ECO 1192

Engineering Economics

Project Decision-Making Criteria

Claude Théoret

First Draft: November 2015

The purpose of this document is to provide detailed calculations for a range of decision-making criteria to determine the
- **validity (acceptability) of projects and**
- **best among competing alternatives.**

Contents

DISCRETE CASH FLOW AND COMPOUNDING

10.00 % DISCRETE RATE OF INTEREST

n	(F/P,i%,n)	(P/F,i%,n)	(A/P,i%,n)	(P/A,i%,n)	(A/F,i%,n)	(F/A,i%,n)	(A/G,i%,n)
1	1.1000	0.9091	1.1000	0.9091	1.0000	1.0000	0.0000
2	1.2100	0.8264	0.5762	1.7355	0.4762	2.1000	0.4762
3	1.3310	0.7513	0.4021	2.4869	0.3021	3.3100	0.9366
4	1.4641	0.6830	0.3155	3.1699	0.2155	4.6410	1.3812
5	1.6105	0.6209	0.2638	3.7908	0.1638	6.1051	1.8101
6	1.7716	0.5645	0.2296	4.3553	0.1296	7.7156	2.2236
7	1.9487	0.5132	0.2054	4.8684	0.1054	9.4872	2.6216
8	2.1436	0.4665	0.1874	5.3349	0.0874	11.4359	3.0045
9	2.3579	0.4241	0.1736	5.7590	0.0736	13.5795	3.3724
10	2.5937	0.3855	0.1627	6.1446	0.0627	15.9374	3.7255
11	2.8531	0.3505	0.1540	6.4951	0.0540	18.5312	4.0641
12	3.1384	0.3186	0.1468	6.8137	0.0468	21.3843	4.3884
13	3.4523	0.2897	0.1408	7.1034	0.0408	24.5227	4.6988
14	3.7975	0.2633	0.1357	7.3667	0.0357	27.9750	4.9955
15	4.1772	0.2394	0.1315	7.6061	0.0315	31.7725	5.2789
16	4.5950	0.2176	0.1278	7.8237	0.0278	35.9497	5.5493
17	5.0545	0.1978	0.1247	8.0216	0.0247	40.5447	5.8071
18	5.5599	0.1799	0.1219	8.2014	0.0219	45.5992	6.0526
19	6.1159	0.1635	0.1195	8.3649	0.0195	51.1591	6.2861
20	6.7275	0.1486	0.1175	8.5136	0.0175	57.2750	6.5081
21	7.4002	0.1351	0.1156	8.6487	0.0156	64.0025	6.7189
22	8.1403	0.1228	0.1140	8.7715	0.0140	71.4027	6.9189
23	8.9543	0.1117	0.1126	8.8832	0.0126	79.5430	7.1085
24	9.8497	0.1015	0.1113	8.9847	0.0113	88.4973	7.2881
25	10.8347	0.0923	0.1102	9.0770	0.0102	98.3471	7.4580
26	11.9182	0.0839	0.1092	9.1609	0.0092	109.1818	7.6186
27	13.1100	0.0763	0.1083	9.2372	0.0083	121.0999	7.7704
28	14.4210	0.0693	0.1075	9.3066	0.0075	134.2099	7.9137
29	15.8631	0.0630	0.1067	9.3696	0.0067	148.6309	8.0489
30	17.4494	0.0573	0.1061	9.4269	0.0061	164.4940	8.1762

The Projects

- **The Exit Company is studying the purchase of a new palletizer.**
- **The parameters of the three palletizers under review are shown below.**

	Palletizer Information		
Project Parameters	**Alpha**	**Beta**	**Gamma**
1. Initial Cost ($)	**75,000**	**85,000**	**100,000**
2. Annual revenues ($)	**40,000**	**30,000 growing annually thereafter by 2%.**	**50,000**
3. Annual costs ($)	**12,000**	**15,000**	**20,000 growing by $500 annually thereafter**
4. End-of-life salvage value ($)	**-5,000**	**0**	**5,000**
5. Useful life (years)	**4**	**10**	**5**
6. Industry Standard	**3 years**		
MARR = 10%			

Section A : Are the palletizers valid?

A1: Annual Equivalent Worth (AEW) Method

AEW (Alpha: N=4 years)
= -75,000(A/P,10%,4)+40,000-12,000-5000(A/F,10%,4)
= $3,262

AEW (Beta: N=10 years)
= -85,000(A/P,10%,10)+{[30,000/(0.1-0.02)][1-(1.02/1.1)^{10}]}(A/P,10%,10)
-15,000+0(A/F,10%,10)
= $3,514

AEW (Gamma: N=5 years)
= -100,000(A/P,10%,5)+50,000-20,000-500(A/G,10%,5)+5,000(A/F,10%,5)
= $3,534

Palletizer	AEW	Acceptable/Unacceptable Is EAW > $0?
Alpha	$3,262	Yes; Acceptable
Beta	3,514	Yes; Acceptable
Gamma	3,534	Yes; Acceptable

A2: Net Present Worth (NPW) Method

NPW (Alpha: N=4 years)
= -75,000+(40,000-12,000)(P/A,10%,4)-5,000(P/F,10%,4)
= $10,341

NPW (Beta: N=10 years)
= -85,000+{[30,000/(0.1-0.02)][1-(1.02/1.1)^{10}]}-15,000(P/A,10%,4)
= $2,159

NPW (Gamma: N=5 years)
= -100,000+50,000(P/A,10%,5)-20,000(P/A,10%,5)-500(P/G,10%,5)
+5,000(P/F,10%,5)
= $13,397

Palletizer	NPW	Acceptable/Unacceptable Is NPW > $0?
Alpha	$10,341	Yes; Acceptable
Beta	21,591	Yes; Acceptable
Gamma	13,397	Yes; Acceptable

A3: Net Future Worth (NFW) Method

NFW (Alpha: N=4 years)
= -75,000(F/P,10%,4)+(40,000-12,000)(F/A,10%,4)-5000
= $15,141

NFW (Beta: N=10 years)
= -85,000(F/P,10%,10)+{[30,000/(0.1-0.02)][1-{1.02/1.1)^{10}]}(F/P,10%,10)
-15,000(F/A,10%,10)
= $56,000

NFW (Gamma: N=5 years)
= -100,000(F/P,10%,5)+(50,000-20,000)(F/A,10%,5)-500(F/G,10%,5)+5,000
= $21,576 [(F/G,i%,N) = (P/A,i%,N)(A/G,i%,N)

Palletizer	NFW	Acceptable/Unacceptable Is NFW > $0?
Alpha	$15,141	Yes; Acceptable
Beta	56,000	Yes; Acceptable
Gamma	21,576	Yes; Acceptable

A4: Internal Rate of Return (IRR) Method

Alpha (N=4 years)

Set AE (Cash Outflows) = AE (Cash Inflows)
75,000(A/P,i*%,4) = 40,000-12,000-5000(A/F,i*%,4)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
i*% = 16.40%

OR

Set PW (Cash Outflows) = PW (Cash Inflows)
75,000 = (40,000-12,000)(P/A,i*%,4)-5,000(P/F,i*%,4)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
i*% = 16.40%

OR

Set FW (Cash Outflows) = FW (Cash Inflows)
75,000(F/P,i*%,4) = (40,000-12,000)(F/A,i*%,4)-5,000
Solve for i*%. (Use Excel or equivalent or a financial calculator)
i*% = 16.40%

Beta (N=10 years)

Set AE (Cash Outflows) = AE (Cash Inflows)

85,000(A/P,i*%,10) = {[30,000/(i*%-0.02)][1-{1.02/(1+i*%))^{10}]}(A/P,i*%,10)
-15,000+0(A/F,i*%,10)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
i*% = 15.28%

OR

Set PW (Cash Outflows) = PW (Cash Inflows)
85,000 = {[30,000/(i*%-0.02)][1-{1.02/(1+i*%))^{10}]}-15,000(P/A,i*%,10)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
I*% = 15.28%

OR

Set FW (Cash Outflows) = FW (Cash Inflows)
85,000(F/P,i*%,5) = {[30,000/(i*%-0.02)][1-{1.02/(1+i*%))^{10}]}(F/P,i*%,10)
-15,000(F/A,i*%,10)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
I*% + 15.28%

<u>**Gamma (N=5 years)**</u>

Set AE (Cash Outflows) = AE (Cash Inflows)
100,000(A/P,i*%,5)= 50,000-20,000-500(A/G,i*%,5)+5,000(A/F,i*%,5)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
I*% + 15.07%

OR

Set PW (Cash Outflows) = PW (Cash Inflows)
100,000 = (50,000-20,000)(P/A,i*%,5)-500(P/G,i*%,5)+5,000(P/F,i*%,5)
Solve for i*%. (Use Excel or equivalent or a financial calculator)
I*% = 15.07%

OR

Set FW (Cash Outflows) = FW (Cash Inflows)
100,000(F/P,i*%,5) = (50,000-20,000)(F/A,i*%,5)-500(F/G,i*%,5)+5,000
Solve for i*%. (Use Excel or equivalent or a financial calculator)
I*% = 15.07%

Palletizer	IRR	Acceptable/Unacceptable Is IRR > MARR (=10%)?
Alpha	16.40%	Yes; Acceptable
Beta	15.28%	Yes; Acceptable
Gamma	15.07%	Yes; Acceptable

A5: External Rate of Return (ERR) Method

Alpha

Set FW (Cash Outflows) = FW (Cash Inflows)
75,000(F/P,i*%,4) = (40,000-12,000)(F/A,10%,4)-5,000
Solve directly for i*% (= %)
i*% = 13.61%

Beta

Set FW (Cash Outflows) = FW (Cash Inflows)
85,000(F/P,i*%,10) = {30,000/(0.1-0.02)][1-{1.02/(1.1))^{10}]}-15,000(F/A,10%,10)
Solve directly for i*% (= %)
i*% = 12.52%

Gamma

Set FW (Cash Outflows) = FW (Cash Inflows)
100,000(F/P,i*%,5) = (50,000-20,000)(F/A,10%,5)-500(F/G,10%,5)+5,000
Solve directly for i*% (= %)
i*% = 12.80%

Palletizer	ERR	Acceptable/Unacceptable Is ERR > MARR (=10%)?
Alpha	13.61%	Yes; Acceptable
Beta	12.52%	Yes; Acceptable
Gamma	12.80%	Yes; Acceptable

A6: Benefit-Cost Ratio (B/C)

- **The AE, PW and FW methods can be used to calculate a project's B/C ratio.**
- **Each method (AE,PW and FW) gives the same ratio.**

	Projects		
	Alpha	Beta	Gamma
AEW Benefits	40,000	32,347	50,000
AEW Costs	36,738	28,833	46,466
PW Benefits	126,795	198,759	189,539
PW Costs	116,453	177,169	176,142

Alpha (N=4 years)

AE (Alpha: Benefits) / AE (Alpha: Costs)
= 40,000/36,738 = 1.09

OR

PW (Alpha: Benefits) / PW (Alpha: Costs)
= 126,795/116,453 = 1.09

Beta (N=10 years)

AE (Beta: Benefits) / AE (Beta: Costs)
= 32,347 / 28,833 = 1.12

PW (Beta: Benefits) / PW (Beta: Costs)
= 198,759 / 177,169 = 1.12

Gamma (N=5 years)

AE (Gamma: Benefits) / AE (Gamma: Costs)
= 50,000 / 46,466 = 1.08

PW (Gamma: Benefits) / PW (Gamma: Costs)
= 189,539 / 176,142 = 1.08

Palletizer	B/C	Acceptable/Unacceptable Is B/C > 1?
Alpha	1.09	Yes; Acceptable
Beta	1.12	Yes; Acceptable
Gamma	1.08	Yes; Acceptable

A7: Simple Payback Method

Payback period (n) = Number of years to recover the initial investment (P) when MARR = 0%

Alpha (N=4 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-75,000	0	-75,000
1	28,000	0	-47,000
2	28,000	0	-19,000
3	28,000	0	9,000

4	23,000	0	

- **Alpha's Recovery Period = 2 + 19000/(19,000+9000) = 2.68 years**

Beta (N=10 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-85,000	0	-85,000
1	15,000	0	-70,000
2	15,600	0	-54,400
3	16,212	0	-38,188
4	16,836	0	-21,352
5	17,473	0	-3,879
6	18,122	0	14,244
7	18,785	0	
8	19,461	0	
9	20,150	0	
10	20,853	0	

- **Beta's Recovery Period = 5 + 3879 / (3879+14244) = 5.21 years**

Gamma (N=5 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-100,000	0	-$100,000
1	30,000	0	-$70,000
2	29,500	0	-$40,500
3	29,000	0	-$11,500
4	28,500	0	$17,000
5	33,000	0	

- **Gamma's Recovery Period = 3 + 11,500 / (11,500+17,000) = 3.40 years**

Palletizer	Simple Payback	Acceptable/Unacceptable Longer than Industry Standard?
Alpha	2.68	Yes; Acceptable
Beta	5.21	No; Unacceptable
Gamma	3.4	No; Unacceptable

A8: Discounted Payback Method

Payback period (n) = Number of years required to recover the initial investment (P) when MARR = 10% (for example)

Alpha (N=4 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-75,000		-75000
1	28,000	-7500	-54,500
2	28,000	-5450	-31,950
3	28,000	-3195	-7,145
4	23,000	-714.5	15,141

- **Alpha's Recovery Period = 3 + 7,145 / (7,145+15,141) = 3.34 years**

Beta (N=10 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-85,000		-8500
1	15,000	-8500	-7850
2	15,600	-7850	-7075
3	16,212	-7075	-6161.3
4	16,836	-6161.3	-5093.81
5	17,473	-5093.81	-3855.89
6	18,122	-3855.89	-2429.24
7	18,785	-2429.24	-793.673
8	19,461	-793.673	1073.017
9	20,150		
10	20,853		

- **Beta's Recovery Period = 7 + 794 / (794+1,073) = 7.45 years**

Gamma (N=5 years; Industry Standard = 3 years)

EOY	Net Cash Flow	Opportunity Cost	Project Balance
0	-100,000		-100,000
1	30,000	-10000	-80,000
2	29,500	-8000	-58,500
3	29,000	-5850	-35,350
4	28,500	-3535	-10,385
5	33,000	-1038.5	21,577

- **Gamma's Recovery Period = 4 + 10,385 / (10,385+21,577) = 4.35 years**

Palletizer	Discounted Payback	Acceptable/Unacceptable Longer than Industry Standard?
Alpha	3.34	No: Unacceptable
Beta	7.45	No; Unacceptable

Gamma	**4.35**	**No; Unacceptable**

Section B : Which of the three projects is best?

B1: Annual Equivalent Worth (AEW) Method

Repeating a project without changing its parameter values has no impact on a [project's AEW. From AEW calculations in Section A, each project has an AEW > $0 and is therefore acceptable.

Palletizer	AEW	Best Project
Alpha	$3,262	Gamma
Beta	3,514	
Gamma	3,534	

B2: Net Present Worth (NPW) Method

- **A 20-year period of analysis (the least-common denominator) is used to determine the best project.**
- **There are several ways to determine each project's NPW over 20 years:**
    1. **Use each project's AEW over 20 years.**
    2. **Use the NPW method by repeating each project within a 20-year period.**

1. Using each project's AEW

Palletizer	AEW	Acceptable/Unacceptable Is EAW > $0?
Alpha	$3,262	Yes; Acceptable
Beta	3,514	Yes; Acceptable
Gamma	3,534	Yes; Acceptable

NPW (Alpha: 20 years) = AEW (Alpha: N=4 years)(P/A,10%,20) = 3,262(8.5136) = $27,771

NPW (Beta: 20 years) = AEW (Beta: N=10 years)(P/A,10%,20) = 3,514(8.5136) = $29,917

NPW (Gamma: 20 years) = AEW (Gamma: N=5 years)(P/A,10%,20) = 3,534(8.5136) = $30,087

Palletizer	NPW (20 years)	Best Project
Alpha	$27,771	Gamma
Beta	29,917	
Gamma	30,087	

2. Repeat each project as many times as required for a 20-year period of analysis. Use each project's NPW during its normal life for calculations.

Alpha is repeated 5 times (including the first investment) during a 20-year period.

NPW (Alpha: 20 years)
= NPW(N=4 years) + NPW(N=4 years)(P/F,10%,4)
+ NPW(N= 4years)(P/F,10%,8)+ NPW(N = 4 years)(P/F,10%,12)
+ NPW(N= 4years)(P/F,10%,16)
= $27,771

Beta is repeated twice (including the first investment) during a 20-year period.

NPW (Beta: 20 years)
= NPW(N=10 years) + NPW(N=10 years)(P/F,10%,10)
= $29,917

Gamma is repeated 4 times (including the first investment) during a 20-year period.

NPW (Gamma: 20 years)
= NPW(N=5 years) + NPW(Gamma=5 years)(P/F,10%,5)
+ NPW(N=5 years)(P/F,10%,10) + NPW(N=5 years)(P/F,10%,15)
= $30,087

B3: Net Future Worth (NFW) Method

- A 20-year period of analysis (the least-common denominator) is used to determine the best project.
- There are several ways to determine each project's NFW over 20 years:
  1. Use each project's AEW over 20 years.
  2. Use the NFW method by repeating each project within a 20-year period.

1. Using each project's AEW

Palletizer	AEW	Acceptable/Unacceptable Is EAW > $0?
Alpha	$3,262	Yes; Acceptable
Beta	3,514	Yes; Acceptable
Gamma	3,534	Yes; Acceptable

NFW (Alpha: 20 years) = AEW (Aplha: N=4 years)(F/A,10%,20)
= 3,262(57.275) = $186,831

NFW (Beta: 20 years) = AEW (Beta: N=10 years)(F/A,10%,20)
= 3,514(57.275) = $201,264

NFW (Gamma: 20 years) = AEW (Gamma: N=5 years)(F/A,10%,20)
= 3,534(57.275) = $202,410

Palletizer	NFW (20 years)	Best Project
Alpha	$186,831	Gamma
Beta	201,264	
Gamma	202,410	

2. Repeat each project as many times as required for a 20-year period of analysis. Use each project's NPW during its normal life for calculations.

Alpha is repeated 5 times (including the first investment) during a 20-year period.

<u>NFW (Alpha: 20 years)</u>
= NFW(N=4 years)(F/P,10%,16) + NFW(N=4 years)(F/P,10%,12)
+ NFW(N= 4years)(F/P,10%,8)+ NFW(N = 4 years)(F/P,10%,4)
+ NFW(N= 4years)(F/P,10%,0)
= $186,831

Beta is repeated twice (including the first investment) during a 20-year period.

<u>NFW (Beta: 20 years)</u>
= NFW(N=10 years)(F/P,10%,10) + NFW(N=10 years)(F/P,10%,0)
= $201,264

Gamma is repeated 4 times (including the first investment) during a 20-year period.

<u>NFW (Gamma: 20 years)</u>
= NFW(N=5 years)(F/P,10%,15) + NFW(N=5 years)(F/P,10%,10)
+ NFW(N=5 years)(F/P,10%,5) + NFW(N=5 years)(F/P,10%,0)
= $202,410

<u>Palletizer</u>	<u>NFW (20 years)</u>	<u>Best Project</u>
Alpha	$186,831	Gamma
Beta	201,264	
Gamma	202,410	

B4: Incremental Internal Rate of Return (IRR) Method

Compare projects Alpha and Beta

- **AEW is the preferred method since Alpha (N=4) and Beta (N=5) have different lives.**
- **If the NPW or the NFW methods are used, a common period of analysis (i.e., 20 years) is required.**

- **Set AEW (Alpha: 4 years) = AEW (Beta: 10 years)**

-75,000(A/P,i%,4)+40,000-12,000-5000(A/F,i**%,4)**
= -85,000(A/P,i%,10)+{[30,000/(i**-0.02)][1-(1.02/(1+i*))^{10}]}(A/P,i**%,10)**
-15,000+0(A/F,i%,10)**
Solve for i%. (Use Excel or equivalent or a financial calculator)**

- **i**% = 11.7%**

Conclusion: Beta is better than Alpha.

Compare projects Beta and Gamma

- **AEW is the preferred method since Alpha (N=4) and Beta (N=5) have different lives.**
- **If the NPW or the NFW methods are used, a common period pf analysis (i.e., 20 years) will be required.**

- **Set AEW (Beta: 10 years) = AEW (Gamma: 5 years)**

-85,000(A/P,i%,10)+{[30,000/(i**-0.02)][1-(1.02/(1+i*))^{10}]}(A/P,i**%,10)**
-15,000+0(A/F,i%,10)**
= -100,000(A/P,i%,5)+50,000-20,000-500(A/G,i**%,5)+5,000(A/F,i**%,5)**
Solve for i%. (Use Excel or equivalent or a financial calculator)**

- **i**% = 10.5%**

Conclusion: Gamma is better than Beta; Gamma is the best project..

B5: Incremental External Rate of Return (ERR) Method

- **The NFW method MUST be used to calculate the incremental ERR.**

Compare projects Alpha and Beta using a 20-year period of analysis.

-75,000[1+(P/F,10%,4)+(P/F,10%,8)+(P/F,10%,12)+(P/F,10%,16)](F/P,i%,20)**
+ (40,000-12,000)(F/A,10%,20)
–5,000[(F/P,10%,16)+(F/P,10%,12)+(F/P,10%,8)+(F/P,10%,4)+(F/P,10%,0)]
= -85,000[1+(P/F,10%,10)](F/P,i%,20)-15,000(F/A,10%,20)**
+ {[30,000/(0.1-0.02)][1-{1.02/1.1)^{10}]}[(F/P,10%,20)+(F/P,10%,10)]

Solve for i%. (Use Excel or equivalent or a financial calculator)**

- **i*% = 10.1% (based on Excel's MIRR function)**

Conclusion: Beta is better than Alpha.

Note: If there is more than 1 negative Net Cash Flows between 2 projects (such as Alpha and Beta), Excel's MIRR function provides an incorrect ERR.

Corrective steps:

1. **Find the Present Worth (with MARR) of each negative net cash flow and add them to the initial cost (or to the differential between the initial costs if you are calculating an incremental ERR).**
2. **Replace each of the negative cash flows between the two projects with a $0 value (actually not required; simply leave the cell empty).**
3. **The positive net cash flows are not adjusted.**
4. **Use Excel's MIRR function to calculate the ERR or incremental ERR using the adjusted net cash flows.**

EOY	Net Cash Flows (Beta – Alpha)	PW of Negative Cash Flows (Beta-Alpha)	Adjusted Net Cash Flows (Beta-Alpha)
0	-10,000	-10,000	-115,012
1	-13,000	-11,818	0
2	-12,400	-10,248	0
3	-11,788	-8,856	0
4	68,836		68,836
5	-10,527	-6,536	0

6	-9,878	-5,576	0
7	-9,215	-4,729	0
8	71,461		71,461
9	-7,850	-3,329	0
10	-92,147	-35,527	0
11	-13,000	-4,556	0
12	67,600		67,600
13	-11,788	-3,415	0
14	-11,164	-2,940	0
15	-10,527	-2,520	0
16	70,122		70,122
17	-9,215	-1,823	0
18	-8,539	-1,536	0
19	-7,850	-1,284	0
20	-2,147	-319	0
		Present Worth of Negative Cash Flows = 115,012	ΔERR = 10.1%

<u>Compare projects Beta and Gamma using a 10-year period.</u>

= -85,000(F/P,i%,10)-15,000(F/A,10%,10)**
+ {[30,000/(0.1-0.02)][1-{1.02/1.1)^{10}]}(F/P,10%,10)
= -100,000[1+(P/F,10%,5)](F/P,i%,10)+(50,000-20,000)(F/A,10%,10)**
-500(F/G,10%,5)[1+(F/P,10%,5)]+5,000[1+(F/P,10%,5)]

Solve for i%. (Use Excel or equivalent or a financial calculator)**

- **i*% = 10.02%**

Conclusion: Gamma is better than Beta. Gamma is the best project.

Note: If there is more than 1 negative Net Cash Flows between 2 projects (such as Alpha and Beta), Excel's MIRR function provides an incorrect ERR.

<u>Corrective steps</u>:

1. **Find the Present Worth (with MARR) of each negative net cash flow and add them to the initial cost (or to the differential between the initial costs if you are calculating an incremental ERR).**
2. **Replace each of the negative cash flows between the two projects with a $0 value (actually not required; simply leave the cell empty).**

3. The positive net cash flows are not adjusted.
4. Use Excel's MIRR function to calculate the ERR or incremental ERR using the adjusted net cash flows.

EOY	Net Cash Flows (Gamma-Beta)	PW of Negative Cash Flows (Gamma-Beta)	Adjusted Net Cash Flows (Gamma-Beta)
0	-15,000	-15,000	-67,451
1	15,000	0	15,000
2	13,900	0	13,900
3	12,788	0	12,788
4	11,664	0	11,664
5	-84,473	-52,451	0
6	11,878	0	11,878
7	10,715	0	10,715
8	9,539	0	9,539
9	8,350	0	8,350
10	12,147	0	12,147
		Present Worth of Negative Cash Flows = 67,461	ΔERR = 10.5%

B6: Benefit-Cost Ratio (B/C)

- The AE, PW and FW methods can be used to calculate a project's B/C ratio.
- If the PW or FW methods are used to calculate the incremental B/C ratio, a common period of analysis must be used.

	Projects		
	Alpha	Beta	Gamma
AEW Benefits	40,000	32,347	50,000
AEW Costs	36,738	28,833	46,466
PW Benefits	126,795	198,759	189,539
PW Costs	116,453	177,169	176,142

Compare projects Alpha & Beta using the AE Method

ΔAE (Benefits: Beta - Alpha) / ΔAE (Costs: Beta - Alpha)
= (32,347- 40,000) / (28,833 - 36,738 = 0.97
Conclusion: Alpha is better than Beta (?????).

Compare projects Alpha & Gamma using the AE Method

ΔAE (Benefits: Gamma - Alpha) / ΔAE (Costs: Gamma - Alpha)
= (50,000 - 40,000) / (46,466 - 36,738 = 1.03
Conclusion: Gamma is better than Alpha.

B7. The Simple Payback Method

- **Use the project recovery periods calculated in section A7.**
- **Since Alpha is the only valid (acceptable) project (Beta and Gamma are unacceptable), Alpha is the best project.**

Palletizer	Simple Payback	Best Project
Alpha	2.68	Alpha
Beta	5.21	
Gamma	3.4	

B8. The Discounted Payback Method

- **Use the project recovery periods calculated in section A8.**
- **Since the projects have recovery periods that exceed the industry standard, no project is acceptable.**

Palletizer	Discounted Payback	Best Project
Alpha	3.34	None.
Beta	7.45	
Gamma	4.35	