Analysis with Inflation

Inflation

*Don’t put your money in your mattress*
- Increase in cost of an item over time
- Decrease in the value of the dollar

The Consumer’s Price Index (CPI) shows prices relative to a base year

The Inflation Rate shows the percentage increase per year
There may be different rates of Inflation for different items

- Computers
- Food
- Fuel oil
- Scarce resources
- Medical expenses
- General inflation rate is $f$

**Inflation is an exponential function**

If the cost of something is $C$ today and is increasing at a $f\%$ rate, the cost in $n$ years is: $C(1 + f/100)^n$.

**Examples**

1. The tuition is $2000 today. We expect college costs to increase at a 6\% annual rate. What will tuition be in 10 years?

   Tuition = 2000(1 + 0.06)^{10} = $3582

2. If the cost of a hamburger is $3 today, what did it cost 40 years ago?
   Assume the average rate of inflation during that time was 5\%.

   Hamburger = 3/(1 + 0.05)^{40} = $0.43

**Why do we Have Inflation?**

- Too many dollars chasing too few goods bid prices up
- Government creates too much money
- Money not backed by hard currency
- Decreasing amounts of raw materials
- Unreasonable demands by labor
- Unreasonable price increases by business
- Inflationary expectations (Inflationary spiral)
- Uncertainty about government survival and policies
- Governments benefit by inflation
- Borrowed money is easier to pay back
- Proportion of income taxed goes up in a progressive tax system

**Effects of Inflation**

- Is inflation good or bad?
- Can inflation be controlled?
- How do we make economic decisions considering inflation?
Expressing Cash Flows

Cash flows may be in real or actual dollars

- Consider an estimated cash flow \( n \) years from today.
- If the cash flow is expressed in terms of today’s dollars, we say the amount is in real (or year-0 or constant) dollars.
- If the cash flow is expressed in terms of the dollars that will be used in \( n \) years, we say the amount is in actual or (year-\( n \) or current) dollars.

To change from real to actual dollars

Assume a general inflation rate of \( f \) per year.

If some cash flow at year \( n \) is the amount \( C \) expressed in real dollars, the amount expressed in actual dollars is: \( C(1 + f)^n = C(F/P, f, n) \).

To change from actual to real dollars

If some cash flow at year \( n \) is the amount \( D \) expressed in actual dollars, the amount expressed in real dollars is: \( D/(1 + f)^n = D(P/F, f, n) \).
Economic Analyses Considering Inflation

The MARR is different with and without inflation

\[ i_c \] is the market MARR (with inflation)
\[ i_r \] is the real MARR (without inflation) \( i_c > i_r \).
\( f \) is the inflation rate

The MARR considering inflation should be

\[ i_c = i_r + f + i_rf \]

If \( f \) and \( i_c \) are given: \( i_r = \frac{i_c - f}{1 + f} \)

Developing the cash flows for analysis

**Economic Analysis with Inflation**

Estimate future costs and revenues as if they were occurring today

Estimate in year \( n = E_n \)

\[ D_n = E_n(1+e_j)^n \]

Use escalation rates for each component to determine the cash flow in actual dollars

\[ C_n = \frac{D_n}{(1+f)^n} \]

Use the general inflation rate to convert actual dollars to real dollars

When all cash flows inflate at the general inflation rate

Real dollar cash flow = Estimate in year \( n \)
Cash Flow Analysis

Present Worth

When cash flows are expressed in actual dollars compute the present worth using \( i_c \), the market MARR.

When cash flows are expressed in real dollars compute the present worth using \( i_r \), the real MARR.

The present worth is the same by either calculation.

Example 1: All components of the cash flow escalate at the same rate as general inflation

- The Investment is $10,000 and the life is 10 years with no salvage.
- Based on today’s prices, we estimate: Operating costs as $500 per year and revenue at $2000 per year.
- All costs and revenues are fully responsive to inflation.
- The MARR without inflation is 4%.
- The general inflation rate is 5%.

When all cash flows increase at the general inflation rate

| Analysis with Real $ and \( i_c = 4\% \) | Analysis with Actual $ and \( i_c = 9.2\% \) |
### Inflation

<table>
<thead>
<tr>
<th>Time</th>
<th>Real $</th>
<th>PW($i_r = 4%)</th>
<th>Time</th>
<th>Actual $</th>
<th>PW($i_c = 9.2%)</th>
</tr>
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<tr>
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<td>10</td>
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</tr>
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</table>

PW = 2166

Sometimes inflation can be neglected

For an economic analysis, if all receipts and expenses escalate at the same rate as the general inflation rate, forget about inflation. Do the analysis with real dollars and $i_r$ (the MARR without inflation)

### When Components of the Problem escalate at Different Rates
- If some components of receipts and disbursements do not have the same escalation rate either:
  - Express all cash flows in actual (year-n) dollars and use $i_c$
  - Express all cash flows in real (year-0) dollars and use $i_r$
Example 2: Some components of the cash flow increase at different rates than general inflation.

- The Investment is $10,000 and the life is 10 years with no salvage.
- Based on today’s prices, we estimate: Operating costs as $500 per year and revenue at $2000 per year.
- We expect the general inflation rate to be 5%. Operating costs escalate at the same rate as general inflation. Revenues do not increase with time.
- The MARR w/o inflation is 4%.

**Analysis with actual dollars and MARR with inflation:**

<table>
<thead>
<tr>
<th>Time</th>
<th>Costs actual $</th>
<th>Revenues actual $</th>
<th>Net CF actual $</th>
<th>PW(9.2%)</th>
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<td>814</td>
<td>2000</td>
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PW = –1332
Or, express the cash flows with real dollars and use MARR without inflation:

<table>
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<tr>
<th>Time</th>
<th>Costs real $</th>
<th>Revenues real $</th>
<th>Net CF real $</th>
<th>PW(4%)</th>
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</table>

PW = −1332

**An Alternative Computation**

**Computing NPW when components have different inflation rates**

- Investment - Not affected by inflation
- A cash flow component that is fully responsive to inflation
  
  Use the MARR w/o inflation \((i_r)\)
- A cash flow component that is does not change with inflation
  
  Use the MARR with inflation \((i_c)\)
- A cash flow component that is escalating at a rate \(e_j\)
  
  Use \([((1 + i_c)/(1 + e_j)) - 1]\)

**Example 3:**
- Investment is $10,000
- Estimate annual costs of 500. They escalate at a 5% rate
- Estimate annual revenues of $2000. They are fixed and do not escalate.
- MARR w/o inflation is 4%.
- Assume general inflation rate is 5%.
- \[\text{NPW} = -10,000 + 2000(P/A, 0.092, 10) - 500(P/A, 0.04, 10) = -1332\]
Inflation

Computing the NAW

**NPW** is the same in both constant and actual dollars

\[
\text{NAW}_c = \text{NPW}(A/P, i_c, \text{Life})
\]

\[
\text{NAW}_r = \text{NPW}(A/P, i_r, \text{Life})
\]

**NAW\_c** in actual dollars

**NAW\_r** in real dollars

This is the most reasonable for comparisons

When comparing alternatives with the NAW method, it is only rational to compare the NAW expressed in real dollars.

Compute the NAW as follows:

\[
\text{NAW} = \text{NPW}(A/P, i_r, n), \text{ where } i_r \text{ is the MARR without inflation.}
\]

\[
\text{NAW} = -1332(A/P, 0.04, 10) = -1332 \times 0.1233 = -$164 \text{ per year.}
\]

Rate of Return Method

Cash flow in actual dollars

Cash flow in real dollars

\[
\text{ROR}_c \text{ with inflation}
\]

Compare with \( i_c \)

\[
\text{ROR}_r \text{ without inflation}
\]

Compare with \( i_r \)
You can find one from the other: \( ROR_c = \frac{ROR_w - f}{1 + f} \) or \( ROR_c = ROR_w + f + (ROR_w)(f) \)

Summary

**Analysis with Taxes**

- Depreciation does not adjust with inflation. It is always in actual dollars.
- An after tax analysis always requires that inflation be considered.
- Either express after tax cash flows in actual dollars and use \( i_c \) or express the after tax cash flows in real dollars and use \( i_r \).
Example 3:
- The Investment is $10,000 and the life is 10 years with no salvage.
- Without adjusting for inflation, we estimate: Operating costs as $500 per year and revenue at $2000 per year.
- Both revenue and costs escalate at the same rate as general inflation.
- The general inflation rate is 5%.
- The asset is depreciated with the straight-line method. The tax rate is 40%.
- The after tax MARR without inflation is 4%.

Inflation reduces the attractiveness of investments requiring depreciation

Assuming 5% inflation, After tax MARR with inflation = 9.2%, Tax Rate = 40%.

<table>
<thead>
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<th>Time</th>
<th>BTCF actual $</th>
<th>Deprec. actual $</th>
<th>Tax. Inc. actual $</th>
<th>Tax actual $</th>
<th>ATCF actual $</th>
<th>PW(i_r)</th>
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</table>

\[ PW = -156 \]

Summary
- When all cash flow components inflate at the general inflation rate, use real dollars and \(i_r\).
- When some cash flow components inflate at different rates, either use real dollars and \(i_r\) or actual dollars and \(i_c\).
- When depreciation is involved, always consider the effects of inflation in an after tax analysis.
Inflation Summary

\[ i_c \text{ is the MARR with inflation.} \]
\[ i_r \text{ is the MARR without inflation. } i_c > i_r. \]
\[ f \text{ is the general inflation rate} \]

The MARR considering inflation should be

\[ i_c = i_r + f + i_r f \]

If \( f \) and \( i_c \) are given:

\[ i_r = \frac{i_c - f}{1 + f} \]

Amounts expressed using the values of dollars of today are called *real* dollars (or year-0 dollars).

Amounts expressed using the values of the dollars \( n \) years from today are called *actual* dollars (year-\( n \) dollars).

Say some cash flow at time \( n \) is given in real (year-0) dollars \( C \).

The general inflation rate is \( f \).

Expressed in actual (year-\( n \)) dollars that cash flow will be:

\[ C(1 + f)^n = C(F/P, f, n) \]

Say some cash flow at time \( n \) is given in actual (year-\( n \)) dollars \( D \).

The general inflation rate is \( f \).

Expressed in real (year-0) dollars that cash flow will be:

\[ D(1 + f)^{-n} = D(P/F, f, n) \]

For an economic analysis, if all receipts and expenses escalate at the same rate as the general inflation rate, forget about inflation. Do the analysis with real dollars and \( i_r \).

If some components of receipts and disbursements do not have the same escalation rate, either:
- Express all cash flows in real (year-0) dollars and use \( i_r \).
- Express all cash flows in actual (year-\( n \)) dollars and use \( i_c \).

Depreciation does not adjust with inflation. It is always expressed in actual dollars.

An after tax analysis always requires that inflation be considered. Either
- Express all cash flows in real (year-0) dollars and use \( i_r \), or
- Express all cash flows in actual (year-\( n \)) dollars and use \( i_c \).
Inflation Problems

1. Gary is considering buying a piece of land to set up a survival games course. Operating expenses are expected to be $2000/yr over the life of the project. Income from the project is expected to be $3000 in year one, and increase $1000/yr. thereafter. After five years he plans to stop running the course, and he will donate the land to the city (meaning no salvage value). All these costs and revenues are in real dollars (year 0 dollars), however, all actual dollar cash flows (year-n dollars) are expected to increase with an 8% per year inflation rate. This is the same rate as general inflation.

a. How much should he pay for the land in order to get a 10% rate of return? This minimum rate of return includes the effect of the 8% inflation rate. Neglect taxes in this analysis.

b. Include taxes in the analysis. Say the investment in the land is $14,030. Assume straight-line depreciation and a 40% tax rate. What after tax rate of return does Gary make on the project?

2. An investor is considering the purchase of a bond originally offered by the Westinghouse Company. The bond will mature in 8 years at which time Westinghouse will pay the investor the face value of $1000. Westinghouse also pays simple interest to the investor each year. The interest is equal to 6% of the face value of the bond. Assume the interest payments are end of the year payments with the first payment one year from now. The revenues obtained from the bond are fixed and not affected by inflation or deflation of the value of money.

The investor’s real MARR is 25%. This is her required return on investment if there were no inflation or deflation in the value of money.

a. Assuming no inflation or deflation in the value of money in the future, what should the investor pay for the bond?

b. If the investor expects an inflation rate of 16% per year for the next 8 years, how much should she be willing to pay for the bond?

c. If the investor instead expects a deflation rate of 18% per year for the next 8 years, how much should she be willing to pay for the bond?
3. An investment of $2000 results in the cash flow to the right. The amounts are expressed in real dollars.

![Cash flow diagram]

a. The general rate of inflation is 6% and future cash flows are expected to escalate at the same rate as general inflation. In the table below, show the amounts in actual dollars.

<table>
<thead>
<tr>
<th>Time</th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
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<td></td>
<td></td>
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</table>

b. Your minimum acceptable rate of return without considering inflation is 10%. Should you accept this investment opportunity?

c. Say you must pay taxes on the incomes shown in the figure. The investment for the project is to be depreciated with the sum of year's digits method. The future incomes are expected to increase with an inflation rate of 6%. The tax rate is 40%, the tax life is 5 years, and the tax and actual salvage are zero.

Show in the table below the after tax cash flows you will use for an analysis of this project. Also show the interest rate you should use that is appropriate for these cash flows. The after tax MARR without considering inflation is 10%.

<table>
<thead>
<tr>
<th>Time</th>
<th>0</th>
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<th>2</th>
<th>3</th>
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</tr>
</tbody>
</table>

Interest rate used for the analysis: _____
4. An investment in a labor savings device of $1,000 results in a savings of $200 per year for five years. The device can be sold for $1,000 at the end of the five-year period. These savings and the salvage are measured in real dollars, but they are expected to grow at an inflationary rate of 6% per year. What is the rate of return for this investment, including the effects of inflation?

5. Your brother needs a $5,000 loan to go to college. Because of his poverty, he will pay nothing for the next four years. Five years from today he will begin paying you $2500 a year for the next 4 years. The first payment occurs 5 years from today and the total of the four payments will be $10,000.

a. If your minimum rate of return is 8%, is this an acceptable investment?

b. For the same payment schedule but with a 5% rate of inflation, is this an acceptable investment? Note that your brother pays you $2500 a year regardless of the inflation rate.
6. In each case I want you to write the formula that you would use to evaluate the investment described by the cash flow on the left. In all cases the inflation rate is 5%. Use as few time-value-of-money factors in the formula as possible. Use numerical interest rates in the formula.

a. Life = 4 years

Write the formula for the NAW expressed in real dollars
The cash flow is in real dollars.
The MARR including the effects of inflation is 20%.

b. Life = 8 years

Write the formula for the NAW expressed in real dollars
The cash flow is in actual dollars.
The MARR including the effects of inflation is 20%.

c. Life = 4 years

Write the formula for the after tax NPW
The cash flow is in actual dollars.
Use Straight-line depreciation.
The tax rate is 40%. The tax and actual salvage are zero.
The after tax MARR not including the effects of inflation is 10%.
7. A process requires an initial investment of $100,000, has a ten-year economic life, has a salvage value of $30,000 at the end of its economic life, and has operating costs of $40,000 per year. Revenue attributable to the process is $80,000.

We expect a general inflation rate of 4% during the next 10 years. The operating cost and salvage value are fully responsive to inflation (increase at the same rate as inflation), but the revenue is not responsive to inflation (does not change with inflation).

Find the before-tax equivalent present worth of the process. The before-tax minimum acceptable rate of return is 20% with no adjustment for inflation. Is this an acceptable investment?

8. A young man has a new baby girl. The man is currently attending Texas A&M University, but his life-long dream was to attend U.T. He vows to send his daughter to U.T., and plans to establish a savings program to accomplish this objective. The current annual cost of attending U.T. is $10,000. The prudent young father knows inflation will affect that amount and estimates a conservative 6% per year general inflation. He assumes college costs will inflate at the rate of general inflation.

Assume the daughter will begin college 18 years from now and will attend for 4 years. Tuition must be paid at the beginning of each year. Help the small child escape the terrible fate of her father by providing the following information.

a. What will be the tuition for each of the four years of college in actual (year-n) dollars?

b. How much money must the father have saved in actual (year-n) dollars by the girl’s 18th birthday if the savings are to pay the college costs of the four years? No deposits will be made after the 18th birthday, but money will be left in savings until required. Assume the savings account earns 10% interest.

c. If the father deposits a fixed amount in actual (year-n) dollars each year (starting one year from now and ending at year 18) how much money must he deposit each year to reach the goal determined in part b?
9. An Engineer is considering a project requiring an investment of $65,000. Initial estimates suggest end of the year revenues and costs associated with the project as given in the table below. The project lasts three years and there is no salvage value. These estimates are based on today’s prices. When considering inflation, however, we expect the revenues to grow at the same rate as general inflation, 5% per year, while because the process uses a scarce resource, the operating costs will grow at a 20% rate per year. The rate of general inflation is estimated at 5% per year for the next three years.

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>70,000</td>
<td>50,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Operating Cost</td>
<td>20,000</td>
<td>20,000</td>
<td>20,000</td>
</tr>
</tbody>
</table>

The company’s MARR without adjusting for inflation is 10%. Is this an acceptable investment?

10. A company has two mutually exclusive investment alternatives to perform some function. The data concerning the alternatives is estimated in today’s prices. The general inflation rate is 8%. You are to do a before tax rate of return analysis to select the best one. The company requires a before tax rate of return of 25% on its investments. This rate includes an allowance for inflation.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Investment</td>
<td>$10,000</td>
<td>13,000</td>
</tr>
<tr>
<td>Annual Profit</td>
<td>8,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Salvage</td>
<td>3,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Life</td>
<td>5 years</td>
<td>5 years</td>
</tr>
</tbody>
</table>

a. The annual profits and salvage values are expected to rise at the same rate as general inflation.

b. The annual profits are expected to rise at 1/2 the rate of general inflation. The salvage values are expected to rise at double the rate of general inflation.