

Executive Certificate Program in

Financial Data Analytics
&
Corporate Finance



IIM VISAKHAPATNAM



IIM

भारतीय प्रबंध संस्थान विशाखपट्टणम
Indian Institute of Management Visakhapatnam

विद्या परं दैवतम्

Program Roadmap (Tentative)

Module 1: Corporate Finance Fundamentals	Nov 03 - Nov 17
Module 2: R Programming Essentials for Financial Data Analytics	Nov 24 - Dec 01
Module 3: Applied Financial Analytics: Cross-sectional Models	Dec 08 - Dec 22
Module 4: Time Series Analysis and Forecasting with R	Dec 29 - Jan 12
Module 5: Investment Analysis and Financial Markets	Jan 19 - Feb 02
Module 6: Applied Corporate Finance	Feb 09 - Feb 16
Module 7: Machine Learning and AI in Finance	Feb 23 - Mar 02
Module 8: Trading Strategies and Sentiment Analysis Using R	Mar 09 - Mar 23
Module 9: Essentials of Emerging Financial Technologies and Innovations	Mar 30
Module 10: Advanced Data Visualization and Financial Dashboarding with Power BI	Apr 20 - Apr 27
Campus Immersion	12/13 April (tentative)

As Discussed in the class, possibility of scheduling sessions on Second and fourth Saturdays (10:00 – 12:30 am) will be explored before finalising the overall roadmap.

Prof. M Shameem Jawed

Associate Professor, IIM Visakhapatnam (Program Director)

- **Education, Background & Pedagogical Excellence**

- Alumnus of **IIM Indore** with an FPM (Ph.D.) in Finance & Accounting
- Formerly Consultant at **SunGard** (now FIS) & Assistant Prof. in Finance at **MDI**.
- Trained twice at **Harvard Business School** in participant-centered learning and case study methodologies
- **1,500+ hours of teaching** experience at Post-Graduate, Doctoral, and executive education levels

- **Teaching & Research Interests**

- Corporate Finance | **Financial Analytics & Trading Strategies** | Cost Management | Corporate Governance | Startup-Finance and Valuation | Behavioural Finance

- **Academic & Entrepreneurial Leadership**

- **Chair Positions Held (Past & Present):** PGPMCI (DBM/MBA) | MGNF | Entrepreneurship Development
 - Founding Director, IIMV FIELD & AIC FIELD
 - Established the first incubator at IIMV in 2018, leading it to incubate 180+ startups as of date
 - Key sponsors: MSDE, DST, NITI Aayog, MeitY, NSRCEL (IIMB), MTAR, NBCC, S2Tech, among others

Prof. Shivshanker Singh Patel

Assistant Professor, IIM Visakhapatnam (Program Co-Director)

Dr. Shivshanker has worked in past as Manager at Mphasis-NextLabs in the domain of data science and as R&D Engineer with Mahindra & Mahindra Automotive. Before joining IIM Visakhapatnam, he was with the Institute of Rural Management, Anand as Assistant Professor. His research interests lie in the domain of system modeling & analysis, forecasting, and optimization, applied to scarce resource management and logistics management. He heads Inter-disciplinary Decision Science & Analytics Lab **(IDeAL)**

Education:

- **Ph.D.:** Ph.D. (Management Science), IISc Bangalore
- **Masters:** M.Tech. (Mechanical Engineering), IIT Roorkee
- **Bachelors:** B.E. (Mechanical Engineering), GEC/NIT Raipur

Faculties

Prince Doliya

Dr. Prince Doliya has been awarded a Ph.D. in Accounting & Finance from the Department of Management Studies, Indian Institute of Technology (IIT) Roorkee. His doctoral work investigates auditing issues in International Financial Reporting Standards (IFRS). Prior to this, He received his MBA from the National Institute of Technology, Kurukshetra, majoring in Finance. Before joining IIMV, he worked at T.A. Pai Management Institute, Manipal, as an Assistant Professor.

His research interests are International Financial Reporting Standards, Decision making in Accounting & Auditing, and the interplay between Accounting and Entrepreneurship.

Faculties

Prof. Vijay Bhaskar Marisetti

Before joining IIM Visakhapatnam, he worked as a Professor at the School of Management Studies, University of Hyderabad. He has worked earlier as faculty at IIM Bangalore, RMIT University, and Monash University, Australia. He holds a PhD degree from Monash University, Australia and a Post Doctoral Fellowship from Wharton Business School, University of Pennsylvania, and Indian School of Business.

His current research primarily focuses on Fintech and its applications in democratizing wealth distribution in India through financial empowerment for the bottom-of-the-pyramid population. He has worked extensively on the usage of technology to empower Indian poor households. He is the recipient of several research grants from the Ministry of Electronics and IT; the Department of Science and Technology; the Reserve Bank of India and the Ministry of Education.

He has received several best paper awards in top conferences and published in Economics, Finance, and Accounting A-star journals. In 2023, his work on citizen science pilot, using blockchain, IoT, and computer vision technologies made him into the Top 100 Global Innovation Pioneers List at the G20 Digital Alliance Summit.

Prof. Marisetti is a visiting professor at the Indian School of Business. He has set up a Blockchain Lab at ISB through funding from S&P Global to increase awareness of fintech innovation for social impact.

Faculties

Prof. Kaveri Krishnan

She completed her PhD from Indian Institute of Management Bangalore, specializing in the Finance & Accounting Area. Her work largely focuses in the area of credit rating. Her dissertation explores the efficacy of the credit rating process in India. The thesis also analyses the determinants of credit rating and the impact of the regulatory disclosure requirements on the credit rating process. Her broad research interests lie in the area of Credit Rating, Corporate Finance, and Investments. Prior to her doctoral degree, she completed her MBA and Engineering degree. After her Master's degree, she worked in the industry for about three years.

Education: PhD (IIM Bangalore), MBA, BTech

Faculties

Prof. Shalini Agnihotri

Prof. Shalini Agnihotri is Ph.D. from Faculty of Management Studies, University of Delhi. Prior to joining IIM Vishakhapatnam, she worked as Assistant Professor at IIM Bodhgaya, LBSIM-Delhi and visiting faculty at USME- Delhi Technical University and University of Delhi. She is working in the area of quantitative finance, financial risk management, Market risk modelling, Investment management and portfolio optimization etc. She has six years of teaching experience.

Education

Ph.D- FMS, University of Delhi, UGC-NET-JRF and SRF recipient ., MBA- Finance, ICFAI Business School & B.Sc.(H) University of Delhi.

Faculties

Abhishek Srivastava

Prof. Abhishek Srivastava holds a PhD degree from IIM Ranchi. Prior to his PhD, he worked with Adobe Systems and Verizon in various capacities. Prior to joining IIM Visakhapatnam, he worked as Assistant Professor at IIM Jammu and as an Independent AI & IT consultant for various domestic and international clients.

His research interests lie in the areas of Personalization using Recommender systems, Privacy, HCI & AI Auditing.

- Digital Transformation using AI & Emerging Technologies
- Cognitive Computing and Neuro Management
- Business Intelligence, Social Media and Cognitive Analytics
- E-Commerce
- Advanced Data Science and Machine Learning
- People Analytics



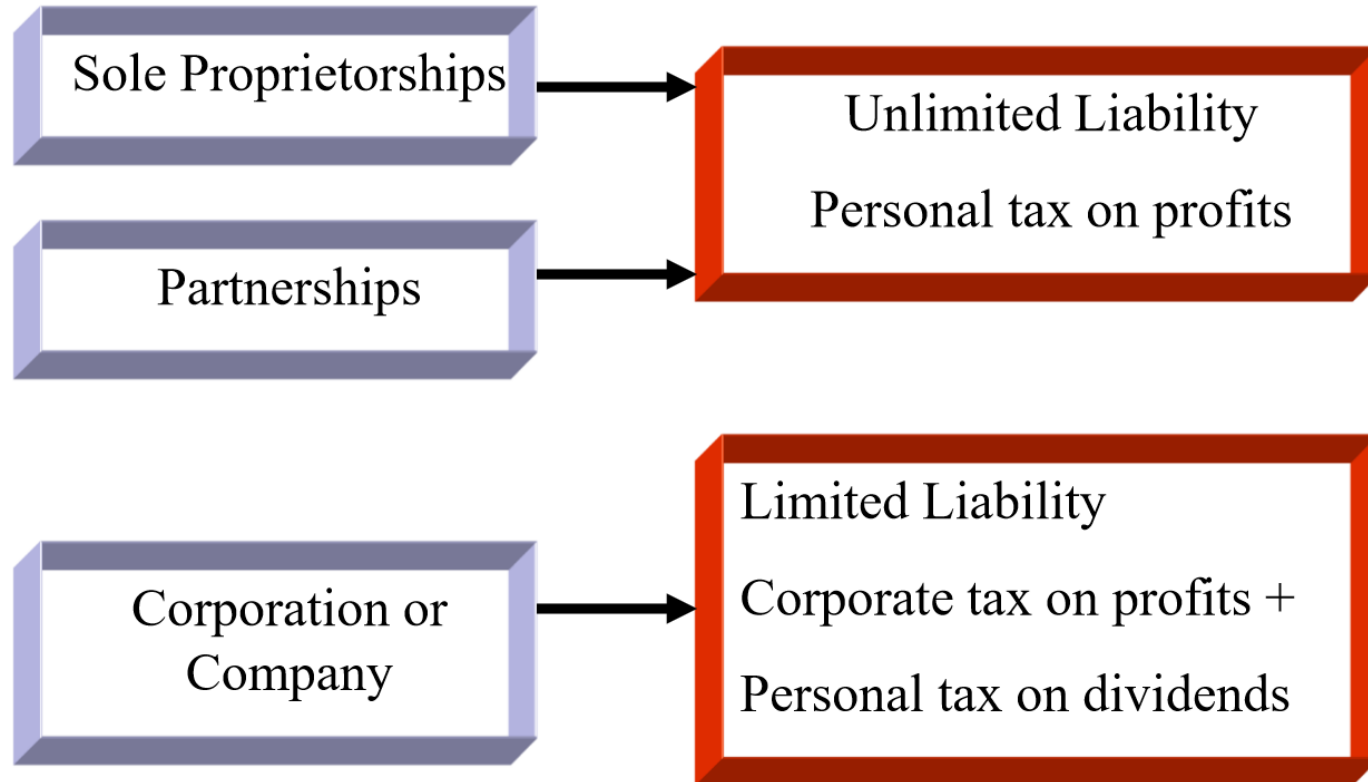
FDAC – Module 1

CORPORATE FINANCE FUNDAMENTALS

Key Topics: Module-1

Date	Time	Session Title	Facilitator(s)
03/Nov/2024	1500-1730	Overview of Corporate Finance, Time Value of Money & Valuation Fundamentals	Prof M Shameem Jawed
10/Nov/2024	1500-1730	Financial Statements Analysis	Prof Prince Doliya
17/Nov/2024	1500-1730	Capital Budgeting: Principles, Tools & Techniques, Cash Flow Estimation	Prof M Shameem Jawed

Business Structure



Understanding Real Assets & Financial Assets

Real Assets

- Used to produce goods and services
- Tangible, eg. Plant and machinery
- Intangible, eg. Technical expertise, brands, patents

Financial Assets/Securities

- Financial claims on income generated by firm's real assets; eg - Stocks, bonds

Capital Budgeting/Capital Expenditure (CAPEX)

- Decision to invest in tangible or intangible assets

Key financial decisions a company makes to support its operations and growth

Investment Decision

- Purchase of real assets

Financing Decision

- Sale of financial assets

Capital Structure

- Choice between debt and equity financing

Corporate Investment and Financing Decisions

Capital Budgeting Examples

- Tangible Assets
 - i.e., Expanding stores
- Intangible Assets
 - i.e., Research and development for new drug



Balance Sheet Model of the Firm

Total Value of Assets:

Current Assets

Fixed Assets

1 Tangible

2 Intangible

Total Firm Value to Investors:

Current
Liabilities

Long-Term
Debt

Shareholders'
Equity

The Capital Budgeting Decision

Current Assets

Fixed Assets
1 Tangible
2 Intangible



What long-term investments should the firm choose?

Current Liabilities

Long-Term Debt

Shareholders' Equity

The Capital Structure Decision

Current Assets

Fixed Assets
1 Tangible
2 Intangible

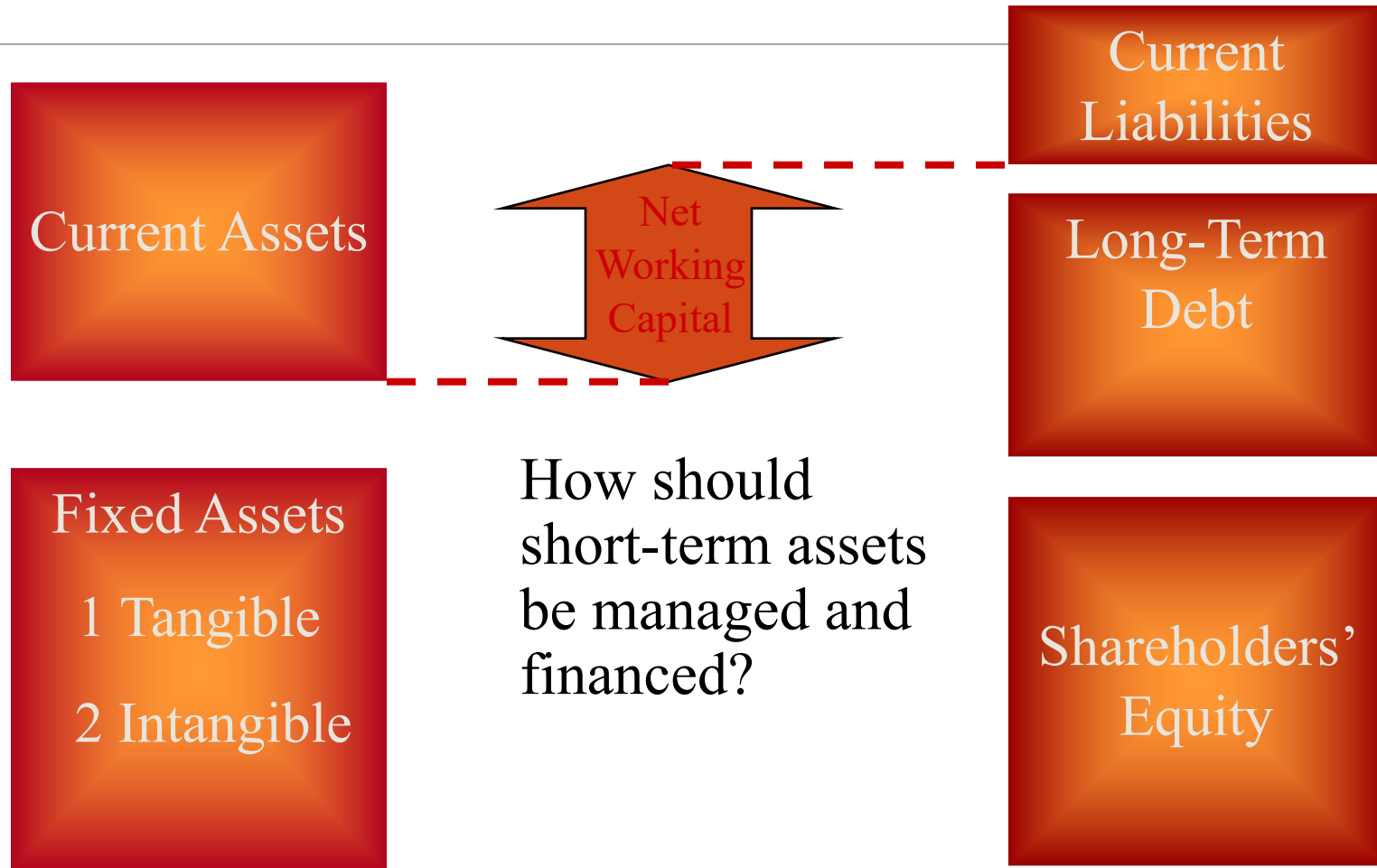
How should the firm raise funds for the selected investments?

Current Liabilities

Long-Term Debt

Shareholders' Equity

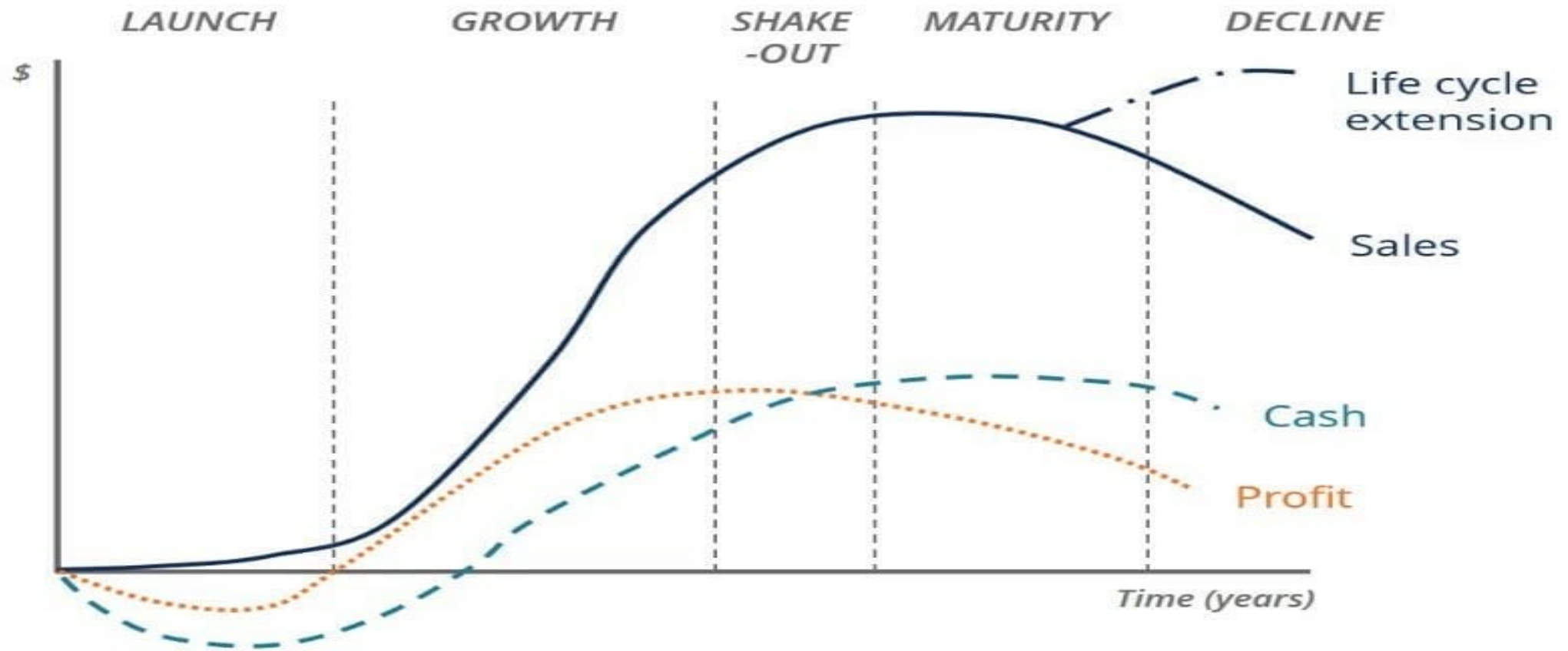
Short-Term Asset Management



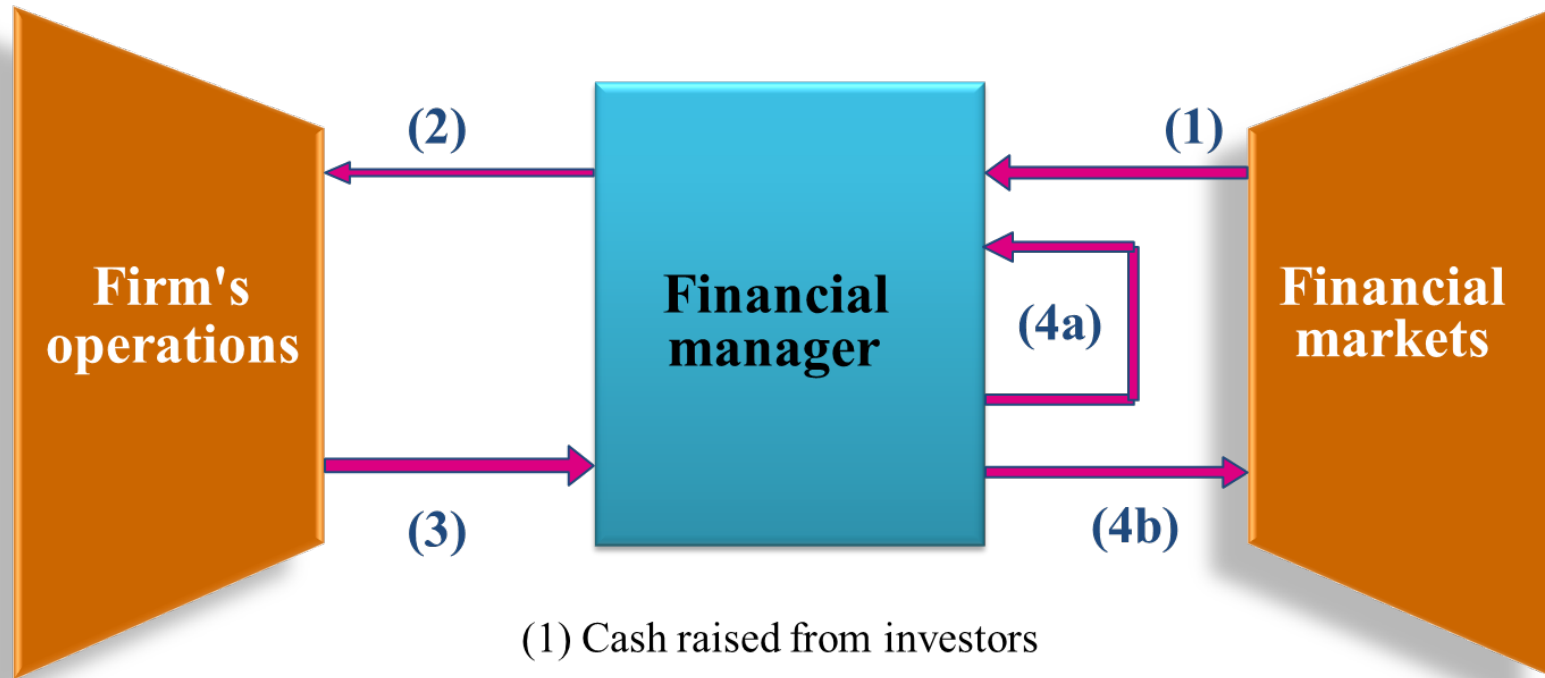
What is a Corporation?

- Legal entity, owned by shareholders
- Can make contracts, carry on business, borrow, lend, sue, and be sued
- Shareholders have limited liability and cannot be held personally responsible for corporation's debts

Life cycle of a corporation



Cash Flow between Financial Markets & Firm's Operations



- (1) Cash raised from investors
- (2) Cash invested in firm
- (3) Cash generated by operations
- (4a) Cash reinvested
- (4b) Cash returned to investors

The Financial Goal of the Corporation

Stockholders Want Three Things

- To maximize current wealth.
- To transform wealth into most desirable time pattern of consumption.
- To manage risk characteristics of chosen consumption plan.

The Financial Goal of the Corporation

Maximize shareholder value: Is it Profit Maximization? - Not a well-defined financial objective!

- Which year's profits?
- Shareholders will not welcome higher short-term profits if long-term profits are damaged
- Company may increase future profits by cutting year's dividend, investing freed-up cash in firm
- Not in shareholders' best interest if company earns less than opportunity cost of capital

Opportunity Cost

- The return on alternative investments of similar risk
- Investing in a project means that the resources could not be used for an alternative investment and the cost associated with the foregone returns from the alternative is the opportunity cost.
- A good investment project should earn more than opportunity cost.

How is value created?

Managers need to compare the return on a project with the opportunity cost.

If the project's return is greater than the opportunity cost, the project is creating value.

Managers look to the financial markets to estimate the opportunity cost.

The Financial Goal of the Corporation

- Shareholders desire wealth maximization, but what do the managers want?
- “**Agency Problems**” represent the conflict of interest between management and owners
- Managers, acting as agents for stockholders, may act in their own interests rather than maximizing value

Agency costs are incurred when:

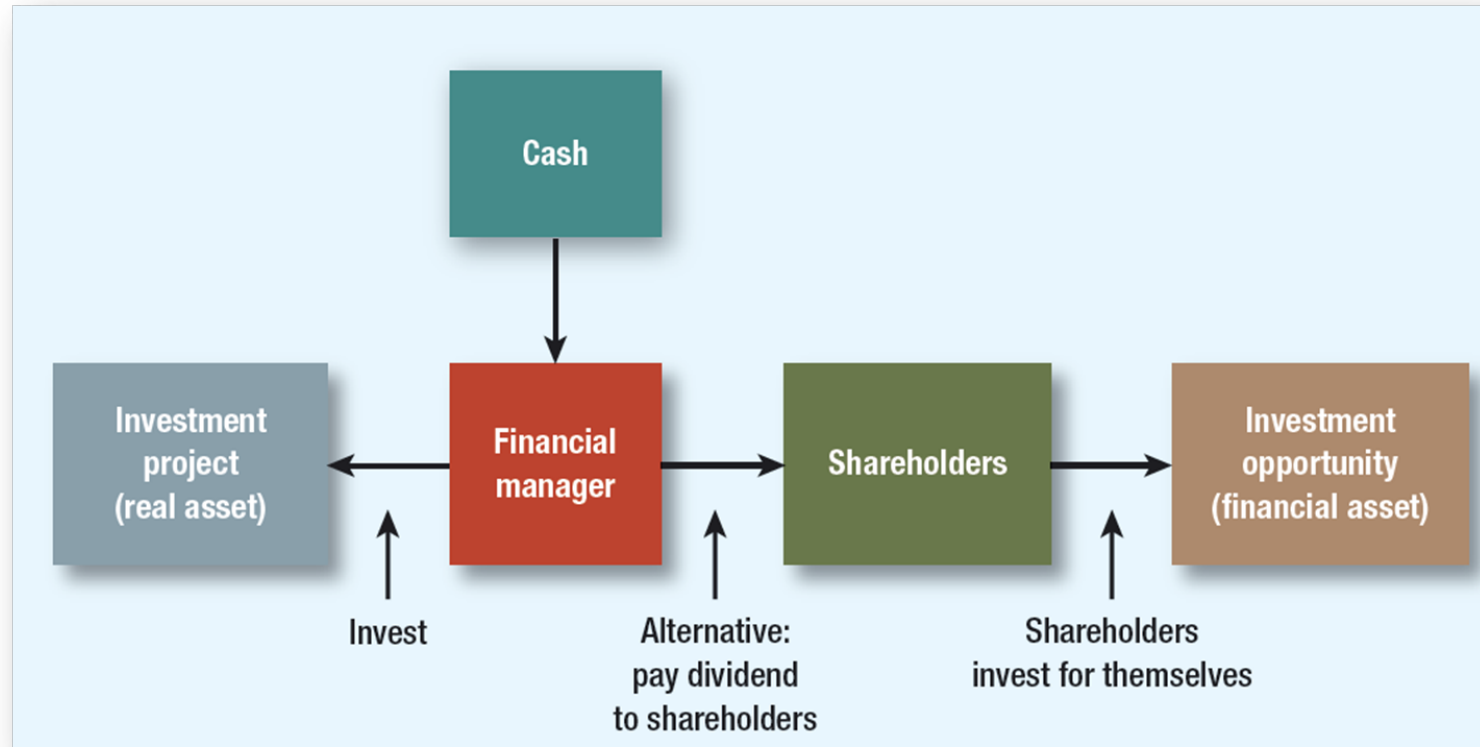
- Managers do not attempt to maximize firm value
- Shareholders incur costs to monitor managers and constrain their actions

The Financial Goal of the Corporation

The Investment Trade-off

- Hurdle Rate/Cost of Capital
 - Minimum acceptable rate of return on investment
- Opportunity Cost of Capital
 - Investing in a project eliminates other opportunities to use invested cash

The Investment Trade-off





How to calculate present values

Time Value of Money

A rupee today is worth more than a rupee tomorrow.

Investments in projects are expected to generate cash flows in the future.

Since the cash received at different time periods is not the same, we need a way to be able to assess their value.

Future Values and Present Values

- **Future Value**

- Amount to which investment will grow after earning interest

- **Present Value**

- Value today of the cash flows received in the future

The one-period case

If you were to invest \$10,000 at 5-percent interest for one year, your investment would grow to \$10,500.

\$500 would be interest ($\$10,000 \times .05$)

\$10,000 is the principal repayment ($\$10,000 \times 1$)

\$10,500 is the total due. It can be calculated as:

$$\$10,500 = \$10,000 \times (1.05)$$

The total amount due at the end of the investment is call the *Future Value (FV)*.

Future Value

In the one-period case, the formula for FV can be written as:

$$FV = C_0 \times (1 + r)$$

Where C_0 is cash flow today (time zero), and r is the appropriate interest rate.

The Multiperiod Case

The general formula for the future value of an investment over many periods can be written as:

$$FV = C_0 \times (1 + r)^T$$

Where

C_0 is cash flow at date 0,

r is the appropriate interest rate, and

T is the number of periods over which the cash is invested.

Present Value

If you were to be promised \$10,000 due in one year when interest rates are 5-percent, your investment would be worth \$9,523.81 in today's dollars.

$$\$9,523.81 = \frac{\$10,000}{1.05}$$

The amount that a borrower would need to set aside today to be able to meet the promised payment of \$10,000 in one year is called the *Present Value (PV)*.

Note that $\$10,000 = \$9,523.81 \times (1.05)$.

Present Value

In the one-period case, the formula for PV can be written as:

$$PV = \frac{C_1}{1+r}$$

- Where C_1 is cash flow at date 1, and
- r is the appropriate interest rate.

Future Values

Future Value of Rs.100 =

$$FV = ` 100 \times (1 + r)^t$$

Example: FV

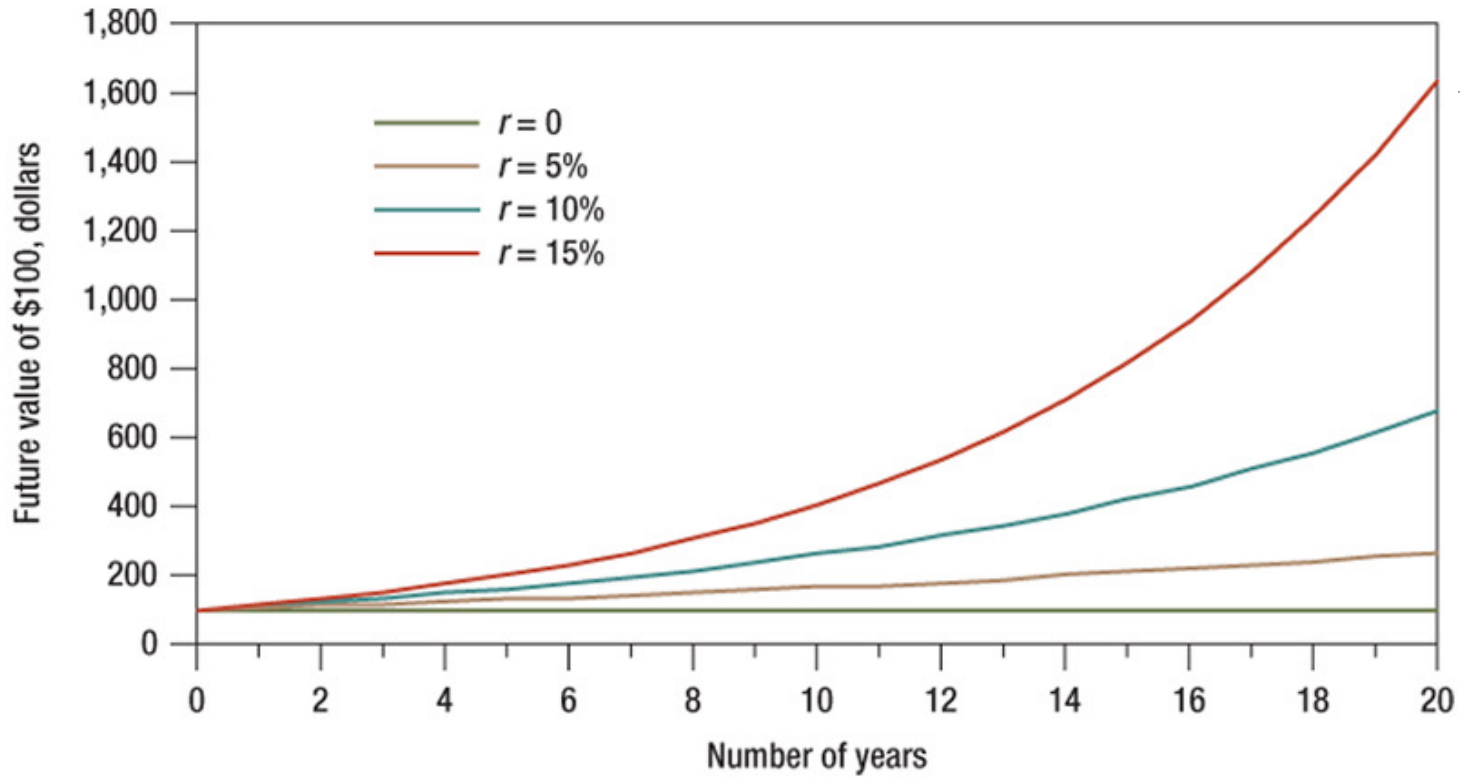
- What is the future value of Rs. 100 if interest is compounded annually at a rate of 7% for two years?

$$FV = ` 100 \times (1.07) \times (1.07) = ` 114.49$$

$$FV = ` 100 \times (1 + .07)^2 = ` 114.49$$

Time	Future Value			
	0%	5%	10%	20%
0	100	100	100	100
1	100	105	110	120
2	100	110	121	144
3	100	116	133	173
4	100	122	146	207
5	100	128	161	249
6	100	134	177	299
7	100	141	195	358
8	100	148	214	430
9	100	155	236	516
10	100	163	259	619
20	100	265	673	3834
30	100	432	1745	23738
40	100	704	4526	146977
50	100	1147	11739	910044

FV of Rs 100 earning
different returns



Future Values with Compounding

Present Values

Present value = PV

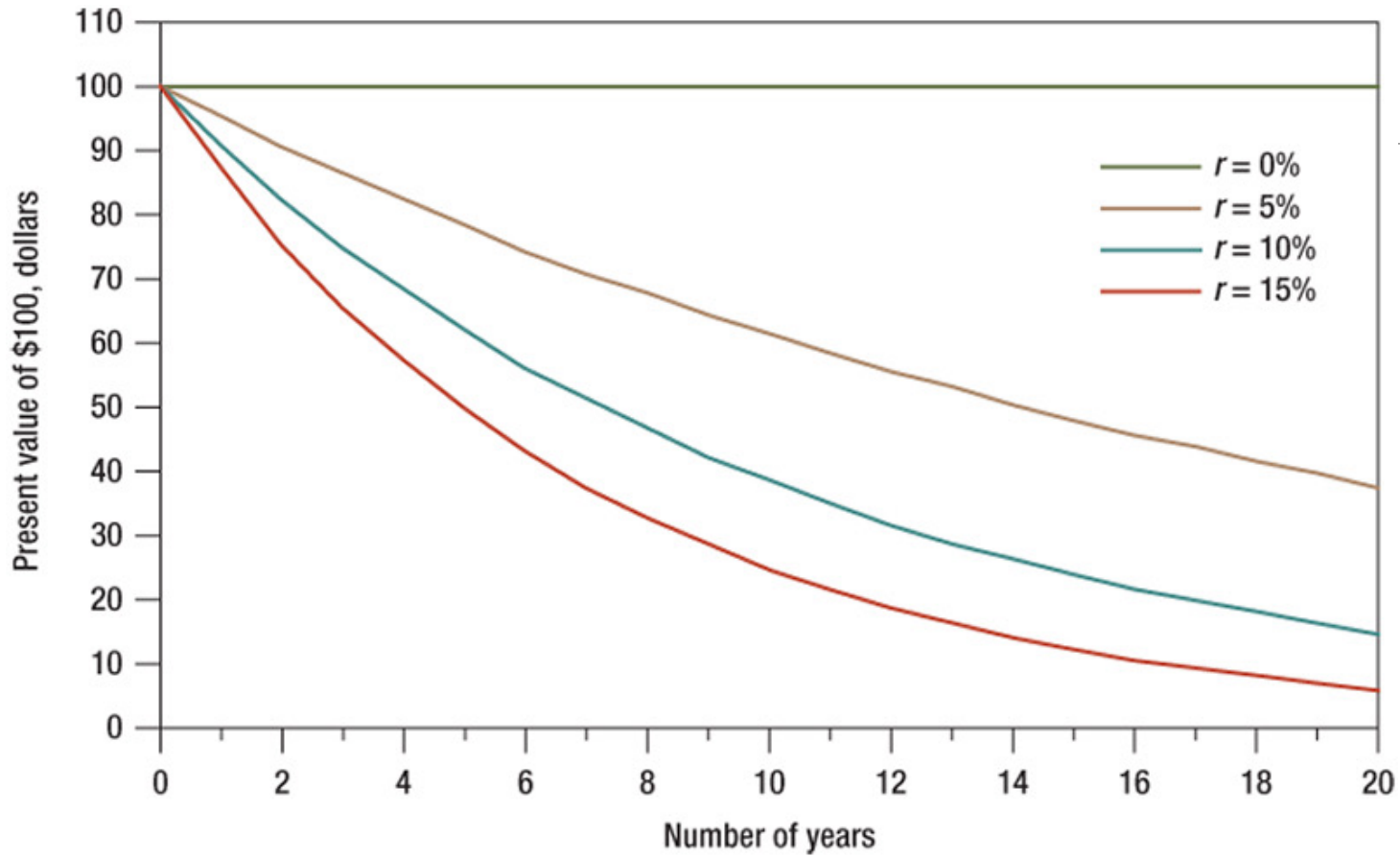
PV = discount factor $\times C_1$

Future Values and Present Values

Discount factor = DF = PV of Rs. 1

$$DF = \frac{1}{(1+r)^t}$$

Discount factors can be used to compute present value of any cash flow



Present Values with Compounding

Future Values and Present Values

Valuing an Office Building

- Step 1: Forecast Cash Flows
 - Cost of building = $C_0 = \text{Rs. } 700,000$
 - Sale price in year 1 = $C_1 = \text{Rs. } 800,000$
- Step 2: Estimate Opportunity Cost of Capital
 - If equally risky investments in the capital market offer a return of 7%, then cost of capital = $r = 7\%$

Future Values and Present Values

Valuing an Office Building

- Step 3: Discount future cash flows

$$PV = \frac{C_1}{(1+r)} = \frac{800,000}{(1+.07)} = 747,664$$

- Step 4: Go ahead if PV of payoff exceeds investment

$$\begin{aligned} NPV &= 747,664 - 700,000 \\ &= 47,664 \end{aligned}$$

Future Values and Present Values

Net Present Value

$$\text{NPV} = \text{PV} - \text{required investment}$$

$$\text{NPV} = C_0 + \frac{C_1}{1+r}$$

Future Values and Present Values

Risk and Present Value

- A safe rupee is more valuable than a risky rupee
- Higher risk projects require a higher rate of return
- Higher required rates of return cause lower PVs

PV of $C_1 = 800,000$ at 12%

$$\text{PV} = \frac{800,000}{1.12} = 714,286$$

Future Values and Present Values

Net Present Value Rule

- Accept investments that have positive net present value
- $NPV = PV(\text{cash inflows}) - PV(\text{investments OR cash outflows})$
- Using the original example: Should one accept the project given a 10% expected return?

$$NPV = -700,000 + \frac{\$800,000}{1.1} = 27,273$$

Future Values and Present Values

Rate of Return Rule

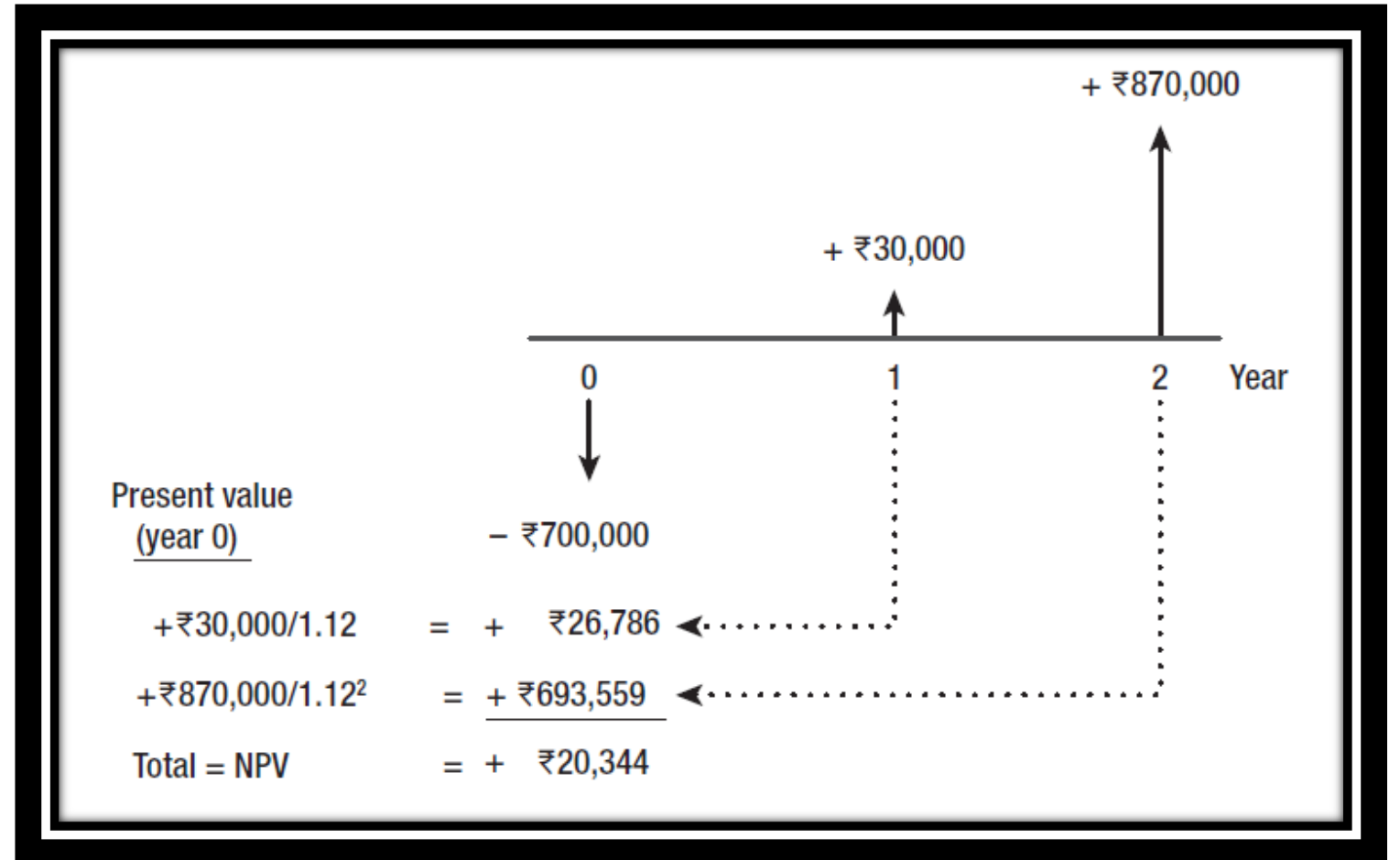
- Accept investments that offer rates of return in excess of their opportunity cost of capital
- In the project listed below, the opportunity cost of capital is 12%. Is the project a wise investment?

$$\text{Return} = \frac{\text{profit}}{\text{investment}} = \frac{\text{\` } 800,000 - \text{\` } 700,000}{\text{\` } 700,000} = .143, \text{ or } 14.3\%$$

Net Present Values

Now, let's say the building can be sold after 2 years for \$840,000 but you will earn \$30,000 in year 1 and 2.

How does it affect the NPV of the project if opportunity cost is 12%?



Future Values and Present Values

Multiple Cash Flows

- Discounted Cash Flow (DCF) formula:

$$PV_0 = \frac{C_1}{(1+r)^1} + \frac{C_2}{(1+r)^2} + \dots + \frac{C_t}{(1+r)^t}$$

$$NPV_0 = C_0 + \sum_{t=1}^T \frac{C_t}{(1+r)^t}$$

Net Present Value

The Net Present Value (*NPV*) of an investment is the present value of the expected cash flows, less the cost of the investment.

Suppose an investment that promises to pay \$10,000 in one year is offered for sale for \$9,500. Your interest rate is 5%. Should you buy?

$$NPV = -\$9,500 + \frac{\$10,000}{1.05}$$

$$NPV = -\$9,500 + \$9,523.81$$

$$NPV = \$23.81$$

If we had *not* undertaken the positive *NPV* project considered on the last slide, and instead invested our \$9,500 elsewhere at 5 percent, our *FV* would be less than the \$10,000 the investment promised, and we would be worse off in *FV* terms :

$$\$9,500 \times (1.05) = \$9,975 < \$10,000$$

Future Value

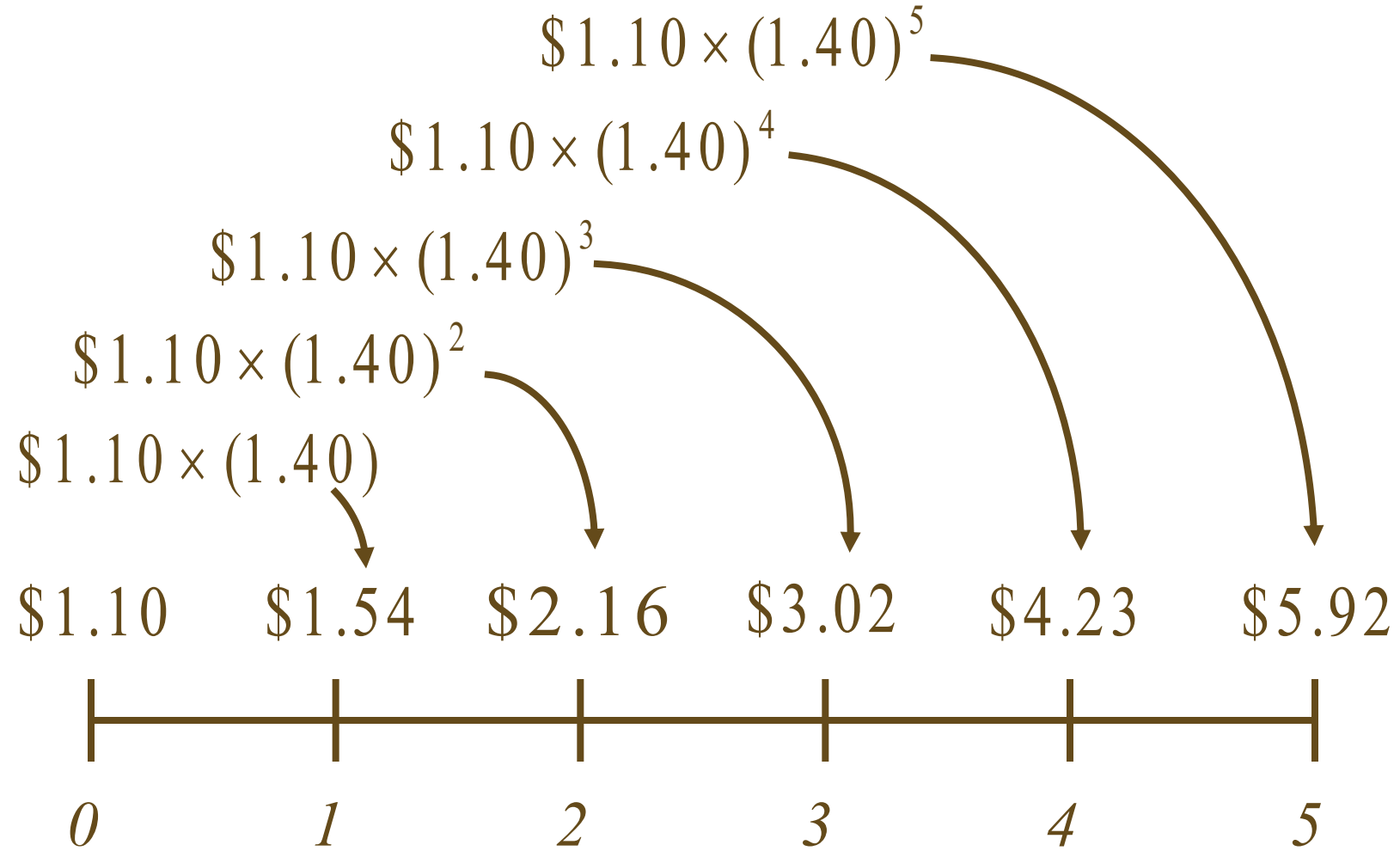
Suppose a stock currently pays a dividend of \$1.10, which is expected to grow at 40% per year for the next five years.

What will the dividend be in five years?

$$FV = C_0 \times (1 + r)^T$$

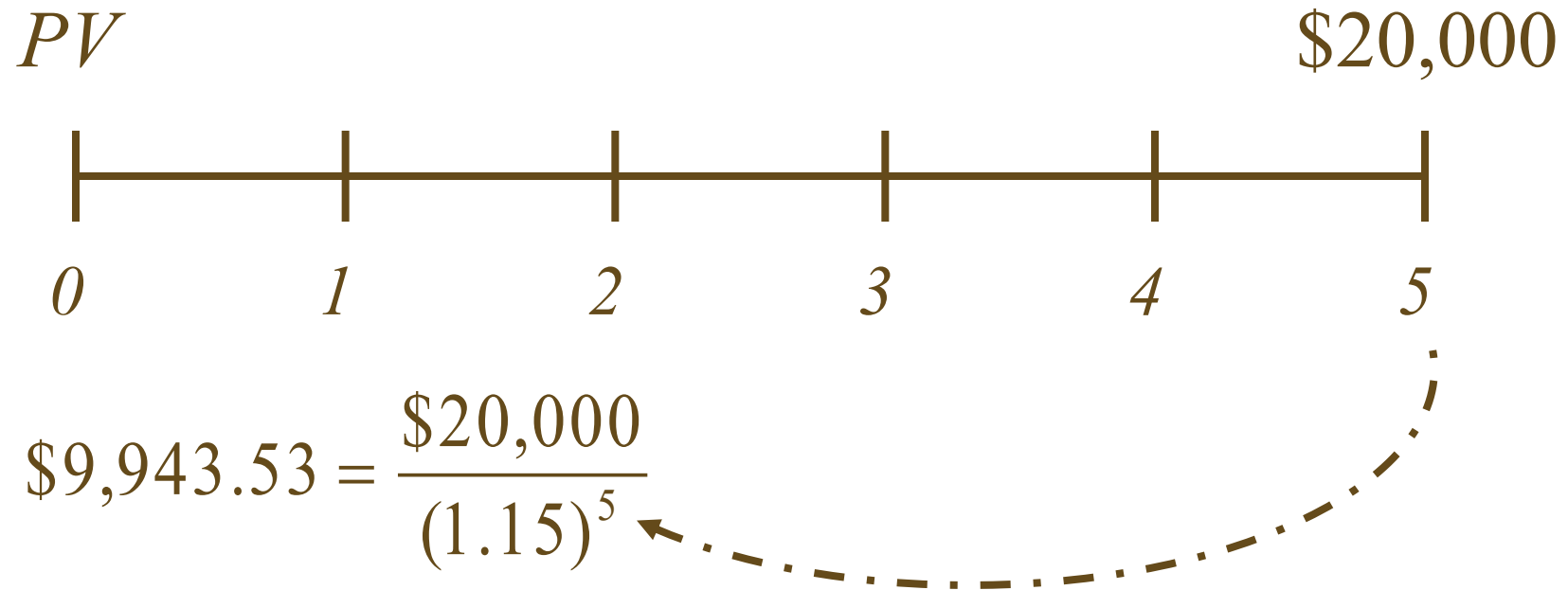
$$\$5.92 = \$1.10 \times (1.40)^5$$

Future Value and Compounding



Present Value and Discounting

How much would an investor have to set aside today in order to have \$20,000 five years from now if the current rate is 15%?



Finding the Number of Periods

If we deposit \$5,000 today in an account paying 10%, how long does it take to grow to \$10,000?

$$FV = C_0 \times (1 + r)^T \quad \$10,000 = \$5,000 \times (1.10)^T$$

$$(1.10)^T = \frac{\$10,000}{\$5,000} = 2$$

$$\ln(1.10)^T = \ln(2)$$

$$T = \frac{\ln(2)}{\ln(1.10)} = \frac{0.6931}{0.0953} = 7.27 \text{ years}$$

Multiple Cash Flows

Consider an investment that pays \$200 one year from now, with cash flows increasing by \$200 per year through year 4.

If the interest rate is 12%, what is the present value of this stream of cash flows?

If the issuer offers this investment for \$1,500, should you purchase it?

$$PV = 1432.93$$

Present Value < Cost → Do Not Purchase

Simplifications

Perpetuity

A constant stream of cash flows that lasts forever

Growing perpetuity

A stream of cash flows that grows at a constant rate forever

Annuity

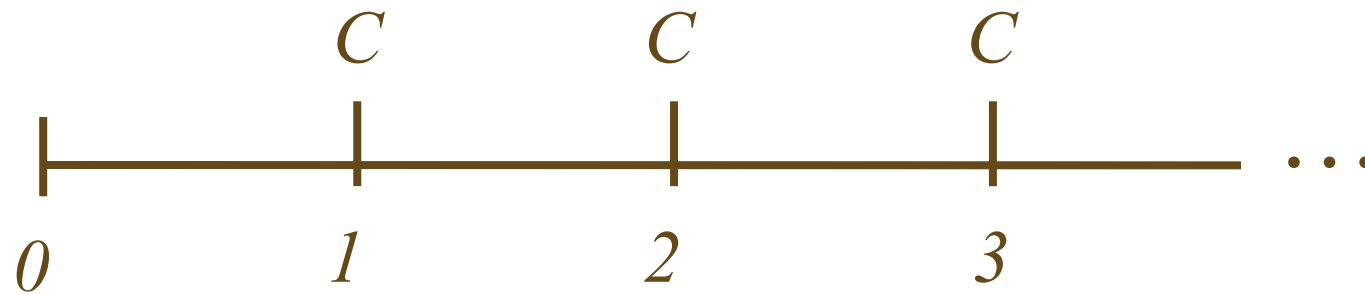
A stream of constant cash flows that lasts for a fixed number of periods

Growing annuity

A stream of cash flows that grows at a constant rate for a fixed number of periods

Perpetuity

A constant stream of cash flows that lasts forever



$$PV = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} + \dots$$

$$PV = \frac{C}{r}$$

Perpetuities

$$\text{PV of Cash Flow} = \frac{\text{cash flow}}{\text{discount rate}}$$

$$PV = \frac{C_1}{r}$$

Perpetuity

- Financial concept in which cash flow is theoretically received forever
- In a perpetual bond (e.g., British Consol), the principal or face value of the bond is not returned to the investors.

Perpetuities

Present Value of Perpetuities

- What is the present value of Rs. 1 billion every year, for eternity, if the perpetual discount rate is 10%?

$$PV = \frac{`1 \text{ bil}}{0.10} = `10 \text{ billion}$$

Perpetuities

Present Value of Perpetuities

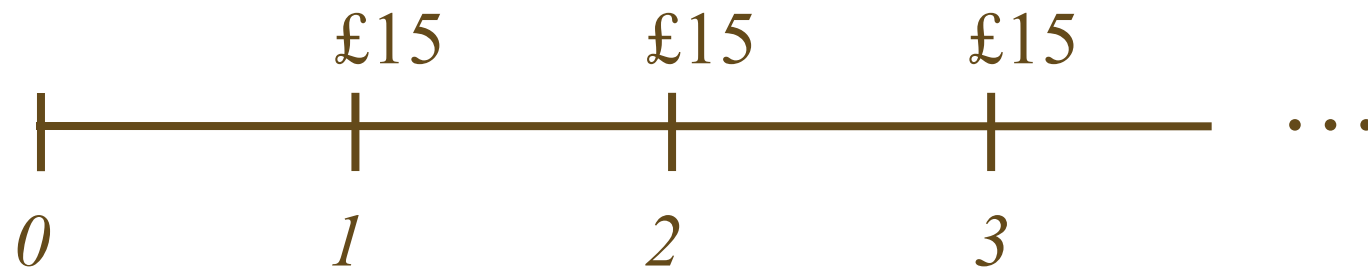
- What if the investment does not start making money for 3 years?

$$PV = \frac{1 \text{ bil}}{0.10} \times \left(\frac{1}{1.10^3} \right) = 7.51 \text{ billion}$$

Perpetuity: Example

What is the value of a British consol that promises to pay £15 every year for ever?

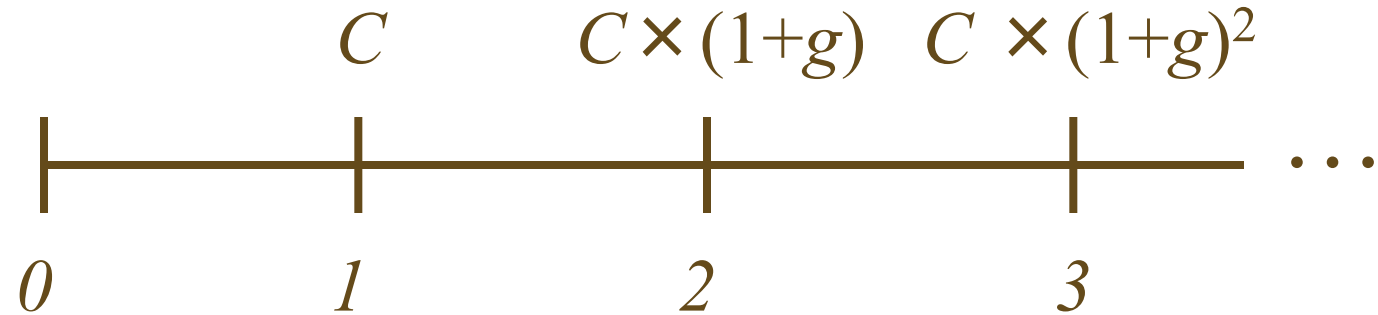
The interest rate is 10-percent.



$$PV = \frac{\pounds 15}{.10} = \pounds 150$$

Growing Perpetuity

A growing stream of cash flows that lasts forever



$$PV = \frac{C}{(1+r)} + \frac{C \times (1+g)}{(1+r)^2} + \frac{C \times (1+g)^2}{(1+r)^3} + \dots$$

$$PV = \frac{C}{r-g}$$

Growing Perpetuities

Constant Growth Perpetuity

$$PV_0 = \frac{C_1}{r - g} \quad g = \text{the annual growth rate of the cash flow}$$

This formula can be used to value a perpetuity at any point in time

$$PV_t = \frac{C_{t+1}}{r - g}$$

Growing Perpetuities

Constant Growth Perpetuity

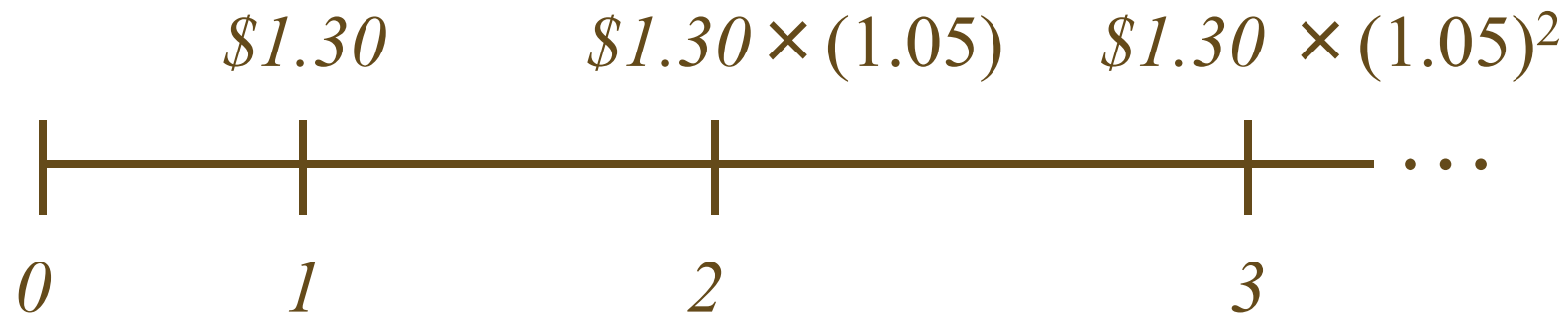
- What is the present value of Rs. 1 billion paid at the end of every year in perpetuity, assuming a rate of return of 10% and constant growth rate of 4%?

$$\begin{aligned}PV_0 &= \frac{1}{.10 - .04} \\ &= ` 16.667 \text{ billion}\end{aligned}$$

Growing Perpetuity: Example

The expected dividend next year is \$1.30, and dividends are expected to grow at 5% forever.

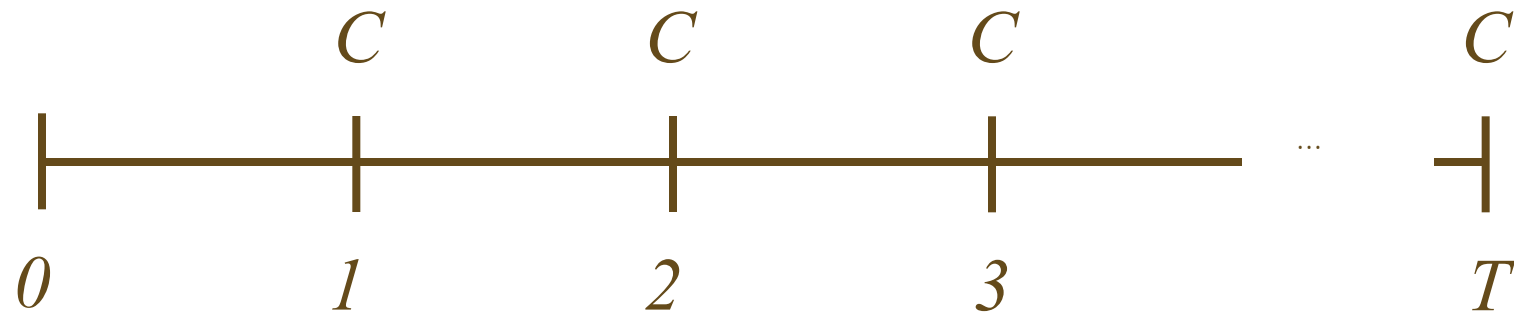
If the discount rate is 10%, what is the value of this promised dividend stream?



$$PV = \frac{\$1.30}{.10 - .05} = \$26.00$$

Annuity

A constant stream of cash flows with a fixed maturity



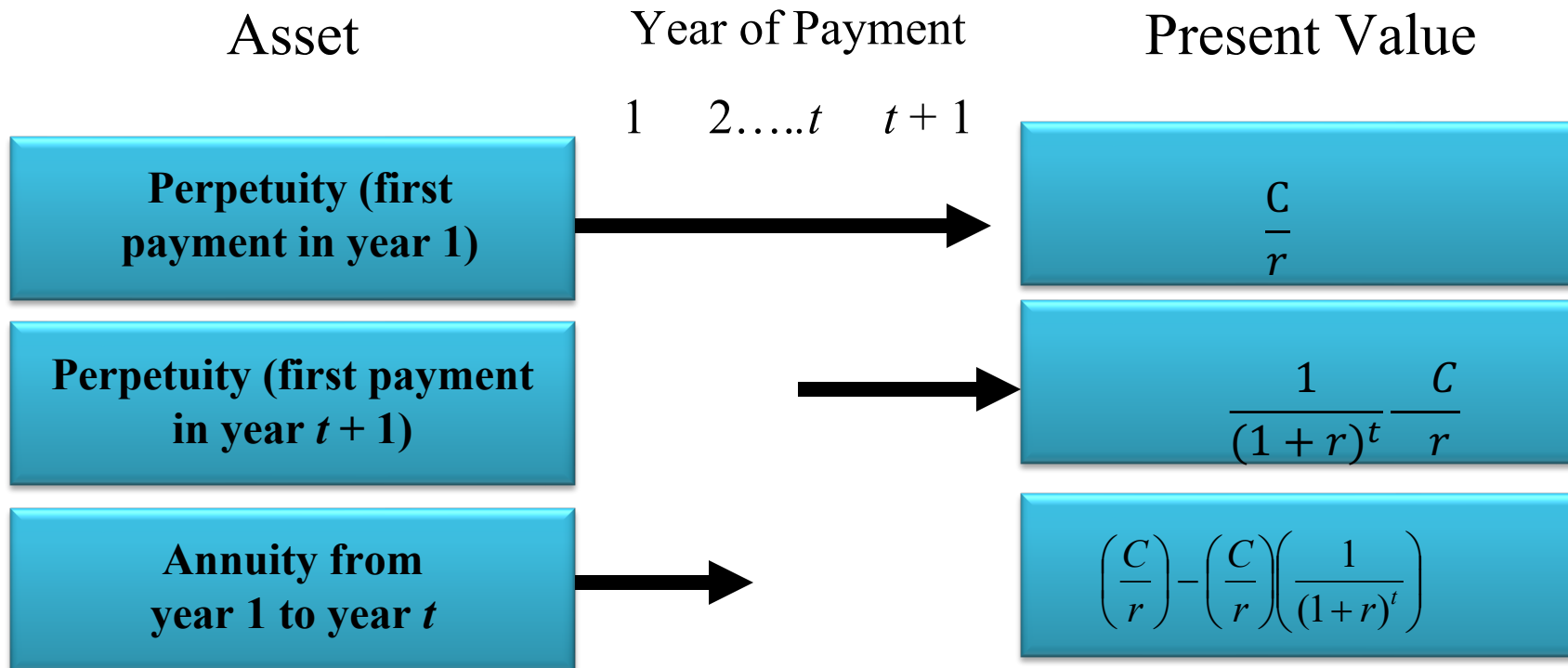
$$PV = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \frac{C}{(1+r)^3} + \dots + \frac{C}{(1+r)^T}$$

$$PV = \frac{C}{r} \left[1 - \frac{1}{(1+r)^T} \right]$$

Annuities

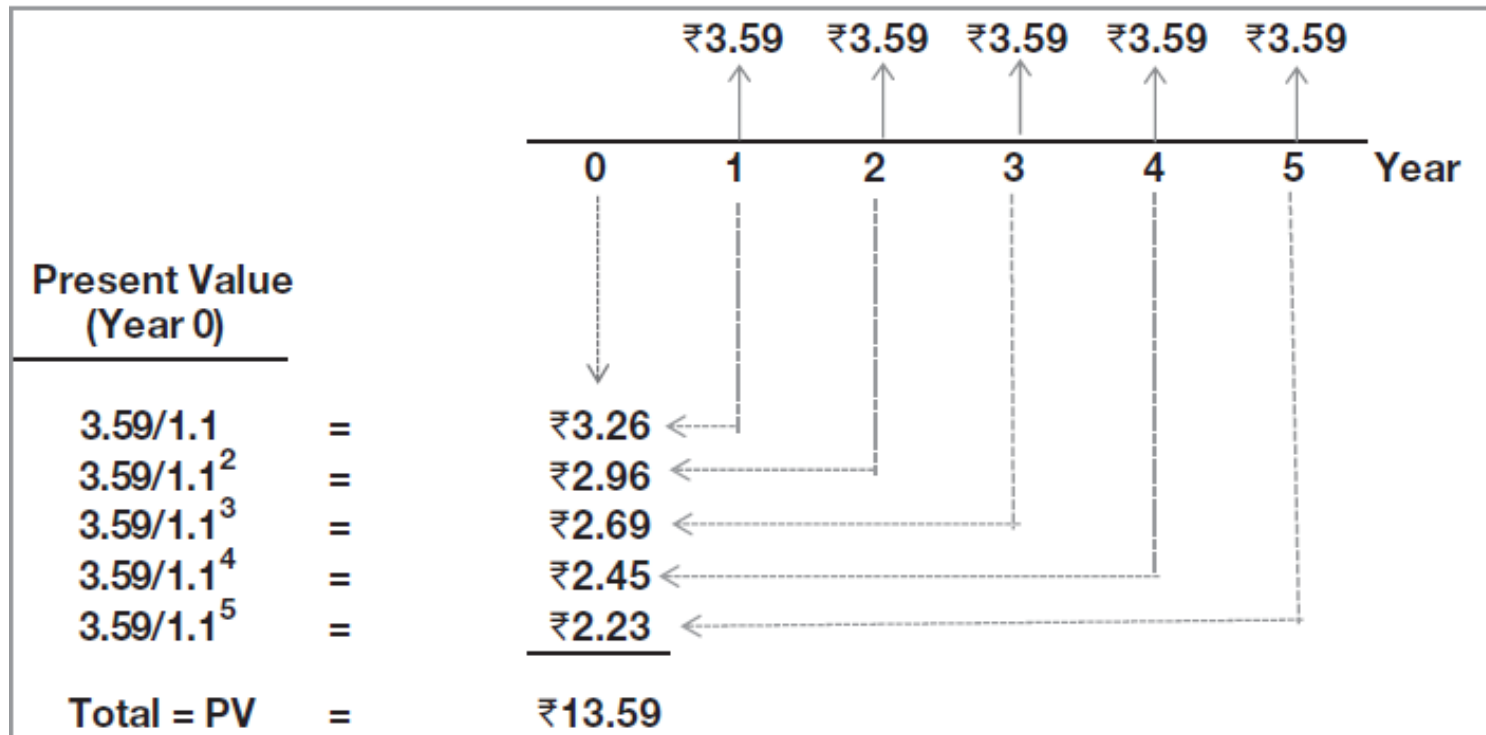
Annuity

- Asset that pays fixed sum each year for specified number of years



Annuities

Example: Aditi Autos offers payments of Rs. 3.59 lakhs per year, at the end of each year for 5 years. If interest rates are 10%, per year, what is the cost of the car?



Annuities

$$\text{PV of annuity} = C \times \left[\frac{1}{r} - \frac{1}{r(1+r)^t} \right]$$

Annuities

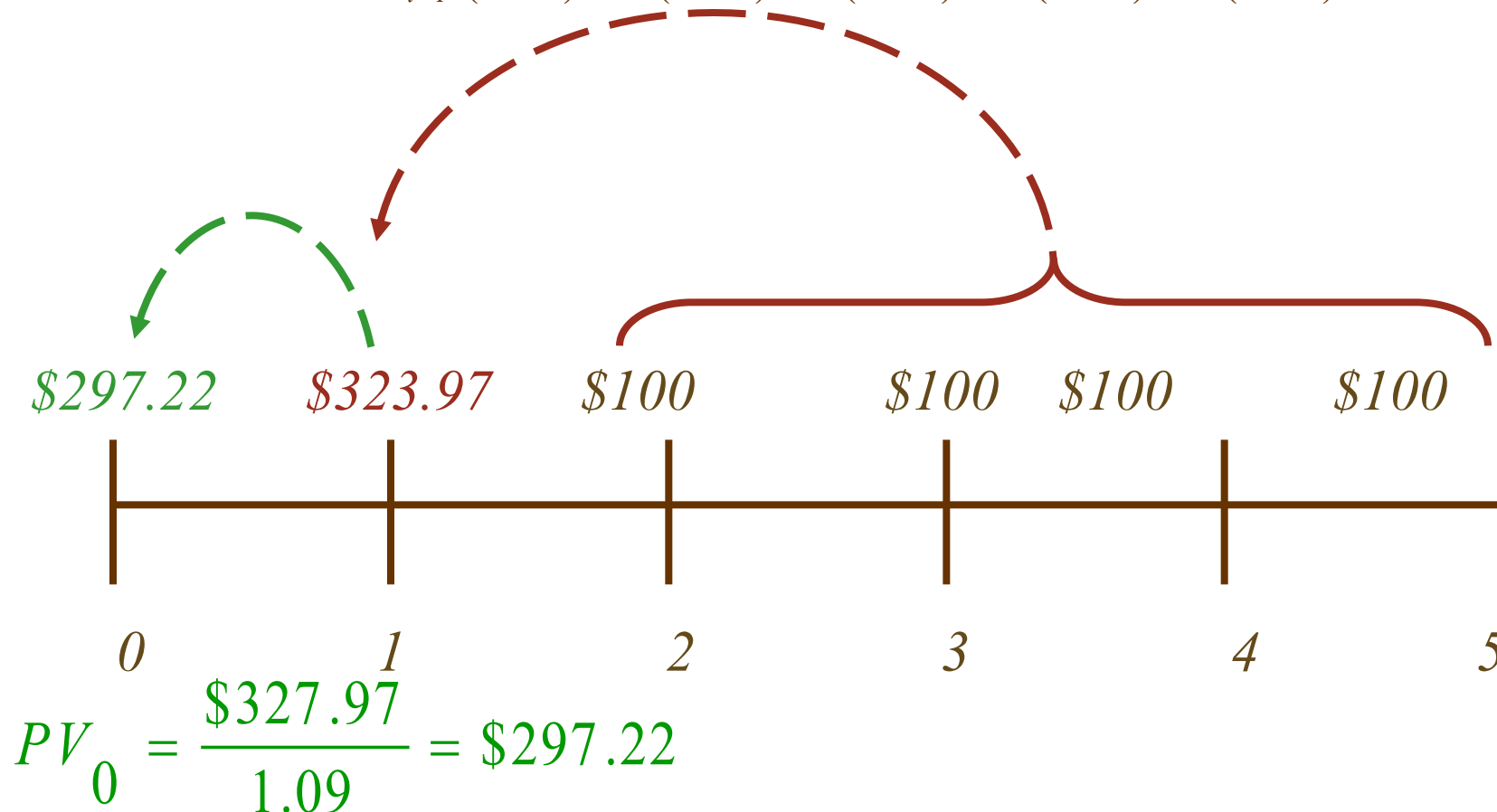
- Example: The state lottery advertises a jackpot prize of \$365 million, paid in 30 yearly installments of \$12.167 million, at the end of each year. Find the true value of the lottery prize if interest rates are 6%.

$$\text{Lottery Value} = 12.167 \times \left[\frac{1}{.06} - \frac{1}{.06(1+.06)^{30}} \right]$$

$$\text{Value} = \$167,500,000$$

What is the present value of a four-year annuity of \$100 per year that makes its first payment two years from today if the discount rate is 9%?

$$PV_1 = \sum_{t=1}^4 \frac{\$100}{(1.09)^t} = \frac{\$100}{(1.09)^1} + \frac{\$100}{(1.09)^2} + \frac{\$100}{(1.09)^3} + \frac{\$100}{(1.09)^4} = \$323.97$$



Annuities

Future Value of an Annuity

$$\text{FV of annuity} = C \times \left[\frac{(1+r)^t - 1}{r} \right]$$

Annuities

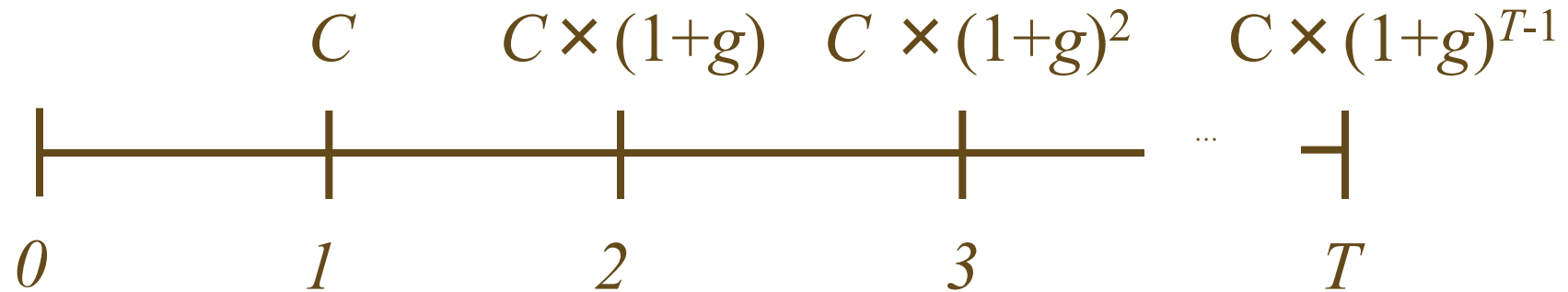
Future Value of an Annuity

- What is the future value of Rs. 20,000 paid at the end of each of the following 5 years, assuming investment returns of 8% per year?

$$\begin{aligned} \text{FV} &= 20,000 \times \left[\frac{(1 + .08)^5 - 1}{.08} \right] \\ &= ` 117,332 \end{aligned}$$

Growing Annuity

A growing stream of cash flows with a fixed maturity

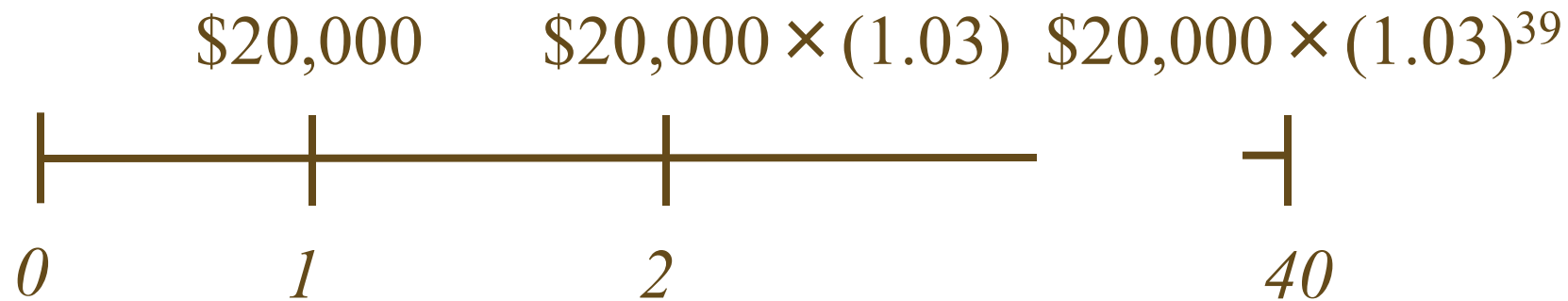


$$PV = \frac{C}{(1+r)} + \frac{C \times (1+g)}{(1+r)^2} + \dots + \frac{C \times (1+g)^{T-1}}{(1+r)^T}$$

$$PV = \frac{C}{r-g} \left[1 - \left(\frac{1+g}{1+r} \right)^T \right]$$

Growing Annuity: Example

A defined-benefit retirement plan offers to pay \$20,000 per year for 40 years and increase the annual payment by 3% each year. What is the present value if the discount rate is 10%?



$$PV = \frac{\$20,000}{.10 - .03} \left[1 - \left(\frac{1.03}{1.10} \right)^{40} \right] = \$265,121.57$$

Growing Annuity: Example

Golf club membership is Rs. 5,000 for 1 year, or Rs. 12,750 for three years. Find the better deal given payment due at the end of the year and 6% expected annual price increase, discount rate 10%.

The present value of the membership fees for the next three years is Rs 13,147.

Better off paying now for a three-year membership.

Compounding Periods

Compounding an investment m times a year for T years provides for future value of wealth:

$$FV = C_0 \times \left(1 + \frac{r}{m}\right)^{m \times T}$$

For example, if you invest \$50 for 3 years at 12% compounded semi-annually, your investment will grow to:

$$FV = \$50 \times \left(1 + \frac{.12}{2}\right)^{2 \times 3} = \$50 \times (1.06)^6 = \$70.93$$

Effective Annual Rates of Interest

A reasonable question to ask in the above example is “what is the effective *annual* rate of interest on that investment?”

$$FV = \$50 \times \left(1 + \frac{.12}{2}\right)^{2 \times 3} = \$50 \times (1.06)^6 = \$70.93$$

The Effective Annual Rate (EAR) of interest is the annual rate that would give us the same end-of-investment wealth after 3 years:

$$\$50 \times (1 + EAR)^3 = \$70.93$$

Effective Annual Rates of Interest

$$FV = \$50 \times (1 + EAR)^3 = \$70.93$$

$$(1 + EAR)^3 = \frac{\$70.93}{\$50}$$

$$EAR = \left(\frac{\$70.93}{\$50} \right)^{1/3} - 1 = .1236$$

So, investing at 12.36% compounded annually is the same as investing at 12% compounded semi-annually.

Effective Annual Rates of Interest

Find the Effective Annual Rate (EAR) of an 18% APR loan that is compounded monthly.

What we have is a loan with a monthly interest rate of $1\frac{1}{2}\%$.

This is equivalent to a loan with an annual interest rate of 19.56%.

$$\left(1 + \frac{r}{m}\right)^m = \left(1 + \frac{.18}{12}\right)^{12} = (1.015)^{12} = 1.1956$$

Frequency of Compounding

Payment frequency can be more than once a year.

If the Annual Percentage Rate, APR (also called the Stated Annual Rate) is r and the frequency of compounding is m times a year, Rs. 1 invested at the beginning of the year would become $[1 + (r/m)]^m$, by the end of the year.

Effective Annual Rate: **$[1 + (r/m)]^m - 1$**

Continuous Compounding

The general formula for the future value of an investment compounded continuously over many periods can be written as:

$$FV = C_0 \times e^{rT}$$

where

C_0 is cash flow at date 0,

r is the stated annual interest rate,

T is the number of years, and

e is a transcendental number approximately equal to 2.718.

Continuous Compounding

As $m \rightarrow$ to infinity, $[1 + (r/m)]^m \rightarrow e^r$

Rs. 1, invested at rate, r , compounded continuously, will become, e^r .

Suppose you invest Rs. 1 at an APR of 20% ($r = 20\%$), continuously compounded for 1 year.

- The end of year value is $e^{0.2} = 1.2214$.
- Investing at 20% compounded continuously is equivalent to investing at 22.14% a year compounded annually.

Suppose you invest Rs. 100 at a continuously compounded rate of 20% ($r = 20\%$) for 3 years.

- The value at the end of year 3 is $= P \times e^{(r.t)} = 100 \times e^{(0.2 \times 3)} = \text{Rs.}182.21$.

Continuous Compounding

Suppose the **annually** compounded rate is 18.5%. What is the PV of a Rs. 100 perpetuity with each cash flow received at the end of the year? If instead of the cash flow being received at the end of each period, it is received **continuously**. What is the PV of the continuously received perpetual cash flow?

The PV of a Rs. 100 perpetuity with each cash flow received at the end of the year is $100/0.185 =$ Rs. 540.54.

The continuously compounded rate that is equivalent to annually compounded rate of 18.5% is $r = \ln(1.185) = 0.1697$.

PV of continuously paid out perpetual cash flow is $100/0.1697 =$ Rs. 589.

Since cash flow is received earlier, they are willing to pay a higher price for the continuously paid cash flow.

Compound Interest

Periods per year	Interest per period	APR	Value after one year	Effective annual interest rate
1	6.00%	6.00%	1.06	6.000%
2	3.00%	6.00%	$1.03^2 = 1.0609$	6.090%
4	1.50%	6.00%	$1.015^4 = 1.06136$	6.136%
12	0.50%	6.00%	$1.005^{12} = 1.06168$	6.168%
52	0.1154%	6.00%	$1.001154^{52} = 1.06180$	6.180%
365	0.0164%	6.00%	$1.000164^{365} = 1.06183$	6.183%
Continuous		6.00%	$e^{0.06} = 1.06184$	6.184%

Finding EMI

Example: You are considering an auto loan of Rs. 1,00,000 to finance the purchase of a new car. The bank offers auto loans at an annual interest rate of 12%. If the tenure of the loan is 2 years, what would be the EMI?

PV = Rs. 1,00,000

Monthly interest rate = $12\%/12 = 1\%$

No. of periods = $2 \times 12 = 24$

EMI = 4707

{In EXCEL, use the PMT function. Rate = 1%, Nper = 24, and Pv = 1,00,000}

Time	Beginning Principle	Installment	Interest	Principle	Ending Principle
1	₹ 1,00,000	₹ -4,707	₹ 1,000	₹ -3,707	₹ 96,293
2	₹ 96,293	₹ -4,707	₹ 963	₹ -3,744	₹ 92,548
3	₹ 92,548	₹ -4,707	₹ 925	₹ -3,782	₹ 88,766
4	₹ 88,766	₹ -4,707	₹ 888	₹ -3,820	₹ 84,947
5	₹ 84,947	₹ -4,707	₹ 849	₹ -3,858	₹ 81,089
6	₹ 81,089	₹ -4,707	₹ 811	₹ -3,896	₹ 77,192
7	₹ 77,192	₹ -4,707	₹ 772	₹ -3,935	₹ 73,257
8	₹ 73,257	₹ -4,707	₹ 733	₹ -3,975	₹ 69,282
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
21	₹ 18,368	₹ -4,707	₹ 184	₹ -4,524	₹ 13,844
22	₹ 13,844	₹ -4,707	₹ 138	₹ -4,569	₹ 9,275
23	₹ 9,275	₹ -4,707	₹ 93	₹ -4,615	₹ 4,661
24	₹ 4,661	₹ -4,707	₹ 47	₹ -4,661	₹ 0

Amortized Loan Payments

Question

A factory costs Rs, 4,000,000. You reckon that it will produce an inflow after operating costs of Rs. 850,000 a year for 10 years. If the opportunity cost of capital is 14%, what is the NPV of the factory? What will be the factory be worth at the end of five years?

$$\text{NPV} = 433698$$

At the end of five years, the factory's value will be the present value of the five remaining cash flows = Rs 2,918,118.824

Question

How much will you have at the end of 20 years if you invest Rs 100 today at 15% annually compounded?

- Will it change if its compounded continuously –if yes what will be the FV?

15% annually compounded : $FV = 100 \times (1.15)^{20} = 1636.65$

15% continuously compounded : $FV = 100 \times e^{(0.15 \times 20)} = 2008.58$

Question

How much would you need to set aside to provide each of the following? The rate of interest is 8%.

a) Rs 1 billion at the end of each year in perpetuity

- $PV = 1 \text{ billion} / 0.08 = 12.5 \text{ billion}$

b) A perpetuity that pays Rs 1 billion at the end of the first year and that grows at 4% a year

- $PV = 1 \text{ billion} / (0.08 - 0.04) = 25 \text{ billion}$

c) Rs 1 billion at the end of each year for 20 years

- $PV = 1/0.08 \times [1 - (1/1.08^{20})] = 9.818 \text{ billion}$

d) Rs 1 billion a year spread evenly over 20 years

- $e^r = 1.08$, $r = \ln(1.08) = 0.07696$

- $PV = 1/0.07696 \times [1 - (1/e^{0.07696 \times 20})] = 10.2059 \text{ billion}$

Present Value (PV) Function

Formula: $PV(\text{rate}, \text{nper}, \text{pmt}, [\text{fv}], [\text{type}])$

- ▶ **rate:** Interest rate per period.
- ▶ **nper:** Number of periods (months, years).
- ▶ **pmt:** Payment per period.
- ▶ **fv** (optional): Future value (default 0).
- ▶ **type** (optional): 0 (end of period), 1 (start).

Example:

$$= PV(5\%/12, 12 * 10, -200, 0, 0)$$

Future Value (FV) Function

Formula: $FV(\text{rate}, \text{nper}, \text{pmt}, [\text{pv}], [\text{type}])$

- ▶ **rate:** Interest rate per period.
- ▶ **nper:** Number of periods.
- ▶ **pmt:** Payment per period.
- ▶ **pv** (optional): Presentvalue.
- ▶ **type** (optional): 0 (end), 1 (start).

Example:

$$= FV(5\%/12, 12 * 10, -200, 0, 0)$$

RATE Function

Formula: `RATE(nper, pmt, pv, [fv], [type], [guess])`

- ▶ **nper:** Number of periods.
- ▶ **pmt:** Payment per period.
- ▶ **pv:** Present value (loan amount).
- ▶ **fv** (optional): Future value (default 0).
- ▶ **type** (optional): 0 (end), 1 (start).
- ▶ **guess** (optional): Guess for the rate.

Example:

= `RATE(12 * 10, -200, 10000)`

NPER Function

Formula: `NPER(rate, pmt, pv, [fv], [type])`

- ▶ **rate:** Interest rate per period.
- ▶ **pmt:** Payment per period.
- ▶ **pv:** Present value (loan amount).
- ▶ **fv** (optional): Future value (default 0).
- ▶ **type** (optional): 0 (end), 1 (start).

Example:

`= NPER(5%/12, -200, 10000)`

PMT Function

Formula: $PMT(\text{rate}, \text{nper}, \text{pv}, [\text{fv}], [\text{type}])$

- ▶ **rate:** Interest rate per period.
- ▶ **nper:** Number of periods.
- ▶ **pv:** Present value (loan amount).
- ▶ **fv** (optional): Future value (default 0).
- ▶ **type** (optional): 0 (end), 1 (start).

Example:

$$= PMT(5\%/12, 12 * 10, 10000)$$

Net Present Value (NPV) Function

Formula: $NPV(\text{rate}, \text{value1}, [\text{value2}], \dots)$

- ▶ **rate:** Discount rate.
- ▶ **value1, value2, ...:** Series of cash flows.

Example:

$$= NPV(10\%, -10000, 3000, 4200, 6800)$$

XNPV Function

Formula: **XNPV**(rate, values, dates)

- ▶ **rate**: Discount rate.
- ▶ **values**: Cash flows (negative for outflows, positive for inflows).
- ▶ **dates**: Corresponding dates for each cash flow.

Example:

= XNPV(10%, {-10000, 3000, 4200, 6800}, {"2024-01-01", "2025-01

EFFECT Function

Formula: `EFFECT(nominal rate, npery)`

- ▶ **nominal rate:** Nominal interest rate.
- ▶ **npery:** Number of compounding periods per year (e.g., 12 for monthly, 4 for quarterly).

Example:

= *EFFECT*(10%, 12)

NOMINAL Function

Formula: **NOMINAL**(effect rate, npery)

- ▶ **effect rate:** Effective annual interest rate.
- ▶ **npery:** Number of compounding periods per year.

Example:

= *NOMINAL*(10%, 12)