hp calculators

HP 12C Internal Rate of Return

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Cash Flow and IRR calculations

Cash flow analysis is an extension of the basic TVM concepts applied to compound interest problems when payments occur in regular periods and do not have the same value. Any financial investment can be represented as an initial investment of money and a series of later cash flows that occur in regular periods of time. Each flow of money can be positive (received) or negative (paid out) and considered as a cash flow. Common cash flow problems usually involve the calculation of the Internal Rate of Return (\( IRR \)) or the Net Present Value (\( NPV \)).

The \( NPV \) expresses the amount of money resulting from the summation of the initial investment (\( CF_0 \)) and the present value of each anticipated cash flow (\( CF_j \)) calculated to the time of the initial investment. The \( IRR \) is the discounted rate applied to all future cash flows that cause \( NPV = 0 \).

The expression that calculates the Internal Rate of Return is:

\[
0 = CF_0 + \sum_{j=1}^{k} CF_j \times \left[ \frac{1 - (1 + IRR)^{-nj}}{IRR} \right] \times (1 + IRR)^{-nj} \quad \text{Figure 1}
\]

Cash flow diagrams

The cash flow diagram in Figure 1 illustrates one of the many possible situations that can be handled by the HP12C.

The HP12C cash flow approach

In the HP12C each cash flow amount is stored in its corresponding register in memory. For each cash flow amount there is a related register to store the number of consecutive occurrences of this amount. This approach is shown below:

<table>
<thead>
<tr>
<th>Registers</th>
<th>Cash flow</th>
<th>( N_j )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R_0 )</td>
<td>( CF_0 )</td>
<td>( N_0 )</td>
</tr>
<tr>
<td>( R_1 )</td>
<td>( CF_1 )</td>
<td>( N_1 )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( R_6 )</td>
<td>( CF_6 )</td>
<td>( N_6 )</td>
</tr>
<tr>
<td>( R_7 )</td>
<td>( CF_7 )</td>
<td>( N_7 )</td>
</tr>
<tr>
<td>( \ldots )</td>
<td>( \ldots )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( R_8 )</td>
<td>( CF_{18} )</td>
<td>( \ldots )</td>
</tr>
<tr>
<td>( R_9 )</td>
<td>( CF_{19} )</td>
<td>( N_{19} )</td>
</tr>
<tr>
<td>( FV )</td>
<td>( CF_{20} )</td>
<td>( N_{20} )</td>
</tr>
</tbody>
</table>

Figure 3
The HP12C memory organization allows up to 20 different cash flow amounts plus the initial investment to be stored and handled according to the diagram in Figure 2. If any cash flow amount repeats consecutively, then it can be stored as a grouped cash flow CFj and its corresponding Nj holds the number of occurrences, up to 99. TVM register n is used as an index to control CF operations.

The keys to enter cash flow data are:

- $gJ$ - stores the number in the display in $R0$ and sets n to zero
- $gK$ - adds 1 unit to current n contents (j) and then stores the number in the display in $Rj$
- $ga$ - stores the number in the display (*) in $Nj$; n contents (j) are not changed

(*) The number in the display must be a positive integer from 1 to 99, otherwise $gN$ returns Error 6 to the display and no operation is performed.

If the last available register has already been used, $gCFj$ adds 1 unit to current n contents and stores the number in the display in TVM register FV. Any attempt to add a cash flow amount with $gCFj$ after FV has already been used or when n contents refer to a register that is not available causes Error 6 to be shown in the display and no operation is performed.

Practice solving IRR problems

Example 1: The cash flow diagram below represents a possible investment and you were chosen to determine if it is feasible. The success of this investment dictates your future in the company, so the analysis must be precise and error free. What is the correct keystroke sequence to fill the HP12C registers with all data?

Solution: Clearing all registers is not necessary to start cash flow analysis because only the registers updated with cash flow data are used.

- $130,000.00 Þ gJ$
- $7,000.00 gK$
- $10,000.00 Þ gK$
- $20,000.00 CF3$
- $12,000.00 CF4$
- $8,000.00 CF5$
- $-130,000.00 CF0$
- $-10,000.00 CF2$
- $12,000.00 CF4$
- $178,500.00 CF6$
- $3$ consecutive occurrences $N3$
- $9,000.00 CHS$
The next cash flow amount occurs three times in a sequence, so it can be entered as a grouped cash flow.

```
20000 gK 3 ga
```

Figure 6

The remaining data is entered with the following keystroke sequence:

```
12000 gK 8000 Þ gK 178500 gK
```

Figure 7

**Answer:** The keystrokes presented above indicate the correct entries.

**Example 2:** The cash flow diagram had all of its information used to compose the cash flow data in the HP12C memory. Show how to check that they were entered correctly.

**Solution:** Now that all data is entered, checking for its correctness is possible in two ways. The most common way is the sequential check and the keystroke sequence for this checking is as follows:

```
RCL n
```

Figure 8

This is the number of the last register used to store the cash flow data. It will be needed later.

```
RCL 9 CF;
```

Figure 9

This is the amount of CF6. The sequential checking works backwards, and each time `RCL 9 CF;` is pressed, \( n \) is decreased by one unit. Now check CF5, CF4 and when checking CF3 verify \( N_3 \) as well.

```
RCL 9 CF;
RCL 9 CF;
RCL 9 N;
```

Figure 10
This is the N3 value. Whenever Nj needs to be checked, it must be recalled first. Now check the CF3 value:

\[
\text{RCL 9 CF1}
\]

\[
20,000.00
\]

Figure 11

Continue checking CF2, CF1 and stop when CF0 is shown in the display.

\[
\text{RCL 9 CF1}
\]

\[
\text{RCL 9 CF1}
\]

\[
\text{RCL 9 CF1}
\]

\[
-130,000.00
\]

Figure 12

Recall \( n \) contents to the display:

\[
\text{RCL n}
\]

\[
-1.00
\]

Figure 13

Answer: The entries are correct.

Example 3: The investment is considered attractive if it shows at least 8% of internal rate of return. Calculate the IRR.

Solution: To perform either IRR or NPV calculations, \( n \) must have its contents restored to the correct value:

\[
6 \ n \ f \text{IRR}
\]

(\text{flashing})

\[
9.37
\]

Figure 14

Answer: Yes, the investment is attractive based on its 9.37% internal rate of return.

How to modify cash flow entries

If it happens that a cash flow entry was wrongly entered, modifying its amount is not difficult and there is no need to enter all data again. In fact there are two ways for doing this.
Example 4: Update the amount of CF₂ for $-9,500.00 and compute the new IRR after this change.

Solution 1: Type in the correct amount and store it in R₂:

\[ 9 \begin{array}{lll} 5 & 0 & 0 \end{array} \] \text{CHS} \hspace{0.5cm} \text{STO} \hspace{0.5cm} 2 \hspace{0.5cm} \text{fIRR} \]

\[ 9.42 \]

Figure 15

Solution 2: Set \( n \) register to \((j-1)\), type in the correct amount, press \[ 9 \begin{array}{l} \text{CF} \end{array} \], then restore \( n \) prior to compute IRR:

\[ 1 \begin{array}{llll} n & 9 & 5 & 0 \end{array} \] \text{CHS} \hspace{0.5cm} 9 \begin{array}{l} \text{CF} \end{array} \hspace{0.5cm} 6 \hspace{0.5cm} n \hspace{0.5cm} \text{fIRR} \]

\[ 9.42 \]

Figure 16

Answer: The investment is still attractive based on revised IRR of 9.42%.

To modify a wrongly entered \( N_j \), it is necessary to change the value stored in the register \( n \).

Example 5: Now change both \( N_3 \) and \( N_4 \) to 2 and calculate the IRR again. The cash flow diagram now looks like this:

\[ \begin{array}{cccccccccc}
\$7,000.00 & CF_1 \\
\$-9,500.00 & CF_2 \\
\$20,000.00 & CF_3 \\
\$12,000.00 & CF_4 \\
\$-8,000.00 & CF_5 \\
\$178,500.00 & CF_6
\end{array} \]

Solution: For each correction, set \( n \) to match \( j \), type in the correct \( N_j \) and press \[ 9 \begin{array}{l} \text{N} \end{array} \]. After all corrections, set \( n \) to its original value and press \[ \text{fIRR} \].

\[ 3 \begin{array}{llll} n & 2 & 9 \end{array} \hspace{0.5cm} \text{N} \hspace{0.5cm} 4 \hspace{0.5cm} n \hspace{0.5cm} 2 \hspace{0.5cm} 9 \hspace{0.5cm} \text{N} \hspace{0.5cm} 6 \hspace{0.5cm} n \hspace{0.5cm} \text{fIRR} \]

\[ 8.77 \]

Figure 18

Answer: The newly computed IRR is 8.77%. 