Chapter 7: Investment Decision Rules

I. Introduction and Review of NPV

A. Introduction

Q: How decide which long-term investment opportunities to undertake?

Key => a number of investment decision rules exist
   => examine each and why inferior to NPV

Note: Projects may be either mutually exclusive or independent

   Mutually exclusive => can accept only one
   Independent => can accept any or all

B. Review of NPV

1. Definition => present value of all cash flows (positive and negative)

2. Criteria:
   Key => NPV measures value of project
      => if undertake project, value of firm changes by NPV of project.

      Independent => accept project if NPV > 0
      Mutually Exclusive => accept project with highest NPV > 0

3. Advantages of NPV

   (1) Based on cash flow
   (2) Considers all cash flows
   (3) Incorporates the time value of money

II. Payback period

A. Definition: number of years to recover investment

   key => # of years before accumulated cash flow becomes ≥ 0

B. Criteria:

   Independent: accept project if payback ≤ acceptable maximum
   Mutually exclusive: accept project with shortest payback ≤ acceptable maximum
C. Problem => project with shortest payback may not be project that increases wealth the most.

Reasons:

1) Ignores timing of cash flow within the payback period

Ex.

Project 1 => CF = -1000, 900, 100, 500
Project 2 => CF = -1000, 100, 900, 500

=> project 1 is clearly better, but projects have same payback period

2) Ignores cash flow after the payback period.

Ex.

Project 1 => CF = -1000, 1000, 100
Project 2 => CF = -1000, 1000, 100 billion

=> project 2 is obviously better, but projects have same payback period

3) Ignores risk differences between projects

4) Arbitrary criteria

=> acceptable maximum cannot be set so that wealth maximizing decisions always made.

Q: Why used at all?

=> easy to understand and use

III. Internal Rate of Return Rule

A. Definition: rate of return on project key => discount rate that makes NPV = 0.

=> Solving for IRR:

1. Use Excel or financial calculator
2. Trial and Error

Steps

1) try a rate
2) if NPV = 0, done
3) if NPV ≠ 0, try again

Note: Graph of relationship between NPV and discount rate may be helpful.

=> IRR is the horizontal intercept for each project
=> Project A has highest IRR regardless of required return
=> Projects A and B have same NPV if required return = 17.4%
=> If required return < 17.4%, project B has highest NPV. If > 17.4%, project A has highest NPV
=> IRR gives incorrect ranking if required return < 17.4%

B. Criteria:

Independent: accept project if IRR ≥ required return
Mutually Exclusive: accept project with highest IRR ≥ required return
C. Problems

1. Project w/ highest IRR may not be project that increases wealth the most.

   Reasons:

   1) Projects differ in scale (size)

      Ex. Would you rather invest $1 and get back $1.50 (50% IRR) or invest $1000
      and get back $1200 (20% IRR)?

   2) Projects have different distributions of cash flows across time

      => NPV of projects dominated by long-term cash flows fall faster as increase
discount rate that projects dominated by short-term cash flows
      => long-term projects may have lower IRR other things equal.

   3) If project is more like borrowing than lending, should reverse the criteria

      => if project is more like borrowing than lending, accept project with lowest
IRR as long as less than required return.

   Keys

   1] lending => early cash outflows followed by cash inflows
      => want highest return possible
   2] borrowing => early cash inflows followed by cash outflows
      => want lowest possible return (interest rate)
Ex. Reversed Criteria

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>+15,000</td>
</tr>
<tr>
<td>1</td>
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</tr>
<tr>
<td>2</td>
<td>-6000</td>
</tr>
<tr>
<td>3</td>
<td>-6000</td>
</tr>
</tbody>
</table>

IRR = 9.7%. NPV positive if required return > 9.7%
=> IRR < required return

Note: Not always easy to tell if project is more like borrowing or lending

2. May have multiple IRRs

Key => can have as many IRRs as changes in sign of cash flows

Notes:

1) unclear which IRR should base decision on
2) unclear what decision rule should be
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Ex. Multiple IRR

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<thead>
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<tbody>
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<tr>
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<tr>
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<td>2000</td>
</tr>
<tr>
<td>3</td>
<td>4000</td>
</tr>
<tr>
<td>4</td>
<td>12,000</td>
</tr>
<tr>
<td>5</td>
<td>-20,000</td>
</tr>
</tbody>
</table>

IRR = 4.5% and 56%

3. May have no IRR

Ex.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cash flows</th>
</tr>
</thead>
<tbody>
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<td>-9000</td>
</tr>
<tr>
<td>1</td>
<td>8000</td>
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</tr>
<tr>
<td>4</td>
<td>12,000</td>
</tr>
<tr>
<td>5</td>
<td>-20,000</td>
</tr>
</tbody>
</table>

No IRR => NPV negative at all discount rates.

4. Cannot compare projects with different risk

IV. Profitability Index (PI)

A. Definition: \( \frac{NPV}{\text{resources consumed}} \)

B. Criteria:
   - Independent: accept project if PI \( \geq 0 \)
   - Mutually Exclusive: accept project with highest PI \( \geq 0 \)
C. Problem => project with largest PI may not be project that increases wealth the most.

Reason => Ignores scale

=> tells us NPV per resource invested

=> impact on wealth also depends on how many resources used in project

Note: useful if single-period capital rationing

capital rationing => insufficient capital to undertake all projects

key => measures “bang for the buck”

=> helps us figure out which combination of projects gives highest total NPV for limited number of $