## Course Title

# Engineering Economic Analysis 

Chapter 8<br>Inflation

# Lecture 13 (Week 13) <br> Concept of inflation and its causes, Measuring inflation, Equivalence calculation under inflation, impact of inflation on economic analysis 

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## Learning Objective

From studying this chapter the students will be able to understand on the topics:
$>$ Concept of inflation and terminologies
$>$ Causes of inflation and Measuring inflation
$>$ Equivalence calculation under inflation
$>$ Impact of inflation on economic analysis.

### 8.1 Concept of inflation

The value $\$ 50$ now cannot purchase the same amount of quantity of goods as $\$ 50$ used to buy the goods five or ten years ago. It means that the value of currency is being decreased as the time is passing by because of inflation. Inflation is the increase in the amount of money necessary to purchase the same amount of product or service over time. [1] The cost of an item tends to increase over time, OR, the same dollar amount buys less of an item over time. [2] When the net demand for services and goods exceeds the total supply. Because of less supply, the net prices of these services/goods increases and this kind of situation is known as inflation. Inflation produces effects on the health of an economy. For example- the uncertainty about the future behavior of "inflation rate" may restrict the investors to invest in the market.

Deflation is the opposite of inflation in that prices usually decreases over time, and hence, a specified dollar amount gains in purchasing power. Inflation is far more common than deflation in real world. Our focus will be restricted to accounting for inflation in economic analysis. If economic decisions are taken without considering the effect of inflation into account, most of them would become meaningless and as a result the organizations would end up with unpredictable return. [3]

### 8.2 Reasons of inflation

1. If the production cost of various services and goods increases then naturally the prices of the final products would also increase.
2. When industries and business houses increase the total prices of their services and goods in order to amplify their profit margins.
3. When a specific section of a mass industry increases the prices of its services and goods, because this step of a particular section of a mass industry will produce considerable effects on various other sections of industry also. For example- increase in the price of crude oil will spontaneously cause increase in the bus fares and airfares.

### 8.3 Causes of inflation

## 1. Demand pull inflation

'Too much money chases too few goods'
Excessive spending power of consumers, sometimes obtained at the expense of savings that pulls price up called demand pull inflation [4].This occurs when there is excess aggregate demand in the economy or in the specific market or industry. It may be due to increase in population, decrease in taxes, increase in money supply etc.

## 2. Cost push inflation

Increase in producer's costs that are passed along to customers, sometimes with disproportionate escalations that pushes price up, called cost push inflation. [4]This occurs when the costs of production or operation are increasing. It may be due to increase in the wages of labor, increase in price of the raw materials, increase in cost of imported materials etc.

## 3. Increased money supply

If the money supply increases faster than the rate of production, this could result in inflation, particularly demand-pull inflation because there will be too many dollars chasing too few products. [5]

## 4. Devaluation

It is the policy of deliberate lowering the value of currency by a country.


Figure 8.1: Causes of inflation [6]

### 8.4 Inflation Terminologies

## 1. Actual (current) dollars (A\$)

Actual dollars are estimates of future cash flow for year ' $n$ ' that take into account any anticipated changes in amount due to inflationary or deflationary effects. [2] Usually these amounts are determined by applying an inflation rate to base year dollar estimates.

## 2. Constant (real) dollars ( $\mathrm{A}^{\prime}$ \$)

Dollars expressed in terms of the same purchasing relative to a particular time. It means that the money have the constant purchasing power independent of passage of time. It does not considers the inflationary or deflationary effect.

## 3. Market interest rate (i)

This rate takes into account the combined effect of the earning value of capital (earning power) and any anticipated inflation or deflation (purchasing power)

## 4. Inflation free interest rate (i')

This rate is an estimate of the true earning power of the money when the inflation effect have been removed. This rate is commonly known as real interest rate.

## 5. Inflation rate (f)

This is the measure of the rate of change in the value of money.

### 8.5 Measuring Inflation

Generally inflation is measured in percentage term which is simply obtained by calculating the percentage change in current price index over the previous year. The most commonly price index used for measuring inflation are
(a) Consumer price index (CPI) and
(b) Producer price index (PPI)
(a) Consumer price index (CPI)

The CPI measures average change in the prices paid for food, shelter, medical care, transportation and other goods and services used by individual or families.
(b) Producer price index (PPI)

The PPI is good measure of the industrial price increases. It is a measure of changes in prices charged by manufacturers and wholesalers for products.

When performing the engineering economic analysis, the appropriate price indexes must be selected to estimate the price increase of raw materials, finished products and operating costs.

Let's suppose we want to calculate the average inflation rate for a 2 -year period: the first year's inflation rate is $4 \%$, and the second year's rate is $8 \%$, using a base price of $\$ 100$. [2]

- Step 1: To find the price at the end of the second year we use the process of compounding.

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$$
\$ \underset{\text { Second Year }}{\stackrel{\text { First year }}{\stackrel{\text { S. }}{\sim 00(1+0.04)}}(1+0.08)}=\$ 112.32
$$

Step 2: to find the average inflation rate (f), we establish the equivalence relation.

$$
\begin{gathered}
\$ 100(1+\mathrm{f})^{2}=\$ 112.32 \\
\text { or, } \$ 100(\mathrm{~F} / \mathrm{P}, \mathrm{f}, 2)=\$ 112.32
\end{gathered}
$$

Solving for f yields,

$$
f=5.98 \%=6 \% \text { (approximately) }
$$

If the inflation rate (f) averages $6 \%$ over the next 10 years,

$$
=\text { Rs. } 100(1+0.06)^{10}=\$ 179.08=\$ 180 \text { (approximately) }
$$

It can be concluded that the
$\%$ increase in the price of the product

$$
=(\$ 180-\$ 100) / \$ 100=80 \%
$$

Money in one period of time $t_{1}$ can be brought to the same value as money in another period of time $t_{2}$, by using the relation:


Today's dollars or Constantvalue dollars


Inflation rate between $t_{1}$ and $t_{2}$

## Example 8.1 (Conversion of constant dollar into actual dollar)

Consider the following net cash flow of a project in a constant dollar.

| Period | Net cash flow in constant \$ |
| :---: | :---: |
| 0 | $-2,50,000$ |
| 1 | $1,00,000$ |
| 2 | $1,10,000$ |
| 3 | $1,20,000$ |
| 4 | $1,30,000$ |
| 5 | $1,20,000$ |

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If the average inflation rate is projected as $5 \%$ per year, convert the cash flow into actual dollars.

| Period | Cash flow in <br> Constant <br> Dollar | Conversion <br> Factor $=(\mathbf{1} \mathbf{f})^{\mathbf{n}}$ | Cash flow in <br> Actual <br> Dollar |
| :---: | :---: | :---: | :---: |
| 0 | $-250,000$ | $(1+0.05)^{0}$ | $-250,000$ |
| 1 | $1,00,000$ | $(1+0.05)^{1}$ | $1,05,000$ |
| 2 | $1,10,000$ | $(1+0.05)^{2}$ | $1,21,275$ |
| 3 | $1,20,000$ | $(1+0.05)^{3}$ | 138,915 |
| 4 | $1,30,000$ | $(1+0.05)^{4}$ | $1,58,016$ |
| 5 | $1,20,000$ | $(1+0.05)^{5}$ | $1,53,154$ |

### 8.6 Equivalence calculation under inflation

In previous chapters, our equivalence analysis took into consideration changes in earning power of money i.e. interest rate. To factor in changes in purchasing power i.e. inflation, we use either (1) constant dollar analysis (2) actual dollar analysis and (3) Mixed dollar analysis

## Procedure to adjust inflation under equivalence calculation [3]

$>$ Estimate all the costs/returns associated with an investment proposal in terms of today's dollar.
> Modify the costs/returns in step one using an assumed inflation rate so that at each future date they represent the costs/revenues at that day in terms of the dollars that must be expended or received at that time respectively.
$>$ As per our requirement, calculate either the annual equivalent amount or future amount or present amount of the cash flow resulting from step 2 by considering the time value of money.

## Case 1: If cash flow elements are estimated in Constant Dollar (Constant Dollar Analysis)

Suppose that all cash flow elements are already given in constant dollar, and that we want to compute the equivalent PW of the constant dollar ( $\mathrm{A}^{\prime}{ }_{\mathrm{n}}$ ) occurring in year ' n '. In the absence of inflationary effect, we use inflation free interest rate ( $i$ ') to account only for the earning power of money. The equivalent present worth is obtained by

$$
\mathbf{P}_{\mathrm{n}}=A_{\mathrm{n}} /\left(\mathbf{1}+\mathrm{i}^{\prime}\right)^{n}
$$

## Example 8.2

Consider the constant dollar flows for a company as follows. If the manager want the company to earn a $12 \%$ inflation free rate of return before tax on any investment, what should be the present worth of this project?

| Period | Net cash flow in constant \$ |
| :---: | :---: |
| 0 | $-2,50,000$ |
| 1 | $1,00,000$ |
| 2 | $1,10,000$ |
| 3 | $1,20,000$ |
| 4 | $1,30,000$ |
| 5 | $1,20,000$ |

Since all values are in constant dollars, we can use the inflation free interest rate. We simply discount the dollar inflows at $i \prime=12 \%$

PW (12\%) $=-\$ 250,000+\$ 100,000(\mathrm{P} / \mathrm{A}, 12 \%, 5)+\$ 10,000(\mathrm{P} / \mathrm{G}, 12 \%, 4)+\$ 20,000(\mathrm{P} / \mathrm{F}$, $12 \%, 5)$

PW $(12 \%)=\$ 163,099$
Since the equivalent net receipts exceeds the investment, the project can be justified before considering any tax effects.

## Case 2: If cash flow elements are estimated in Actual Dollar (Actual Dollar Analysis)

In this method, all cash flow elements are estimated in actual dollars. To find the equivalent present worth of this actual dollar amount $\left(\mathrm{A}_{\mathrm{n}}\right)$ in year n , we may use either
(a) Deflation method or (b) Adjusted-discount method.

## (a) Deflation Method

It requires two steps to convert actual dollars into equivalent present worth dollars. First, we convert actual dollars into equivalent constant dollars by discounting by the general inflation rate which removes the inflationary effect. Second, finding the equivalent present worth using i'\%.

## Example 8.3

The project is expected to generate the following cash flows in actual dollars

| Period | Net Cash flow in Actual \$ |
| :---: | :---: |
| 0 | $-75,000$ |
| 1 | 32,000 |
| 2 | 35,700 |
| 3 | 32,800 |
| 4 | 29,000 |
| 5 | 58,000 |

(a) What are the equivalent year 0 dollars (constant dollars), if the general inflation rate (f) is 5\% per year?
(b) Compute the present worth of these cash flows in constant dollars at $\mathrm{i}^{\prime}=10 \%$.

The net cash flows in actual dollars can be converted to constant dollars by deflating them by $5 \%$ yearly deflation factor. The deflated or constant dollar cash flows can then be used to determine NPW at i\%.
(a) Convert the actual dollars into constant dollars using deflation rate of $\mathrm{f}=5 \%$

| Period | Cash flow in <br> Actual Dollar | Deflation Factor <br> $=(\mathbf{( 1 + f})^{-\mathbf{n}}$ | Cash flow in <br> Constant Dollar |
| :---: | :---: | :---: | :---: |
| 0 | $-75,000$ | $(1+0.05)^{-0}$ | $-75,000$ |
| 1 | 32,000 | $(1+0.05)^{-1}$ | 30,476 |
| 2 | 35,700 | $(1+0.05)^{-2}$ | 32,381 |
| 3 | 32,800 | $(1+0.05)^{-3}$ | 28,334 |
| 4 | 29,000 | $(1+0.05)^{-4}$ | 23,858 |
| 5 | 58,000 | $(1+0.05)^{-5}$ | 45,445 |

(b) Compute the equivalent present worth of constant dollar using i' $=10 \%$

| Period | Cash flow in <br> Constant Dollar | Discounting <br> Factor $=(\mathbf{1}+\mathbf{f})^{-\mathbf{n}}$ | Equivalent <br> PW |
| :---: | :---: | :---: | :---: |
| 0 | $-75,000$ | $(1+0.1)^{-0}$ | $-75,000$ |
| 1 | 30,476 | $(1+0 .)^{-1}$ | 27,706 |
| 2 | 32,381 | $(1+0.1)^{-2}$ | 26,761 |
| 3 | 28,334 | $(1+0.1)^{-3}$ | 21,288 |
| 4 | 23,858 | $(1+0.1)^{-4}$ | 16,295 |
| 5 | 45,445 | $(1+0.1)^{-5}$ | 28,218 |
| Total Present Worth |  |  |  |

## Adjusted - discount method

The two-step process shown in previous example can be streamlined by the efficiency of the adjusted-discount method, which performs deflation and discounting in one step.

Mathematically,
We can combine this two-step procedure into one step

$$
\begin{align*}
& P_{n}=\frac{\frac{A_{n}}{(1+f)^{n}}}{\left(1+i^{\prime}\right)^{n}} \\
& P_{n}=\frac{A_{n}}{(1+f)^{n}\left(1+i^{\prime}\right)^{n}} \\
& P_{n}=\frac{A_{n}}{\left\{(1+f)\left(1+i^{\prime}\right)\right\}^{n}}
\end{align*}
$$

Since the market interest rate (i) reflects both the earning power and the purchasing power, we have following relation relationship

$$
\begin{equation*}
P_{n}=\frac{A_{n}}{(1+i)^{n}} \tag{2}
\end{equation*}
$$

The equivalent present worth values in equation (1) and (2) must be equal at year 0 . Therefore,

$$
\frac{A_{n}}{\left\{(1+f)\left(1+i^{\prime}\right)\right\}^{n}} \quad=\frac{A_{n}}{(1+i)^{n}}
$$

This leads to the following relationship among $\mathrm{f}, \mathrm{i}$, i

$$
(1+\mathbf{i})=(1+\mathbf{f})\left(1+i^{\prime}\right)
$$

Simplifying the term yields,

$$
i=i^{\prime}+i^{\prime} * f+f
$$

## Example 8.4

Consider the cash flows in actual dollar as in previous example as follows. Compute the equivalent present worth of these flows using the adjusted discount method. $\mathrm{f}=5 \%$, and $\mathrm{i}^{\prime}=10 \%$

| Period | Net Cash flow in Actual \$ |
| :---: | :---: |
| 0 | $-75,000$ |
| 1 | 32,000 |
| 2 | 35,700 |
| 3 | 32,800 |
| 4 | 29,000 |
| 5 | 58,000 |

First, determine the market interest rate (i)

$$
\begin{aligned}
& i=i^{\prime}+f+i^{\prime} * f \\
& i=0.10+0.05+(0.10)(0.05)=15.5 \%
\end{aligned}
$$

| Period | Cash flow in <br> Actual Dollar | Multiplied by <br> $=(\mathbf{1}+\mathbf{0 . 1 5 5})^{-\mathbf{n}}$ | Cash flow in <br> Constant <br> Dollar |
| :---: | :---: | :---: | :---: |
| 0 | $-75,000$ | $(1+0.155)^{-0}$ | $-75,000$ |
| 1 | 32,000 | $(1+0.155)^{-1}$ | 27,706 |
| 2 | 35,700 | $(1+0.155)^{-2}$ | 26,761 |
| 3 | 32,800 | $(1+0.155)^{-3}$ | 21,288 |
| 4 | 29,000 | $(1+0.155)^{-4}$ | 16,295 |
| 5 | 58,000 | $(1+0.155)^{-5}$ | 28,218 |
| Total Present Worth |  |  | $\mathbf{4 5 , 2 6 8}$ |

The equivalent present worth that is obtained using adjusted - discount method ( $\mathrm{i}=15.5 \%$ ) is exactly same as the result obtained using the deflation method ( $\mathrm{f}=5 \%$ and $\mathrm{i}^{\prime}=10 \%$ )

## Case3: Some of the cash flow elements are estimated in constant dollars and others are estimated in actual dollars. (Mixed Dollar Analysis)

> Convert all cash flow elements into the same dollar units (either constant or actual)
$>$ If the cash flow is converted into actual dollars, the market interest rate is (i) should be used in calculating the equivalence value.
$>$ If the cash flow is converted in terms of constant dollars, the inflation free interest rate (i') should be used.

### 8.7 Impact of Inflation in engineering economic analysis

The purchasing power of money never remains stationary or still, which indicates the importance of inflation in the economic world. When inflation is modest, 2 to 4 percent per year, it is generally ignored in economic evaluations of proposals. It is argued that all proposals are affected similarly by price changes and that there are too little differences between current and future costs to influence the order of preference. When inflation is high and some goods and services escalate much more rapidly than others and there is a chance of project being suffered and cannot generate the income as expected. Therefore it is necessary to make some consideration regarding the inflation while making the analysis of investment proposals.

There are two ways to make meaningful economic calculations when the value of the currency is changing [7]
(a) Convert the amounts that occur in the different time periods into amounts that make the currencies have the same value before time value calculations are made, or
(b) Change the interest rate that is used in the economic equations in such a way that it accounts for the different valued currencies as well as the time value of money.

## References

[1] Basics of Engineering Economy: Leland Blank and Anthony Tarquin, Indian Edition, Tata McGraw Hill Education Private Limited, New Delhi, India, 2013.
[2] Contemporary Engineering Economics, Chan S. Park, Second Edition, Addison-Wesley Publishing Company, 1997.
[3] Engineering Economics: R. Paneerselvam, Eastern Economy Edition, Prentice Hall of India Private Limited, New Delhi, India, 2001.
[4] Engineering Economics: James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Fourth Edition, Tata McGraw Hill Education Private Limited, New Delhi, India, 2004.
[5] https://www.businessinsider.com/personal-finance/causes-of-inflation (Viewed November 2022)
[6] https://www.tutor2u.net/economics/reference/inflation-causes-of-inflation (Viewed November 2022)
[7] http://engineering.utep.edu/enge/EE/14/02/1.htm (Viewed November 2022)

