



Class: FY MSc

Subject : Financial Mathematics

Subject Code: PPSAS102

Chapter: Unit 2 Chapter 1

Chapter Name: Real and Monetary Interest rates

Today's Agenda

1. Inflation
 1. Extreme inflation Hyperinflation
 2. Effects of Inflation
2. Monetary and Real Interest Rates
 1. Example
 2. Relationship between Monetary and Real rates
3. Deflation

$$\begin{array}{c}
 \boxed{14\%} \\
 \hline
 \end{array}
 \cdot
 \begin{array}{c}
 \boxed{14\% - 8\%} \\
 \hline
 \end{array}
 =
 \begin{array}{c}
 8\% \\
 \hline
 \end{array}
 =
 \begin{array}{c}
 \boxed{6\%} \\
 \hline
 \end{array}$$

~~7%~~

real rate of ret.

$$\begin{array}{c}
 \boxed{6\%} \\
 \hline
 \end{array}$$

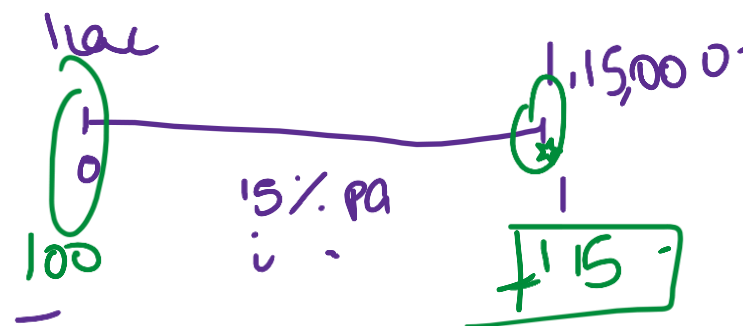
Answer this!

?

If an individual invests Rs. 1 lac at the start of the year which gets accumulated at 15% effective rate of interest.

Tell me the accumulated value after 1 year?

Also, will the value of the accumulated amount be the same as the value it accumulated to?



1.15

1.15
Inflation
True value purchasing power < 1.15

1 Inflation

Consumer price index
wholesale — CPI
WPI

apples
cabbages
carrots

- Refers to the rise in the prices of goods and services
- Inflation measures the average price change in a basket of commodities and services over time.
- Indicates loss of purchasing power per monetary unit.
- Purchasing power is the amount of goods that your money can buy. When inflation occurs you can buy less goods with the same amount of money. i.e. it takes more monetary units (now) to buy what you could buy for lesser monetary units a period of time ago.
- Important indicator of a country's economic performance.



1 Inflation

- Measure of Inflation – Consumer Price Index (CPI), quoted on annual basis
- The change in CPI measure the effective annual rate of change in the cost of a specified “basket” of consumer goods.
- Alternative measures: Wholesale Price Index (WPI) and sector wise in the economy.
- Decreasing CPI – Deflation

CPI
↓
Deflation

Factors -

Inflation

MEV impact
(govt policies, FX
rate, int rates, etc.)

demand pull
inflation

increase in supply
of money

↓

Inflation

Pro:
moderate inf is good (hyperinflation is detrimental)
controlled

Import export

15% - 20%

35% - 40% 30%

100%

15 000 /-

8% ~~2%~~ CASA

current acc
savings acc

41.9 quadrillions %

1.1

Extreme Inflation/ Hyperinflation

Country A – 1946 (Post world war II)

Hungary:-

- Caused because of the reparations that were paid for the war
- Estimated daily inflation rate – 200%
- Monthly inflation rate – 41.9 quadrillion% for July 1946 i.e. price doubling every 15.3 hours

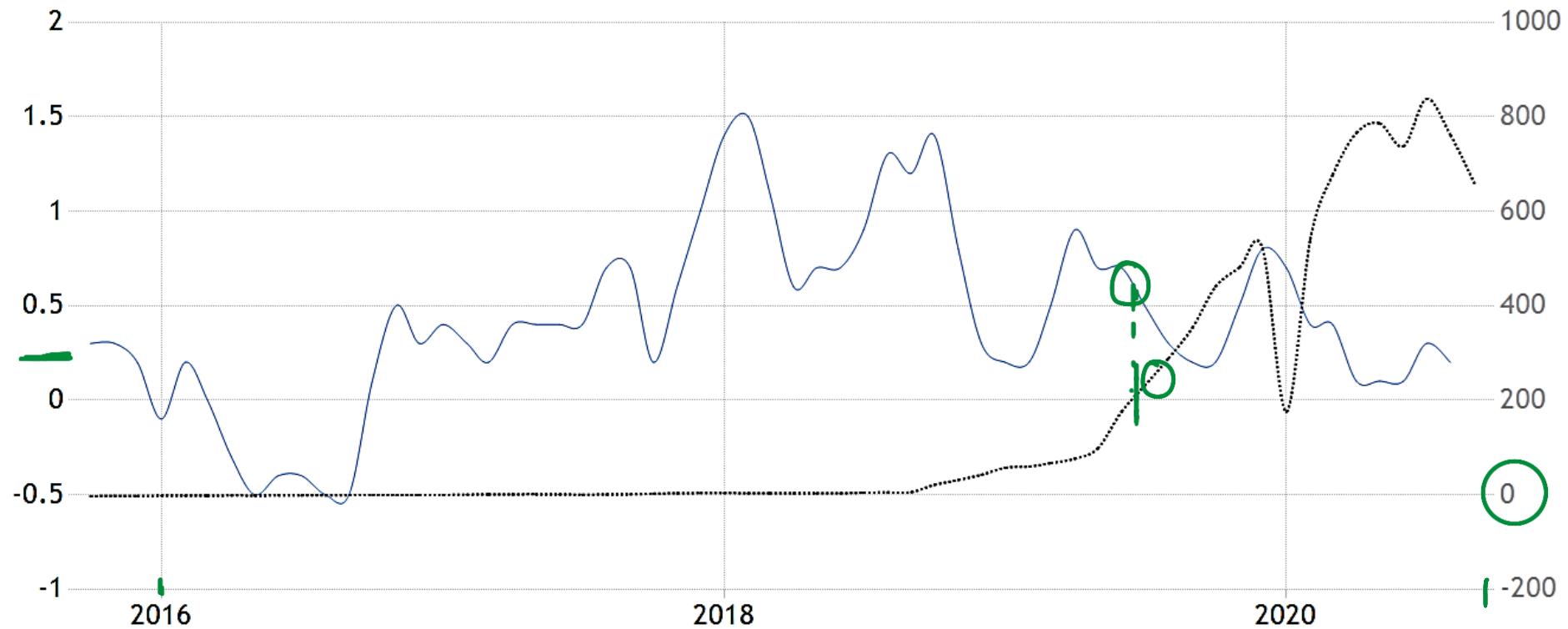
Country B – 2004 to 2009 (War)

Zimbabwe

- Printed money to pay for war
- Droughts and farm confiscation restricted the supply of food and other locally produced goods
- Estimated daily inflation rate – 98%
- Price doubling every 24 hours
- Ended when the country changed its currency to the U.S. dollar

1.1 Inflation comparison (Japan vs Zimbabwe)

— JAPAN INFLATION RATE ZIMBABWE INFLATION RATE



SOURCE: TRADINGECONOMICS.COM

1.1 Extreme Inflation/ Hyperinflation

Venezuela – Currently

bolivar.

- Prices rose 41% in 2013, and by 2018 inflation was at 65,000% (In 2017, govt. increased money supply by 14%)
- A new cryptocurrency, the "petro," is promoted because the bolivar lost almost all its value against the U.S. dollar
- In response, people began using eggs as currency. A carton of eggs was worth 250,000 bolivars compared to 6,740 bolivars in January 2017
- Unemployment rose to over 20%
- The annual inflation rate for consumer prices was at 15,000% percent in early 2020
- Currently, the only country to suffer from hyperinflation

How did Venezuela create such a mess?

Former President Hugo Chávez had instituted price controls for food and medicine. But mandated prices were so low it forced domestic companies out of business. In response, the government paid for imports.

In 2014, oil prices plummeted, eroding revenues to the government-owned oil companies. When the government ran out of cash, it started printing more.

1.2 Effects of Inflation

- Investors are concerned with the level of inflation in the country
- High rate of inflation has the effect of rapidly reducing the value of currency as time goes on
- When inflation is expected, investors will require higher interest rates because they are interested in actual growth in their buying power, not just the growth in the monetary terms that they possess
- Common understanding: Interest rates reflect predicted inflation rather than the actual inflation
- In the above situations and situations similar to these, money interest rates cannot be the ideal variable for measurement of investment growth as they do not account for inflation. Thus it is important to consider real interest rates which take into account the inflation in the economy

monetary

↓

do not account
of inflation

everything that
we have done.

real

↓

account the inflation^{o.}

↓

this chapter -

2

Monetary Interest rates vs Real Interest rates

Monetary Interest Rate

- Monetary interest rate is the interest rate we have been considering up till now.
- Suppose Rs.100 invested at time 0 for 10 years, grows at the rate of 7% per annum interest.
- In the above case, we have a money interest rate of 7% p.a.
- If we are given the information on the initial investment of 1 in the specified currency, the period of the investment, and the cash amount of money accumulated, then the underlying interest rate is termed a “money rate of interest”

Real Interest Rate

- The Real rate of Interest refers to the inflation-adjusted rate of return. A real interest rate is adjusted to remove the effects of inflation and gives the real rate of a bond or loan.
- The real interest rate gives lenders and investors an idea of the real rate they receive after factoring in inflation. This also gives them a better idea of the rate at which their purchasing power increases or decreases

2.1 Example

A Vadapav ^{pragya} costs Rs. 10 as at 1/1/16 and Rs. 12 as at 1/1/17.

The annual rate of inflation, j is: $1 + j = \frac{12}{10} = 1.2$. i.e. $j = 20\%$.

Suppose you had a sum of money, say Rs. 120. It would buy 12 vadapavs on 1/1/16, but only 10 vadapavs on 1/1/17.

Since Rs. 120 can only buy 10 vadapavs on 1/1/17, it is equivalent to Rs. 100 (10 Vadapavs x Rs.10) at the start of the year.

$$\text{i.e. } \frac{120}{1+j} = \frac{120}{1.2} = 100$$

$i = 20\%$
 i greater 20%.



$$10 \times (1+j) = 12$$

$$1+j = \frac{12}{10}$$

$$j = 20\%$$

$j = \text{infl rate}$

2.2 Relationship between Real & Monetary rates

- Simple and commonly used measure of the real rate of interest is: $i-j$, where i is the annual rate of interest and j is the annual inflation rate
- The real growth of an investment or real growth in purchasing power, $i-j$ is not theoretically correct.

i = eff roi = monetary roi

j = annual rate of inflation

r = effective real rate of return

$$i = 15\%$$

$$j = 8\%$$

$$r = i - j$$

$$r = 15\% - 8\%$$

$$= 7\%$$

crude way / layman

2.2 Example

(items / underlying qty) .



Suraj invests Rs. 1000 for one year at effective annual rate 15.5%. At the time of investment, cost of certain item is Rs 1. One year later, when interest is paid and principal is returned to Suraj, the cost of item has become Rs. ^{per}1.

1.1. What is the annual growth rate in Suraj's purchasing power with respect to the consumer item?

$$i = 15.5\%$$

$$j = 10\%$$

Crude / lay man terms -

$$r = 15.5\% - 10\%$$

$$r = 5.5\% \longleftrightarrow$$

$$r = \frac{i - j}{1 + j}$$

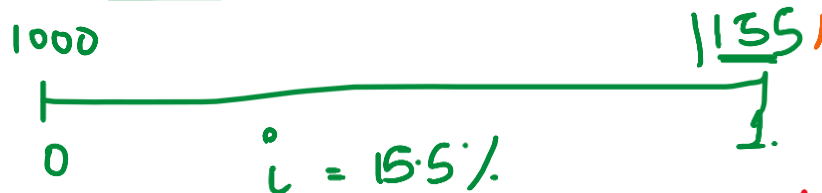
$$= \frac{15.5\% - 10\%}{1 + 10\%}$$

$$j = \frac{1.1}{1} - 1 = 10\%$$

$$1 \times (1 + j) = 1.1$$

$$j = 10\%$$

$$\frac{1}{1000 \text{ pers.}}$$



$$\frac{1155}{1.1}$$



$$1000 \times (1 + i)$$

$$1000 \times (1 + 15.5\%)$$

$$= 1155$$

$$r = \frac{50 \text{ pers.}}{1000 \text{ pers.}} = 5\%$$

$\boxed{\gamma} i, j$

100 $\longrightarrow$ 110 $\longrightarrow$ 10% MIR

$j = 10\% \leftarrow$ no real growth in this scenario

$j = 10\% \rightarrow \text{MIR} = 12\%$

$\frac{i}{j}$

RR.

j  MIR

$\frac{12\%}{10\%} = 1.2$ times more than if

$\gamma \rightarrow i - j$

$$\frac{(1+i)}{(1+j)} = \frac{(1+j)(1+\gamma)}{(1+j)} = (1+\gamma)$$

$$\frac{(1+i)}{(1+j)} = (1+\gamma) \quad \boxed{\gamma} = \frac{(1+i)}{1+j} - 1 = \frac{(1+i) - 1 - j}{(1+j)} = \frac{i - j}{1+j}$$

$j \rightarrow 0 \quad 1+j \approx 1$

2.2 Relationship between Real & Monetary rates

- Consider an investment of one unit of principal at time 0 that produces an accumulated value of $A(0,t)$ at the rate of interest i .
- Suppose there is inflation in the economy so that the cash $A(0,t)$ is effectively worth only $A^*(0,t)$ after allowing for inflation, where $A^*(0,t) < A(0,t)$.
- In this case, the rate of interest at which the original sum of 1 would have to be accumulated to produce the sum A^* is lower than the money rate of interest.
- The sum $A^*(0,t)$ is referred to as the real amount accumulated, and the underlying interest rate, reduced for the effects of inflation, is termed a "real rate of interest".
- With an annual rate of interest i and an annual inflation rate j , the real rate of interest r is given by :

$$1 + r = \frac{1+i}{1+j} . \text{ Thus } r = \frac{i-j}{1+j}$$

2.2 The other way

2.2 Example



In an economy, at the start of the year the cost of a certain consumer item was 1.05. Now today the same consumer item costs 1.10. What will be the inflation rate for the year?

Under the same scenario, Dhruv plans to make an investment of Rs.10000 at time 0 for a quoted rate of 10.5% for a period of 1 year. Find the real rate of return and the real accumulated value.



$$1.05(1 + j) = 1.10$$

$$j = \frac{1.10}{1.05} - 1 = 4.7619\%$$

$$j = 4.7619\%$$

$$r = 5.4778\%$$

$$r = \frac{i - j}{1 + j} = \frac{10.5\% - 4.7619\%}{1 + 4.7619\%}$$

$$10547.73$$

$$10000(1 + r)$$

60 marks -

10 mcs.

15m Q1 $\begin{cases} A - 5m \\ B - 5m \\ C - 5m \end{cases}$

mcq

Bookwork

15m Q2 $\begin{cases} A - 5m \\ B - 5m \\ C - 5m \end{cases}$

Application

15m Q3 $\begin{cases} A - 5m \\ B - 5m \\ C - 5m \end{cases}$

Knowledge

15m Q4 $\begin{cases} A - 15m \\ B - 5m \end{cases}$

Difficulty
 $Q1 < Q2 < Q3 < Q4$

3 Deflation

deflation

- Where the inflation rate is negative, termed “deflation”, the theory still applies and $A^*(0,t) > A(0,t)$, giving rise to the conclusion that the real rate of interest in such circumstances would be higher than the money rate of interest.
- As might be expected, where there is no inflation $A^*(0,t) = A(0,t)$, and the real and money rates of interest are the same.
- These scenarios occur very rarely in practice.

Recap

UI ✓

- Inflation refers to the rise in the prices of goods and services.
- If we are given the information on the initial investment of 1 in the specified currency, the period of the investment, and the cash amount of money accumulated, then the underlying interest rate is termed a "money rate of interest".
- The Real rate of Interest refers to the inflation-adjusted rate of return. A real interest rate is adjusted to remove the effects of inflation and gives the real rate of a bond or loan.
- With an annual rate of interest i and an annual inflation rate j , the real rate of interest r is given by :

$$1 + r = \frac{1+i}{1+j} . \text{ Thus } r = \frac{i-j}{1+j}$$
- Where the inflation rate is negative, termed "deflation".