity is calculated by:

Total fixed costs / (price - average variable costs)

(Explanation - in the denominator, "price minus average variable cost" is the variable profit per unit, or contribution margin of each unit that is sold.)

Firms may still decide not to sell low-profit products, for example those not fitting well into their sales mix. Firms may also sell products that lose money - as a loss leader, to offer a complete line of products, etc. But if a product does not break even, or a potential product looks like it clearly will not sell better than the break even point, then the firm will not sell, or will stop selling, that product.

An example:

* Assume we are selling a product for ksh.2 each.
* Assume that the variable cost associated with producing and selling the product is 60 cents.
* Assume that the fixed cost related to the product (the basic costs that are incurred in operating the business even if no product is produced) is ksh.1000.
* In this example, the firm would have to sell (1000/ (2 - 0.6) = 714) 714 units to break even.

**In price changes**

By inserting different prices into the formula, you will obtain a number of break even points, one for each possible price charged. If the firm to change the selling price for its product, from ksh.2 to ksh.2.30, in the example above, then it would have to sell only (1000/(2.3 - 0.6))= 589 units to break even, rather than 714.



To make the results clearer, they can be graphed. To do this, you draw the total cost curve (TC in the diagram) which shows the total cost associated with each possible level of output, the fixed cost curve (FC) which shows the costs that do not vary with output level, and finally the various total revenue lines (R1, R2, and R3) which show the total amount of revenue received at each output level, given the price you will be charging.

The break even points (A,B,C) are the points of intersection between the total cost curve (TC) and a total revenue curve (R1, R2, or R3). The break even quantity at each selling price can be read off the horizontal, axis and the break even price at each selling price can be read off the vertical axis. The total cost, total revenue, and fixed cost curves can each be constructed with simple formula. For example, the total revenue curve is simply the product of selling price times quantity for each output quantity. The data used in these formulas come either from accounting records or from various estimation techniques such as regression analysis.

In potential expenditures Break-Even Analysis can be used in the evaluation of the cost-effectiveness of a new expenditure for a sales-revenue based business. Here, the cost can be evaluated in terms of revenues needed to break even on the investment, or more specifically, to determine how much of an increase in sales revenues would be necessary to break even.

An illustrative example of this is a retail lumberyard who is considering the purchase of a delivery truck. The goal is to evaluate how large an increase in sales revenue is necessary to break even on the investment in a delivery truck. For this example, the company’s front-door margin (that is, sales revenue minus the cost of goods sold and costs of doing business) is 5%, and the cost of the desired delivery truck is ksh.50,000. To calculate the break-even level of expenditure, the following formula can be used:

Expenditure (Ksh) = (Front-door margin %) X (Revenue Increase needed to break even)

To break even using the above example, ksh.50,000 must equal 5% of the sales INCREASE (“SI”) in order to break even. The variable which must be isolated is the Sales Increase.

$50,000 = 5% of SI

$50,000 = .05 \* SI

$50,000/.05 = SI

$1,000,000 = SI

Sales increase of ksh.1,000,000 is needed to break even on the investment on the delivery truck. The business must then decide how it can use the delivery truck to help increase sales by ksh.1,000,000; if it can, then they will break even, and if it can not, then it would be an ill-advised investment. If sales revenues pass the break-even point, 5% of further increase would be bottom line profit.

Of course, in most cases, such an investment will not be paid out in lump sum or in one year, so appropriate adjustments can be made for the payments, and the scenario can be focused on a monthly basis during repayment, or can be extended out through and beyond the repayment period to evaluate a longer term return. Also such calculations can be used with smaller-scale and shorter-term scenarios (such as a temporary employee or a new computer) or on a much larger scale such as a new construction or acquisition.

It is notable that, since most businesses have among their goals to be profitable, desired profits should be added as a cost of doing business.

**Limitations**

* This is only a supply side (i.e.: costs only) analysis.
* It tells you nothing about what sales are actually likely to be for the product at these various prices.
* It assumes that fixed costs (FC) are constant
* It assumes average variable costs are constant per unit of output, at least in the range of sales (both prices and likely quantities) of interest.

**ECONOMIC BEAK-EVEN**

The problem associated with accounting break even is that accounting earnings are calculated after the deduction of all costs except the opportunity cost of the capital that is invested in the project. Accounting for the cost of capital is simple, at least in principle, when working out income or profit, we

should also deduct the opportunity cost of capital employed just as we deduct all other costs. Income that is worked out, as this (after deducting cost of capital) is known as economic profit or economic value added (EVA). A project that has a positive EVA adds to firm value; one with a negative EVA reduces firm value.