

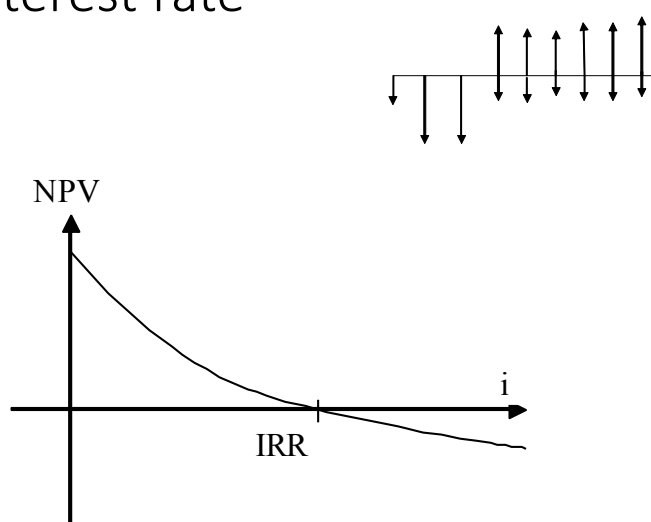
Effect of leverage (risk)

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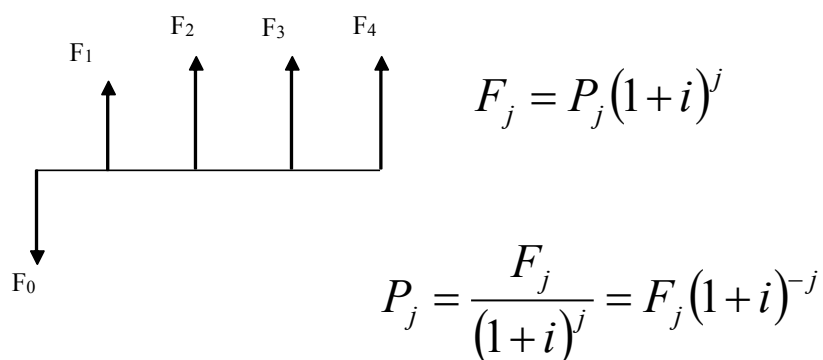
Building Economics

NPV and interest rate



Present value of the future elements

- i interest rate
- F future value
- n lifetime



Net Present Value

Sum of the present values of the future elements

$$NPV = \sum_{j=0}^n F_j(1+i)^{-j}$$

Leverage

- Leverage= debt/equity (debt to equity ratio)
- For example investment cost is 100.
- Loan is 80, own money (equity) is 20.
- leverage = $80 / 20 = 4$
- When loan is 90, own money is 10, then leverage is $90/10$ that is 9.

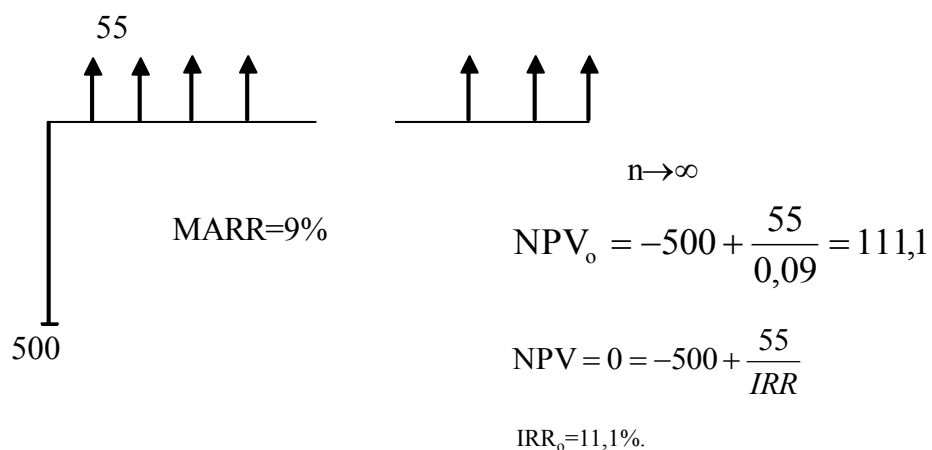
NPV, IRR ?

- How is the NPV and IRR when leverage is growing.

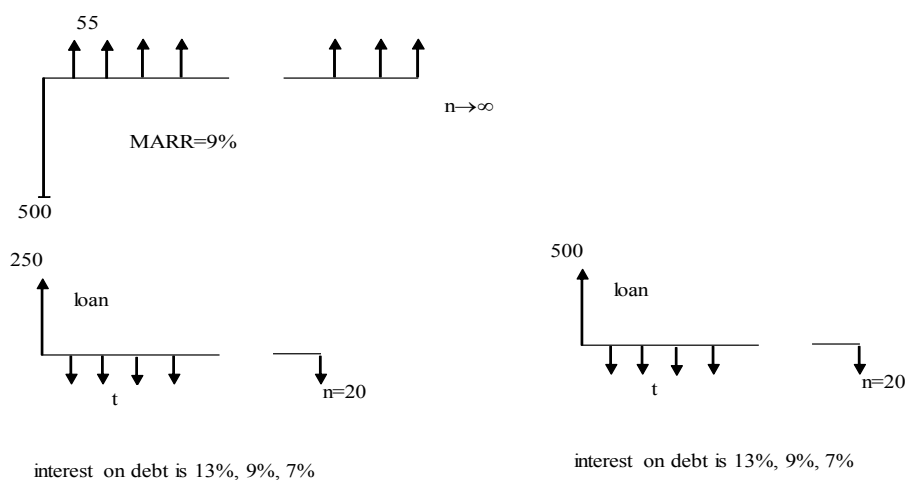
Example

- Investment cost is 500 million
- Net income is yearly 55 million forever
- Minimum Attractive Rate of Return (MARR) is 9% that is 0,09.
- Interest on debt (credit, loan) is 13%, 9%, 7%.
- Three cases are examined: 0%, 50%, 100% of the investment cost is credit (loan)
- How is the NPV and IRR?

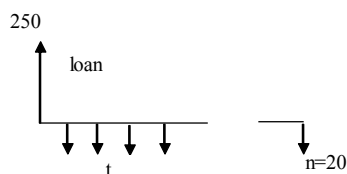
Cash flow of our example without credit



Cash flow of our example with credit



Installment (yearly repayment) when 50% of the investment cost is loan



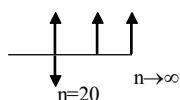
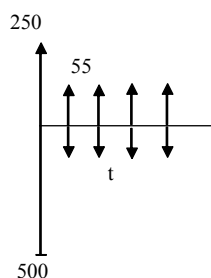
interest on debt is 13%, 9%, 7%

$$t = 250 \frac{0,13}{1 - 1,13^{-20}} = 35,6$$

$$t = 250 \frac{0,09}{1 - 1,09^{-20}} = 27,4$$

$$t = 250 \frac{0,07}{1 - 1,07^{-20}} = 23,6$$

Result when 50% of the investment cost is loan



interest on debt is 13%

$$NPV_{13} = 36,27 \quad IRR_{13} = 10\%$$

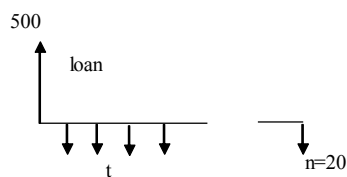
interest on debt is 9%

$$NPV_9 = 111,11 \quad IRR_9 = 12\%$$

interest on debt is 7%

$$NPV_7 = 145,72 \quad IRR_7 = 13\%$$

Installment (yearly repayment) when 100% of the investment cost is loan



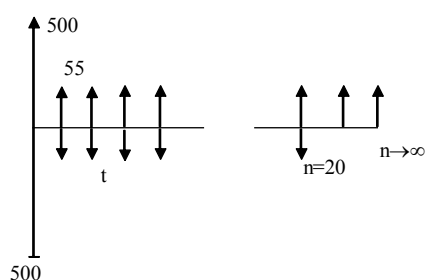
interest on debt is 13%, 9%, 7%

$$t = 500 \frac{0,13}{1 - 1,13^{-20}} = 71,2$$

$$t = 500 \frac{0,09}{1 - 1,09^{-20}} = 54,77$$

$$t = 500 \frac{0,07}{1 - 1,07^{-20}} = 47,2$$

Result when 100% of the investment cost is loan



interest on debt is 13%

$$NPV_{13} = 38,38 \quad IRR_{13} = 7,7\%$$

interest on debt is 9%

$$NPV_9 = 111,11 \quad IRR_9 = \infty$$

interest on debt is 7%

$$NPV_7 = 180,30 \quad IRR_7 = \infty$$

Results

Interest on debt 13%	$l=0$	$l=1$	$l=\infty$
$IRR_{13}, i_t > IRR_e$	11%	10%	7,7%
$NPV_{13}, i_t > MARR$	111,1	36,27	-38,38

Interest on debt 9%	$l=0$	$l=1$	$l=\infty$
$IRR_9, i_t < IRR_e$	11%	12%	$\rightarrow \infty\%$
$NPV_9, i_t = MARR$	111,1	111,1	111,1

Interest on debt 7%	$l=0$	$l=1$	$l=\infty$
$IRR_7, i_t < IRR_e$	11%	13%	$\rightarrow \infty\%$
$NPV_7, i_t < MARR$	111,1	145,72	180,3

Conclusion

- When MARR is bigger than interest on debt then if the portion of the loan is higher the NPV is bigger.
- When IRR without credit is higher than interest on debt then if the portion of the loan is higher the IRR is bigger.

Modigliani-Miller (Franco Modigliani-Merton Miller)

- the value of a firm/project is unaffected by how that firm/project is financed

Effect of leverage on investment (bull market)

expected growing is 10%				
bull market	10%			
investment cost	100	100	100	100
debt	0	50	80	98
equity	100	50	20	2
leverage	0	1	4	49
interest on debt	5%	5%	5%	5%
cost of debt	0	2,5	4	4,9
result	10	7,5	6	5,1
IRR	10%	15%	30%	255%

Effect of leverage on investment

no growing	0			
investment cost	100	100	100	100
debt	0	50	80	98
equity	100	50	20	2
leverage	0	1	4	49
interest on debt	5%	5%	5%	5%
cost of debt	0	2,5	4	4,9
result	0	-2,5	-4	-4,9
IRR	0%	-5%	-20%	-245%

Effect of leverage on investment (bear market)

bear market	-10%			
investment cost	100	100	100	100
debt	0	50	80	98
equity	100	50	20	2
leverage	0	1	4	49
interest on debt	5%	5%	5%	5%
cost of debt	0	2,5	4	4,9
result	-10	-12,5	-14	-14,9
IRR	-10%	-25%	-70%	-745%

The leverage is higher the risk is bigger