Lesson 18-2 – Analysis of Inflation

Engineering Economic Analysis for Inflation

- Engineers must be aware of potential changes in price levels over the life of a project.
- If inflation is anticipated, the MARR needs to be increased.
- If we expect inflation, the actual dollars returned by a project does not reflect the actual purchasing power of the future cash flow.
- The purchasing power depends on the real dollar value of the earnings

Definitions

- Inflation rate (f)
  - Annual rate of increase in the number of dollars needed to pay for the same services
- Real interest rate (i_R or i')
  - Measures the 'real' growth of money, excluding the effect of inflation (inflation-free rate)
- Market (or nominal) interest rate (i)
  - The rate that one obtains in the general marketplace (combined rate—because it includes both inflation and real interest)

Definitions Continued…

- Mathematical relationship for market rate (i):
  - (1+i) = (1+i')(1+f) Use this for all calculations.
- Actual (or nominal) dollars (A$ or A_N):
  - What we normally think of as actually existing physically (money at face-value)
  - Sometimes called inflated dollars because they carry the effect of inflation (decreased purchase power)
- Real (or constant) dollars (R$ or R_N):
  - Dollars with constant purchasing power, expressed using a base year. These are inflation-free (fictitious) dollars.

Actual vs Real Dollars

- Suppose that the food plan at UBC residence costs $1500 now and is expected to cost $1530 one year from now, based on an expectation that prices will increase at the general inflation rate of 2% per year.
- The real (constant) dollar cost of the plan next year is $1500.
- The actual (nominal) dollar cost of the next year is $1530. (Actual: the price you pay)

Converting Between Real & Actual Dollars

- If we have an estimate of the inflation rate per period over N periods, we can convert actual dollars in period N to real dollars.

A_N = nominal dollars in year N

(Note: A_N is <u>not</u> an annuity amount)

$R_{0,N}$ = real dollars equivalent to A_N relative to year 0

Year 0 = the base year

f = the inflation rate per year

Assumed to be constant from year 0 to year N

Converting Between Real & Actual Dollars

- The conversion from actual dollars in year *N* to real dollars in year *N* is*:*

$$R_{0,N} = \frac{A_N}{(1+f)^N}$$

- The base year (0) is usually omitted from the notation:

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

- This can conveniently be written and computed with the Present Worth Factor:

$$R_N = A_N(P/F, f, N)$$

Conversion Example

The residence food plan in two years from now is expected to be $2050. Inflation is expected to be 1.5% per year for the next 2 years. What is the real dollar cost of a food plan at that time (two years from now)?

Solution:

N = 2, f = 1.5%, A_N= 2050

R_N = A_N(P/F, f, N)

= 2050(P/F, 1.5%, 2)

= 2050(0.97066)

= 1989.86

The real dollar cost of the food plan two years from now is $1989.86.

Actual and Real Dollars Analysis

- Analysis must be consistent: either real $ with real interest rates, or nominal (or actual) $ with nominal interest rates, but never mixed.
- Results of either form of NPW analysis should be the same if there are no taxes or after-tax.
- However, equal before-tax rates of return do not produce equal after-tax rates of return. Inflation reduces the after-tax rate of return even if the benefits increase at the same rate as the inflation.

Example Without & With Taxes

Before-tax analysis	*$ values at Year 0 (000s)*	*Year*	*Real*	*Nominal*
Investment:	$5,500	0	-$5,500	-$5,500.000
Salvage value:	$220	1	$1,000	$1,022.100
Annual operating profit:	$1,000	2	$1,000	$1,044.688
Lifetime (years):	10	3	$1,000	$1,067.776
Inflation rate:	2.21%	4	$1,000	$1,091.374
Nominal cost of capital:	12%	5	$1,000	$1,115.493
Nominal NPV ($000)=	**$845.61227**	6	$1,000	$1,140.146
Nominal IRR=	**15.4563%**	7	$1,000	$1,165.343
Real cost of capital=	9.578%	8	$1,000	$1,191.097
Real NPV ($000)=	**$845.61227**	9	$1,000	$1,217.420
Real IRR=	**12.9599%**	10	$1,000	$1,244.325
After-tax analysis		0	-$5,500	-$5,500.000
Tax rate:	26.5%	1	$735	$751.244
Straight-line annual amount=	$522.62	2	$735	$767.846
Nominal cost of capital (after-tax):	8.683%	3	$735	$784.815
PV(nominal deprec tax shields)=	$901.33894	4	$735	$802.160
Nominal NPV ($000)=	**$845.61227**	5	$735	$819.888
Nominal IRR (after-tax)=	**11.8726%**	6	$735	$838.007
Real cost of capital (after-tax):	6.122%	7	$735	$856.527
PV(real deprec tax shields)=	$930.15939	8	$735	$875.456
Real NPV ($000)=	**$845.61227**	9	$735	$894.804
Real IRR (after-tax)=	**9.7381%**	10	$735	$914.579

Spreadsheet by Ron McKinnon

Engineering Economic Analysis for Inflation

- Two ways to approach economic analysis:
  1. Ignoring inflation (constant or real dollars using i')
  2. Incorporating inflation (actual or nominal dollars using the market or nominal rate i)
- In most analyses inflation is addressed by using real-dollar terms and using a "real" interest rate because it is generally assumed that costs and benefits will increase at the same rate of inflation as the economy as a whole.
- The purchasing power depends on the real dollar value of the earnings

Inflation Cash Flow Analysis

- Real/Constant Dollar analysis (Note: In the absence of inflation, all economic analyses up to this point was in fact, real/constant dollar analysis.)

- Estimate all future cash flows in constant dollars.
- Use i' as an interest rate to find equivalent worth.

- Actual/Nominal Dollar Analysis

- Estimate all future cash flows in actual dollars.
- Use i as an interest rate to find equivalent worth.

Actual/Nominal Analysis

To calculate the present worth of actual dollars, choose one of the two processes below:

1. Deflation method:

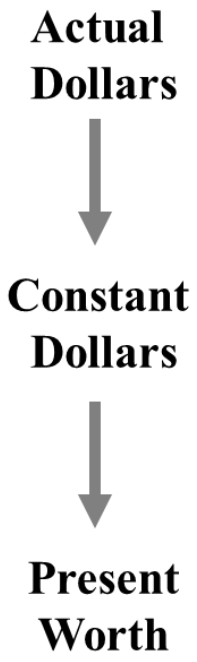
   Bring all cash flows to have common purchasing power - Convert actual dollars by deflating with the general inflation rate of f

   Consider the earning power - Calculate the PW of constant dollars by discounting at i’

2. Adjusted-discount method:

   Compute the market interest rate.

   Use the market interest rate and the actual dollar amount to find the present value.



Deflation Method: Convert Actual Dollars to Constant Dollars

n	Cash Flows in Actual/Nominal Dollars	Multiplied by Deflation Factor	Cash Flows in Real/Constant Dollars
0	-$75,000	1	-$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

Deflation Method: Convert Constant Dollars to Equivalent Present Worth

n	Cash Flows in Real/Constant Dollars	Multiplied by Discounting Factor	Equivalent Present Worth
0	-$75,000	1	-$75,000
1	30,476	$(1+0.1)^{-1}$	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
			$45,268

Adjusted-Discount Method: Find Market Interest Rate

n	Cash Flows in Actual/Nominal Dollars	Multiplied By i where: i = i'+f+(i'f)	Equivalent Present Worth
0	-$75,000	1	-$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	$(1+0.155)^{-4}$	16,296
5	58,000	$(1+0.155)^{-5}$	28,217
			$45,268

Effects of Inflation on Cash Flow

Item	Effects of Inflation
Depreciation expense*	Depreciation expense is charged to taxable income in dollars of declining values; taxable income is overstated, resulting in higher taxes

Note: Depreciation expenses are based on historical costs and always expressed in actual dollars

Effects of Inflation on Cash Flow

Item	Effects of Inflation
Salvage value	Inflated salvage value combined with book values based on historical costs results in higher taxable gains.

Item	Effects of Inflation
Loan repayments	Borrowers repay historical loan amounts with dollars of decreased purchasing power, reducing the debt-financing cost.

Effects of Inflation on Cash Flow

Item	Effects of Inflation
Working capital requirement	Known as working capital drain, the cost of working capital increases in an inflationary environment.

Item	Effects of Inflation
Rate of Return and NPW	Unless revenues are sufficiently increased to keep pace with inflation, tax effects and/or a working capital drain result in lower rate of return or lower NPW.

Inflation Issues

- It is not uncommon that different commodities will inflate at different rates.
  - Historical price indexes can be used as an indicator in future estimates.
  - By using individual rates, the actual dollar amounts can be placed in the cash flow.
- Inflation rates can change over time.
  - Handle by applying the inflation rates in the years they occur and convert to actual dollars (deflation method)
  - The real discount rate can then be used.