Economic Analysis of Project

Kulapa Kuldilok

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Outline

- Time value of Money
- Capital Budgeting
  - Payback Period (PB)
  - Net Present Value (NPV)
  - Internal Rate of Return (IRR)
  - Profitability Index (PI)
  - Sensitivity

The Time Value of Money

What is Time Value?

- We say that money has a time value because that money can be invested with the expectation of earning a positive rate of return
- In other words, “a dollar received today is worth more than a dollar to be received tomorrow”
- That is because today’s dollar can be invested so that we have more than one dollar tomorrow

The Terminology of Time Value

- **Present Value** - An amount of money today, or the current value of a future cash flow
- **Future Value** - An amount of money at some future time period
- **Period** - A length of time (often a year, but can be a month, week, day, hour, etc.)
- **Interest Rate** - The compensation paid to a lender (or saver) for the use of funds expressed as a percentage for a period (normally expressed as an annual rate)

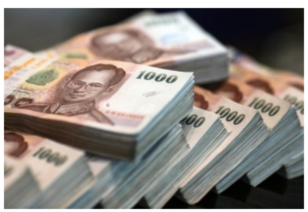
Abbreviations

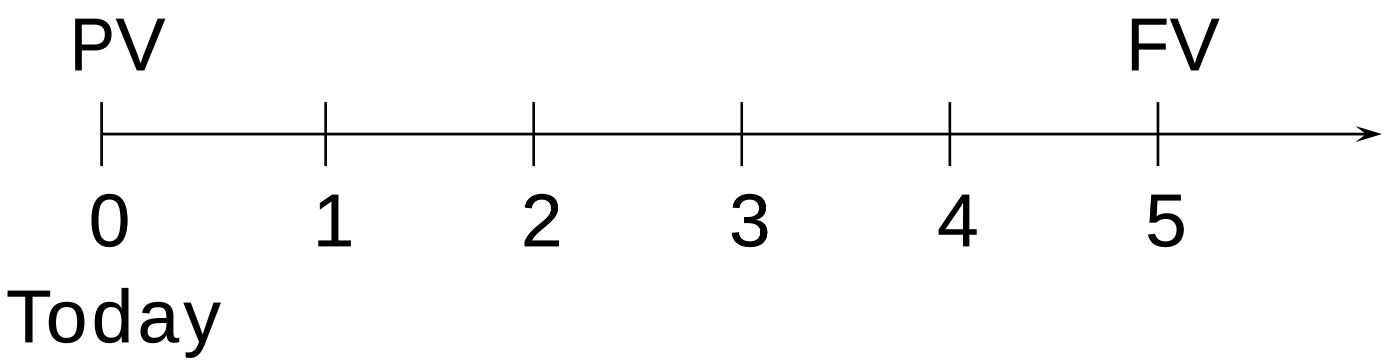
- PV - Present value
- FV - Future value
- Pmt - Per period payment amount
- N - Either the total number of cash flows or the number of a specific period
- i - The interest rate per period

Timelines

- A timeline is a graphical device used to clarify the timing of the cash flows for an investment

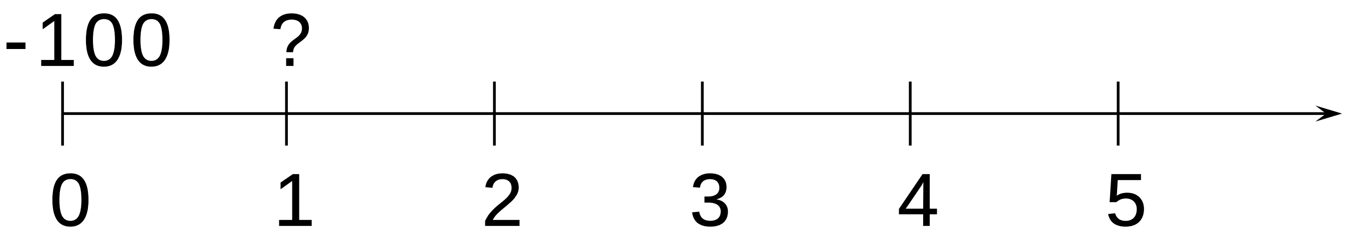
- Each tick represents one time period





Calculating the Future Value

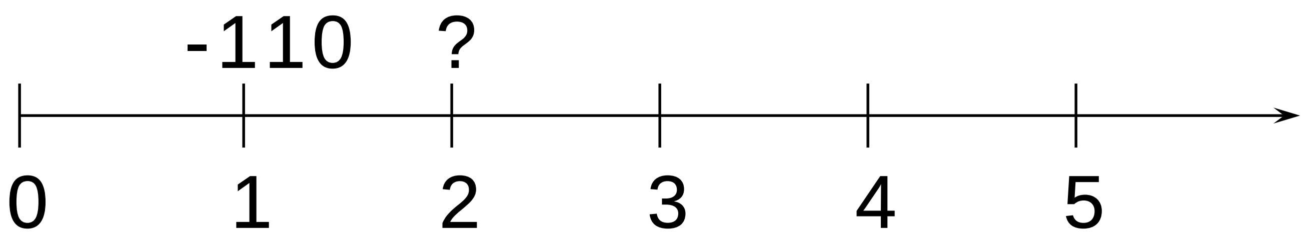
- Suppose that you have an extra $100 today that you wish to invest for one year. If you can earn 10% per year on your investment, how much will you have in one year?



$$FV_1 = 100(1 + 0.10) = 110$$

Calculating the Future Value (cont.)

- Suppose that at the end of year 1 you decide to extend the investment for a second year. How much will you have accumulated at the end of year 2?



$$FV_2 = 100(1 + 0.10)(1 + 0.10) = 121$$

or

$$FV_2 = 100(1 + 0.10)^2 = 121$$

Generalizing the Future Value

- Recognizing the pattern that is developing, we can generalize the future value calculations as follows:

$$FV_t = PV(1+i)^t$$

Table: Future Value Factor for Single Present Amount

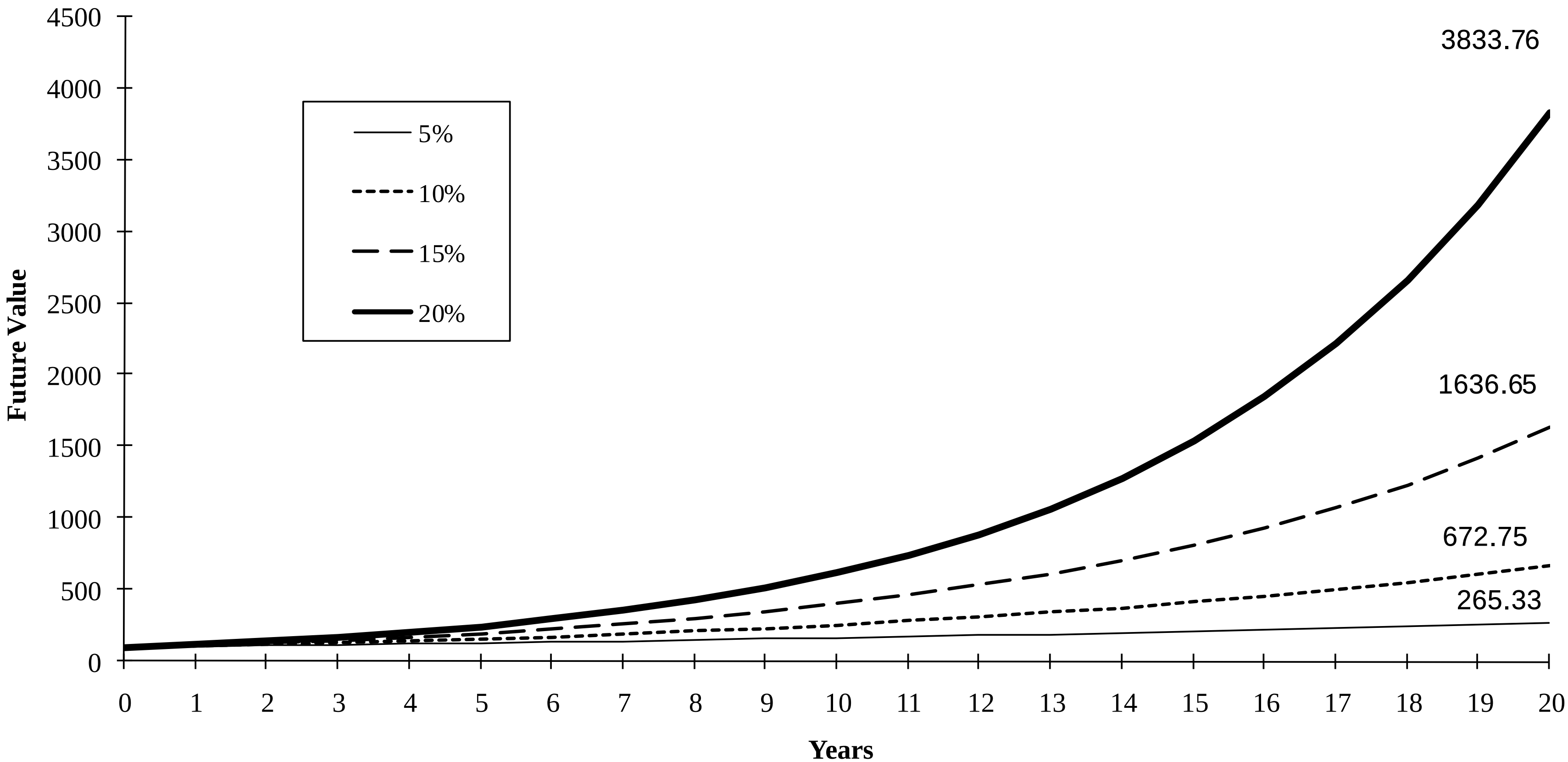
❖ If you extended the investment for a third year, you would have:

$$\mathrm{FV}_3 = 100(1+0.10)^3 = 133.10$$

Compound Interest

- Note from the example that the future value is increasing at an increasing rate
- In other words, the amount of **interest** earned each year is increasing
  - Year 1: $10
  - Year 2: $11
  - Year 3: $12.10
- The reason for the increase is that each year you are earning interest on the interest that was earned in previous years in addition to the interest on the original principle amount

Compound Interest Graphically



The Magic of Compounding

- On Nov. 25, 1626 Peter Minuit, a Dutchman, reportedly purchased Manhattan from the Indians for $24 worth of beads and other trinkets. Was this a good deal for the Indians?
- This happened about 371 years ago, so if they could earn 5% per year they would in 1997 had:

$$\$1,743,577,261.65 = 24(1.05)^{371}$$

- ❖ If they could have earned 10% per year, they would now have:

$$\$54,562,898,811,973,500.00 = 24(1.10)^{371}$$

That's about 54,563 <u>Trillion</u> dollars!

Calculating the Present Value

- So far, we have seen how to calculate the future value of an investment
- But we can turn this around to find the amount that needs to be invested to achieve some desired future value:

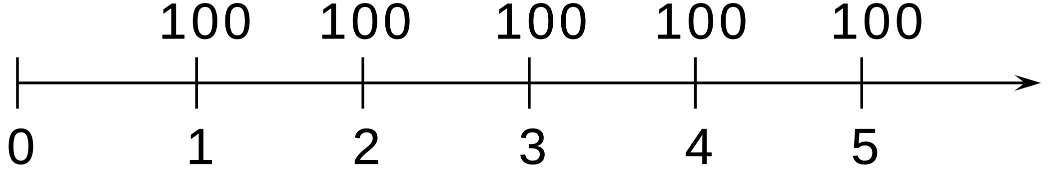
$$PV = \frac{FV_t}{(1+i)^t} \Rightarrow \boxed{\text{Table: Present Value Factor for Single Future Amount}}$$

Present Value: Exercise

- Suppose that your **five**-year old daughter has just announced her desire to invest a small lime farm. After some research, you determine that you will need about **$100,000** on her **18**th birthday to pay for farm investment. If you can earn **8%** per year on your investments, how much do you need to invest today to achieve your goal?

Annuities

- An annuity is a series of nominally equal payments equally spaced in time
- Annuities are very common:
  - Rent
  - Mortgage payments
  - Machine payment
  - Pension income
- The timeline shows an example of a 5-year, $100 annuity



The Principle of Value Additivity

- How do we find the value (PV or FV) of an annuity?
- First, you must understand the principle of value additivity:
  - The value of any stream of cash flows is equal to the sum of the values of the components
- In other words, if we can move the cash flows to the same time period we can simply add them all together to get the total value

Present Value of an Annuity

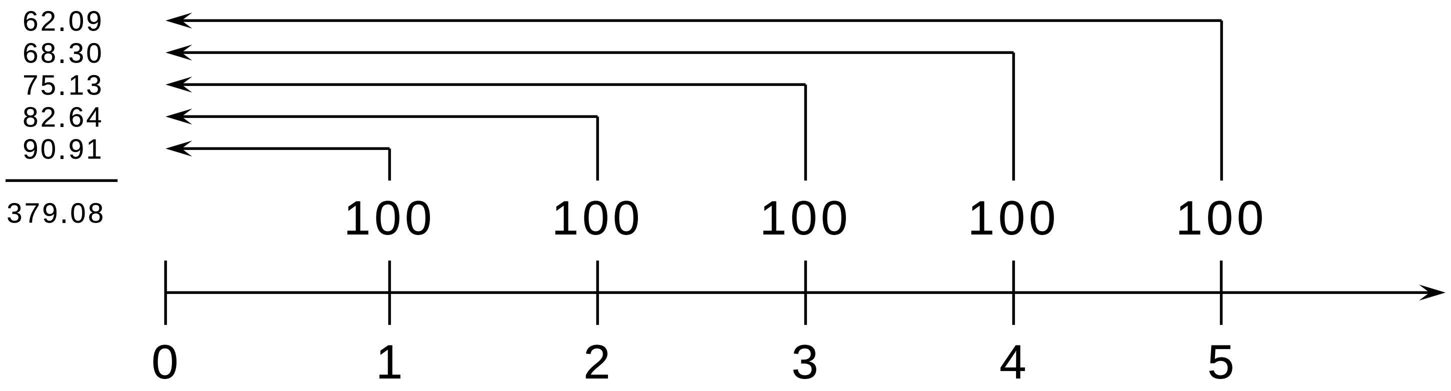
- We can use the principle of value additivity to find the present value of an annuity, by simply summing the present values of each of the components:

$$PV_A = \sum_{t=1}^{T} \frac{Pmt_t}{(1+i)^t} = \frac{Pmt_1}{(1+i)^1} + \frac{Pmt_2}{(1+i)^2} + \cdots + \frac{Pmt_T}{(1+i)^T}$$

Present Value of an Annuity (cont.)

- Using the example, and assuming a discount rate of 10% per year, we find that the present value is:

$$PV_A = \frac{100}{(1.10)^1} + \frac{100}{(1.10)^2} + \frac{100}{(1.10)^3} + \frac{100}{(1.10)^4} + \frac{100}{(1.10)^5} = 379.08$$



Present Value of an Annuity (cont.)

- Actually, there is no need to take the present value of each cash flow separately
- We can use a closed-form of the PV_A equation instead:

$$PV_A = \sum_{t=1}^{T} \frac{Pmt_t}{(1+i)^t} = Pmt \left[\frac{1 - \frac{1}{(1+i)^T}}{i} \right]$$

Table: Present Value Factor for Ordinary Annuity

Present Value of an Annuity (cont.)

- We can use this equation to find the present value of our example annuity as follows:

$$PV_A = Pmt\left[\frac{1 - \frac{1}{(1.10)^5}}{0.10}\right] = 379.08$$

❖ This equation works for all regular annuities, regardless of the number of payments

The Future Value of an Annuity

- We can also use the principle of value additivity to find the future value of an annuity, by simply summing the future values of each of the components:

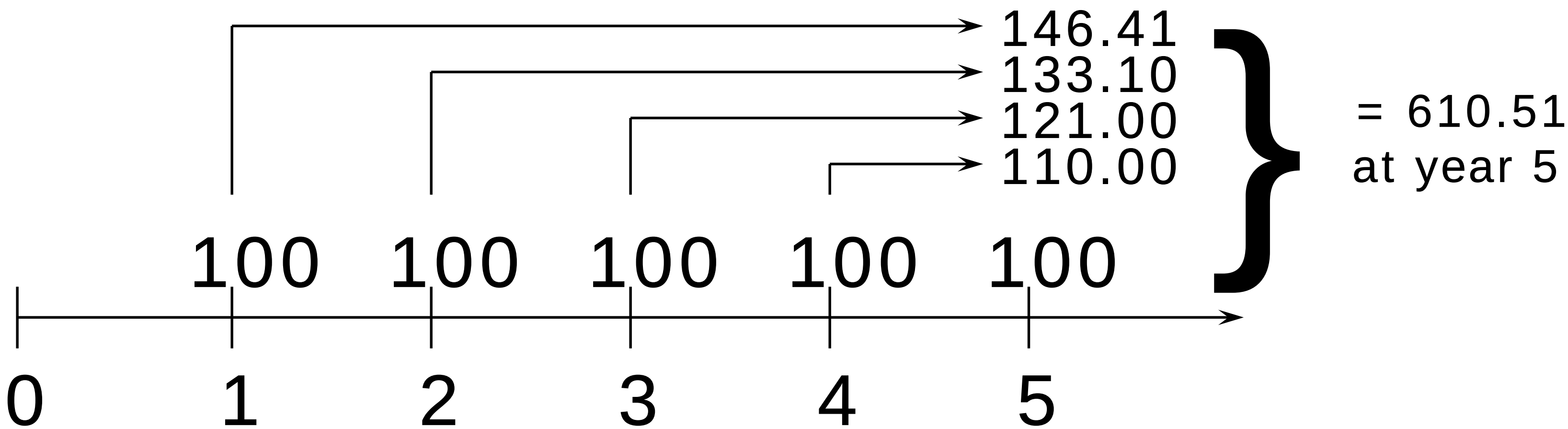
$$FV_A = \sum_{t=1}^{T} Pmt_t (1+i)^{T-t} = Pmt_1 (1+i)^{T-1} + Pmt_2 (1+i)^{T-2} + \cdots + Pmt_T$$

Table: Future Value Factor for Ordinary Annuity

The Future Value of an Annuity (cont.)

- Using the example, and assuming a discount rate of 10% per year, we find that the future value is:

$$FV_A = 100(1.10)^4 + 100(1.10)^3 + 100(1.10)^2 + 100(1.10)^1 + 100 = 610.51$$



The Future Value of an Annuity (cont.)

- Just as we did for the PV_A equation, we could instead use a closed-form of the FV_A equation:

$$FV_A = \sum_{t=1}^{T} Pmt_t (1+i)^{T-t} = Pmt\left[\frac{(1+i)^T - 1}{i}\right]$$

❖ This equation works for all regular annuities, regardless of the number of payments

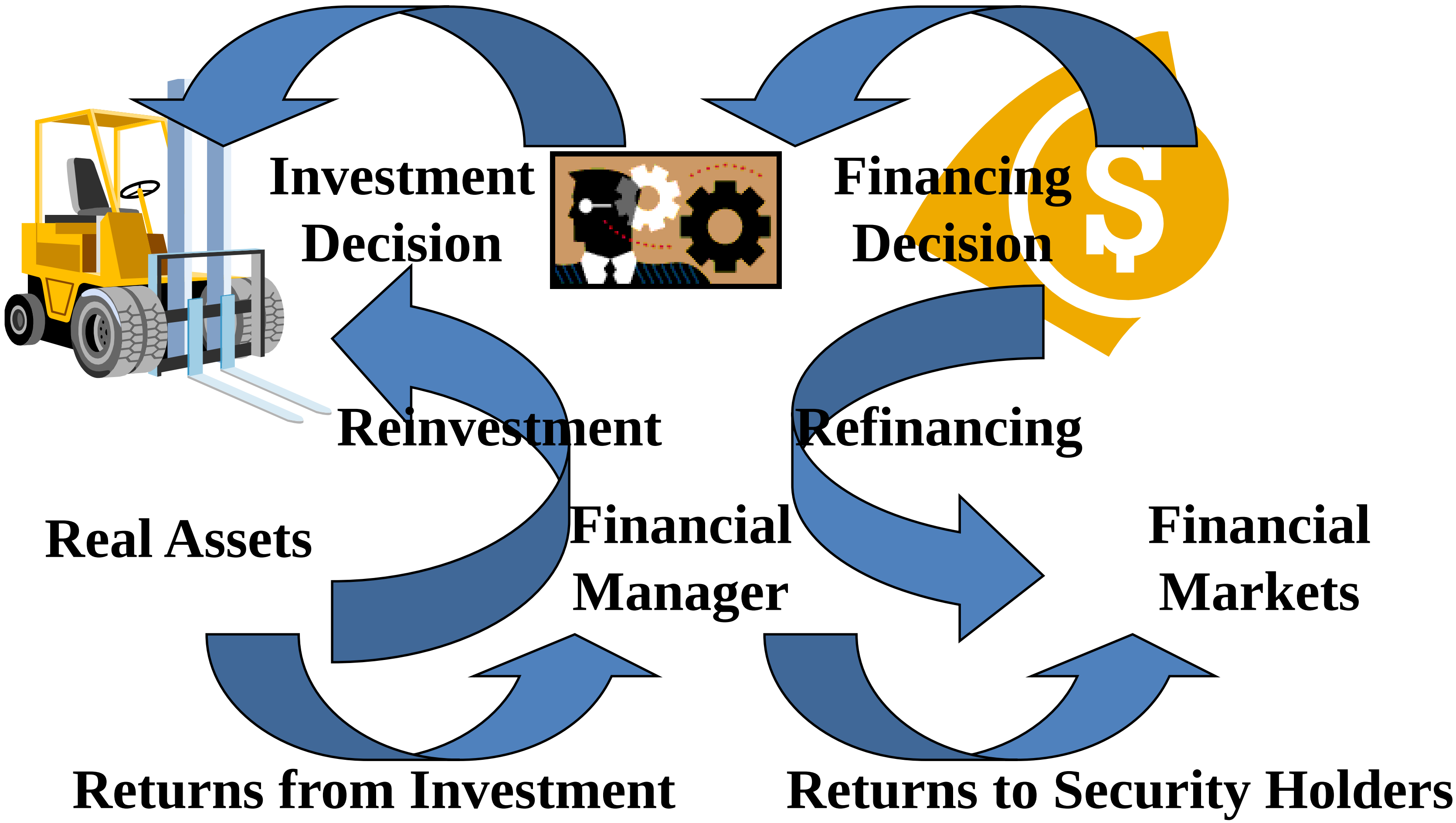
The Future Value of an Annuity (cont.)

- We can use this equation to find the future value of the example annuity:

$$\mathrm{FV_A} = 100\left[\frac{(1.10)^5 - 1}{0.10}\right] = 610.51$$

Capital Budgeting

the Flows of funds and decisions important to the financial farm manager



Capital Budgeting is used to make the Investment Decision

Introduction

- Capital Budgeting is the process of determining which real investment projects should be accepted and given an allocation of funds from the firm.
- To evaluate capital budgeting processes, their consistency with the goal of shareholder wealth maximization is of utmost importance.

Discounted Cash Flow (DCF) Techniques

- The main DCF techniques for capital budgeting include: Payback Period, Net Present Value (NPV), Internal Rate of Return (IRR), and Profitability Index (PI)
  - Each requires estimates of expected cash flows (and their timing) for the project.
    - Including cash outflows (costs) and inflows (revenues or savings) – normally tax effects are also considered.
  - Each requires an estimate of the project's risk so that an appropriate discount rate (opportunity cost of capital) can be determined.
    - The discussion of risk will be deferred until later. For now, we will assume we know the relevant opportunity cost of capital or discount rate.
- Sometimes the above data is difficult to obtain – this is the main weakness of all DCF techniques.

Identifying alternative projects

YEAR	INV in farm A	INV in farm B	INV in farm C
0	-20,000	- 20,000	- 20,000
1	2,000	5,800	10,000
2	4,000	5,800	8,000
3	6,000	5,800	6,000
4	8,000	5,800	3,000
5	10,000	5,800	1,000

Payback period

- Cash inflow = Cash outflow
- Criterion for acceptance: Accept if the project has a payback period that is less than the maximum required payback period.
-

Year	Project A	Net Cash flow
0	-20,000	-20,000
1	2,000	-18,000
2	4,000	-14,000
3	6,000	-8,000
4	8,000	0

pay back period = 4 years

Payback period

Year	Project B	Net Cash flow
0	-20,000	-20,000
1	5,800	-14,200
2	5,800	-8.400
3	5,800	-2,600
4	5,800	3,200

pay back period = 3+2600/5800 = 3.45 years

- Project (C) =2.33 years
- If the required payback period is 3.5 years what do you decide?

Discounted payback period

See in table PVIF

Year	Project A	PV	Net Cash flow
0	-20,000	-20,000	
1	2,000	2000*PVIF(0.06,1) =1,887	-18,113
2	4,000	4000*PVIF(0.06,2) =3,560	-14,553
3	6,000	6000*PVIF(0.06,3)=5,038	-9,515
4	8,000	8000*PVIF(0.06,4)=6,337	-3,178
5	10,000	10000*PVIF(0.06,5)=7,473	4,295

pay back period (A)= 4+ (20,000-(1,887+3,560+5,038+6,337)/7,473=4.43 years

pay back period (B)= 3.98 years

pay back period (C)= 2.68 years

Net Present Value (NPV)

- Method: $NPV = PV_{inflows} – PV_{outflows}$
- If $NPV \geq 0$, then accept the project; otherwise reject the project.

Net Present Value: NPV

- NPV

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+i)^t}$$

$$NPV = \sum_{t=0}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Net Present Value (NPV) - -

- Find NPV(A):

NPV(A) at 0% = -20,000 + 2,000 + 4,000 + 6,000 + 8,000 + 10,000

= **10,000**

NPV(A) at 4% = -20,000 + 2,000*PVIF(.04,1) + 4,000*PVIF(.04,2)
+6,000*PVIF(.04,3) + 8,000*PVIF(.04,4) + 10,000*PVIF(.04,5)

= -20,000 + 1,923 + 3,698 + 5,334 + 6,838 + 8,219

= **6,013**

NPV(A) at 8% = **2,730**

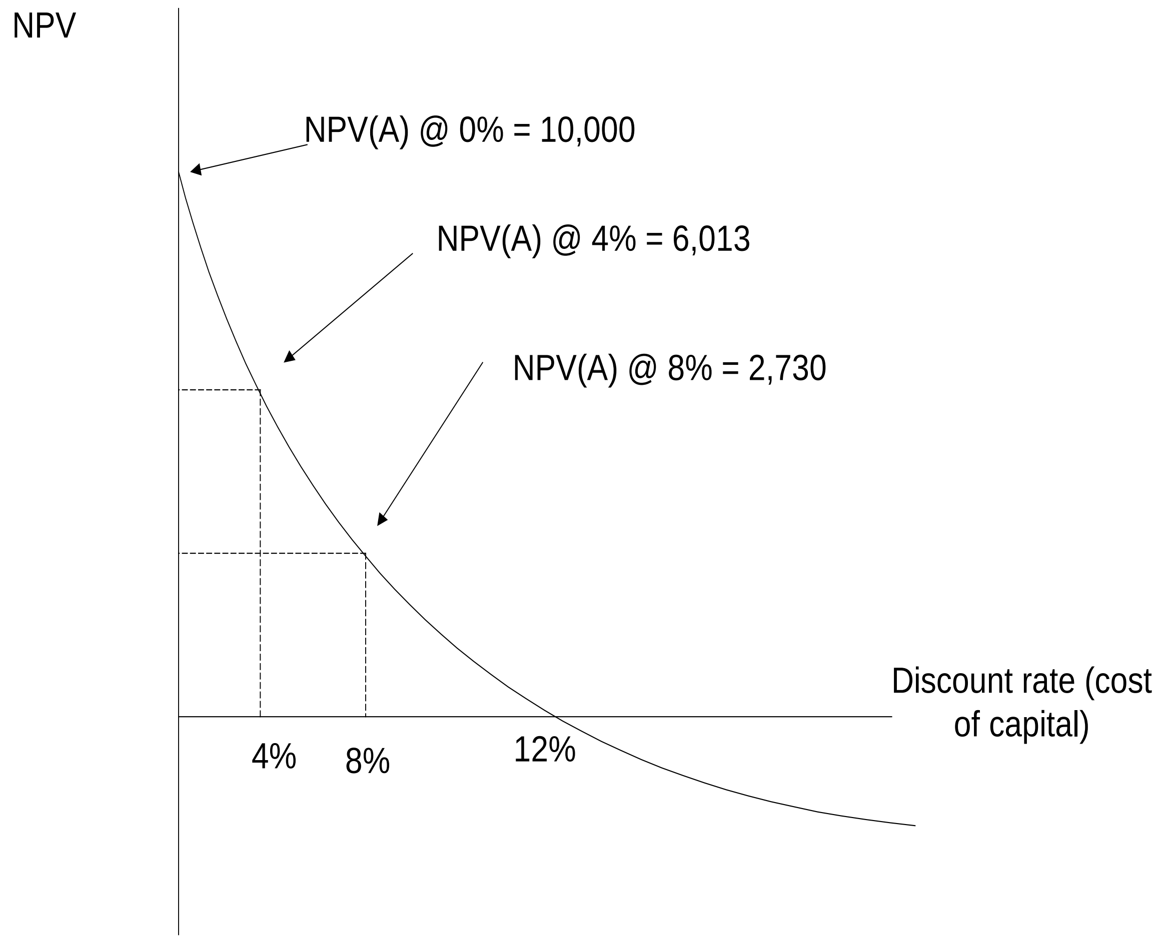
Net Present Value (NPV) - -

- excel

Cell D2

CELL	**CF**	**Discount rate**	**4%**	
B3	-20000	**NPV**	6,013	
B4	2000	Excel equation		
B5	4000	=NPV(0.04,B4:B8)+B3		
B6	6000	=NPV(D2,B4:B8)+B3		
B7	8000			
B8	10000			

NPV Profile


NPV
NPV(A) @ 0% = 10,000
NPV(A) @ 4% = 6,013
NPV(A) @ 8% = 2,730
Discount rate (cost of capital)
4%
8%
12%

NPV: Strengths and Weaknesses

- Strengths
  - Resulting number is easy to interpret: shows how wealth will change if the project is accepted.
  - Acceptance criteria is consistent with shareholder wealth maximization.
  - Relatively straightforward to calculate
- Weaknesses
  - Requires knowledge of finance to use.

Internal Rate of Return (IRR)

- IRR is the rate of return that a project generates. Algebraically, IRR can be determined by setting up an NPV equation and solving for a discount rate that makes the NPV = 0.
- Equivalently, IRR is solved by determining the rate that equates the PV of cash inflows to the PV of cash outflows.
- Method: Use your financial calculator or a spreadsheet; IRR usually cannot be solved manually.
- If IRR ≥ opportunity cost of capital (or hurdle rate), then accept the project; otherwise reject it.

Internal Rate of Return (IRR)

- IRR = discount rate that makes NPV = 0:

$$0 = \sum_{t=0}^{n} \frac{B_t - C_t}{(1 + IRR)^t}$$

$$0 = -INV + P_1/(1+IRR) + P_2/(1+IRR)^2 + \ldots + P_n/(1+IRR)^n + V_n/(1+IRR)^n$$

$$INV = P_1/(1+IRR) + P_2/(1+IRR)^2 + \ldots + P_n/(1+IRR)^n + V_n/(1+IRR)^n$$

IRR> required rate of return

IRR calculation

Guess

- Project A
- i=8% PV =2000*PVIF 8%,1 +4000*PVIF 8%,2+6000*PVIF 8%,3+8000*PVIF 8%,4+ 10,000*PVIF 8%,5 =22730 >20,000
- i =9% PV=2000*PVIF 9%,1 +4000*PVIF 9%,2+6000*PVIF 9%,3+8000*PVIF 9%,4+ 10,000*PVIF 9%,5 =22,000
- i=12% PV =20,003.58
- i =13% PV=19394.95
- IRR between 12-13%
- PV =20,003.58-19394.95=608.6361   i differs (13%-12%) = 1%
- PV =20,003.58-20000=3.58   i = 1*3.58/608.6361= 0.01%

Rule of three

- IRR =12.01%

- **Excel**

CELL	CF			
A3	-20000	**IRR =**	12.01%	
A4	2000	Excel equation		
A5	4000	=IRR(A3:A8)		
A6	6000			
A7	8000			
A8	10000			

IRR: Strengths and Weaknesses

- Strengths
  - IRR number is easy to interpret: shows the return the project generates.
  - Acceptance criteria is generally consistent with shareholder wealth maximization.
- Weaknesses
  - Requires knowledge of finance to use.
  - Use in excel is easier

Profitability index / Benefit-Cost Ratio (BCR)

- PI/ BCR/BC ratio

BCR = PV(Benefits) / PV(Costs)

$$BCR = \sum_{t=0}^{n} \frac{B_t}{(1+i)^t} / \sum_{t=0}^{n} \frac{C_t}{(1+i)^t}$$

= PV(cash inflows) / PV(cash outflows)

= [NPV + Initial cost] / Initial Cost

- Criteria for acceptance : If BCR >1

Profitability index

- Find BCR(A):

BCR = PV(Benefits) / PV(Costs)

= PV(cash inflows) / PV(cash outflows)

= [NPV + Initial cost] / Initial Cost

BCR(A) at 0% = (10,000 + 20,000) / 20,000 = 1.50

BCR(A) at 4% = (6,013+20,000) / 20,000 = 1.30

BCR(A) at 8% = (2,730 + 20,000) / 20,000 = 1.14

- Strengths
  - PI number is easy to interpret: shows how many $ (in PV terms) you get back per $ invested.
  - Acceptance criteria is generally consistent with shareholder wealth maximization.
  - Relatively straightforward to calculate.
- Weaknesses
  - Requires knowledge of finance to use.

- Sensitivity Analysis
  - A sensitivity analysis calculates the consequences of incorrectly estimating a variable in your NPV analysis.
  - If forces you:
    - To identify the variables underlying your analysis.
    - To focus on how changes to these variables could impact the expected NPV.
    - To consider what additional information should be collected to resolve uncertainties about the variables.

- **Sensitivity Analysis**
  - You must run a sensitivity analysis by asking yourself what if your forecasts (initial investment, sales, costs) change ?
  - The following table shows what would be the NPV if each variable changes at a time
    - Only one variable changes at a time, all the other variables stay at their expected level

	Range			NPV		
Variable	Pessimistic	Expected	Optimistic	Pessimistic	Expected	Optimistic
Investment	$6,200,000	$5,400,000	$5,000,000	($120,897)	$478,141	$777,660
Sales	$14,000,000	$16,000,000	$18,000,000	($1,217,477)	$478,141	$2,173,758
Variable costs	83%	81.25%	80%	($787,920)	$478,141	$1,382,470
Fixed costs	$2,100,000	$2,000,000	$1,900,000	$26,976	$478,141	$930,306

- Sensitivity Analysis
  - For example, if the initial investment in the project were \$6.2 million, instead of \$5.4 m, you would recalculate NPV as:

NPV = PV of Cash Flows - Investment (C_0)

= [\$806,667 x 12 year annuity factor] - 6.2 m

= [\$806,667 x 7.536] – 6.2 m

= -**\$120,897 ***

* Don’t forget to change the depreciation for the project!

- Sensitivity Analysis
- You now know how badly the project could be thrown off course by changes in certain variables.
- Looking at the previous table, can you answer following questions:
  - What is the least critical variable to the success of the project?
  - What are two most critical variables to the success of the project?
- You can see that the principal uncertainties come from sales and variable costs, under pessimistic assumptions, NPV could be significantly negative
  - If your sales are $14 mil. instead of $16 mil. the NPV is -$1.2 mil.
  - If your variable costs are set at 83% if sales, NPV is -$0.8 mil.
- Fixed costs is the least critical variable, even the pessimistic assumption would lead to a positive NPV

- Sensitivity Analysis
- Now that you have identified the critical success/failure factors, you may wish to focus your attention on them:
  - You might collect additional data on sales and costs so as to resolve some of the uncertainty concerning these variables
- Sensitivity analysis is not a "cure-all".
- It does have its drawbacks:
  - The results are ambiguous since the terms "optimistic" and "pessimistic" are completely subjective.
  - Variables are often related and it may be difficult to identify all of the consequences associated with a change in one of them.
- When variables are interrelated, it may be helpful to look at how the project would fare under different scenarios.
  - Scenario analysis allows us to look at different but consistent combinations of variables

- ## Scenario Analysis
  - A scenario analysis involves changing several variables at once in your NPV forecast
  - Example: Suppose that managers are worried that a competitor decides to build a new store near their new superstore, and assume that this will reduce the sales and tighten your margins
  - The NPV is negative

		Year 0	Years 1-12
Investment		-$5,400,000	
1. Sales			$13,600,000
2. Variable costs	82.00%		$11,152,000
3. Fixed costs			$2,000,000
4. Depreciation			$450,000
5. Pretax profit (1-2-3-4)			-$2,000
6. Taxes (at 40%)			-$800
7. Profit after tax			-$1,200
8. Cash flow from operations (4+7)			$448,800
Net cash flow		-$5,400,000	$448,800
NPV (at 8%)		**-$2,017,808**	

- Simulation Analysis
- A scenario analysis is helpful to see how interrelated variables impact NPV. But one must run several hundred possible scenarios.
- A simulation analysis uses a computer to generate hundreds, or even thousands, of possible scenarios.
- A probability distribution is assigned to each combination of variables to create an entire range of potential outcomes.

Example with 3 scenarios

Variable	Scenario 1 30%	Scenario 2 55%	Scenario 3 15%
Investment	$6,200,000	$5,400,000	$5,000,000
Sales	$14,000,000	$16,000,000	$18,000,000
Variable costs	83.00%	81.25%	80%
Fixed costs	$2,100,000	$2,000,000	$1,900,000
Scenario NPV	($3,376,483)	$478,141	$3,942,813
Probability x NPV	($1,012,945)	$262,977	$591,422
Expected NPV	**($158,545)**		

Cost-Benefit analysis of Greenhouse summer crops production in Iran

Table 1. Ten sample greenhouses of Lenjan area

Modern green houses (metallic skeleton)	1	2	3	4	5
Sample Zone	Esmaeel Tarkhan	Johar-estan	Johar-estan	Esmaeel Tarkhan	Karkevand
Land area (m^2)	3400	2000	3000	1500	2000
Traditional greenhouse (woody skeleton)	6	7	8	9	10
Sample Zone	Esmaeel Tarkhan	Tangeh Khule-njan	Tangeh Poly Aakril	Khulenjan	Khulenjan
Land area (m^2)	8000	4000	1000	5000	14000

Table 2. Category of depreciation groups

Depreciation group	Items which should be changed after their economic life
3 years	Plastic, band, wire, manual tools, PVC tubes, drippers
5 years	Woody skeleton of traditional greenhouse
9 years	Terminal system, poison sprinkler, valve, central control system of irrigation

Table 3. Interest cost of greenhouse growers during, 2004-2008 (Rials)

Borrower	2004	2005	2006	2007	2008
2	26600000	21000000	15400000	9800000	4200000
4	18630000	16114950	13939430	12057600	10429830
5	25650000	20250000	14850000	9450000	4050000

1USD = 31,752.00 Iranian Rial

Table 4. Yield productivity

Crops	Parthenocarpic cucumber	Radish	Kingship	Sweet basil	Pepper
Product per acre per year	20-25	5	5	2-4	15-20

Table 5. Cost and benefit of 10 units of greenhouses (Rials)

Cost and benefit	Modern greenhouse				
	1	2	3	4	5
Fixed Cost	102287000	41907143	187340000	101790000	180350000
Total depreciation	13684000	10555556	13555556	4722222	9666667
Operating Cost	104627000	66189667	82334500	38227500	76898000
Working Capital	4299735	19040910	14662310	- 4712985	15800925
Cash Receipt	176800000	122000000	182500000	40000000	179000000
Cost and benefit	**Traditional greenhouse**				
	6	7	8	9	10
Fixed Cost	15780000	23573000	12110000	11900000	33200000
Total depreciation	22908889	22288889	1211111	17922222	46562222
Operating Cost	178224000	118720000	30787000	157305000	364610000
Working Capital	14414247	24394521	3795658	- 58181301	- 74919836
Cash Receipt	368000000	220000000	40000000	320000000	760000000

Table 6. Summary of profitability evaluation of 10 samples during 2003-2012 (Rials)

Modern greenhouse	Capital recovery (monthly)	Net present value	Internal rate of return	Benefit-cost ratio
1	13	170699673	52 %	1.227
2	54	31743913	25 %	1.054
3	16	175107162	36 %	1.225
4	Indeterminate Period	- 144167423	-	0.582
5	46	149388109	32 %	1.198
Traditional greenhouse				
6	Less than 12 months	844300837	-	9.206
7	12	251465637	232 %	1.293
8	12	13285762	52 %	1.058
9	Less than 12 months	1213466152	-	2.688
10	Less than 12 months	2525240895	-	2.223

Sample	Type of sensitivity	Net present value	Benefit-cost ratio
7	Delay in operation	30662228	1.299
2	Interest cost elimination	90149207	1.171
4	Interest cost elimination	9297295	0.684
5	Interest cost elimination	205707499	1.295