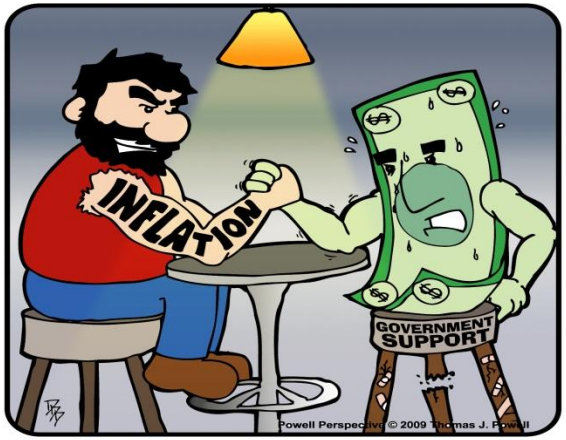
American University of Armenia
IE 340 – Engineering Economics
Spring Semester, 2016

Chapter 9 – Inflation and Price Changes



Agenda for today

- Definitions
  - Inflation
  - Nominal money
  - Real money
- Examples
- Impact of inflation
- Exchange rate and its implications

When the monetary unit does not have a **constant value** in exchange for goods and services, and when future price changes are expected to be significant, an undesirable choice among alternatives can be made if price changes are not considered

Price Changes

- **Inflation**
  - Increase in the general level of prices of goods or services over a period of time
- **Deflation**
  - Decrease in the general level of prices of goods or services over time
- **Price changes will affect cash flows**

Consequences of high Inflation

- **Greater uncertainty:** There may be greater uncertainty for both firms and households. Firms will postpone their investments due to uncertainty in the market

- **Redistributive effects:** High rate of inflation will affect people who have constant incomes, such as retired people, students, and dependents. Moreover, rise in prices of essential commodities (food & clothing) will affect the poor segment of the society as they spend a major part of their income on these good.

- **Less saving:** High rate of inflation will have an adverse effect on the savings in the economy. As people spend more to sustain their present standard of living, less is being saved

Consequences of Inflation

- **Damage to export competitiveness:** High rate of inflation will hit hard the export industry in the economy. The cost of production will rise and the exports will become less competitive in the international market

- **Social unrest:** High rate of inflation leads to social unrest in the economy. There is increase in dissatisfaction among the workers as they demand higher wages to sustain their present living standard

- **Interest rates:** The Central Bank might use monetary tools to control high inflation rate by increasing interest rates. This will increase the cost of borrowing and will have a negative effect on both consumption and investment

Consequences of Inflation

- **Shoe Leather** cost refers to the cost of time and effort (more specifically the opportunity cost of time and energy) that people spend trying to counter-act the effects of inflation, such as holding less cash and having to make additional trips to the bank
- **Menu costs**
- **Inflation Transfers Money from Savers and Investors to Debtors**
  - The effect of inflation on savers and investors is that they lose purchasing power
  - The effect of inflation on debtors is positive because debtors can pay their debts with money that is less valuable

Price Increase Due to Inflation

Item	1967 Price	2000 Price	% Increase
Consumer price index (CPI)	100	512.9	413
Monthly housing expense	$114.31	$943.97	726
Monthly automobile expense	82.69	471.38	470
Loaf of bread	.22	1.84	736
Pound of hamburger	.39	2.98	564
Pound of coffee	.59	4.10	595
Candy bar	.10	0.90	800
Men's dress shirt	5.00	39.00	680
Postage (first-class)	0.05	0.33	660
Annual public college tuition	294.00	3,960.00	1,247

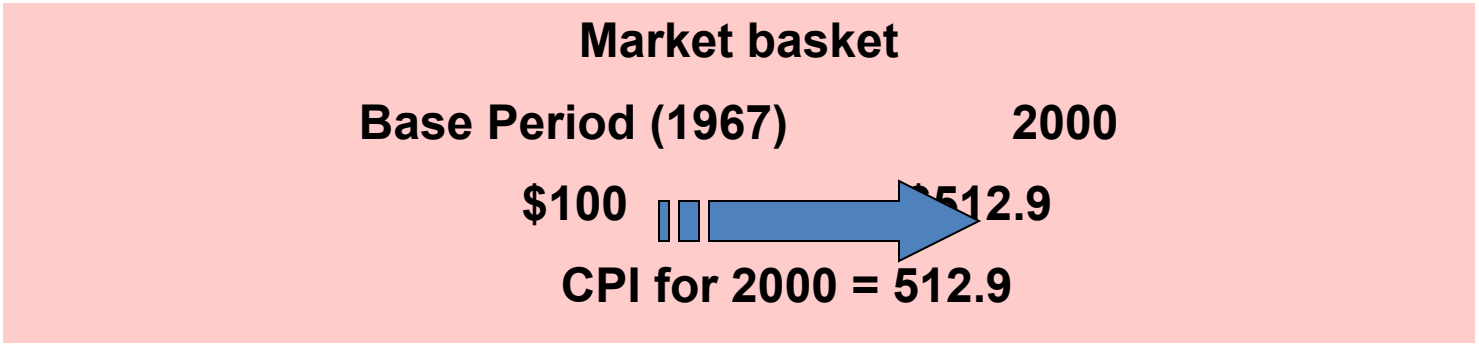
Consumer Basket

- The **basket of consumer goods** or **consumer basket** is the market basket intended for tracking the prices of consumer goods and services

- The list used for such an analysis would contain a number of the **most commonly bought food and household items by an average household**

Consumer Price Index (CPI)

Consumer Price Index (CPI): the CPI compares the cost of a sample "consumer basket" of goods and services in a specific period relative to the cost of the same "market basket" in an earlier reference period. This reference period is designated as the **base period.**



Consumer Price Index (CPI)

- A price index is calculated relative to a **base** year.
- Indices are typically normalized at 100 in the base year.
- Starting from a base year, a price index P_t represents the price of the commodity bundle over time t. In base year zero, P_0 is set to 100.

Consumer Price Index (CPI)

(CPI annual inflation rate)k = $$\frac{(CPI)_k - (CPI)_{k-1}}{(CPI)_{k-1}}(100)$$

Indices to measure inflation

- **A Laspeyres Index** is known as a "base-weighted" or "fixed-weighted" index because the price increases are weighted by the quantities in the base period

$$P_L = \frac{\sum(p_{c,t_n} \cdot q_{c,t_0})}{\sum(p_{c,t_0} \cdot q_{c,t_0})}$$

- **A Paasche Index** when the price increases are weighted by the quantities in the current period

$$P_P = \frac{\sum(p_{c,t_n} \cdot q_{c,t_n})}{\sum(p_{c,t_0} \cdot q_{c,t_n})}$$

Price Indices

- Vary from country to country
- Only *approximate:*
  - "Market baskets" may differ
    - Technological progress
    - Change in consumption patterns
    - Substitution between goods

Inflation

- **Time value of money:**
  - **Money at different times has different values**
    - **Accounted for by the interest rate**

- **If purchasing power changes:**
  - **That is *another* difference!**
    - **Accounted for by the inflation rate**

Definitions

- **Real (Constant) value of money – Refers to the purchasing power of money (the value of money)**
- **Nominal (Actual) value of money – Refers to the amount of money (not to the value) as of the time it occurs**
- **Base period – The reference or base time period used to define the constant purchasing power of real money**
  - **Often, in practice, the b.p. is designated as time of the engineering economic analysis, or reference time 0…**

Decisions

- **Real money accounts for the lost value of the money because of inflation**
- **Therefore we want to make decision based on real money**
- **So now, when making decisions we need to make sure we account for the inflation**

Relationship between A$ and R$

$A(\$)_N$ = actual (nominal) dollars in year N
$R(\$)_N$ = real dollars in year N
f = inflation rate per year
b = base period

$$R(\$)_N = A(\$)_N / (1+f)^{N-b}$$

from tables: $R_N = A_N (P/F,f,N-b)$

if base period b=N, then $R(\$)_1 = A(\$)_1$

Example

You will receive $10,000 ten years from now.

- **What is the value of those $10,000 in today's dollars?**
- **Assuming 5% inflation $10,000 in 10 years would buy what $6,139 would buy today.**
  - **Which makes sense. If things are more expensive in the future, I will be able to buy less with the same amount of money….**
- **Real dollars in year 10 = $6,139**
- **Nominal dollars in year 10 = $10,000**

Examples

- **Bonds (and investment in general) are bad in times of inflation:**
  - **A bond may pay $700 per year, but those $700 will be worth less over time!**
- **Loans are *good* investments in times of inflation:**
  - ***Pay*** **$700 per year, worth less over time**

General formula for inflation

$$\text{Past Value} * (1 + f)^{n} = \text{Present Value}$$

… Similar to: $P (1 + i)^{n} = F$

f = inflation rate

General formulas for inflation

$$\text{Past(\$)}\ (1 + f)^{n} = \text{Present(\$)}$$

$$\text{Present(\$)}\ (1 + f)^{n} = \text{Future(\$)}$$

$$\text{Real(\$)}\ (1 + f)^{n} = \text{Nominal(\$)}$$

Real($) = The real value (in present time) of a nominal amount

Nominal($) = The numeric value or amount (in future or past) = Non-real($)

Example

A house was worth $60,000 15 years ago. Today its value is $200,000. Assuming that the price change is only due to the inflation, what was the annual inflation rate during those 15 years?

Past Value $(1 + f)^n$ = Present Value

$60,000\ (1+f)^{15} = 200,000$

f = (200,000/60,000)^(1/15) - 1

f = .0836 = 8.36%

Another example

A dinner for two in a fast food restaurant was worth $4.00 15 years ago. Today its value is $6.50. What was the inflation rate during those 15 years?

Past Value $(1 + f)^n$ = Present Value

$4.00\ (1+f)^{15} = 6.50$

f = (6.50/4)^(1/15) - 1

f = .0329 = 3.29%

Examples

- Mortgages are good investments in times of inflation (they are like loans)
- Real estate (house, land) is also a good investment

Examples

- Sometimes loan payments are *indexed* to inflation:
  - We stated in the beginning of this course the determinants of the interest rate (risk, administrative costs, return)
  - Now the expected level of inflation can be added to these

Equivalence Calculation Under Inflation

1. **Types of Interest Rate**
   - Market (nominal) interest rate (i)
   - Inflation free (real) interest rate (i')

2. **Types of Cash Flow**
   - In constant dollars (real)
   - In actual dollars (nominal)

3. **Types of Analysis Method**
   - Constant dollar analysis
   - Actual dollar analysis
   - Deflation method
   - Adjusted-discount method

Inflation Terminology

- **Inflation-free Interest Rate (i_r):** an estimate of the true earning power of money when the inflation effects have been removed. It is also known as **real interest rate**

- **Market interest rate (i_c):** interest rate which takes into account the **combined effects** of the earning power of money and any anticipated inflation (or changes in purchasing power). It is also known as **inflation-adjusted interest rate or combined interest rate**

Interest rates versus inflation

- If you invest $M, it will yield $M(1+i) at the end of year.
- If there is an inflation rate of *f* over the next year, then the real value of cash flow will be $M (1+i)/(1+f)

i = nominal interest rate

i' = real interest rate

- M(1+i') = M (1+i)/(1+f)

- i' = [(1+i)/(1+f)] -1
- i = i'+ f + i' x f (Fisher equation)

  i' = (i-f)/(1+f)

Example

An one-year deposit is paying 12% interest. The inflation rate is 5% over the next year. What is the real interest rate? What is the real dollar value of $5000 deposit at the end of the year?

$i' = [(1+i)/(1+f)] - 1 = (1.12 / 1.05) - 1 = 0.067$

A $5000 deposit will return $5600 at the end of the year. The real value of $5600 is $5600/1.05 = $5333 in today's dollar. Or, simply $5000*(1+0.067) = $5333

The Effect of Inflation on IRR

- $IRR_A = IRR_R + f + IRR_R \times f$
- $IRR_R = [(1 + IRR_A)/(1 + f)] - 1$

One more example

A project has a first cost of $10,000 and a saving of $15,000 at the end of year two. Inflation rate is 5%, $MARR_R$ is 18%. Should the project be accepted (based on IRR analysis)?

$-10{,}000 + 15{,}000 / (1+i)^2 = 0 \rightarrow IRR_A = 22.5\%$

$IRR_R = (1+0.225) / (1+0.05) - 1 = 16.6\%$

Project Evaluation Methods with Inflation

- Constant (real) Dollar analysis
  - Estimate all future cash flows in constant dollars.
  - Use (i_r) as an interest rate to find equivalent worth.

- Actual Dollar Analysis
  - Estimate all future cash flows in actual dollars.
  - Use (i_c) as an interest rate to find equivalent worth.

- **DO NOT MIX THE TWO!**

And another example

- You can put your money in an investment that will pay $1000 per year for the next four years and $10,000 at the end of the fifth year. Inflation rate is 5%, real MARR is 8%. What is the PW of this investment?

Example – Cont.

- Real cash flows and real MARR

$$R_N = \frac{A_N}{(1+f)^N}$$

$$PW = \frac{1000}{(1.05)(1.08)} + \frac{1000}{(1.05)^2(1.08)^2} + \frac{1000}{(1.05)^3(1.08)^3} + \frac{1000}{(1.05)^4(1.08)^4} + \frac{10000}{(1.05)^5(1.08)^5}$$

$$PW \cong 8282$$

Example 4 – Cont.

- Actual cash flows and actual MARR

$$MARR_A = MARR_R + f + MARR_R \times f$$

$$MARR_A = 0.08 + 0.05 + (0.08)(0.05) = 0.134$$

$$PW = 1000(P/A, MARR_A, 4) + 10000(P/F, MARR_A, 5)$$

$$PW = 1000(P/A, 13.4\%, 4) + 10{,}000(P/F, 13.4\%, 5) \cong \$8282$$

Another example

- Choose between two alternatives:
  - year A B
    - 0 0 -15,000
    - 1-3 -9200 -6140
- Now assume 6% inflation
  - (Same for both projects)

Another example (cont.)

- Now assume 6% inflation:
  - year A B
    - 0 0 -15,000
    - 1 -9200(1.06) -6140(1.06)
    - 2 $-9200(1.06)^2$ $-6140(1.06)^2$
    - 3 $-9200(1.06)^3$ $-6140(1.06)^3$
- Will inflation make B more or less desirable?

Another example (cont.)

- Will inflation make B more or less desirable?
  - *Neither!*
- If all prices change at the same rate,
  - Then inflation is irrelevant!

Observations

- If different prices inflate with different rate, then the relative prices change (not like in the example above)
- In such cases the “relative” inflation (relative changes in prices) becomes important

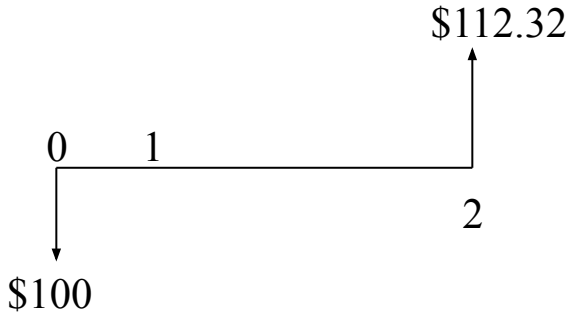
Average Inflation Rate (f)

Fact: Base Price = $100 (year 0)
Inflation rate (year 1) = 4%
Inflation rate (year 2) = 8%
Average inflation rate over 2 years?

Step 1: Find the actual inflated price at the end of year 2.
$100 (1 + 0.04) (1 + 0.08) = $112.32

Step 2: Find the average inflation rate by solving the following equivalence equation.

$100 (1+ f)^2 = $112.32
f = 5.98%



General Inflation Rate (f)

Average inflation rate based on the CPI

$$CPI_n = CPI_0(1+\bar{f})^n,$$

$$\bar{f} = \left(\frac{CPI_n}{CPI_0}\right)^{1/n} - 1$$

where $\bar{f}$ = The genreal inflation rate,

CPI_n = The consumer price index at the end period n,

CPI_0 = The consumer price index for the base period.

Average Inflation Rate

Item	1967 Price	2000 Price	Average Inflation Rate
Consumer price index (CPI)	100	512.9	5.07%
Monthly housing expense	$114.31	$943.97	6.61
Monthly automobile expense	82.69	471.38	5.42
Loaf of bread	0.22	1.84	6.64
Pound of hamburger	0.39	2.98	6.36
Pound of coffee	0.59	4.10	6.05
Candy bar	0.10	0.90	6.88
Men's dress shirt	5.00	39.00	6.42
Postage (first-class)	0.05	0.33	5.89
Annual public college tuition	294.00	3,960.00	8.19

Example: Yearly and Average Inflation Rates

Year	Cost
0	$504,000
1	538,000
2	577,000
3	629,500

What are the annual inflation rates
and the average inflation rate over 3 years?

Solution

Inflation rate during year 1 (f_1):

($538,400 - $504,000) / $504,000 = 6.83%.

Inflation rate during year 2 (f_2):

($577,000 - $538,400) / $538,400 = 7.17 %.

Inflation rate during year 3 (f_3):

($629,500 - $577,000) / $577,000 = 9.10%.

The average inflation rate over 3 years is

$$f = \left(\frac{\$629,500}{\$504,000}\right)^{1/3} - 1 = 0.0769 = 7.69\%$$