CAPITAL BUDGETING TECHNIQUES: ESTIMATION OF INTERNAL RATE OF RETURNS

Abstract

The enormity of costs associated with long-term assets and the length of exposure to risk of such investments makes it essential to properly evaluate capital budgeting decisions before embarking on them. The estimation of cash flows of uncertain future period itself is problematic and to add a complex technique of project evaluation that will require trial and error could be frustrating. This study is to simplify the estimation of Internal Rate of Return (IRR) without going through the rigours of trial and error process. The study allows the estimation of IRR even when net present value at two levels are positive or the two are negative. Investments analysists were advised to properly evaluate projects so that investors will source for funds where the interest rate is not higher than the projects' IRR.

Keywords: Capital Budgeting, Internal Rate of Return, Sustainability, Complexity.

Capital budgeting is the investment in long term assets. As a result of the huge amount involved, the inability or expensive cost involved in disposing the assets off and the exposure of such investment to long term risk, there is a need for proper evaluation of capital budgeting decisions before embarking on them. According to Konstatin and Konstatin (2018), investment appraisal is the evaluation of investments with regards to their profitability and/or cost of effectiveness. Block and Hirt (2000) state that capital budgeting is capital allocating because it is used to determine whether future benefits are sufficiently large to justify the initial outlays. Chandra (2001) defines capital budgeting as investment in a project with the expectation of a stream of benefits extending far into the future with long term consequences involving substantial outlays that are difficult or expensive to reverse.

Some of the techniques for the evaluation of capital budgeting decisions are Accounting Rate of Returns (ARR), the Payback Period (PBP), the Net Present Value (NPV) and the Internal Rate of Returns (IRR). Of all the four techniques the IRR is the most complex. In fact, it is more correct to say that IRR is estimated rather than calculated (Institute of Chartered Accountants of Nigeria, ICAN, 2014). IRR is often estimated by interpolation after trial and error use of rates of return. This complexity makes the estimation of IRR to be dreaded by students and even investment analysists. This paper is therefore an attempt at contributing to the literature on capital budgeting decisions by profiling a method of estimating the IRR of a project without resulting to trial and error method.

Concept of Internal Rate of Returns

The Internal Rate of Returns (IRR) which is also called discounted cash flow yield method is the rate of returns that equates the present values of cash inflows to the present value of cash outflows from a project. In a nutshell, IRR is the breakeven rate of return on a project. When the IRR is applied on a project, the project generates net present value of zero. The IRR of a project is the discounted rate of return on the investment (ICAN, 2014).

In the discounted cash flow methods of project evaluation, the NPV has a known cost of capital or rate of return that will generate NPV to be used in the evaluation of the project but IRR sort for the rate that will generate NPV of zero (Oki & Sivaruban, 2016). The determination of IRR requires two steps of first calculating NPV using any chosen discount rate and subsequently, choose (and keep trying) a lower or higher rate to have NPV equal to zero, depending on whether the initial NPV is positive or negative (Oki & Sivaruban, 2016). Block and Hirt (2000) suggested a process of averaging by dividing cumulative cash flows by the life of the project. Thereafter, divide the investment by the average to derive present value factor that will give an idea of the range for the IRR from the annuity factor table. This process can be described as guess work and will still require trial and error.

Malomo (1999) states that IRR is the expected earning rate of an investment and that if the IRR of a project exceeds the company's target rate of return for investments, the project should be considered viable. Malomo (1999) states how to estimate IRR by first computing ARR and use the value gotten as the base for determining the rate to use. Subsequently, a trial and error is introduced with the following formula to be applied:

$$\text{IRR} = \text{lower COC} + \frac{\text{Positive NPV}}{\text{Positive NPV} + \text{Negative NPV in absolute value}} \times \text{Difference in rates}$$

Akinsulire (2006) describes IRR as the cut off rate as it is the rate that break-even the cost of capital. A striking point by Akinsulire (2006) is that if a company borrows at a rate higher than the IRR estimated, the project will eventually be rendered unviable. Consequently, the proper estimation of IRR is necessary such that investors should avoid expensive funds that will render their projects unviable.

IRR represents the yield on an investment and it is a discounted cash flow technique which takes account of the magnitude and timing of cash flows (Pandey, 2005). Pandey (1995) posits that IRR depends solely on the outlay and proceeds associated with the investment and not on any rate determined outside the investment. The technique is called IRR because the rate of return depends on the project's cash flows rather than any outside factor (Pandey, 2005). The IRR represents the true interest rate earned on any investment over the course of its economic life and it is the maximum cost of capital that can be applied to finance a project without causing harm to the shareholders (Drury, 2012).

Drury (2012) separates estimation of IRR of projects with even cash flow from projects with uneven cash flows. He posits that IRR of projects with even cash flows can be estimated simply by the following formula:

$$\text{IRR} = \frac{\text{Investment cost}}{\text{Annual cash flows}}$$

The figure derived here can then be checked up from the annuity factor table.

For example, if XYZ Ltd has the following investment proposal:

Initial outlay is N100,000 while the annual cash flow is N40,000 for four years.

The IRR can be determined as follows:

$$\text{Discount rate} = \frac{100,000}{40,000}$$

$$= 2.5$$

2.5 in year 4 lies between 21% and 22%. Consequently, these rates will be compared with the company's cost of capital (COC). As long as 21% is higher than the company's cost of capital, a decision can be taken on the viability of the project. As simple and straight forward as this process is, it is certain that cash flows from a project cannot be same over the entire life of the project. Consequently, attention should be focussed on uneven cash flows.

Estimating IRR of Projects with Uneven Cash Flows

If IRR is the rate of returns that yields zero NPV when applied on an investments' cash flows, it means then that IRR lies between the rate that yields positive NPV and the rate that yields negative NPV. NPV has an inverse relationship with cost of capital; the higher the cost of capital, the lower the NPV. Lower cost of capital is therefore expected to yield positive NPV while higher cost of capital will yield negative NPV. Consequently, by interpolation, the mid-rate that will yield zero NPV can be estimated. This rate that yields zero NPV is the IRR. It must be noted that the closer the two rates chosen to the IRR, the less the error in estimation of IRR, hence, the continuous trial of rates.

For example, the following information about a project is given as follows:

The initial outlay of the project is N106,000 while the net cash flows for the four years that the project will last are; N34,000; N50,000; N32,000 and N24,000 respectively. The minimum desirable rate of returns for projects in the company is 11%. Estimate the viability of the project using IRR.

To begin with, generate NPV of 11% rate of returns as follows:

Table 1: Computation of NPV at 11% Rate of Return

Years	Cash Flows	Discount Factor@11%	Present Values
0	(106,000)	1.0000	(106,000)
1	34,000	0.9009	30,631
2	50,000	0.8116	40,581
3	32,000	0.7312	23,398
4	24,000	0.6587	<u>15,810</u>

		NPV	4,420

Source: Author's Computation (2019)

Please, note that the evaluation starts from year zero. Year zero here represents the beginning of the project. It is tagged year zero so that the discount factor will be one ($1/1.11^0 = 1$). The basis for this is that when considering time value of money, the value of the money with the investor at the beginning of the project remains the same amount.

The NPV of the project at 11% is positive N4,420. Since this NPV is positive a rate of return higher than 11% should be applied to generate a negative NPV. It must be noted that N4,420 is a way from N0. However, consideration must be given to the relationship between the initial outlay and the NPV; the wider the gap, the closer is the NPV to zero. As a result, I will select a rate of return of 13% to generate another NPV. This is as follows:

Table 2: Computation of NPV at 13% Rate of Return

Years	Cash Flows	Discount Factor@13%	Present Values
0	(106,000)	1.0000	(106,000)
1	34,000	0.8850	30,088
2	50,000	0.7831	39,157
3	32,000	0.6931	22,178
4	24,000	0.6133	14,720
		NPV	143

Source: Author's Computation (2019)

From this, computation, it is known that 13% cannot give NPV of zero nor a negative NPV. Consequently, there is a need to use a higher rate of return. This is why it is called, trial and error. However, this NPV is close to zero, hence, 14% rate of return will yield a negative NPV. Using 14% rate of return:

Table 3: Computation of NPV at 14% Rate of Return

Years	Cash Flows	Discount Factor@14%	Present Values
0	(106,000)	1.0000	(106,000)
1	34,000	0.8772	29,825
2	50,000	0.7695	38,473
3	32,000	0.6750	21,599
4	24,000	0.5921	14,210
		NPV	(1,893)

Source: Author's Computation (2019)

Now that I have a negative NPV close to zero, by interpolation, the IRR can be estimated as follows:

$$IRR = 13 + \frac{143}{143 + 1893} \times (14 - 13)$$

$$= 13 + \frac{143}{2036} \times 1$$

$$= 13 + 0.0702$$

$$= 13.07\%$$

It is also possible that the first two rates applied yield negative NPVs such as follows:

XYZ proposes to engage in the manufacture a product for household use. It is believe that the project was be carried and sold for five years. The initial outlay is N200,000 while outlay in year one is projected to be N120,000. Cash flow in the next four years are estimated to be N50,000; N80,000; N120,000 and N150,000. The cost of capital for the company is 15%. Determine the viability of the project using IRR.

Computation of IRR

Table 4: Computation of NPV at 15% Rate of Return

Years	Cash Flows	Discount Factor@15%	Present Value
0	(200,000)	1.0000	(200,000)
1	(122,000)	0.8696	(106,087)
2	80,000	0.7561	60,491
3	100,000	0.6575	65,752
4	150,000	0.5718	85,763
5	170,000	0.4972	84,520
		NPV	(9,561)

Source: Author's Computation (2019)

Since the NPV is negative, a lower rate of returns should be applied to generate positive NPV.

Using rate of return of 14%:

Table 5: Computation of NPV at 14% Rate of Return

Years	Cash Flows	Discount Factor@14%		Present Value
0	(200,000)	1.0000		(200,000)
1	(122,000)	0.8772		(107,018)
2	80,000	0.7695		61,557
3	100,000	0.6750		67,497S
4	150,000	0.5921		88,812
5	170,000	0.5194		<u>88,293</u>
			NPV	<u>(859)</u>

Source: Author's Computation (2019)

Since 14% rate of returns yields a negative NPV, there is a need to use a further rate of return to generate a positive NPV.

Table 6: Computation of NPV at 13% Rate of Return

Years	Cash Flows	Discount Factor@13%		Present Value
0	(200,000)	1.0000		(200,000)
1	(122,000)	0.8896		(107,965)
2	80,000	0.7831		62,652
3	100,000	0.6931		69,305
4	150,000	0.6133		91,998
5	170,000	0.5428		<u>92,269</u>
			NPV	<u>8,259</u>

$$IRR = 13 + \frac{8,259}{8,259 + 859} \times (14 - 13)$$

$$= 13 + \frac{8,259}{9,118} \times 1$$

$$= 13 + 0.9058$$

$$= 13.9\%$$

Theoretical Framework

This model is based on the theories of complexity and sustainability.

Theory of Complexity

Complexity theory is the appropriate setting for the study of problems that are concerned with the resources such as time and space (Terwijn, 2017). One of the goals of complexity theory is to classify problems according to their complexity.

Complexity theory does not need to have a complex explanation. Ability to simplify otherwise complex situation is what makes the world a jolly-going habitation. According to Sammut-Bonnici (2015), adaptation of human to environment and situations and the modification of behaviour simplifies otherwise complex problems.

Theory of Sustainability

To sustain is to maintain some concepts, beliefs or process over time. In its increasing common use of sustainability, the concept frames the way human beliefs and practices jeopardise the conditions of healthy, social and progressive living (Berkshire Encyclopedia of sustainability). Both the strong and the weak are often sustained. However, what must be sustained are those that gives priority to the general good of the society. Any complex solution to a problem cannot be categorised as that of the good of the society. Where possible, a weak situation should be modified for the good of the society.

Model for Estimating IRR without Trial and Error

Analysis of IRR requires NPV at two levels that does not require the use of interpolation or trial and error. The procedures for the estimation of IRR is as follows:

(1) Compute NPV at two levels of rates of return their results whether positive and positive or negative and negative do not matter.

(2) Compute the NPV of 1% rate of return as follows:

$$\frac{\text{Difference in NPV of the two rates}}{\text{Difference in the two rates}}$$

(3) Compute the ratio of NPV of any of the rates to the NPV of 1% rate of return

(4) The addition of ratio of NPV of any of the two rates to the chosen rate will yield the IRR

(5) Compute the IRR by adding the rate of return chosen to the ratio of NPV of the chosen rate to the ratio of NPV to NPV of 1% rate of return if the NPVs are positive.

(6) If however, the NPVs are negative, deduct the ratio of NPV of the chosen rate to NPV of 1% from the chosen rate of return to derive the IRR.

Demonstration of the Model

Introducing the examples earlier used

The initial outlay of the project is N106,000 while the net cash flows for the four years that the project will last are; N34,000; N50,000; N32,000 and N24,000 respectively. The minimum desirable rate of returns for projects in the company is 11%. Estimate the viability of the project using IRR.

To begin with, generate NPV of 11% rate of returns as follows:

Table 7: Computation of NPV at 11% Rate of Return

Years	Cash Flows	Discount Factor@11%	Present Values
0	(106,000)	1.0000	(106,000)
1	34,000	0.9009	30,631
2	50,000	0.8116	40,581
3	32,000	0.7312	23,398
4	24,000	0.6587	15,810
		NPV	4,420

Source: Author's Computation (2019)

Table 8: Computation of NPV at 13% Rate of Return

Years	Cash Flows	Discount Factor@13%	Present Values
0	(106,000)	1.0000	(106,000)
1	34,000	0.8850	30,088
2	50,000	0.7831	39,157
3	32,000	0.6931	22,178
4	24,000	0.6133	14,720
		NPV	143

Source: Author's Computation (2019)

NPV at 11% is 4,420 and NPV at 13% is 143.

The NPV of 1% COC is determined as follows:

$$\frac{\text{Difference in NPV}}{\text{Difference in Rates}} \quad \frac{(4420 - 143)}{(13 - 11)} = \frac{4,277}{2}$$

$$= 2,138.5$$

Therefore, NPV at any of the level will move to the rate of zero by the addition of that rate to the NPV of the rate to NPV of 1% COC.

IRR using 13% is $\frac{143}{2,138.5} = 0.0669$

IRR = 13 + 0.0669

= 13.07%

The lower rate can also be used to estimate the IRR with the same result.

IRR = $11 + \frac{4,420}{2,138.5}$

= 11 + 2.0669

= 13.0669

= 13.07%

Estimation of IRR when NPV are negative and negative.

The IRR can also be estimated even when the two NPVs are negative:

XYZ proposes to engage in the manufacture a product for household use. It is believe that the project was be carried and sold for five years. The initial outlay is N200,000 while outlay in year one is projected to be N120,000. Cash flow in the next four years are estimated to be N50,000; N80,000; N120,000 and N150,000. The cost of capital for the company is 15%. Determine the viability of the project using IRR.

Computation of IRR

Table 9: Computation of NPV at 15% Rate of Return

Years	Cash Flows	Discount Factor@15%	Present Value
0	(200,000)	1.0000	(200,000)
1	(122,000)	0.8696	(106,087)
2	80,000	0.7561	60,491
3	100,000	0.6575	65,752
4	150,000	0.5718	85,763
5	170,000	0.4972	84,520
			(9,561)

Source: Author's Computation (2019)

Since the NPV is negative, a lower rate of returns should be applied to generate positive NPV.

Using rate of return of 14%:

Table 10: Computation of NPV at 14% Rate of Return

Years	Cash Flows	Discount Factor@14%	Present Value
0	(200,000)	1.0000	(200,000)
1	(122,000)	0.8772	(107,018)
2	80,000	0.7695	61,557
3	100,000	0.6750	67,497S
4	150,000	0.5921	88,812
5	170,000	0.5194	88,293
		NPV	(859)

Source: Author's Computation (2019)

Estimation of NPV of 1% rate of return is as follows:

$$\frac{\text{Difference in NPV}}{\text{Difference in CoC}} = \frac{(9{,}561) - (859)}{15 - 14}$$

$$= \frac{8{,}702}{1}$$

$$= 8{,}702$$

$$\text{IRR} = 14 - \frac{859}{8{,}702}$$

$$= 14 - 0.0987$$

$$= 13.9\%$$

The IRR can also be gotten using 15% as follows:

$$\text{IRR} = 15 - \frac{9{,}561}{8{,}702}$$

$$= 15 - 1.0987$$

$$= 13{,}9\%$$

Conclusion:

The need to make the world an easy one should be the desire of every living being. The need to be sure of the viability of investment of any investor cannot be over emphasised. A wrong step taken at the beginning of any project will be carried for a long period of time. This makes the proper evaluation of projects very essential. One of the techniques for project evaluation is IRR which has become a challenge to students and investment analysts. Hence, the need for a simplifying method of estimation of the IRR of projects. This study provides a model for the estimation of IRR. Investment analysts must take time to estimate the IRR of projects so that investors can source for funds that will not jeopardise the investments. Any fund whose interest rate is higher than the IRR of the project will render the project unviable.

REFERENCES

1. Akinsulire O. (2006). Financial Management. 4th Edition. Ceemol Nigeria Ltd, Lagos, Nigeria
2. Block S.B, Hirt G.A. (2000). Foundations of Financial Management. 9th Edition. McGraw-Hill Higher Education, USA
3. Chandra P. (2001). Financial Management: Theory and Practice. 5th Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
4. Drury C. (1995). Management and Cost Accounting. 8th Edition, Chagman and Hall, London, UK
5. Institute of Chartered Accountants of Nigeria (2014). Strategic Financial Management. Emile Woolf International, Berkshire, United Kingdom.
6. Konstatin P, Konstatin M. (2018). Investment Appraisal Methods. Power and Energy Systems Engineering Economics, 39-64.
7. Malomo M. (1999). Management Accounting With Application of Quantitative Techniques. Chinedum Publishers Ltd, Lagos, Nigeria.
8. Oki F, Sivaruban S. (2016). Capital Budgeting and Cost Evaluation Techniques: A Conceptual Analysis. International Journal of Science and Research, 1553 – 1557.
9. Pandey I.M. (2005). Financial Management. 9th Edition, Publishing House PVT Ltd, New Delhi, pg 145.