IME 611: Introduction

Investment Science/Financial Engineering

Investment

- *Definition:* current commitments of resources in order to achieve later benefits
  - The amount of money obtained later may be known or may not be known
  - Example: bank certificate of deposits vs dividends

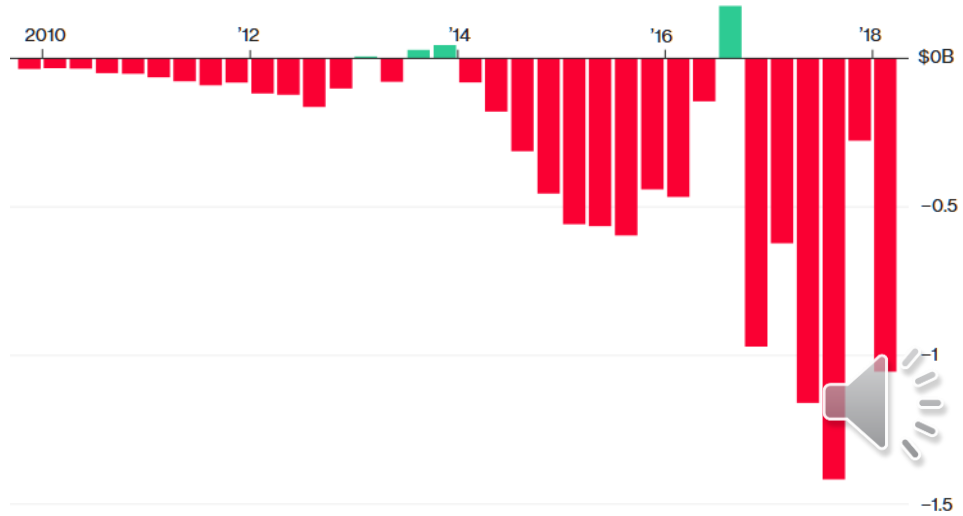
- Broader view of investment – to tailor the pattern of flows of expenditures and receipts spanning over a period to be as desirable as possible

- *Investment science* (or *Financial Engineering*) is application of computational methods to investment
- Art of investment!

Cash flows

- When expenditures and receipts are denominated in cash, the net receipts at any time period is termed as *cash flow*
- The series of flow over several periods is called a *cash flow stream*

- Tesla's free cash flow stream (*Bloomberg, April 30, 2018*)
- Future cash flows can be
  - Certain or uncertain



Investments in terms of cash flow streams

- Which of two cash flow streams is most profitable?
- How much would I be willing to pay to own a given stream?
- Are two streams together worth more than the sum of their individual values?
- If I can purchase a share of a stream, how much should I purchase?
- Given a collection of available cash flow streams, what is the most favourable combination of them?

Complex cash flow streams

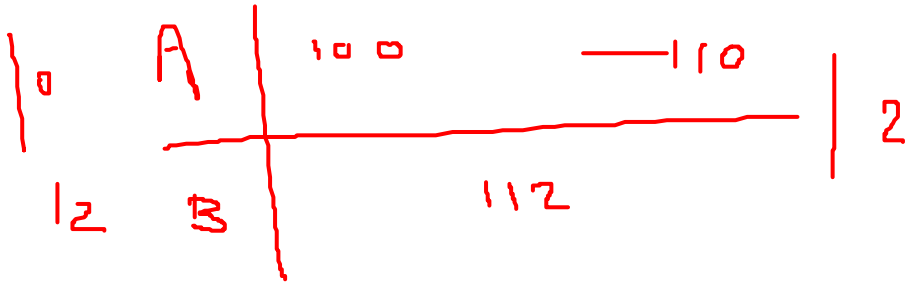
- Sometimes the timing of all cash flows is not fixed, but can be *influenced* by the investor
  - Stock of a company which pays dividend
- Investments can be actively managed to influence both the amounts and the timing of all cash flows
  - Getting a contract to mine coal
- Designing a strategy to combine stocks, bonds, and other investment products into an overall package that has desirable properties
  - Generating attractive combinations from assets that in isolation may be too risky

Investment and markets

- Most investments are carried out within the framework of a *financial market*
- Financial markets simplify decision making through *comparison principle*
  - Your friend offers you a special investment. If you give him 100 rupees, he will repay you 110 rupees in one year. Would you accept the offer?
  - Evaluate the investment by comparing it with other investments available in the financial market

- If your friend offers to sell a portrait of batchmates whose value is largely sentimental – an outside comparison is not available

Investment and markets



- Arbitrage
  - Earning money without investing anything
  - No-arbitrage assumption: two different securities with identical properties must have approximately the same price – otherwise there would be an arbitrage
  - Example
    - Consider (idealized) banks that offer to loan money or accept deposits at the same rate of interest
    - Rate at one bank is 10% and at another bank the rate is 12%
    - Explain how arbitrage exists
    - The interest rates in the two banks would soon equalize
  - Pricing of derivatives: options and futures

Investment and markets

- Dynamics
  - Future price of an asset is a process moving in time and subject to uncertainty
  - Standard frameworks to represent price processes: binomial lattice, differential equations

- Risk aversion
  - Consider two investments with same cost
  - Both have same expected return (greater than the initial cost)
  - The return is certain for the first investment, but not for the second
  - Which alternative would you pick?

Investment problems

$\frac{X}{1+r}$

- Pricing
  - If the interest rate is *r*, and the investment pays X rupees after one year then what is its current value?
    - Arbitrage principle
  - General problem: given an investment with known payoff characteristics (possibly random), what is the reasonable price?
  - Bonds, share of stock, futures and options

- Hedging
  - The process of reducing of financial risk that arise while making investment decisions
  - Example insurance – by paying a fixed amount (a premium)
  - Bakery – using futures contracts to buy flour

Investment problems

- Risk assessment and management
  - The issue of risk dominates the appraisal of a large investment or portfolio
  - Example: credit default swap, VaR

- Pure investment
  - Objective: obtaining increased future return for present allocation of capital
  - Portfolio selection problem