

Recommended Evaluation Practices (REPs) represent the society of Petroleum Evaluation Engineers' (SPEE) suggested treatment of hypothetical reserve evaluation topics. SPEE recognizes that, due to the varied nature of actual reserve evaluation situations likely to be encountered, these REPs are presented merely as suggested approaches. The REPs are not standards or guidelines. The use of or adherence to this SPEE REP is not required in any situation. The REPs should not be considered a substitute for the evaluator's professional judgment. This REP is subject to future revision(s) by the SPEE.

SPEE Recommended Evaluation Practice #10 – Calculating Internal Rate of Return

Background:

The internal rate of return (IRR) is the interest rate that causes the sum of the discounted net cash flows to equal zero. Alternatively defined, it is the interest rate that causes the discounted investment in an opportunity to just equal the discounted net cash benefits from that opportunity. In solving for the internal rate of return, a trial and error method is used wherein the cash flows are discounted at varying interest rates. Often, linear interpolation between two discount rates is used to estimate IRR. Since a graph of net present value as a function of discount rate is not linear, the choice of interest rates between which to interpolate affects the result.

In the Interpolation Method, net present values are calculated only at the interest rates stipulated by the user for output as a present value profile. The program finds the discount rates between which the sign of the net present value changes from positive to negative and interpolates between those two interest rates, typically using linear interpolation. Two users who specify different series of discount rates may see different reported IRR's.

In the Root-Finding Method, a mathematical technique such as bisection, Newton's method, or Generalized Reduced Gradient (GRG2) nonlinear optimization¹ is used to find the interest rate at which the net present value goes to zero. The reported value of IRR is accurate to the convergence criterion set by the programmer.

IRR is normally reported on an annual basis even though the calculation is often done on a monthly basis. After finding the monthly IRR there are two ways to convert to an annual IRR. One method is to simply multiply the monthly interest rate by 12 as shown in the following equation:

$$i_y = i_m * 12$$

An alternative method is to convert the monthly interest rate to an annual rate using the equation:

$$i_y = (1 + i_m)^{12} - 1$$

¹ www.solver.com discusses GRG2. Other algorithms can be found in applied mathematics texts.

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The 12th power equation is consistent with the discounting methodology recommended in SPEE REP #5 – Discounting Cash Flows.

Discussion:

A numerical example will illustrate the calculation. The IRR was calculated from the Net Cash Flows shown in the following table using mid-year discounting:

Example 1						
Year	Net Cash Flow	NPV @10%	NPV @20%	NPV @30%	NPV @40%	NPV @50%
0	-1000	-1000	-1000	-1000	-1000	-1000
1	500	477	456	439	423	408
2	400	347	304	270	241	218
3	300	236	190	156	129	109
4	200	143	106	80	62	48
5	150	98	66	46	33	24
6	120	71	44	28	19	13
7	70	38	21	13	8	5
Total	740	410	188	31	-85	-174

Using the Root-Finding Method, the IRR is 32.4% to one decimal place accuracy. Using the Interpolation Method, a user specifying the six discount rates in the profile shown in the table would calculate an IRR of 32.7%.

The difference may be magnified at higher IRRs and widely spaced discount rates. The table below shows another example where the Root-Finding Method yields an IRR of 61.6%, while the Interpolation Method results in an IRR of 118.0%.

Example 2					
Year	Net Cash Flow	NPV @10%	NPV @25%	NPV @50%	NPV @600%
0	-1000	-1000	-1000	-1000	-1000
1	700	667	626	572	265
2	600	520	429	327	32
3	300	236	172	109	0
4	200	143	92	48	0
5	150	98	55	24	0
6	120	71	35	13	0
7	70	38	16	5	0
Total	1140	774	426	98	-694

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SPEE Recommended Evaluation Practice:

The internal rate of return should be calculated using the same discounting basis as the net present value as shown in SPEE REP #5 – Discounting Cash Flows. If monthly calculations are performed the monthly interest rate should be converted to annual using the equation:

$$i_y = (1 + i_m)^{12} - 1$$

IRR should not be reported to more significant figures than it is calculated.

