Capital Budgeting

Learning Problems

Answer Keys

Problem: Project Evaluation Methods at Topley

1. Payback period

= 4.4 years

1. Discounted payback period

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cash Flow** | **Discount Factor** | **Present Value** | **Cumulative Present Value** |
| 0 | -220,000 | (1+.16)^0 | -220,000.00 | -220,000.00 |
| 1 | 50,000 | (1+.16)^1 | 43,103.45 | -176,896.55 |
| 2 | 50,000 | (1+.16)^2 | 37,158.15 | -139,738.40 |
| 3 | 50,000 | (1+.16)^3 | 32,032.88 | -107,705.52 |
| 4 | 50,000 | (1+.16)^4 | 27,614.55 | -80,090.97 |
| 5 | 50,000 | (1+.16)^5 | 23,805.65 | -56,285.32 |
| 6 | 50,000 | (1+.16)^6 | 20,522.11 | -35,763.21 |
| 7 | 50,000 | (1+.16)^7 | 17,691.48 | -18,071.73 |
| 8 | 50,000 | (1+.16)^8 | 15,251.27 | -2,820.46 |
| 9 | 50,000 | (1+.16)^9 | 13,147.65 | 10,327.19 |
| 10 | 50,000 | (1+.16)^10 | 11,334.18 | 21,661.37 |

Discounted payback period = 8 + = 8.21 years

1. NPV

50,000 () = 241,661.37

241,661.37 – 220,000 = 21,661.37

NPV is what remains after compensating investors for the RRR of 16%. This is the excess profit of the project in dollar terms and is equivalent to 2.60% in Part 4.

1. IRR

220,000 = 50,000 ()

i = .1860 or 18.60%

The RRR of the project is 16.00%, so the project is earning 2.60% more than required. This is the excess profit of the project in percentage terms.

Note: The IRR function in Excel can be used to solve for i.

1. Modified IRR

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | Cash Flow | FV Factor | FV (16%) | FV (18.6%) |
| 1 | 50,000 | (1+i)9 | 190,148.07 | 232,130.50 |
| 2 | 50,000 | (1+i)8 | 163,920.75 | 195,725.55 |
| 3 | 50,000 | (1+i)7 | 141,310.99 | 165,029.97 |
| 4 | 50,000 | (1+i)6 | 121,819.82 | 139,148.38 |
| 5 | 50,000 | (1+i)5 | 105,017.09 | 117,325.78 |
| 6 | 50,000 | (1+i)4 | 90,531.97 | 98,925.62 |
| 7 | 50,000 | (1+i)3 | 78,044.80 | 83,411.15 |
| 8 | 50,000 | (1+i)2 | 67,280.00 | 70,329.80 |
| 9 | 50,000 | (1+i)1 | 58,000.00 | 59,300.00 |
| 10 | 50,000 | (1+i)0 | 50,000.00 | 50,000.00 |
|  |  |  | 1 1,066,073.50 | 2  1,211,326.80 |



MIRR is 17.09%

1. PI

= 1.10

**Problem: Project Evaluation Methods at Cott Beverages**

1. Payback period

|  |  |
| --- | --- |
| **Year** | **Cumulative**  **Cash Flows** |
| 1 | 10,000 |
| 2 | 18,000 |
| 3 | 24,000 |
| 4 | 29,000 |
| 5 | 33,000 |
| 6 | 36,000 |
| 7 | 39,000 |

3 + () (1) = 3.8 years

1. Discounted payback period

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Cash Flow** | **Discount Factor** | **Present Value** | **Cumulative Present Value** |
| 0 | (28,000) | (1+.16)^0 | -28,000.00 | -28,000.00 |
| 1 | 10,000 | (1+.16)^1 | 8,620.69 | -19,379.31 |
| 2 | 8,000 | (1+.16)^2 | 5,945.30 | -13,434.01 |
| 3 | 6,000 | (1+.16)^3 | 3,843.95 | -9,590.06 |
| 4 | 5,000 | (1+.16)^4 | 2,761.46 | -6,828.60 |
| 5 | 4,000 | (1+.16)^5 | 1,904.45 | -4,924.15 |
| 6 | 3,000 | (1+.16)^6 | 1,231.33 | -3,692.82 |
| 7 | 3,000 | (1+.16)^7 | 1,061.49 | -2,631.33 |

The project does not break even on a present value basis.

1. NPV

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Cash Flow** | **Discount Factor** | **Present Value** |
| 1 | 10,000 | (1+.16)^1 | 8,620.69 |
| 2 | 8,000 | (1+.16)^2 | 5,945.30 |
| 3 | 6,000 | (1+.16)^3 | 3,843.95 |
| 4 | 5,000 | (1+.16)^4 | 2,761.46 |
| 5 | 4,000 | (1+.16)^5 | 1,904.45 |
| 6 | 3,000 | (1+.16)^6 | 1,231.33 |
| 7 | 3,000 | (1+.16)^7 | 1,061.49 |
| Total | | | 25,368.67 |

25,368.67 – 28,000.00 = <2,631.33>

The project is not earning its RRR of 16% as the NPV is negative.

1. IRR

28,000 = () + () + () + () + () + () + ()

i = .1186 or 11.86%

The project is not earning the RRR of 16%.

Note: IRR function in Excel can be used to solve for i.

1. PI

= .91

**Problem: Standalone Decision at Rogers**

1. No

|  |  |
| --- | --- |
| Initial investment | -120,000.00 |
| Tax Shield (120,000) (.45) () () | 34,531.85 |
| Increase in working capital | -5,000.00 |
| 1Annual savings | 71,332.15 |
| Salvage value (10,000) / (1+.12)4 | 6,355.18 |
| Lost tax shield (100,000) (.45) () () / (1+.12)4 | -1,828.80 |
| Decrease in working capital (5,000) / (1+.12)4 | 3,177.59 |
| NPV | -11,432.03 |

190,000 – 22,000 – 6,000 – 3,300 – 7,000 – 9,000 = 42,700

(42,700) (1 - .45) () = 71,332.15

1. Yes

(200) (90,000/450) – (22,000) – (200) (6,000/450) – (200) (7,000/450) – (200) (9,000/450) = 8,222.22

(8,222.22) (1 - .45) () = 13,735.57

-11,432.03 + 13,735.57 = 2,303.54

**Problem: Replacement Decision at Ruby**

1. Yes

|  |  |
| --- | --- |
| Net investment (500,000 – 50,000) | -450,000.00 |
| Tax shield (450,000) (.35) ()() | 100,277.27 |
| Increase in net working capital | -10,000.00 |
| Annual saving  (200,000) (2) (1-.35) () + (20,000) (4 + 2) (1-.35)) () | 1,803,205.05 |
| Salvage value (80,000-10,000) / (1+.10)8 | 32,655.52 |
| Lost tax shield (80,000-10,000) (.35) ()() / (1+.10)8 | -7,273.27 |
| Decrease in net working capital (10,000) / (1+.10)8 | 4,655.07 |
| NPV | 1,473,469.64 |

**Problem: Replacement Decision at Zebra**

1. Yes

|  |  |
| --- | --- |
| Net investment (141,000 – 10,000) | -131,000.00 |
| Tax shield (131,000) (.31) () () | 24,454.45 |
| Decrease in net working capital | 30,000.00 |
| 1Annual savings (191,250) (1-.31) () | 550,322.43 |
| Salvage value (18,000) / (1 + .115)6 | 9,367.49 |
| Lost tax shield (18,000) (.31) () () / (1+.115)6 | -1,748.68 |
| Increase in net working capital (30,000) / (1+.115)6 | 15,612.49 |
| NPV | 465,783.20 |

1

|  |  |
| --- | --- |
| Additional units (12.00-5.75) (15,000) | 93,750 |
| Savings – VC (7.50-5.75) (50,000) | 87,500 |
| Savings – FC | 10,000 |
| Total | 191,250 |

**Problem: Standalone Decision with Inflation at Weatherly**

1. Nominal approach

|  |  |
| --- | --- |
| Investment | -3,500,000 |
| Tax shield (3,500,000) (.21) ()() | 542,043 |
| 1Annual savings | 2,776,826 |
| Salvage value (450,000) (1 + .02)5 / (1 + .09)5 | 322,910 |
| Lost tax shield (496,836) (.21) ()() / (1 + .09)5 | -50,009 |
| NPV | 91,770 |

1 (6,000) (16) (17.21 – 5.24) – (2) (115,000) – 65,000 = 854,120

(854,120) (1 - .21) = 674,755

Year 1 (674,755) (1 + .02)1 / (1 + .09)1 = 631,422

Year 2 (674,755) (1 + .02)2 / (1 + .09)2 = 590,872

Year 3 (674,755) (1 + .02)3 / (1 + .09)3 = 552,926

Year 4 (674,755) (1 + .02)4 / (1 + .09)4 = 517,417

Year 5 (674,755) (1 + .02)5 / (1 + .09)5 = 484,189

Total PV = 2,776,826

1. Real approach

(1 + .09) = (1 + .02) (1 + Real rate) - 1

Real rate = .0686

|  |  |
| --- | --- |
| Investment | -3,500,000 |
| Tax shield (3,500,000) (.21) ()() | 579,008 |
| 1Annual savings | 2,777,030 |
| Salvage value (450,000) / (1 + .0686)5 | 322,951 |
| Lost tax shield (450,000) (.21) ()() / (1 + .0686)5 | -64,175 |
| NPV | 114,814 |

1 (6,000) (16) (17.21 – 5.24) – (2) (115,000) – 65,000 = 854,120

(854,120) (1 - .21) = 674,755

Year 1 (674,755) / (1 + .0686)1 = 631,438

Year 2 (674,755) / (1 + .0686)2 = 590,902

Year 3 (674,755) / (1 + .0686)3 = 552,969

Year 4 (674,755) / (1 + .0686)4 = 517,470

Year 5 (674,755) / (1 + .0686)5 = 484,251

Total PV = 2,777,030

**Why are the NPVs for the nominal and real approach not equal?** It is due to more than simply rounding errors. Under the nominal approach, it is assumed that future cash flows will increase by 2.0% each year and that the nominal discount rate of 9.0% has an allowance for this inflation plus the real rate. Under the real approach, the increase in future cash flows due to inflation is ignored and inflation is left out of the discount rate as well and all discounting is done at the real rate of 6.86% - inflation essentially cancels out in the numerator and denominator.

When the CAD 3,000,000 is put in a CCA pool, the government does not allow these amounts to be increased each year to compensate for inflation. The government has considered indexing the contents of CCA pools but has decided against it because of the magnitude of lost tax revenues. As a result, the RRR used in the present value of the CCA tax shield calculation must be 9.0% and not 6.86% since the value of the pool does not rise by the inflation rate each year. There is no inflation in the numerator to cancel out with the denominator.

The correct calculation of the NPV under the real approach is:

|  |  |
| --- | --- |
| Investment | -3,500,000 |
| Tax shield (3,500,000) (.21) ()() | 542,043 |
| 1Annual savings | 2,777,030 |
| Salvage value (450,000) / (1 + .0686)5 | 322,951 |
| Lost tax shield (450,000) (.21) ()() / (1 + .0686)5 | -50,015 |
| NPV | 92,009 |

1 (6,000) (16) (17.21 – 5.24) – (2) (115,000) – 65,000 = 854,120

(854,120) (1 - .21) = 674,755

Year 1 (674,755) / (1 + .0686)1 = 631,438

Year 2 (674,755) / (1 + .0686)2 = 590,902

Year 3 (674,755) / (1 + .0686)3 = 552,969

Year 4 (674,755) / (1 + .0686)4 = 517,470

Year 5 (674,755) / (1 + .0686)5 = 484,251

Total PV = 2,776,826

1. The general inflation estimate of 2.0% is reasonable for operating costs, but not for metal prices. The price of most metals is unstable. A more thorough analysis of the metal price over the next five years is needed before a decision can be made. Even with this, the price of most metals is difficult to forecast meaning project risk is high.

**Problem: Standalone Decision with Inflation at Quaker**

1. No

.05 + .03 = .08

(1 + .08) = (1 + .0250) (1 + X)

X = .0537

|  |  |  |
| --- | --- | --- |
| Net investment | (2,500,000) (.95) | -2,375,000 |
| Tax Shield | (2,375,000) (.3) ()() | 490,079.31 |
| Change in NWC | (2,900,000) (.3) | -870,000 |
| 1Annual Savings |  | 2,241,556.23 |
| Change in NWC | ((3,500,000) (.3) – (2,900,000) (.3)) / (1 + .0537)6 | 131,513.59 |
| Overhaul | (850,000) (.95) / (1 + .0537)6 | -589,984.57 |
| **Tax Shield** | (850,000) (.95) (.3) () () / (1 + .0537)6 | 121,742.85 |
| Salvage value | 350,000 / (1 + .0537)12 | 186,837.60 |
| **Lost Tax Shield** | (350,000) (.3) () () / (1 + .0537)12 | -38,553.79 |
| Change in NWC | (3,500,000) (.3) / (1 + .0537)12 | 560,512.80 |
|  | NPV | -141,295.98 |

**1Years 1–6**

(2,900,000 - 1,900,000 - 800,000) = 200,000

(200,000) (1 - .3) () = 702,265.44

**Years 7–12**

(3,500,000 - 2,100,000 - 800,000) = 600,000

(600,000) (1 - .3) () / (1 + .0537)6 = 1,539,290.79

**Problem: Capital Rationing at Bosie**

1. D and F

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Project** | **Investment** | **Profitability Index** | **NPV** | **Selection** | **Total Investment** | **Total NPV** |
| A | 4,000,000 | 1.18 | 720,000 | 0 |  |  |
| B | 3,000,000 | 1.08 | 240,000 | 0 |  |  |
| C | 5,000,000 | 1.33 | 1,650,000 | 0 |  |  |
| D | 6,000,000 | 1.31 | 1,860,000 | 1 | 6,000,000 | 1,860,000 |
| E | 4,000,000 | 1.19 | 760,000 | 0 |  |  |
| F | 6,000,000 | 1.20 | 1,200,000 | 1 | 6,000,000 | 1,200,000 |
| G | 4,000,000 | 1.18 | 720,000 | 0 |  |  |
|  |  |  |  | Total | 12,000,000 | 3,060,000 |

See the Excel spreadsheet

**Problem: Projects of Varying Lives at Wilson**

1. Project 1 (Best Project)



Project 2



2. Project 1 (Best Project)



Project 2



1. The assumption is that once the project is complete it can be repeated with the same return. This is reasonable for routine projects like machinery replacement, but it is not reasonable for one-time projects like new products.

**Problem: Projects of Varying Lives at Jensen**

1.

Project 1 (Best Project)

+ + – 65,000 = 37,956.87

37,956.87 + = 68,088.26

Project 2

27,000 () – 79,000 = 45,817.75

2.

Project 1 (Best Project)

P () = 37,956.87

P = 14,728.54

Project 2

P () = 45,817.75

P = 9,911.08

3.

The assumption is that once the project is complete it can be repeated with the same return. This is reasonable for routine projects like machinery replacement, but it is not reasonable for one-time projects like new products.

**Problem: Changes in Net Working Capital at Amsterdam**

1**.**

|  |  |  |
| --- | --- | --- |
| **Year** | **Net Working Capital** | **Change in Net Working Capital** |
| 2012 | 2,500,000 / 9.1 = 274,725 |  |
| 2013 | 3,400,000 / 7.9 = 430,380 | +155,655 |
| 2014 | 3,800,000 / 7.9 = 481,013 | +50,633 |
| 2015 | 3,900,000 / 7.9 = 493,671 | +12,658 |
| 12015 | 493,671 – 274,725 = 218,946 | -218,946 |

NWC will rise over the life of the project (2013 - CAD 155,655, 2014 – CAD 50,633, 2015 - CAD 12,658) before returning to its original level (CAD 274,725) at the end of 2015.

**Problem: Taxation Effects of Terminal Cash Flows**

1.

**Case 1**

**Terminal Cash Flows**

Sale of land 4,000,000

1Capital gains tax -525,000

1(4,000,000 – 1,000,000) (.50) (.35)

What if the land is sold for CAD 500,000?

**Terminal Cash Flows**

Sale of land 500,000

1Capital loss benefit 87,500

1(500,000 – 1,000,000) (.50) (.35)

**Case 2**

**Terminal Cash Flows**

Sales of building 600,000

1Capital gain -17,500

2Recapture -53,804

1(600,000 – 500,000) (.5) (.35)

2(346,275 – 500,000) (.35)

What if the building is sold for CAD 100,000?

**Terminal Cash Flows**

Sale of building 100,000

1Terminal loss 86,196

1(346,275 – 100,000) (.35)

**Case 3**

**Terminal Cash Flows**

Sale of equipment 50,000

1Present value of future CCA 13,040

1(102,042 – 50,000) (.35) () ()

What if the equipment is sold for CAD 120,000?

**Terminal Cash Flows**

Sales of equipment 120,000

1Present value of future CCA -4,500

1(102,042 – 120,000) (.35) () ()

What if the equipment is sold for CAD 600,000?

**Terminal Cash Flows**

Sales of equipment 600,000

1Capital gains tax -17,500

2Present value of future CCA -97,716

1(600,000 – 500,000) (.5) (.35)

2(102,042 – 500,000) (.35) () ()

**Problem: Managing Risk by Adjusting the Discount Rate at Rexall**

1. Yes

(1 + .09) = (1 + Real rate) (1 + .025) - 1

Real rate = .0634

|  |  |
| --- | --- |
| Net investment (85,600 + 5,992 + 1,000 + 2,500 - 45,500) | -49,592 |
| Tax shield (49,592) (.32) () () | 11,187 |
| Change in working capital | 25,000 |
| 1Annual savings | 1,037,981 |
| Overhaul 200,000 / (1 + .0634)5 | -147,078 |
| Tax shield (200,00) (.32) () () / (1 + .0634)5 | 33,178 |
| Salvage value (12,000 – 1,500) / (1 + .0634)10 | 5,678 |
| Lost tax shield (10,500) (.32) () () / (1 + .0634)10 | -1,281 |
| Change in working capital 25,000 / (1 + .0634)10 | -13,520 |
| NPV | 901,553 |

1 Years 1 – 5

(55,000) (1.50 – (1.29 - .35)) – 10,000 = 20,800

(580,000) (.35) = 203,000

(20,800 + 203,000) (1 - .32) () = 635,168.23

Years 6 – 10

(580,000) (.35) = 203,000

203,000 – 10,000 = 193,000

(193,000) (1 - .32) () = 547,754.55

547,654.55 / (1 + .0634)5 = 402,812.29

Total PV = 1,037,981

**Problem: Managing Risk by Adjusting the Discount Rate at Dodson**

1.

**Project A (Best Project)**

-185,000 + + + + = 43,549

**Project B**

-240,000 + + + + = 37,111

**Project C**

-315,000 + 95,000 () = 27,454

**Problem: Managing Risk through Management Options at Hansen**

1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **t=0** | **t=1** | **t=2** | **t=3** | **t=4** | **t=5** | **Joint Probability** |
|  |  |  | 17,500  50% | 22,500 | 22,500 | 0.210 |
|  |  | -9,000  60% | 7,500  30% | 7,500 | 7,500 | 0.126 |
|  | -1,000  70% |  | -3,000  Stop  20% |  |  | 0.084 |
| -620 |  | Stop  40% |  |  |  | 0.280 |
|  | Stop  30% |  |  |  |  | 0.300 |
| Note: All values are in thousands. | | | | | | |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NPV** | **Joint Probability (P)** | **NPV x P** | **NPV – E(NPV)** | **P (NPV – E(NPV))2** |
| 34,232.65 | 0.210 | 7,188.86 | 27,771.93 | 161,968,767.54 |
| 6,654.08 | 0.126 | 838.41 | 193.36 | 4,710.78 |
| -11,324.30 | 0.084 | -951.24 | -17,785.02 | 26,569,790.23 |
| -1,533.24 | 0.280 | -429.31 | -7,993.96 | 17,892,961.20 |
| -620.00 | 0.300 | -186.00 | -7,080.72 | 15,040,979.85 |
|  | **E(NPV)** | **6,460.72** | **Ơ2** | **221,477,209.61** |
|  |  |  | **Ơ** | **14,882.11** |
|  |  |  | **CV (Ơ/E(NPV))** | **2.30** |

2.

**Abandonment:** The project could be abandoned at three different points over its life depending on the potential outcomes.

**Flexibility:** The price could be increased in Years 4 and 5 if demand for the product was high.

**Growth:** Production could be expanded in Years 4 and 5 if demand for the product was high.

**Problem: Managing Risk through Management Options at Acme**

1.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **t=0** | **t=1** | **t=2** | **t=3** | **t=4** | **t=5** | **t = 6** | **Joint Probability** |
|  |  |  | 3,500-1,000  60% | 4,500 | 4,500 | 4,500 | 0.18 |
|  |  | <5,000>  50% | 2,000  20% | 2,000+3,000  Stop |  |  | 0.06 |
|  | <475>  60% |  | 1,000+3,000  Stop  20% |  |  |  | 0.06 |
| <500> |  | 150  Stop 50% |  |  |  |  | 0.30 |
|  | 125  Stop  40% |  |  |  |  |  | 0.40 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NPV** | **Joint Probability (P)** | **NPV x P** | **NPV – E(NPV)** | **P (NPV – E(NPV))2** |
| 4,562.47 | 0.18 | 821.24 | 4,222.50 | 3,209,308.69 |
| -275.83 | 0.06 | -16.55 | -615.80 | 22,752.43 |
| -1,841.92 | 0.06 | -110.52 | -2,181.89 | 285,638.10 |
| -718.33 | 0.30 | -215.50 | -1,058.30 | 335,998.36 |
| -346.78 | 0.40 | -138.71 | -686.75 | 188,649.09 |
|  | **E(NPV)** | **339.97** | **Ơ2** | **4,042,346.67** |
|  |  |  | **Ơ** | **2,010.56** |
|  |  |  | **CV** | **5.91** |

2.

**Abandonment:** The project could be abandoned at four different points over its life depending on the potential outcomes.

**Growth:** Production could be expanded to take advantage of high product demand in Years 4, 5, and 6.

**Problem: Complex Capital Budgeting with Spreadsheets at Magnum**

1. See the Excel spreadsheet
2. See the Excel spreadsheet
3. Electric cars are the preferred project with a positive NPV and an IRR that exceeds its RRR.

|  |  |
| --- | --- |
| **Electric Cars** | |
| NPV | CAD 67,198,203 |
| IRR | 24.73% (RRR = 10.00%) |
| Payback Period | 6 Years, 3 Months (15 Year Project) |
| **Solar Generators** |  |
| NPV | -CAD 5,325,555 |
| IRR | 13.18% (RRR=16.00%) |
| Payback Period | None |

The NPV of the solar generators project was affected by its high-risk level (i.e. a more cyclical business in a new industry) and narrow profit margin. To generate a positive NPV, increasing prices or lowering operating costs should be explored. Also, a larger factory may help the company better meet demand (i.e. plant capacity was reached) in the later years of the project which will increase its NPV.