

# NET PRESENT INDEX RATE, A NEW INTEGRATED TECHNIQUE FOR INVESTMENT DECISION UNDER CERTAINTY/UNCERTAINTY CONDITIONS

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## ABSTRACT

*The innovative research for the development of a set of the new formula to derive innovative design of integrated sensitivity, scenario, breakeven, certainty equivalent cash flow techniques of investment analysis as the technique that ensure to overcome their limitations mutually and combine their advantages with the use of the modified Profitability index rate as net present index rate. It is able to provide the more effective application of profitability index which is free from the limitation of NPV and assumptions of IRR.*

## INTRODUCTION:

There are different methods available for the evaluation of investment proposals under certainty/uncertainty conditions. All are based on the two categories i.e. the traditional and the Discounted Cash Flow (DCF) techniques. The traditional Methods are confined to evaluate the proposals based on either pure risk (PBP) or pure returns (ARR) and no consideration for time value of money. The DCF based methods are considered more effective because they are able to consider the time value of money apart from giving due consideration for both risk and return factors in the process of evaluation. There are different DCF methods. All are projected to evaluate either on NPV or IRR. The Profitability Index (PI) is considered only as an extension to NPV. The PI is a simple and more relevant measure that provides equal weight-age for both risk and return than the NPV's weight-age on Risk or IRR's weight-age on returns.

Further, the methods of evaluation under uncertainty conditions like sensitivity, scenario, present value breakeven and certainty equivalent cash inflows. Though they are effective, they are suffering from certain limitations. Viz. the sensitivity is not able to provide the change effects of more than one element/variable at once; the scenario though considers the change effects of all the variables but no provision for independently identifiable effect of any one variable alike of sensitivity. Further the certainty equivalents are unable to implicate the effects of change in the operating aspects alike of sensitivity/scenario directly. Further more importantly, though the uncertainty is confined to operating aspects and affects the returns more than the cash inflows, for which there is no provision for it in the certainty equivalents. Finally, the evaluation criterion is no parity on the risk return weight-age with either NPV or IRR. The proposed integrated technique is designed with the consideration of equal weight-age for both risk and return apart from time value of money and avoiding the limitations of the stated methods and avoiding the limitation of effects NPV and assumption effects of IRR through the proposed calculation of Net Present Index Rate / net present Internal Index Rates. Further, the graphical presentation of Index Rate in progression provides clarity on the risk mitigation and return projection under such changing conditions of certainty/uncertainty of the proposals after checking the acceptability under certainty equivalent Net Present Index Rate. More importantly it is best suited for projecting the strategic product life

cycle decision implications on the results with a perfect flexible budget implied operating integrated capital budgeting analysis.

**Key words:** ETROS (elasticity of target return on target sales revenues), CEROS (certainty equivalent return on target sales), CEACIFR (certainty equivalent annual cash inflow rate on initial investment), PVCEACIFR (present values of certainty equivalent annual cash inflow rate), CENPIR (certainty equivalent net present index rate), PVACIFR (present value of annual cash inflow rate on initial investment), CENPIR (certainty equivalent net present index rate on initial investment), NPIR (net present index rate on initial investment), NPIIR (net present internal index rate on initial investment), NPIIRTV (NPIIR at terminal value), sensitivity, scenario, sensitivity to scenario.

Objectives:

1. To design an integrated technique that free from assumptions of existing IRR and limitations of NPV through a distinct present value index rate.
2. To provide more effective report graphically, the progressive net present (value) index rate/net present internal index rate.

**Methodology:** innovative research to design more effective investment decision analysis through the innovation of new formulae on the basis of direct costing & Cost Volume Profit (CVP)/breakeven analysis (BEA).

*The innovated new formulae are:*

**Determination of the impact of changes in variables individually:**

- a. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change only in price (SP) of the product/product mix  
 $a = ETROS_{sp} = \Delta SPR$
- b. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change only in volume of the product/product mix  
 $b = ETROS_{vol} = \{[(\Delta VolR_2) * (BER * CMR)] * (1 + \Delta VolR_1)\} + (TROS * \Delta VolR_1)$
- c. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change only in Variable Cost of the product/product mix  
 $c = ETROS_{vc} = \Delta VCR$
- d. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change only in Fixed Cost of the product/product mix  
 $d = ETROS_{fc} = \{(\Delta FCR) * BER * (CM \text{ Ratio})\}$

**Determination of the impact of changes in one variable together with other variables:**

- a. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change in price (SP) of the product/product mix  
 $a = ETROS_{sp} = \Delta SPR * (1 + \Delta VolR_1)$
- b. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change in volume of the product/product mix  
 $b = ETROS_{vol} = \{[(\Delta VolR_2) * (BER * CMR)] * (1 + \Delta VolR_1)\} + (TROS * \Delta VolR_1)$
- c. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change in Variable Cost of the product/product mix  
 $c = ETROS_{vc} = \Delta VCR * (1 + \Delta VolR_1)$
- d. The Elasticity of ROS on planned/target Revenues (ETROS) with respect to a given change only in Fixed Cost of the product/product mix  
 $d = ETROS_{fc} = \{[(\Delta FCR) * (1 - \Delta VolR_2)] * BER * CMR\} * (1 + \Delta VolR_1)$
- e. The extent of net Sum of effect on TROS:  
 $e = ETROS_{all} = (a + b) - (c + d)$

### Hypothetical case analysis of the integrated technique under uncertainty:

**Case analysis-I:** XYZ company is considering a project for investment with the credential as: life of the project =5 years, cost of the project Rs.100000/- scrap value =10000 and cost of capital 12% and applicable tax rate is 40%. The capacity of plant is 20000 units. The forecasted Operating details at the present/ideal/normal operating capacity and the forecasts likely extent of changes in variables under different economic scenario conditions are given below: (determine the Net present value of index rate when the uncertainty is confined only to operating results and when it is up to the cash inflows).

Table. I-1. The detailed forecasts of changes in the variables to different economic the scenario conditions.

cost and prices	Planned/ideal/normal conditions & at 90% capacity utilization: 18000 units		forecasted scenario effects on costs, price as a proportionate change and volume in proportion of capacity utilization (- indicates reduction & +indicates increase of price and costs)		
	Rs. per unit (as per the ABC costing)	total Rs. /Ratio	slump scenario	recession scenario	boom scenario
(Allocated to products and absorbed to units as per ABC) the costs other than the throughput and depreciation are of semi Fixed (SFC) and the changes forecasted of SFC are from the total of the respective variable and depreciation is fixed and the price and throughput are directly proportional to Volume.					
<b>Volume / Level of Activity</b>	90% capacity	18000	0.5	0.6	1
<b>Selling Price/Sales revenue</b>	10	180000	-0.10	0.20	0.300
<b>Through-Put Cost or Variable Cost-(VC)</b>	4	72000	-0.25	-0.10	0.125
<b>Batch Level Costs(SFC)</b>	0.7	12600	-0.40	-0.30	0.150
<b>Product Level Costs-(SFC)</b>	0.6	10800	-0.45	-0.12	0.120
<b>Firm/Facility Level-(SFC)</b>	0.5	9000	-0.33	-0.20	0.180
<b>(allocated to products and not absorbed to units) customer Level-(SFC)</b>	0.8	14400	-0.10	0.12	0.150
<b>Project Book Costs (depreciation)-(FC)</b>	1	18000	0	0	0.000
<b>TFC(SFC+FC)</b>	3.6	64800			
<b>TC</b>	7.6	136800			
<b>Profit</b>	2.4	43200			
<b>ROS on Ideal/Normal Revenues</b>		0.240			

Further, the occurrence of number of times of the scenarios during the life in random as: normal -1, the slump -1, recession-2 and boom-1 in its life. Inconsideration of the risks of scenarios you are requested to find out the certainty equivalent returns and net Present Index Rate (NPR) with details of sensitivity of operating returns to each variable to the above said scenarios effects on the net returns using suitable technique.

Solution: on application of integrated technique (IPPPA):

Step-1:

Table-I-2 Determination of ROS with IPPPA technique at the given IDEAL conditions/scenario:

particulars	formula	result
<b>Investment/cost of the project</b>	as given	100000
<b>Contribution Margin(CM) Rs. Per unit</b>	sp-vc	6
<b>CM Ratio</b>	CM/SP	0.6
<b>Break Even Point (BEP) Rupees</b>	TFC/CMR	108000
<b>Break Even Ratio (BER)</b>	BEP/S	0.600
<b>Return on Sales (ROS / ΔROS)</b>	ROS=(CMR*(1-BER))	0.24

Source table:I.1.

Step-2:

Table-I.3 the sensitivity constants(SC) are determined relating to each variable based on the present/initial/planned values as: volume= PVR\*BER; SP=1, VC= VCR i.e. VC/SP; each component of SFC or FC: PVR\*BER\*(each component of SFC or FC /TFC) determined as follows.

Particulars of variables affected by the scenarios for measuring their scenario change effects on the ideal/Normal ROS	variable short name	Formula for determining sensitivity constant as the given normal/Ideal basis	sensitivity constant (SC)
<b>Volume of output &amp; Sales</b>	Volume	(CMR*BER)	0.36
<b>Selling Price/Sales revenue</b>	SP	SP/SP	1.00
<b>through put cost or Variable Cost</b>	VC	VC <sub>pu</sub> /SP	0.40
<b>batch level costs</b>	SFCa	(SFCa/TFC)*(CMR*BER)	0.07
<b>(allocated to products and not absorbed to units) product level costs</b>	SFCb	(SFCb/TFC)*(CMR*BER)	0.06
<b>(allocated to products and not absorbed to units) firm/Facility level</b>	SFCc	(SFCc/TFC)*(CMR*BER)	0.05
<b>(allocated to products and not absorbed to units) customer level</b>	SFCd	(SFCd/TFC)*(CMR*BER)	0.08
<b>Project Book Costs (depreciation)</b>	FC	(FC/TFC)*(CMR*BER)	0.10
	TFC:	(sum of SFC &FC)	0.36

Source table:I.1,2.

Formulae for determination of impacts of variables individually on ideal/normal ROS as extent of effect or sensitivity using the sensitivity constants (SC) are:

1. Volume effect:  $((SC * \Delta VolR_2) * (1 + \Delta VolR_1)) + (ROS_{Idl.} * \Delta VolR_1)$
2. Price (SP) effect:  $((SC * \Delta SPR_1) * (1 + \Delta VolR_1))$
3. Variable Cost (VC) effect:  $((SC * \Delta VCR_1) * (1 + \Delta VolR_1))$
4. Concerned Individual SFC/FC effect:  $((SC * \Delta SFCR_1 \text{ or } \Delta FCR_1) * (1 - \Delta VolR_2)) + (1 + \Delta VolR_1)$
5. To determine the sum extent or net extent of sensitivity from the ideal ROS:  
(Sum of effects of Price and Volume) – (sum of the cost effects)
6. To determine the new ROS at the Ideal revenues after the net extent of sensitivity from the ideal ROS: (Ideal ROS + net extent of effects)
7. To determine the new ROS at the respective scenario revenues after the net extent of sensitivity from the ideal ROS: (scenario ROS at Ideal revenues(as determined f point 6 above)/  $((1 + \Delta VolR_1) * (1 + \Delta SPR_1))$ )
8. The formula to convert the ROIAT on initial investment to PV of total investment = concerned year/scenario ROIAT\* initial investment/PV of total Investment.

Interpretation of impacts of variables on ROS: a negative (-) value of price and volume and positive (+) value of costs indicates adverse and vice versa. The net impact is calculated as deducting the sum of costs effects from the sum of Price and Volume effects. The net negative indicate adverse and net positive indicates favorable. Finally, the net positive impact will be added to (net negative deducted from) the initial/Target ROS of target/ideal/normal revenues to determine the ROS on the target revenues after the impacts of all the concerned variables. The ROS on the each scenario revenues individually be calculated by dividing the respective scenario net ROS on ideal revenues after the effects with the product of  $(1+\Delta\text{SPR}1)$  and  $(1+\Delta\text{VolR}1)$  of the respective scenario. In the calculation of  $\Delta$  Ratios 1 represents the limit-1 as the basis and 2 refers to limit-2 as the basis for calculating the ratio. Further the limit-1 is always the ideal/normal/base value and limit-2 is the respective scenario value concerned.

**A: when the uncertainty is confined to operating activities/results:**

Step-3a:

Table-I.4. shows the assessment of elasticity or extent of effect/responsiveness of the Targeted/Ideal ROS to a given change in the variables individually and in total.

forecasted scenario effects on costs, price as a proportionate change and volume in proportion of capacity utilization as given					sensitivity of ROS to the scenario changes in the variables (the extent of effect for a given change in each variable to each of the distinct scenarios as the individual and net total effect on the ROS of normal/ideal Revenues)				
differential ratios of variable		slump scenario	recession scenario	boom scenario	sensitivity constant	acronym of variable to represent the variable for their effect	slump scenario	recession scenario	boom scenario
volume of sales	Ideal/normal	18000	18000	18000					
	scenario volume	10000	12000	20000					
Vol	$\Delta\text{VolR}1$	-0.444	-0.333	0.111					
Vol	$\Delta\text{VolR}2$	-0.800	-0.500	0.10	0.36	$\Delta\text{Vol}$	<b>-0.267</b>	<b>-0.200</b>	<b>0.067</b>
SP	$\Delta\text{SPR}1$	-0.10	0.20	0.30	1.00	$\Delta\text{SPR}$	<b>-0.056</b>	<b>0.133</b>	<b>0.333</b>
VC	$\Delta\text{VCR}1$	-0.25	-0.10	0.125	0.40	$\Delta\text{VCR}$	<b>-0.056</b>	<b>-0.027</b>	<b>0.056</b>
SFCa	$\Delta\text{SFCRa}1$	-0.40	-0.30	0.15	0.07	$\Delta\text{SFCRa}$	-0.028	-0.021	0.011
SFCb	$\Delta\text{SFCRb}1$	-0.45	-0.12	0.12	0.06	$\Delta\text{SFCRb}$	-0.027	-0.007	0.007
SFCc	$\Delta\text{SFCRc}1$	-0.33	-0.20	0.18	0.05	$\Delta\text{SFCRc}$	-0.017	-0.0100	0.009
SFCd	$\Delta\text{SFCRd}1$	-0.10	0.12	0.15	0.08	$\Delta\text{SFCRd}$	-0.008	0.0096	0.012
FC	$\Delta\text{FCR}1$	0.00	0.00	0.00	0.10	$\Delta\text{FCRe}$	0	0	0
	$\Delta\text{TFCR}1 \sum \Delta\text{SFCR} + \Delta\text{FCR}$	-1.280	-0.500	0.600	0.36	$\Delta\text{TFCR}$	<b>-0.0795</b>	<b>-0.0286</b>	<b>0.0387</b>
<b>net impact on ROS at the planned revenues</b>							-0.187	-0.011	0.306
<b>new ROS after the scenario effects on planned revenues</b>							<b>0.053</b>	<b>0.229</b>	<b>0.546</b>
<b>new ROS after the scenario effects on the respective scenario revenues</b>							<b>0.106</b>	<b>0.286</b>	<b>0.378</b>

Source table:I.1,2,3.

Step-4a: expected returns on Ideal sales revenues: based on the information of random occurrences of the scenarios the Probability (P) is determined and the CEROS at  $3\sigma$  as:

Table-I.5. shows the details of average ROS after probability weights and the standard deviation of such and the certainty equivalent ROS

scenario	ROS	P(probability)	P*ROS
Ideal/planned/normal	0.240	0.2	0.0480
slump	0.053	0.2	0.0106
recession	0.229	0.4	0.0914
boom	0.546	0.2	0.1091
mean		(sum of p*ROS)	0.2591
Stn.Dev. $\sigma$		Stndv of (p*ROS)	0.04431
certainty equiv valet returns (CEROS)	(Mean ROs) - ( $3*\sigma = 3*0.04431 = 0.1329$ ) = (0.2591 - 0.1329)	(CEROS)	0.1262

Source table:I.3.

Step-5a: The determination of net Present Rate (NPR) as follows:

Table-I.6. shows the certainty equivalent Net Present Index Rate under the uncertainty confined to only operating returns.

CEVROS	determined above	0.1262
tax at 40%	as given	0.0505
ROSAT	(CEVROS-T)	0.0757
ITR	(IDEAL-S/I)	1.8
ROIAT	(ROSAT*ITR)	0.1363
add depreciation rate	% of Depreciation	0.18
CIFR	ROIAT+CIFR	0.3162
PV annuity at KI 12%	as per the table	3.605
PVCIFR	(PVA*CIFR)	1.1403
PV factor yr5 at 12%	as per the table	0.567
scrap rate	as given	0.10
PVCIF of scrap	scrap*PV <sup>5</sup>	0.057
Total CEPVCIFR	(PVIFR+PVIF Scrap)	1.1973
CENPIR	(1-PVIFR)	0.1973

Source table:I. 1,4,5.

: When the uncertainty is extended to operating cash inflows: step 1b&2b same as above 1a&2a.

Step-3b & 4b:

Table-I.7. shows determination of elasticity of ROS/ROI/Cash flows after taxes at the Ideal conditions as an extent of variation to the changes in each variable individually to the distinct scenario.

forecasted scenario effects on costs, price as a proportionate change and volume in proportion of capacity utilization as given					sensitivity of ROS to the scenario changes in the variables (the extent of effect for a given change in each variable to each of the distinct scenarios as the individual and net total effect on the ROS of normal/ideal Revenues)										
<b>differential ratios of variable</b>		slump scenario	recession scenario	boom scenario	sensitivity	acronym of variable to represent the variable for their effect	slump scenario	recession scenario	boom scenario						
<b>volume of sales</b>	Ideal/normal	18000	18000	18000											
	scenario volume	10000	12000	20000											
<b>Vol</b>	$\Delta\text{VolR1}$	-0.444	-0.333	0.111	constant										
<b>Vol</b>	$\Delta\text{VolR2}$	-0.800	-0.500	0.10						0.36	$\Delta\text{Vol}$	<b>-0.267</b>	<b>-0.200</b>	<b>0.067</b>	
<b>SP</b>	$\Delta\text{SPR1}$	-0.10	0.20	0.30						1.00	$\Delta\text{SPR}$	<b>-0.056</b>	<b>0.133</b>	<b>0.333</b>	
<b>VC</b>	$\Delta\text{VCR1}$	-0.25	-0.10	0.125						0.40	$\Delta\text{VCR}$	<b>-0.056</b>	<b>-0.027</b>	<b>0.056</b>	
<b>SFCa</b>	$\Delta\text{SFCRa1}$	-0.40	-0.30	0.15						0.07	$\Delta\text{SFCRa}$	-0.028	-0.021	0.011	
<b>SFCb</b>	$\Delta\text{SFCRb1}$	-0.45	-0.12	0.12						0.06	$\Delta\text{SFCRb}$	-0.027	-0.007	0.007	
<b>SFCc</b>	$\Delta\text{SFCRc1}$	-0.33	-0.20	0.18						0.05	$\Delta\text{SFCRc}$	-0.017	-0.0100	0.009	
<b>SFCd</b>	$\Delta\text{SFCRd1}$	-0.10	0.12	0.15						0.08	$\Delta\text{SFCRd}$	-0.008	0.0096	0.012	
<b>FC</b>	$\Delta\text{FCR1}$	0.00	0.00	0.00						0.10	$\Delta\text{FCRe}$	0	0	0	
	$\Delta\text{TFCR1}\sum\Delta\text{SFCR}+\Delta\text{FCR}$	-1.280	-0.500	0.600						0.36	$\Delta\text{TFCR}$	<b>-0.0795</b>	<b>-0.0286</b>	<b>0.0387</b>	
<b>net impact on ROS on the ideal/normal revenues</b>										Ideal/normal		-0.187	-0.011	0.306	
Scenario ROS after the scenario effects on the ideal/normal revenues												<b>0.24</b>	<b>0.053</b>	<b>0.229</b>	<b>0.546</b>
<b>Tax @ 40%</b>												0.096	0.0212	0.0916	0.2184
<b>Scenario ROSAT after the scenario effects on the ideal/normal revenues</b>							0.144	0.0318	0.1374	0.3276					
<b>ITR (IDEAL-S/I)</b>							1.8	1.8	1.8	1.8					

<b>ROIAT</b>	0.2592	0.05724	0.24732	0.58968
<b>add depreciation Rate</b>	0.18	0.18	0.18	0.18
<b>CIFR</b>	0.4392	0.23724	0.42732	0.76968
<b>Probability</b>	0.2	0.2	0.4	0.2
<b>P weighted CFR</b>	0.08784	0.047448	0.170928	0.153936
<b>Mean of CIFR</b>	0.08784+0.047448+0.170928+0.153936=0.4602			

Source table:I.1,2.

Step-5b: expected returns on Ideal sales revenues: based on the information of random occurrences of the scenarios the Probability (P) is determined and the CECIFR at  $3\sigma$  as:

Table-I.8. shows the steps in the determination Certainty equivalent cash inflows rate and the net present value index Rate under the situation of the uncertainty is extended to the cash inflows after taxes.

<b>Mean of CIFR</b>	<b>0.4602</b>
<b>Stn.Dev. <math>\sigma</math> of scenario CIFR</b>	0.0576
<b>CECIFR: (CIFR) - ( <math>3*\sigma = 3*0.0576 = 0.1727</math>) = (0.4602-0.1727)</b>	0.2874
as per the PVA table @12% by the end of 5 <sup>th</sup> year	3.605
CEPVCIFR: (PVA*CIFR)	1.0362
as per the PV table @12% 5 <sup>th</sup> year	0.567
as given	0.1
scrap*PV <sup>5</sup>	0.057
(CEPVCIFR+PVIF Scrap)	1.0932
CENPIR: (1-PVIFR)	0.0932

Source table:I.1,2,7.

Verification of the ROS results (if required):

Table-I.9. shows the verification of the ROS on the Ideal Revenues after the scenario effects.

PARTICULARS	ideal/normal conditions & at 90% capacity utilization: 18000 units		forecasted scenario effects on costs, price as a proportionate change and volume in proportion of capacity utilization			verification of results		
	Rs. per unit (as per the ABC costing)	total Rs. /Ratio	slump scenario (- indicates reduction & +indicates increase of price and costs)	recession scenario (- indicates reduction & +indicates increase of price and costs)	boom scenario(- indicates reduction & +indicates increase of price and costs)	slump scenario	recession scenario	boom scenario
<b>Volume/ level of activity</b>	90% capacity	18000	0.5	0.6	1	10000	12000	20000
<b>Selling Price/Sales revenue</b>	10	180000	-0.10	0.20	0.300	90000	144000	260000
<b>through put cost or Variable Cost-(VC)</b>	4	72000	-0.25	-0.10	0.125	30000	43200	90000
<b>batch level costs</b>		12600	-0.40	-0.30	0.150	7560	8820	14490
<b>product level costs-(SFC)</b>		10800	-0.45	-0.12	0.120	5940	9504	12096
<b>firm/Facility level-(SFC)</b>		9000	-0.33	-0.20	0.180	6030	7200	10620
<b>(allocated to products and not absorbed to units) customer level-(SFC)</b>		14400	-0.10	0.12	0.150	12960	16128	16560
<b>Project Book Costs (depreciation)- (FC)</b>		18000	0	0	0.000	18000	18000	18000
<b>TFC(SFC+FC)</b>		64800				<b>50490</b>	<b>59652</b>	<b>71766</b>
<b>TC</b>		136800				80490	102852	161766
<b>Profit</b>		43200				9510	41148	98234
<b>ROS on ideal/normal revenues</b>		0.240				<b>0.053</b>	<b>0.229</b>	<b>0.546</b>
<b>ROS on respective scenario revenues</b>			scenario revenue based ROS			<b>0.106</b>	<b>0.286</b>	<b>0.378</b>

Source table:I.1,2,7,8.

**Conclusion:** it is to conclude that the IPPPA tool -2 is not only effective for decision making on operating aspects in progression but also provide the platform for capital budgeting decisions of long-term as a system of operating integrated investment decision analysis, being meaningfully unifying uncertainty based advanced capital budgeting techniques of sensitivity, scenario, break-even and integrated with the certainty equivalent technique used for uncertainty conditions. Therefore it is a compact technique applicable for both certainty and uncertainty conditions analysis. It is being measuring the sensitivity/elasticity of returns with reference to the ideal/standard/normal/budgeted sales revenues on one hand and the initial/ PV of total investments of phase-out investments, enable to standardize the analysis to assess the effects/impacts of changes in any one or more variables at predicted different scenario conditions directly as the extent of effect on the results more importantly in terms of proportions rather than the absolute amounts. Further, it is enabled to assess the effectiveness of the capital budgeting decision being assessed the cash flows directly as a proportion to investments. It is able to relieve the misinterpretation of NPV and ambiguous assumption of possibility of reinvestment of earlier period cash inflows at the IRR of the IRR.

Further the IPPPA Tool-1 is able to provide the important data of operating and investment risk premium analysis for operating and capital budgeting decisions under uncertainty conditions. The application of proportion measurement is able to integrate the investment analysis with the operating market risk analysis viz. the demand, supply, competition analysis of managerial economic theory for strategic product life cycle analysis. Following cognizant hypothetical firm data enable to provide the insights for application of both the IPPPA tools for capital budgeting decision analysis for product life cycle.

**Note:** if the uncertainty is applicable to cash-inflows then the probability will be applied at the cash inflows after taxes i.e. at the point of ROIAT+ depreciation rate on investment/project cost as implied in case b..

## **Analysis of Product lifecycle under uncertainty and expected certainty conditions:**

### **Case analysis-II**

PQR Company is planning to introduce the newly developed product 'T'. The forecasts of potential market are 50000 units pa. The company is aiming to attain 40% of it as its share in the market at the target maturity level. The forecasted data for the product's life cycle are as given below. Initial cost of the project Rs.100000/- and cost of capital at risk free rate as 8% and expected risk premium is 2% and the additional investment at the development stage is Rs. 20000 and in the initial stage of growth is Rs. 20000 The capacity of plant is 20000 units. The expected life of the project of the product is 10 years. and the likely span of spread of life cycle is as: entry level 1.year, development 1 years, growth 2 years, maturity 2 years initial fall for 2 years, declining 1 year about to die/exit/withdrawal 1 year.

the forecasted Operating details at entry level of operating capacity and the forecasts of likely extent of changes in operating variables under different economic/market conditions during the life cycle of the proposed product of the project from the initial entry level are:



Table-II.1. shows the forecasts of expected changes in the operating variables and activity levels during the lifecycle of a product from its introductory conditions.

cost and prices	ideal/normal conditions & at 90% capacity utilization: 18000 units		Forecasted effects from the entry level to each stage of product life cycle. The effects measured as proportionate changes. The price and variable costs at per unit and the Semi fixed and fixed costs in total and the changes in volume as a proportion of capacity utilization.					
(allocated to products and absorbed to units as per ABC) the costs other than the throughput and depreciation are of semi Fixed (SFC) and the changes forecasted of SFC as deemed not absorbed and the calculated are from the total of the respective variable and depreciation is as fixed and the price and throughput are directly proportional to Volume.	Rs. per unit (as per the ABC costing) market potential projected 50000 units	entry level at 40% capacity	develop ment level	growth level	maturit y	falling level	further falling	dying/ex it/ withdra wal
Volume/ level of activity	target market share 40% at the maturity	8000	0.6	0.8	1	0.9	0.7	0.55
Selling Price/Sales revenue	11.25	90000	0.15	0.20	0.25	0.20	0.12	-0.06
through put cost or Variable Cost-(VC)	6	48000	0.12	0.15	0.18	0.20	0.10	0.08
(allocated to products and deemed not absorbed to units) batch level costs (SFC)	1.5	12000	0.10	0.15	0.18	0.16	0.12	0.10
(allocated to products and deemed not absorbed to units) product level costs-(SFC)	1	8000	0.10	0.12	0.15	0.13	0.10	0.12
(allocated to products and deemed not absorbed to units) firm/Facility level-(SFC)	0.75	6000	0.05	0.90	0.12	0.10	0.08	0.07
(allocated to products and deemed not absorbed to units) customer level-(SFC)	1.5	12000	0.15	0.18	0.20	0.20	0.12	0.10
TSFC		38000						
Project Book Costs (depreciation)-(FC)		10000	0.2222	0.4722	0.4722	0.4722	0.4722	0.4722
TFC(SFC+FC)		48000						
TC		96000						
Profit		-6000						
ROS on ideal/normal revenues		-0.067						
initial and additional investments in progression		100000	20000	20000	0	0	0	0

Note: The depreciation is calculated on the basis of life time spread of the total project cost from the respective point of initial and additional investments.

Further, in consideration of the risks of scenarios, you are requested to verify the certainty equivalent returns with details of sensitivity of operating returns to each variable at each stage of the life cycle of the above proposal for acceptance being considering likely uncertain conditions and the detailed spread of returns as of likely certainty of the forecasts in its life cycle in the report using suitable technique.

## Checking the feasibility of the proposal when the forecast imply uncertainty:

Solution:

Table-II.2. shows the determination of ROS at the introductory level using the direct costing/TOC Throughput/CVP/BEA called IPPPA developed by the author.

Determination of ROS with IPPPA technique at the given entry level:

particulars	formula	result
Investment/cost of the project	as given	100000
Contribution Margin(CM) Rs. Per unit	sp-vc	5.25
CM Ratio	CM/SP	0.467
Break Even Point (BEP) Rupees	TFC/CMR	102857
Break Even Ratio (BER)	BEP/S	1.143
Return on Sales	$ROS=(CMR*(1-BER))$	-0.067

Source table:II.1.

Step-2:

The sensitivity constants(SC) are determined relating to each variable based on the present/initial/planned values as: volume= PVR\*BER; SP=1, VC= VCR i.e. VC/SP; each component of SFC or FC: PVR\*BER\*(each component of SFC or FC /TFC) determined as follows.

Table-II.3. shows determination of sensitivity constants for the product life cycle

Particulars of variables affected by the scenarios for measuring their scenario change effects on the ideal/Normal ROS	variable short name	Formula for determining sensitivity constant as the given normal/Ideal/entry level as the basis	sensitivity constant (SC)
<b>Volume of output &amp; Sales</b>	Volume	$(CMR*BER)$	0.53
<b>Selling Price/Sales revenue</b>	SP	$SP/SP$	1.00
<b>through put cost or Variable Cost</b>	VC	$VC_{pu}/SP$	0.53
<b>batch level costs</b>	SFCa	$(SFCa/TFC)*(CMR*BER)$	0.13
<b>(allocated to products and deemed not absorbed to units) product level costs</b>	SFCb	$(SFCb/TFC)*(CMR*BER)$	0.09
<b>(allocated to products and deemed not absorbed to units) firm/Facility level</b>	SFCc	$(SFCc/TFC)*(CMR*BER)$	0.07
<b>(allocated to products and deemed not absorbed to units) customer level</b>	SFCd	$(SFCd/TFC)*(CMR*BER)$	0.13
<b>Project Book Costs (depreciation deemed not absorbed to units)</b>	FC	$(FC/TFC)*(CMR*BER)$	0.11
	TFC:	$(\text{sum of SFC \& FC})$	0.53

Source table:II.1,2.

Formulae for determination of impacts of variables individually on ideal/normal ROS as extent of effect or sensitivity using the sensitivity constants (SC) are:

1. Volume effect:  $((SC * \Delta VolR_2) * (1 + \Delta VolR_1)) + (ROS_{Idl.} * \Delta VolR_1)$
2. Price (SP) effect:  $((SC * \Delta SPR_1) * (1 + \Delta VolR_1))$
3. Variable Cost (VC) effect:  $((SC * \Delta VCR_1) * (1 + \Delta VolR_1))$
4. Concerned Individual SFC/FC effect:  $((SC * \Delta SFCR_1 \text{ or } \Delta FCR_1) * (1 - \Delta VolR_2)) + (1 + \Delta VolR_1)$
5. To determine the sum extent or net extent of sensitivity from the ideal ROS:  
(Sum of effects of Price and Volume) – (sum of the cost effects)
6. To determine the new ROS at the Ideal revenues after the net extent of sensitivity from the ideal ROS:  
(Ideal ROS + net extent of effects)
7. To determine the new ROS at the respective scenario revenues after the net extent of sensitivity from the ideal ROS: (scenario ROS at Ideal revenues(as determined f point 6 above)/  $((1 + \Delta VolR_1) * ((1 + \Delta SPR_1))$ )
8. The formula to convert the ROIAT on initial investment to PV of total investment = concerned year/scenario ROIAT\* initial investment/PV of total Investment.

Interpretation of impacts of variables on ROS: a negative (-) value of price and volume and positive (+) value of costs indicates adverse and vice versa. The net impact is calculated as deducting the sum of costs effects from the sum of Price and Volume effects. The net negative net positive indicates favorable and vice versa. Finally, the net positive impact will be added to (net negative deducted from) the entry level ROS to determine the ROS at each stage of the product life concerned of all the variables on the entry level revenues. The ROS at each stage of the life cycle on revenues of the stage concerned can be calculated by dividing the net ROS of the respective stage on entry level revenues with the product of  $(1+\Delta SPR1)$  and  $(1+\Delta VolR1)$  of the respective stage. In the calculation of  $\Delta$  Ratios '1' represents the limit-1 as the basis and 2 refer to limit-2 as the basis for calculating the ratio. Further the limit-1 is always the initial/entry level/ideal/normal and limit-2 is the respective scenario value concerned.

Table-II.4. shows the process of determination of the elasticity of Entry level ROS to the product lifecycle changes of the product.

variab le short name	the measurements for assessment of effects as an extent of from the entry level ROS of the forecasted changes in costs & price as given as a proportionate change from the entry level. And the changes in volume in proportion to initial entry level ( $\Delta VolR1$ ) & at the respective stage in the life cycle( $\Delta VolR2$ ) of the product.									Sensitivity or the extent effect on the entry level ROS for the changes in all the variables individually with respect to each of the stages of life cycle of the product and in total of such effects at each stage of the life cycle.						
	sensitiv y constant	differen tial ratios of variable	develo pment level	grow th level	maturi ty	falling level	further falling	dying/ withdr awal		develo pment level	grow th level	matu rity	fallin g level	further falling	dying/ withdra wal	
	Entry level volume	8000	8000	8000	8000	8000	8000	8000								
volume scenario	12000	16000	20000	18000	14000	11000										
Volume	Vol1		$\Delta VolR1$	0.5	1	1.5	1.25	0.75	0.375		12000	16000	20000	18000	14000	10000
	Vol2	0.53	$\Delta VolR2$	0.333	0.500	0.600	0.556	0.429	0.273	$\Delta Vol$	<b>0.233</b>	<b>0.467</b>	<b>0.700</b>	<b>0.583</b>	<b>0.350</b>	<b>0.175</b>
Selling Price/Sales revenue	SP/S	1.00	$\Delta SPR1$	0.15	0.20	0.25	0.20	0.12	-0.06	$\Delta SPR$	<b>0.225</b>	<b>0.400</b>	<b>0.625</b>	<b>0.450</b>	<b>0.210</b>	<b>-0.083</b>
through put cost or Variable Cost	VC	0.53	$\Delta VCR1$	0.12	0.15	0.18	0.20	0.10	0.08	$\Delta VCR$	<b>0.096</b>	<b>0.160</b>	<b>0.240</b>	<b>0.240</b>	<b>0.093</b>	<b>0.059</b>
batch level costs	SFCa	0.13	$\Delta SFCRa1$	0.10	0.15	0.18	0.16	0.12	0.10	$\Delta FCRa$	0.013	0.020	0.024	0.021	0.016	0.013
(allocated to products and not absorbed to units) product level costs	SFCb	0.09	$\Delta SFCRb1$	0.10	0.12	0.15	0.13	0.10	0.12	$\Delta FCRb$	0.009	0.011	0.013	0.012	0.009	0.011
(allocated to products and not absorbed to units) firm/Facility level	SFCc	0.07	$\Delta SFCRc1$	0.05	0.90	0.12	0.10	0.08	0.07	$\Delta FCRc$	0.003	0.060	0.008	0.007	0.005	0.005
(allocated to products and not absorbed to units) customer level	SFCd	0.13	$\Delta SFCRd1$	0.15	0.18	0.20	0.20	0.12	0.10	$\Delta FCRd$	0.020	0.024	0.027	0.027	0.016	0.013
											0.046	0.115	0.072	0.066	0.046	0.042
Project Book Costs (depreciation)	FC	0.11	$\Delta FCR1$	0.22	0.47	0.47	0.47	0.47	0.47	$\Delta FCRe$	0.025	0.052	0.052	0.052	0.052	0.052
		0.53	$\Delta TFCR1 \sum \Delta SFCR + \Delta FCR$							$\Delta TFCR$	<b>0.070</b>	<b>0.167</b>	<b>0.124</b>	<b>0.119</b>	<b>0.099</b>	<b>0.094</b>
net impact on ROS at the entry level revenues										-	0.292	0.540	0.961	0.675	0.368	-0.061

Source table:II.1,2,3.

Table-II.5. shows the process of determining the Probability weighted Cash Inflow Rates on the PV of total investments in different stages of product lifecycle.

Particulars	entry level at 40% capacity	develo pment level	growth level	maturity	falling level	further falling	dying/ withdra wal
life cycle ROS on entry level revenues before Tax	-0.067	0.225	0.473	0.894	0.6080	0.301	-0.127
Tax: (ROSI*TR at .4)	0	0.090	0.189	0.358	0.243	0.121	0.000
ROSAT=(ROSI -Tax)	-0.067	0.135	0.284	0.536	0.365	0.181	-0.127
cost of the project at present value terms	100000	100000	100000	100000	100000	100000	100000
ITR=(IS/I)	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000	0.9000
ROIAT=(ROSAT*ITR)	-0.060	0.122	0.255	0.483	0.328	0.163	-0.115
depreciation rate on initial investment(100000)	0.1000	0.1222	0.1472	0.1472	0.1472	0.1472	0.1472
CIFR at initial investment=(ROIAT+DR)	0.0400	0.2439	0.4026	0.6299	0.4755	0.3099	0.0327
Present value of total investment (@10%discount of addl. capital)	131555	131555	131555	131555	131555	131555	131555
CIFR on PV of total investment (TI): (@10% )	0.0304	0.1854	0.3060	0.4788	0.3615	0.2356	0.0248
life span probability	0.100	0.100	0.200	0.200	0.200	0.100	0.100
Probability weighted life span CIFR on PV of total investment (PWCIFR on TI)	0.0030	0.0185	0.0612	0.0958	0.0723	0.0236	0.0025

Source table:II.4.

Table-II.6. shows process of determining the certainty equivalent Net Present Index Rate on PV of total Investments.

particulars	Rate on TI
AACIFR: Mean (Sum of PWACIFR on PV of TI)	0.2769
Stndv. of PWCIFR on T	0.0368
3*Stndv.	0.1103
CEAAIFR (Certainty Equiv. AACIFR):	0.1666
PV annuity @ 10% for 10 yeas	6.145
PVAACIFR: PV of CEAACIFR	1.024
CENPIR: (-1+PV of CIFIR) i.e.(-1+1.024)	0.024

Source table:II.4,5.

### Analysis of Product lifecycle expected certainty of forecasts:

Table-II.7. shows the determination of Net present Index Rate in progression under Normal annual returns and cash flow

particulars	entry level	development level	growth level		maturity		falling level		further falling	dying/exit/withdrawal
	1	2	3	4	5	6	7	8	9	10
Annual ROSBT(AROSBT)	-0.067	0.225	0.473	0.473	0.894	0.894	0.608	0.608	0.301	-0.127
tax	0.000	0.090	0.189	0.189	0.358	0.358	0.243	0.243	0.121	0.000
AROSAT	-0.067	0.135	0.284	0.284	0.536	0.536	0.365	0.365	0.181	-0.127
ITR=(IS/I) at initial investment(100000)	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
AROIAI at initial investment	-0.060	0.122	0.255	0.255	0.483	0.483	0.328	0.328	0.163	-0.115
ADR(annual depreciation Rate on initial investment)	0.100	0.122	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.147
ACIFR(on initial investment)	0.040	0.244	0.403	0.403	0.630	0.630	0.476	0.476	0.310	0.033
PV of total investment	131555	131555	131555	131555	131555	131555	131555	131555	131555	131555
ACIFR (on PV of total investment(131555))	0.030	0.185	0.306	0.306	0.479	0.479	0.361	0.361	0.236	0.025
PV Factor at 10 % rate	0.909	0.909	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386
PV of ACIFR on total investment at PV	0.028	0.169	0.230	0.209	0.297	0.270	0.185	0.169	0.100	0.010
NPIRP: (net present index rate in progression)	-0.972	-0.804	-0.574	-0.365	-0.068	0.203	0.388	0.557	0.657	0.666

Source table:II.4,5.

Table-II.8. shows the determination of Net present Index Rate under year to year progression (i.e. as cumulative progression) of operations.

Particulars	entry level	development level	growth level		maturity		falling level		further falling	dying/withdrawal
	1	2	3	4	5	6	7	8	9	10
extent of change in the returns during the life cycle from entry level	0	0.292	0.540	0.540	0.961	0.961	0.675	0.675	0.368	-0.061
ROSBT on revenues at the entry level	-0.067	0.225	0.473	0.473	0.894	0.894	0.608	0.608	0.301	-0.127
PROSBT (cumulative ROSBT of above)	-0.067	0.159	0.632	1.104	1.998	2.892	3.500	4.108	4.409	4.282
Progressive tax as per the financial accounting regulations (cumulative tax)	0.000	0.090	0.279	0.468	0.826	1.184	1.427	1.670	1.790	1.790

ROSAT=(ROSI -Tax)	-0.067	0.069	0.352	0.636	1.172	1.709	2.073	2.438	2.619	2.492
ITR=(IS/I) at initial investment(100000)	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
PROIAT	-0.060	0.062	0.317	0.572	1.055	1.538	1.866	2.194	2.357	2.243
Add PDR(progressive depreciation Rate on initial investment)	0.100	0.222	0.369	0.517	0.664	0.811	0.958	1.106	1.253	1.400
PCIFR(on initial investment)	0.040	0.284	0.687	1.089	1.719	2.349	2.824	3.300	3.610	3.643
*less rate of total depreciation to initial inv	1.0	1.2	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
PROIAT	-0.960	-0.916	-0.713	-0.311	0.319	0.949	1.424	1.900	2.210	2.243
PV of total investment	131555	131555	131555	131555	131555	131555	131555	131555	131555	131555
PCIFR (on PV of total investment)	-0.730	-0.696	-0.542	-0.236	0.242	0.721	1.083	1.444	1.680	1.705
PV Factor at 10 % rate	0.909	0.909	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386
NPIIR: (Progressive NPIR)	-0.663	-0.633	-0.407	-0.161	0.151	0.407	0.556	0.674	0.712	0.657

Source table:II.4,5,7.

Table-II.9. shows the determination of Net present Index Rate under year to year progression (i.e. as cumulative progression) of operations at the terminal value

Particulars	entry level	development level	growth level		maturity		falling level		further falling	dying/ withdrawal
	1	2	3	4	5	6	7	8	9	10
PROIAT=(PROSAT*ITR)	-0.730	-0.696	-0.542	0.236	0.242	0.721	1.083	1.444	1.680	1.705
annual depreciation rate on PV of total investment	0.076	0.169	0.281	0.393	0.505	0.617	0.728	0.840	0.952	1.064
** terminal value Rate on PV of total investment	0.924	0.831	0.719	0.607	0.495	0.383	0.272	0.160	0.048	-0.064
CIFRAT at Terminal value on PV of total investment	0.194	0.135	0.177	0.371	0.738	1.105	1.354	1.604	1.728	1.640
PV Factor at 10 % rate	0.909	0.909	0.751	0.683	0.621	0.564	0.513	0.467	0.424	0.386
NPIIRTV: (NPIIR at terminal value)	0.177	0.123	0.133	0.253	0.458	0.624	0.695	0.748	0.733	0.632

Source table:II.4,5,7,8.

Note:\* the deduction of total depreciation rate at the initial stage is to implicate the concepts of, being deemed of the project cost as sunk cost of the project and determination of results that enable to determine the net cash inflows in progression to assess the exact internal rate of index returns at present value. It is enabled to assess the results on net cash flows by the end of n<sup>th</sup> year in progression in the condition of no recognition of results up to the n<sup>th</sup> year under such sunk cost conditions.

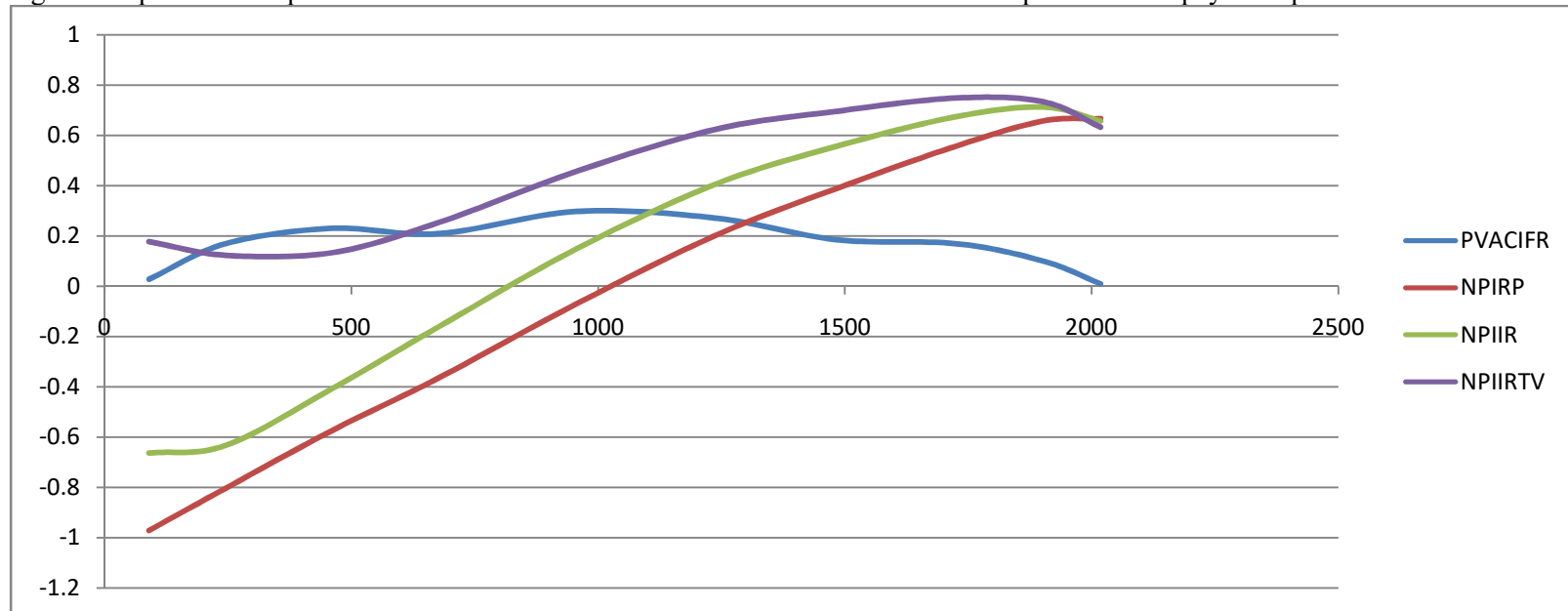
\*\*And in the other context i.e. the recognition of residual value/terminal value in the next enable to provide the net cash inflow rate at the terminal condition in progression as the possible realization of such sunk cost with the addition of residual value/terminal value rate at the end of each stage of assessment of results as of net cash inflows in progression to determine the net cash inflow rate at the terminal value.

Table-II.10. is data of the above analysis collected for graphical presentation of Net present Index/internal Index rates for clarity of purpose and distinctiveness of the rate of return in the progression of operations.

year	Progressive Sales by the end of year Rs. In '000	PVACIFR	NPIRP	NPIIR	NPIIRTV
1	90.00	0.028	-0.972	-0.663	0.177
2	245.25	0.169	-0.804	-0.633	0.123
3	461.25	0.230	-0.574	-0.407	0.133
4	677.25	0.209	-0.365	-0.161	0.253
5	958.50	0.297	-0.068	0.151	0.458
6	1239.75	0.270	0.203	0.407	0.624
7	1482.75	0.185	0.388	0.556	0.695
8	1725.75	0.169	0.557	0.674	0.748
9	1902.15	0.100	0.657	0.712	0.733
10	2018.48	0.01	0.666	0.657	0.632

Source table:II.7,8,9.

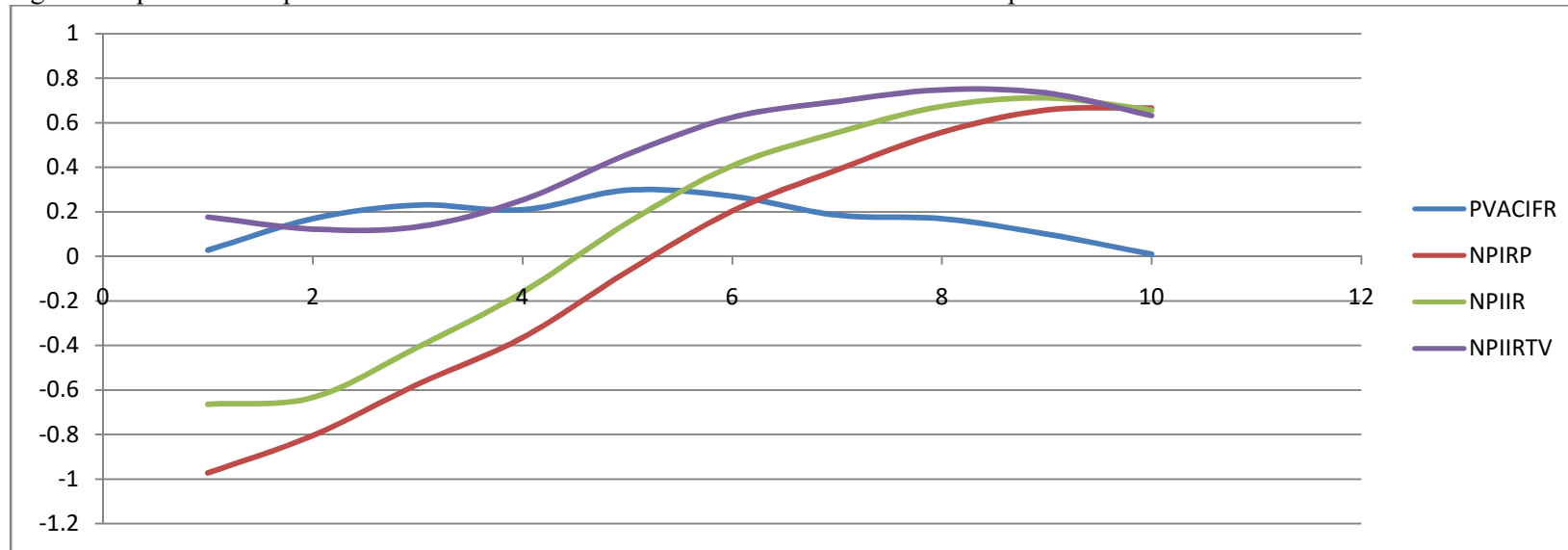
Figure-II.1 provides the picture of cash inflow rates under different criteria with distinct present value pay back periods



Source table:II.10



Figure-II.2 provides the picture of cash inflow rates under different criteria with distinct present value breakeven value of sales revenue



Source table:II. 10

The above graphical presentation enable to provide the much needed pay-back period in (accounting if needed), present value of normal annual cash inflow conditions as well as under deemed reinvestment within the project of earlier period cash inflows through the progressive accumulation concept. The points of intersection of X axis by the NPIRP, NPIIR and (as if NPIIRTV) reveals that a) The point of intersection by the NPIRP represents the normal discounted PBP, similarly the NPIIR represents the Discounted PBP under deemed internal reinvestment. Finally the NPIIRTV, if intersected, it indicates the discounted PBP under terminal value conditions. And the state of the curves beyond the intersection point represents the post pay-back period cash inflow index rate in progression of their respective condition. It can be observed at a glance on the figure II.1. Further, the figure II.2 the intersection points indicates the required sales for discounted Break-even under such distinct condition.

#### Conclusion:

This concept or technique that integrates the sensitivity with scenario through breakeven enables to provide the entire spectrum of parameters in period to period (year to year) in progression providing the reports in terms of normal present value of annual cash inflow rate on initial or present value of total investments and provides the profitability index rate directly. This integrated technique is enabled to provide the NPIR & NPIIR in terms of two conditions i.e. under deemed sunken and terminal investment value. And finally through the graphical presentation of results enable to provide the Present value Pay-back period under different conditions viz. under terminal value condition, under internal reinvestment of earlier cash inflows condition and as per the present value of annual cash inflow conditions of a project(s) under consideration. Further, the graphical presentation of the net present rate of index returns is very much helpful to determine the present value breakeven point of sales. The point of intersection of X axis by the respective curves in year/period based curve indicates the present value pay-back period and the revenue based graph indicates the present value break-even sales for recovery of total investment.

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