Selection Techniques for Mutually Exclusive Projects

Project Selection Methods

Some Terminology…

Mutually Exclusive Projects: Only 1 project can be selected among several options. By selecting one project, you are deciding not to select the other projects.

Example: You can buy an Acme 3D Printing machine, or a Hi-Tech 3D printing machine, but not both.

Independent Projects: Several projects can be selected, limited only by how much money is available to invest. Selecting one project has no bearing on the decision to select other projects.

Example: Your company has $1M to invest in new projects. It selects the best 4 projects from a list of 20 submitted for review.

Selection of Mutually Exclusive Projects

At a Discount Rate of 15%, which project do you select?

	Investment (Today)	End of Year 1	End of Year 2	End of Year 3	End of Year 4	End of Year 5
Project A	$1,000	$5,000				
Project B	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000

What are the NPVs & IRRs for these projects?

Selection of Mutually Exclusive Projects

	A	B	C	D	E	F	G
1	**Comparing Mutually Exclusive Projects**						
2							
3	**Initial Investment:**	**$1,000**					
4	**Discount Rate:**	**15%**					
5							
6		**End of Year Cash Flows**					
7		**0**	**1**	**2**	**3**	**4**	**5**
8	**Project A**	-$1,000	$5,000				
9	**Project B**	-$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
10							
11	**Project A**						
12	PV (Yr 1-5):	$4,348	*=NPV(B4, C8:G8)*				
13	Init. Investment:	$1,000	*=B3*				
14	**NPV:**	**$3,348**	*=B12-B13*				
15	**IRR:**	**400%**	*=IRR(B8:G8)*				
16							
17	**Project B**						
18	PV (Yr 1-5):	$3,352	*=NPV(B4, C9:G9)*				
19	Init. Investment:	$1,000	*=B3*				
20	**NPV:**	**$2,352**	*=B18-B19*				
21	**IRR:**	**97%**	*=IRR(B9:G9)*				

Project A:
NPV = $3,348
IRR = 400%

Project B:
NPV = $2,352
IRR = 97%

Just select the project with the greatest NPV and you'll be correct all the time…

What about these projects?

Project X:

Initial Investment	1	2	3	4	5	6	7	8	9	10
-2500	500	500	500	500	500	500	500	500	500	500

Project Y:

Initial Investment	1	2	3	4	5	6	7	8	9	10
-2500	100	200	300	400	500	600	700	800	900	1000

	NPV (Disc. Rate = 5%)	IRR
Project X	$1,361	17%
Project Y	$1,437	13%

The NPV approach, *always* selects the right project (Benefits exceed Costs).

Selecting a project based on IRR is usually right, but sometimes may not be consistent with the NPV selection.

Into the Weeds: the Internal Rate of Return

While the IRR is useful at determining a project's actual rate of return, it sometimes has some problems…

Consider the following: you invest $100 into an account that is yields a 5% rate of return. What is your account worth after 3 years?

Year 0	Year 1	Year 2	Year 3
$100.00	$105.00	$110.25	$115.76

In essence, we "reinvest" the interest earned, which then compounds at the 5% interest rate.

Into the Weeds: the Internal Rate of Return

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Year 0	Year 1	Year 2	Year 3
$100.00	$105.00	$110.25	$115.76

The Present Value of our $115.76 is: $$PV = \frac{FV}{(1+i)^N} = \frac{\$115.76}{(1+0.05)^3} = \$100.00$$

Our Present Value calculations assume the earnings are reinvested at the interest rate, i.

Into the Weeds: the Internal Rate of Return

When we calculate NPV of a project:

$$NPV = PV_{Inflows} - PV_{Outflows}$$

we resort to the formula for the inflows (or let excel do it):

$$PV = A\left[\frac{(1+i)^N - 1}{i\,(1+i)^N}\right]$$

In this case, we implicitly assume that the cash flows are reinvested at the the rate of return determined by the discount rate.

The company takes a project's annual profits and reinvests them into new projects, with a rate of return of at least the hurdle rate.

Into the Weeds: the Internal Rate of Return

But when we calculate IRR of a project:

IRR is the rate of return when: $PV_{Inflows} = PV_{Outflows}$

We do this by iterating on the formula (or let excel do it):

$$A\left[\frac{(1+IRR)^N - 1}{IRR\,(1+IRR)^N}\right] = P_0$$

In this case, we implicitly assume that the cash flows are now reinvested at the IRR, which companies don't do.

This leads to the project's rate of return being higher than it really is (the source of the problems we've seen so far…).

Into the Weeds: the Internal Rate of Return

We can solve this dilemma using the “Modified Internal Rate of Return”, or MIRR.

The MIRR forces the “reinvestment” to be at the discount rate (or whatever rate you want), providing a more accurate assessment of a project’s actual rate of return.

Excel’s MIRR Function:

MIRR (values, finance rate, reinvest rate)

values: the same cash flows we selected for the IRR

finance rate: typically the discount rate, or whatever the rate is for a loan

reinvest rate: what you want it to be, but take the discount rate again…

Modified Internal Rate of Return (MIRR)

Back to our 3D Printer Example…

By forcing the finance rate & reinvestment rate to be the discount rate, we effectively are saying the company takes the profits from this project and uses them for other projects that achieve at least the MARR.

	A	B	C	D	E	F	G
1	**3D Printer Example**						
2							
3	**Initial Investment:**	**$100,000**					
4	**Annual Profits:**	**$40,000**					
5	**Time (years):**	**5**					
6	**Discount Rate:**	**16%**					
7							
8		**End of Year Cash Flows**					
9	**Year**	**0**	**1**	**2**	**3**	**4**	**5**
10	**Cash Flow**	-$100,000	$40,000	$40,000	$40,000	$40,000	$40,000
11							
12	PV (Yr 1-5):	$130,972	*=NPV(B7, C11:G11)*				
13	Initial Investment:	$100,000	*=B3*				
14	**Net Present Value, NPV:**	**$30,972**	*=B13-B14*				
15							
16	**Internal Rate of Return, IRR:**	**29%**	*=IRR(B10:G10)*				
17							
18	**Modified IRR, MIRR:**	**22%**	*=MIRR(B10:G10, B6, B6)*				

If the MIRR > Discount Rate, It is a good project.

=MIRR(values, finance rate, reinvest rate)

One last example…

	A	B	C	D	E	F	G	H	I
1	**Fixing the IRR Dilemma with the MIRR**								
2									
3	**Initial Investment:**	**$1,000**							
4	**Discount Rate:**	**10%**							
5									
6	**Project A**	**End of Year Cash Flows**				**Project B**	**End of Year Cash Flows**		
7		**0**	**1**	**2**			**0**	**1**	**2**
8	**Cash Flows:**	-$1,000	$1,150	$100		**Cash Flows:**	-$1,000	$100	$1,300
9									
10	PV (Yr 1-2):	$1,128				PV (Yr 1-2):	$1,165		
11	Init. Investment:	$1,000				Init. Investment:	$1,000		
12	**NPV:**	**$128**				**NPV:**	**$165**		
13									
14	**IRR:**	**23.1%**				**IRR:**	**19.1%**		
15									
16	**MIRR:**	**16.8%**				**MIRR:**	**18.7%**		

The MIRR effectively fixes the challenges with project selection using the IRR…

Modified Internal Rate of Return (MIRR)

Was it worth being in the weeds?

The MIRR seems to more accurately reflects a project's rate of return than the IRR.

However, there is some controversy in the use of the MIRR, and most managers understand the basic idea of the IRR.

Therefore, the IRR is still the metric commonly used in practice.

To demonstrate your newly acquired financial expertise, ask someone in your finance department whether they use the IRR or MIRR for calculating a project's rate of return!

Main Takeaways…

When you're deciding between two (or more) projects, select the one with the greatest NPV.

Selecting mutually exclusive projects based on the NPV will always select the correct project.

Selecting mutually exclusive projects based on the IRR is mostly right, but not always – yet is still commonly used in business.

The Modified IRR, the MIRR, fixes the dilemma with the IRR by forcing the reinvestment rate to be the same as the discount rate.

Mutually exclusive project offer some challenges independent projects do not have. Base your decision on the NPV and you'll always be correct.

Next Time…

Where does the Discount Rate Come From?

Credits & References

Slide 1: Business concept, Businessman confused about two direction by Aeko, Adobe Stock (99051263.jpeg).

Slide 5: Yellow emoticons and emojis by rvlsoft, Adobe Stock (295356062.jpeg).

Slide 15: WACC - Weighted Average Cost of Capital acronym, business concept background on blackboard by dizain, Adobe Stock (468355259.jpeg).