In the name of Allah

Amirkabir University of Technology
(Tehran Polytechnic)
Industrial Engineering Department

Course Title: Engineering Economics

12. Effects of Inflation

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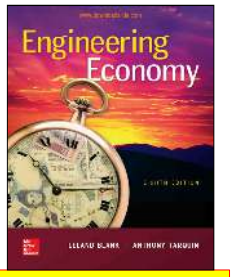
Learning Stage 4: Rounding Out the Study

- Chapter 14
  - Effects of Inflation
- Chapter 15 *not covered in this course
  - Cost Estimation and Indirect Cost Allocation
- Chapter 16
  - Depreciation Methods
- Chapter 17
  - After-Tax Economic Analysis
- Chapter 18
  - Sensitivity Analysis and Staged Decisions
- Chapter 19
  - More on Variation and Decision Making under Risk



Chapter 14 of EE (BT) book 8th edition

LEARNING OUTCOMES

- Purpose:
  - Consider the effects of inflation when performing an engineering economy evaluation.

1. Understand inflation/deflation
2. Calculate PW of cash flows with inflation
3. Calculate FW with inflation considered
4. Calculate capital recovery (AW) with inflation considered

Understanding Inflation

- Inflation:
  - Increase in amount of money needed to purchase the same amount of goods or services.
  - Occurs because the value of the currency has changed over time.
- Inflation results in a decrease in purchasing power,
  - i.e., one unit of money buys less goods or services
  - 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 either of the followings

$$\text{Amount in period } t_1 = \frac{\text{amount in period } t_2}{1 + \text{inflation rate between } t_1 \text{ and } t_2}$$

$$\text{Constant-value dollars} = \frac{\text{future dollars}}{(1+f)^n}$$

  - f: inflation rate per period (year), n: number of time periods between t_1 & t_2

Understanding Inflation

- Two ways to work problems when considering inflation:
  - (1) Convert cash flows to constant value (CV) dollars, then use real interesrt rate i.

$$\text{Constant-value (CV) dollars} = \frac{\text{future dollars}}{(1+f)^n} = \frac{\text{then-current dollars}}{(1+f)^n}$$

    - f: inflation rate (% per year)
  - (2) Leave money amounts as is and use interest rate adjusted for inflation, i_f
    - $i_f = i + f + (i)(f)$

Example: Constant Value Dollars

- How much would be required today to purchase an item that increased in cost by exactly the inflation rate?
  - The cost 30 years ago was $1000 and inflation has consistently averaged 4% per year.

Solution: Solve for future dollars

$$\text{Future dollars} = \text{constant value dollars}(1+f)^n$$
$$= 1000(1+0.04)^{30}$$
$$= \$3243$$

It means there is 224.3% inflation rate over 30 years.

Note: This calculation only accounts for the decreased purchasing power of the currency. It does not take into account the time value of money.

Three Different Rates

- Real (inflation-free) interest rate i
  - Rate at which interest is earned when effects of inflation are removed; i represents the real increase in purchasing power
- Market (inflation-adjusted) rate i_f
  - Rate that takes inflation into account. Commonly stated rate everyday
    - A company's MARR adjusted for inflation is referred to as the inflation-adjusted or market MARR
- Inflation rate f
  - Rate of change in value of currency
  - Relation between three rates is derived using the relation

$$P = F\frac{1}{(1+i_f)^n} = F(P/F, i_f, n)$$

Market rate is: $\boldsymbol{i_f = i + f + (i)(f)}$

Example: Market vs. Real Rate

- Money in a medium-risk investment makes a guaranteed 8% per year.
  - Inflation rate has averaged 5.5% per year.
  - What is the real rate of return on the investment?
- Solution: Solve for the real rate i in relation for i_f

$$\boldsymbol{i_f = i + f + (i)(f)}$$

$$i = \frac{i_f - f}{1+f} = \frac{0.08 - 0.055}{1 + 0.055} = 0.024$$

  - That means investment pays only 2.4% per year in real terms vs. the stated rate of 8%.

Deflation

- Deflation:
  - Opposite of the inflation; when deflation is present,
    - the purchasing power of the monetary unit is greater in the future than at present.
- Inflation occurs much more commonly than deflation,
  - especially at the national economy level.
- In deflationary economic conditions,
  - the market interest rate is always less than the real interest rate.
- For deflation computation,
  - use the inflation equation except the deflation rate is a −f value.
    - For example, if deflation is estimated to be 2% per year, an asset that costs $10,000 today would have a first cost 5 years from now as
    - $10{,}000(1 - f)^n = 10{,}000(0.98)^5 = 10{,}000(0.9039) = \$9039$

PW Calculations with Inflation

- Two ways to account for inflation in PW calculations:
- 1) Convert cash flows into constant-value (CV) dollars and using regular I to determine PW.
  - where: CV = future dollars/$(1 + f)^n$ = then-current dollars/$(1 + f)^n$
    - f = inflation rate
    - Note: Calculations up to now have assumed constant-value dollars
- 2) Express cash flows in future (then-current) dollars and use inflated interest rate i_f
  - where $i_f = i + f + (i)(f)$
    - Note: Inflated interest rate is the market interest rate

Example: PW calculation

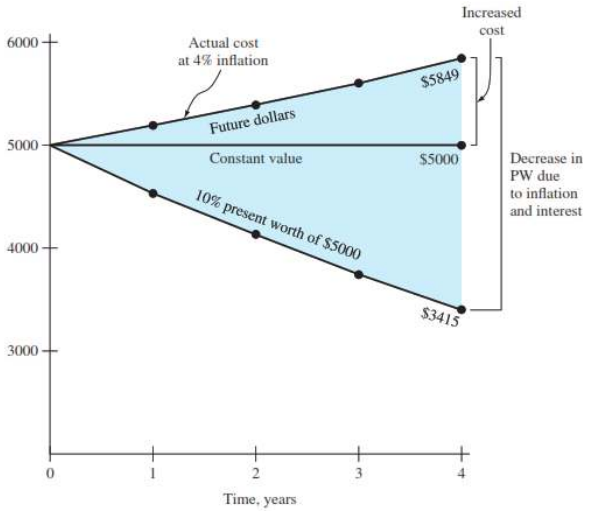
- Inflation Calculations Using Constant-Value Dollars
  - f = 4%, i = 10%

Year n (1)	Cost Increase due to 4% Inflation, $ (2)	Cost in Future Dollars, $ (3)	Future Cost in Constant-Value Dollars, $ (4) = (3)/1.04^n	Present Worth at Real i = 10%, $ (5) = (4)(P/F,10%,n)
0		5000	5000	5000
1	5000(0.04) = 200	5200	$5200/(1.04)^1 = 5000$	4545
2	5200(0.04) = 208	5408	$5408/(1.04)^2 = 5000$	4132
3	5408(0.04) = 216	5624	$5624/(1.04)^3 = 5000$	3757
4	5624(0.04) = 225	5849	$5849/(1.04)^4 = 5000$	3415

  - Conclusions
    - At f = 4%, $5000 today inflates to $5849 in 4 years.
    - $5000 four years in the future has a PW of only $3415 now in constant-value dollars at a real interest rate of 10% per year.

Example: PW calculation

- Differences over a 4-year period of the constant-value amount of $5000, the future-dollar costs at 4% inflation, and the present worth at 10% real interest with inflation considered.



Example: PW with Inflation

- A honing machine will have a cost of $25,000 (future cost) six years from now.
  - Find the PW of the machine, if the real interest rate is 10% per year and the inflation rate is 5% per year using
  - (a) constant-value dollars, and
  - (b) future dollars.

Solution: (a) Determine constant-value dollars and use i in PW equation

$$CV = 25{,}000/(1+0.05)^6 = \$18{,}655$$
$$PW = 18{,}655(P/F, 10\%, 6) = \$10{,}530$$

(b) Leave as future dollars and use i_f in PW equation

$$i_f = 0.10 + 0.05 + (0.10)(0.05) = 15.5\%$$
$$PW = 25{,}000(P/F, 15.5\%, 6) = \$10{,}530$$

FW Calculations with Inflation

- FW values can have four different interpretations
  - 1) The actual amount accumulated
    - Use i_f in FW equation → $FW = PW(F/P, i_f, n)$
  - 2) The purchasing power in terms of CV dollars of the future amount
    - Use i_f in FW equation and divide by $(1+f)^n$ or use real i where real $i = (i_f - f)/(1+f)$ → $FW = PW(F/P, i, n)$
  - 3) The number of future dollars required to have the same purchasing power as a dollar today with no time value of money considered
    - Use f instead of i in F/P factor → $FW = PW(F/P, f, n)$
  - 4) The amount required to maintain the purchasing power of the present sum and earn a stated real rate of return
    - Use i_f in FW equation → $FW = PW(F/P, i_f, n)$

Example: FW with Inflation (1)

- An engineer invests $15,000 in a savings account that pays interest at a real 8% per year. If the inflation rate is 5% per year, determine
  - (a) the amount of money that will be accumulated in 10 years,
  - (b) the purchasing power of the accumulated amount (in terms of today's dollars),
  - (c) the number of future dollars that will have the same purchasing power as the $15,000 today, and
  - (d) the amount to maintain purchasing power and earn a real 8% per year return.

Solution:

(a) The amount accumulated is a function of the market interest rate, i_f

$$i_f = 0.08 + 0.05 + (0.08)(0.05) = 13.4\%$$

$$\text{Amount Accumulated} = 15{,}000(\text{F/P}, 13.4\%, 10) = \$52{,}750$$

Example: FW with Inflation (2)

(b) To find the purchasing power of the accumulated amount deflate the inflated dollars

$$\text{Purchasing power} = 15{,}000(F/P, 13.4\%, 10)/(1 + 0.05)^{10}$$
$$= \$32{,}384$$

(c) The number of future dollars required to purchase goods that cost $15,000 now is the inflated cost of the goods

$$\text{Number of future dollars} = 15{,}000(\text{F/P}, 5\%, 10)$$
$$= \$24{,}434$$

(d) In order to maintain purchasing power and earn a real return, money must grow by the inflation rate and the interest rate, or $i_f = 13.4\%$, as in part (a)

$$\text{FW} = 15{,}000(\text{F/P}, 13.4\%, 10)$$
$$= \$52{,}750$$

Capital Recovery with Inflation

- The A/P and A/F factors require the use of i_f when inflation is considered.
  - Example: If a small company invests $150,000 in a new production line machine, how much must it receive each year to recover the investment in 5 years?
    - The real interest rate is 10% and the inflation rate is 4% per year.

Solution: Capital recovery (CR) is the AW value

$$i_f = 0.10 + 0.04 + (0.10)(0.04) = 14.4\%$$

$$CR = AW = 150{,}000(A/P, 14.4\%, 5)$$

$$= \$44{,}115 \text{ per year}$$

Summary of Important Points

- Inflation occurs because value of currency has changed
- Inflation reduces purchasing power; one unit buys less goods ort services
- Two ways to account for inflation in economic analyses:
  - (1) Convert all cash flows into constant-value dollars and use i
  - (2) Leave cash flows as inflated dollars and use i_f
- During deflation, purchasing power of money is greater in future than at present
- Future worth values can have four different interpretations,
  - requiring different interest rates to find FW
- Use i_f in calculations involving A/P or A/F when inflation is considered