Capital Budgeting

The $I$ in $V_{f,m} = f(I,F,D)$

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Capital Budgeting

- Process of deciding which long-term investments to make
- Current outlay followed by cash inflows beyond one year in the future
  - New equipment, plants, new products
  - Often replacing old equipment with new
- Expected return = required return?

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Temporary assumption

- Required return is given and is the same for all projects
- $k_o =$ required return or the hurdle rate
- Assumption will be relaxed in the next chapter when we consider risk
5 steps to capital budgeting

1. Generation of investment proposals
2. Estimation of expected cash flows
3. Evaluation of expected cash flows
4. Selection of proposals
5. Continual reevaluation of proposals after acceptance

We are mainly concerned with 2, 3 and 4

Estimation of expected cash flows

• Incremental $\Rightarrow$ CF of the firm with proposal vs. CF of firm without proposal
• After-tax $\Rightarrow$ what actually affects the common stockholders (available for retention or payout)
• CF = Net Income + Depreciation

Incremental cash flows

$\Delta CF = (\Delta S - \Delta C - \Delta D)(1-t) + \Delta D$

? S = change in sales revenue
? C = change in operating costs
? D = change in depreciation
t = firm's marginal tax rate
Horizontal income statement

Given: \( (\Delta S - \Delta C - \Delta D) = \Delta (\text{before - tax profits}) \)
if \( (\Delta S - \Delta C - \Delta D)(1 - t) = \Delta \text{taxes} \)
then \( (\Delta S - \Delta C - \Delta D)(1 - t) = \Delta (\text{after - tax profits}) \)
\[ \Delta CF = (\Delta S - \Delta C - \Delta D)(1 - t) + \Delta D \]

Replacement example

Old equipment: original cost= 60,000  \( SV = 0 \)
15 yr original life  currently 5 yrs old with a
\( MV = 8,000 \)
New equipment: Cost = 40,000  \( SV = 4,000 \)
10 yr life \( \Delta S = +4,000/\text{yr} \)  \( \Delta C = -8,000/\text{yr} \)
\( \Delta NWC = 10,000 \)
t = 50%  \( k = 10\% \)  straight-line depr. on both

Initial Outlay

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price new</td>
<td>$40,000</td>
</tr>
<tr>
<td>-Net proceeds sale of old</td>
<td>-24,000</td>
</tr>
<tr>
<td>+( \Delta NWC )</td>
<td>+10,000</td>
</tr>
<tr>
<td>Initial Outlay</td>
<td>$26,000</td>
</tr>
</tbody>
</table>
Net proceeds from sale of old

Net proceeds = MV – t(MV – BV)
MV = market value, BV = book value

D_{old} = (Cost – SV)/n = (60000-0)/15 = 4000/yr
BV = 60000 – 5(4000) = 40000
Net proceeds = 8000-.50(8000-40000)
Net proceeds = 24000

Net proceeds from sale of old

Net proceeds = MV – t(MV – BV)
What if MV>BV and machine is sold for a gain? Then there is a tax on the gain equal to t(MV-BV), and this tax is subtracted from the selling price to yield the net proceeds
The formula works for gains or losses

ΔNWC

ΔNWC = Δcurrent assets – Δcurrent liabilities
ΔNWC is additional motor oil or nuts and bolts needed to service the equipment
ΔNWC is additional cash that must be kept on hand if the proposal is accepted
ΔNWC is part of the initial outlay and is also a cash inflow at the end of the life of the project
Incremental Cash Flows ($\Delta CF$)

\[
\Delta CF = (\Delta S - \Delta C - \Delta D) (1 - t) + \Delta D
\]

$\Delta S = 4000$/yr and $\Delta C = -8000$/yr

$D_{old} = 4000$ $D_{new} = (40000 - 4000) / 10 = 3600$

$\Delta D = 3600 - 4000 = -400$/yr

$\Delta CF = (4000 - (-8000) - (-400))(1 - .5) - 400$

$\Delta CF = 5800$/yr for 10 years

Terminal cash flow

Often there is an extra cash inflow in the terminal year

Return of the $\Delta NWC = 10000$ since the motor oil, nuts and bolts, and cash are no longer needed

Incremental salvage value $\Delta SV = SV_{new} - SV_{old}$

$\Delta SV = 4000 - 0$

Total non-operating CF $= 10000 + 4000 = 14000$

Cash flow time line

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>-26000</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
<td>5800</td>
</tr>
</tbody>
</table>

Accept or reject?

Is forecasted rate of return $\geq k_s = 10$%?

Looks like a job for time value of money
Acceptance criteria

Two discounted cash flow methods

Internal Rate of Return (IRR)

Net Present Value (NPV)

Internal Rate of Return (IRR)

IRR \(=\) that discount rate that equates the present value of the expected cash inflows with the present value of the expected cash outflows

IRR \(=\) that discount rate that makes \(\text{PV}_{\text{in}} = \text{PV}_{\text{out}}\)

Accept if IRR \(\geq k_0\) and reject if IRR \(< k_0\)

Internal Rate of Return (IRR)

\[
\text{CF}_0 = \frac{\text{CF}_1}{(1+r)^1} + \frac{\text{CF}_2}{(1+r)^2} + \cdots + \frac{\text{CF}_n}{(1+r)^n} = \sum_{t=0}^{n} \frac{\text{CF}_t}{(1+r)^t}
\]

\(\text{CF}_t\) = cash flow, end of period \(t\)
\(n\) = life of the project
\(r\) = IRR
Internal Rate of Return

\[
26000 = \frac{5800}{(1+r)^1} + \frac{5800}{(1+r)^2} + \ldots + \frac{5800 + 4000 + 10000}{(1+r)^9}
\]

Solve for \( r \)

Accept if \( r = k_0 \), Reject if \( r < k_0 \)

Finding IRR using a financial calculator:

\(-26000 \rightarrow CF_j \quad 5800 \rightarrow CF_j \quad 9 \rightarrow N_j \)

\(19800 \rightarrow CF_j \quad IRR = 20.58\%\)

<table>
<thead>
<tr>
<th>Project</th>
<th>Outlay</th>
<th>IRR</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>1,000,000</td>
<td>30%</td>
</tr>
<tr>
<td>C</td>
<td>2,000,000</td>
<td>20%</td>
</tr>
<tr>
<td>A</td>
<td>500,000</td>
<td>13%</td>
</tr>
<tr>
<td>D</td>
<td>500,000</td>
<td>7%</td>
</tr>
</tbody>
</table>

IRR Schedule

- Capital Raised
- Cumulative outlay
Net Present Value (NPV)

NPV is present value of the expected cash inflows minus the present value of the expected cash outflows when all cash flows are discounted at the required rate $k_0$

Accept if $NPV = 0$
Reject if $NPV < 0$

Finding NPV using a financial calculator:
-26000\(\rightarrow CF_j\) 5800\(\rightarrow CF_j\) 9\(\rightarrow N_j\)
19800\(\rightarrow CF_j\) 1/YR\(\rightarrow 10\) NPV=15,036.10
Another definition of IRR

Since \( NPV = PV_{in} - PV_{out} \)
and IRR makes \( PV_{in} = PV_{out} \)

IRR can be defined as the discount rate that makes \( NPV = 0 \)

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Quick summary

Two alternative methods:
NPV = \( PV_{inflows} - PV_{outflows} \) discount at rate \( k_0 \)
IRR: \( PV_{inflows} = PV_{outflows} \) solve for IRR

Accept if \( NPV = 0 \) or IRR = \( k_0 \)
Reject if \( NPV < 0 \) or IRR < \( k_0 \)

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Quick summary of example

\[
NPV = -26000 + \frac{5800}{(1.10)^1} + \frac{5800}{(1.10)^2} + \cdots + \frac{5800 + 4000 + 10000}{(1.10)^5}
\]

\( NPV = 15,036 \)

\[
26000 = \frac{5800}{(1+IRR)^1} + \frac{5800}{(1+IRR)^2} + \cdots + \frac{5800 + 4000 + 10000}{(1+IRR)^5}
\]

\( IRR = 20.58\% \)
Why IRR = k₀ or NPV = 0?

Pretend entire $26,000 outlay is financed by a 10 yr loan at interest rate = 10%
Annual uniform payment to retire loan:
26000 = R(PVIFₜ₋₁₀%‐₁₀)  R=$4231/yr
Annual CF=5800 plus extra 14000 in yr 10
(5800-4231)(PVIFₜ₋₁₀%‐₁₀) + 14000/(1.10)¹⁰ = 15036

Possible conflict

<table>
<thead>
<tr>
<th>Period</th>
<th>Project A</th>
<th>Project B</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>23616</td>
<td>23616</td>
</tr>
<tr>
<td>1</td>
<td>10000</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10000</td>
<td>5000</td>
</tr>
<tr>
<td>3</td>
<td>10000</td>
<td>10000</td>
</tr>
<tr>
<td>4</td>
<td>10000</td>
<td>32675</td>
</tr>
<tr>
<td>NPV(k₀=10%)</td>
<td>8083</td>
<td>10347</td>
</tr>
<tr>
<td>IRR</td>
<td>25%</td>
<td>22%</td>
</tr>
</tbody>
</table>
Assumed reinvestment rates

IRR → All CF’s reinvested at the IRR
NPV → All CF’s reinvested at $k_0$

NPV: more realistic, more conservative, more consistent
Normally choose project with higher NPV

Modified IRR (MIRR)

Eliminates flaw of regular IRR method
 Assumes all CF’s reinvested at $k_0$
 Compute sum of CF’s at terminal point assuming reinvestment at $k_0$
 Solve for MIRR: discount rate that equates the PV of this terminal sum with initial outlay

Modified IRR (MIRR)

\[ FV_{A,4} = 10000 \times (FVIF_{a\text{-}10\%\text{-}4}) = 46,410 \]
\[ 23616 = 46410 / (1 + MIRR_A)^4 \] \quad MIRR_A \approx 18.4\%

\[ FV_{B,4} = 5000 \times (1.10)^2 + 10000(1.10)^1 + 32675 \]
\[ FV_{B,4} = 49,725 \]
\[ 23616 = 49725 / (1 + MIRR_B)^4 \] \quad MIRR_B \approx 20.5\%
Choose project B