CENG 6108 Construction Economics

Taxes and Inflation

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TO DO

1. Taxes
2. Inflation

Taxes

- So far we have ignored the effect of taxation and inflation/deflation on the financial analysis.
- As government will levy taxes on the profits of a project, the cash flows need to account for tax on project profits.
- Example:
- The yearly net before tax income (IBT) of a project is shown in the second column of the following table. Tax is assumed to be 30% of the IBT. Calculate the before and after-tax Net Present Worth of the project, MARR =10%.

Year	IBT	Tax = 30%	IAT
1	+100,000	+30,000	+70,000
2	-30,000	-10,000	-30,000(-10,000)= -20,000
3	+200,000	+60,000	+140,000

Taxes

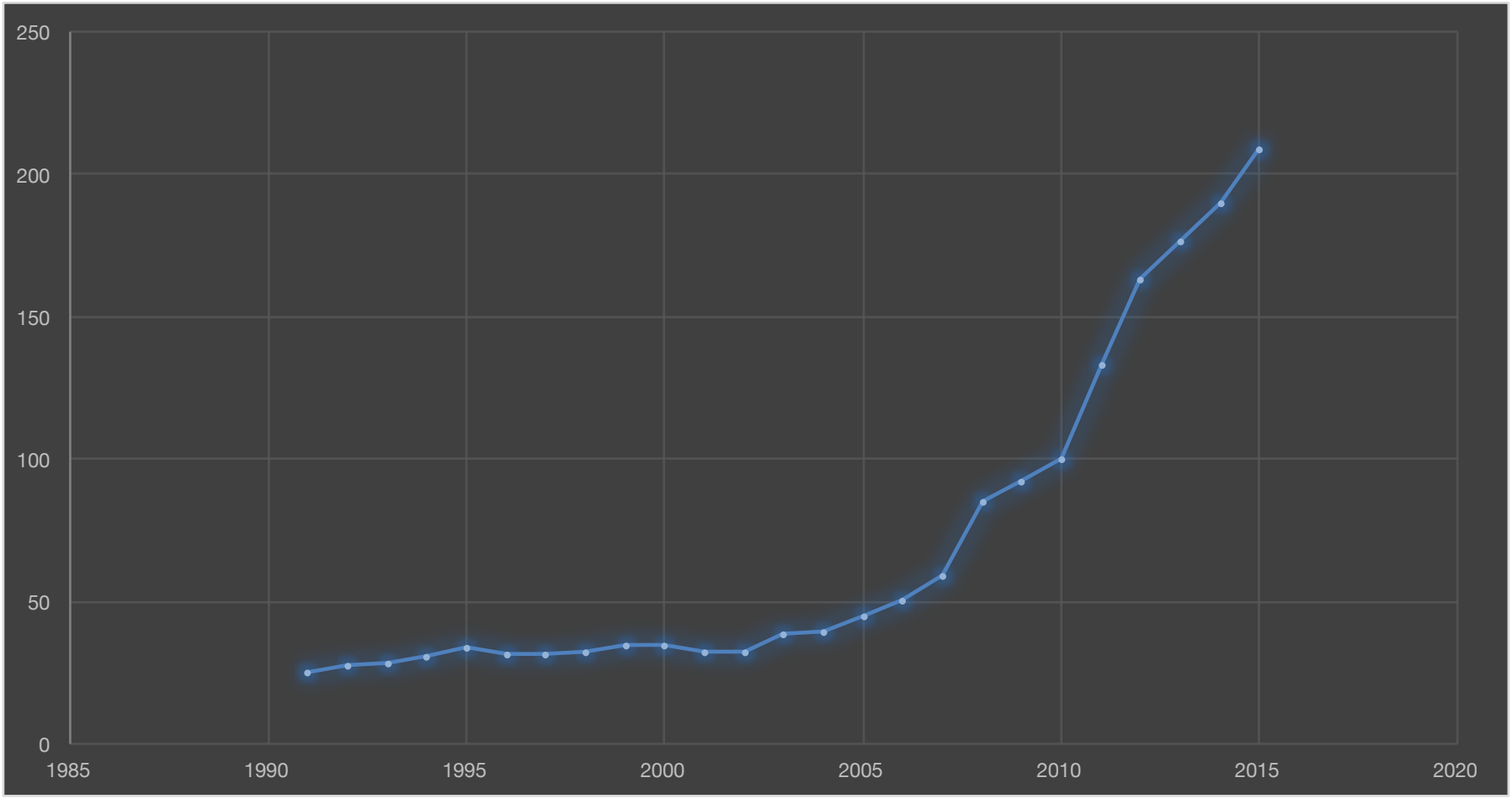
- Before and After Tax MARR:
- If we do not account for the impact of taxes in the project cash flows, then we need to adjust MARR:
  - $MARR_{after-tax} \cong MARR_{before-tax} * (1 - t)$
  - where t is the corporate tax rate
- Generally, if a MARR is given without specifying the effect of tax, it can be assumed to be a before-tax MARR.
- Approximate after-tax rate of return calculations:
- An approximate IRR analysis for tax will be:
  - $IRR_{after-tax} \cong IRR_{before-tax} * (1 - t)$
- As IRR represents the percentage of the total investment that is net income, and tax is applied on net income, it correspondingly reduces the IRR by the same proportion.
  - If after-tax IRR is close to after-tax MARR, precise calculation is needed.

Inflation

- Inflation:
  - Inflation reflects the purchasing power of money.
  - If one birr buys less of the special commodity, e.g., sugar, as time passes, say today (x) and a year from now (y) $\rightarrow y > x$. Thus,
  - $Inflation\ Rate = f = \frac{y-x}{x}$
- If $y < x$, then the change is called a deflation.
- The rate of inflation or deflation depends on the particular item under consideration.
- Consumer Price Index ($CPI = V_{n+1}/V_n$)
  - Assume an average citizen, determine the commodity this citizen consumes (meat, cooking oil, vegetable, electricity, etc.)
  - Multiply these by their respective unit price and add it to get the dollar value of the average citizen (V_n), and repeat this for every year, to get the dollar value of the next year (V_{n+1})

Inflation

Consumer Price Index of Ethiopia:



Source: https://ycharts.com/indicators/ethiopia_consumer_price_index_wdi

Inflation

- For a constant rate of inflation, f, the buying power referred to the base year will be:

  $R_N = A_n\,(1+f)^{-n}$, where

  A_n = Actual dollar value after n years

  R_N = Real or Equivalent dollars at the base year (usually Year 0)

  f = Rate of inflation

- R_N represents the constant or real dollar value:
- $R_N = A_n(\mathrm{P/F, f, n})$
- In effect inflation rate and interest rate work the same way:
  - Inflation rate influences the buying power of money
  - Interest rate influences the earning power of money

Inflation

- Example:
- The salary of an engineer is increased every year according to the following table. The inflation rate during these years has been a constant 3%. Calculate the constant dollar value of these salaries.

Year	Yearly Salary	Constant $ Value
1991 $(n = 0)$	30,000	$R_{o,N} = A_{91,91} = 30{,}000$
1992 $(n = 1)$	33,000	$R_{91,92} = A_{92}\,(1 + 0.03)^{-1} = 32{,}040$
1993 $(n = 2)$	36,000	$R_{91,93} = A_{93}(1 + 0.03)^{-2} = 33{,}934$
1994 $(n = 3)$	40,000	$R_{91,94} = A_{94}(1 + 0.03)^{-3} = 36{,}604$

- If the rate of inflation is not constant over several years, then the constant dollar value should be calculated year by year using annual values.

Effect of Inflation on the MARR:

- Investors expect that they should earn enough on their investment to compensate for inflation: MARR has to be adjusted to reflect the expected inflation rate during the investment period.
- If the rate of inflation, f,is constant or can be assumed to be constant during the life of the project, the effect of inflation is compensated using:

$\$M(1+i') = \$M\left(\frac{1+i}{1+f}\right)$	$i = (1+i')(1+f) - 1$
$i' = \frac{1+i}{1+f} - 1$	$i = i' + f + i' * f$

i = Actual interest rate, stated interest rate based on actual dollars

i' = Real interest rate (interest rate the would yield the same amount of real dollars in the absence of inflation as the actual interest rate yields in the presence of inflation).

Effect of Inflation on the MARR:

- $i = i' + f + i' * f$
  - Implies: Although the bank states that it is giving an actual interest of i per a given period, you are in effect receiving an interest rate of i' that is less than i.
- Accordingly, the present value of each year's payment or cash flow is reduced due to inflation and also due the time value of money, represented by the interest rate.
- The combination of these two factors reduces the present value based on the inflation adjusted discount rate:

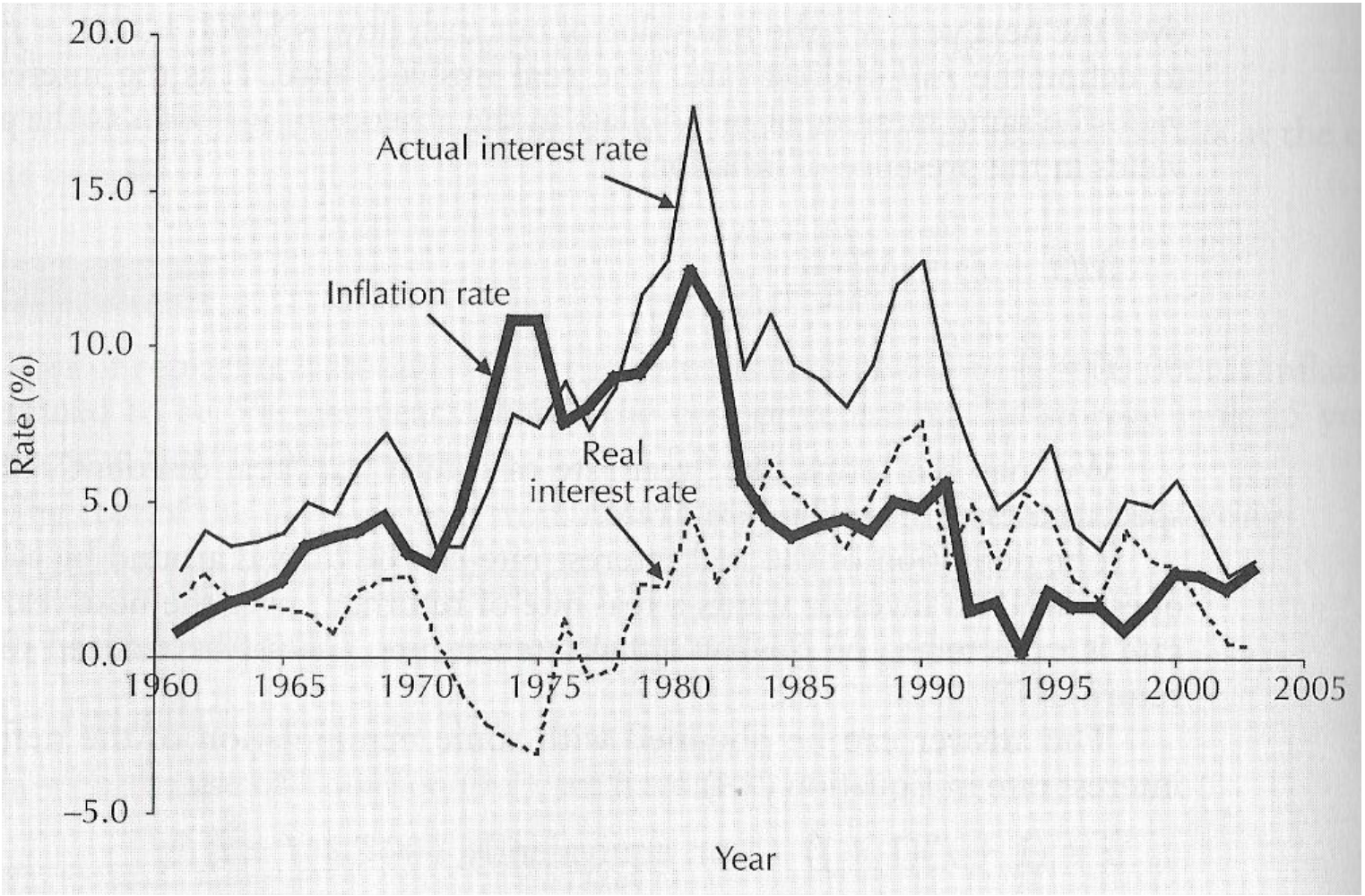
$$MARR_A = MARR_R + f + MARR_R * f$$

$$MARR_R = \frac{1 + MARR_A}{1 + f} - 1$$

- where,
- $MARR_A$ = Actual MARR and $MARR_R$ = Real MARR

Effect of Inflation on the MARR:

Canadian Inflation Rate and Actual and Real Interest Rates (1961-2003):



Effect of Inflation on the MARR:

- Example:
- A trust is paying 12% on one-year investments. The inflation rate is expected to be 5% over the next year. What is the real rate of interest? For a $5 000, what will be the real dollar value of the amount received at the end of the year?
- Example:
- A developer is given the following two options for the purchase of a property:
  - A. Pay $120,000
  - B. Pay $32,000 at the end of each year, starting one year after purchase and continuing for the next six years.
- If the inflation rate is assumed to be 4.4% per year and the real interest rate is 15%, which option should he take? Ignore tax.

Effect of Inflation on the IRR

- The effect of inflation on the IRR is that the actual IRR will be the real IRR plus an upward adjustment that reflects the effect of inflation:

$$IRR_A = IRR_R + f + IRR_R * f$$

$$IRR_R = \frac{1 + IRR_A}{1 + f} - 1$$

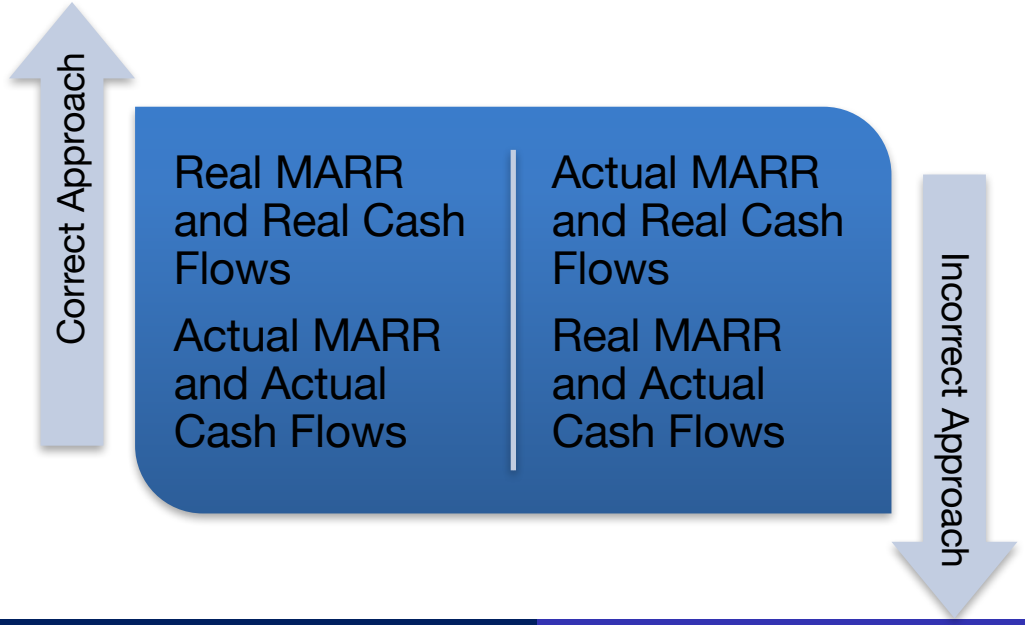
- where,
- IRR_A = Actual IRR, rate of return on the project on the basis of actual dollar cash flows.
- IRR_R = Real IRR, rate of return on the project on the basis of actual real dollar cash flows.

Effect of Inflation on the IRR

- Example:
- Consider a two-year project that has a $10 000 first cost and that is expected to bring about a saving of $15 000 at the end of two years. If inflation is expected to be 5% per year and the real MARR is 13%, should the project be undertaken, based on IRR results?

Project Evaluation Methods with Inflation

- Usually projected cash flows are based on current prices (real dollars) and do not incorporate the effect of inflation.
- However, MARR are based on observed (actual) MARR.
- If we have an estimate of inflation, the correct project evaluation will:
  - Use actual values for cash flows and actual interest rate, or
  - Real values for cash flows and real interest rates



Effect of Inflation on the IRR

- Example:
- An investor is considering purchasing a bond with a face value of $5 000 and a coupon rate of 8%, due in 10 years. Inflation is expected to be 5% over the next 10 years. The investor's real MARR is 10%, compounded semi-annually. What is the present worth of this bond to this investor.

Deflation

- In some economic circumstances, the price of certain goods falls as the years go by (e.g. New products such as Personal Computers)
- The effect of this reduction in price is called deflation.
- Deflation can be considered as a negative inflation, and the same equations can be used to determine the deflation adjusted interest rate:

$$i' = \frac{1+i}{1+df} - 1$$

$$i = i' + df + i * df$$

Construction Cost Indices

- Construction Cost Index is an indicator of the average cost movement over time of a fixed basket of representative goods and services related to Construction Industry.
- It is the monthly measure of Construction Cost movement for the Construction Industry released by many country specific organizations:

United States Census Bureau

Statistics Canada

BCIS ONLINE
Price Adjustment Formulae Indices

ENR
Engineering News-Record

Construction Cost Indices

- Primary objective of CCI is to bring out an estimate of inflation / deflation values for the Construction Industry.
- It can help in evaluating the cost variation for project delays, escalation claims, liquidated damages, etc.
- Ultimate use of the index compilation will depend upon the quality of data management and data dissemination.

Construction Cost Indices

- CCI Formation Process:
  - Identification of the base year;
  - Identification of the item basket;
  - Allocation of weights at item, groups/ sub- groups level;
  - Statistical analysis for the number evaluation;
  - Publishing the Indices;
  - Data management and warehousing.
- Criteria for Base Year
  - A normal year i.e., a year in which there are no abnormalities in the level of production, trade and in the price level and price variations;
  - A year for which reliable production, price and other required data are available; and
  - A year as recent possible and comparable with other data series at national and state level.

Construction Cost Indices

- Item Basket:
  - Constitution of the basket of goods and services is done so that their cost variations best represents the inflationary/deflationary changes of a specific sector of construction industry (e.g. Building Cost Index) or cumulatively for the entire Industry
- Basket Composition:
  - Items in the index basket are the best representatives of the sector;
  - All the important items transacted in the economy during the base year are included;
  - The importance of an item depends on its traded value during the base year;
  - At CCI level, bulk transactions of goods and services are captured;
  - Current prices are collected as per the item basket from the designated sources:
    - Vendors will be registered and rates/costs are incorporated from awarded rates/quotations (if rates are not available)

Construction Cost Indices

- Derivation of Weightages:
  - Weights used in the CCI are value weights not quantity weights as its difficult to assign quantity weights.
  - Distribution of the appropriate weight to each of the item is the most important exercise for reliable index.
  - Weightages are allotted as per the sound engineering practices/standards.
- CCI Calculation:
- Step 1: Calculation of Price relative as the ratio of the current price to the base price multiplied by 100:
  - $\frac{P_1}{P_0} * 100$
- Step 2: Apply the Weightage for each representative Item
- Step 3: Calculate the indices for the sub groups/groups/ major groups using Laspeyres formula.

Construction Cost Indices

- Laspeyres Index Formula:
- Suppose there are n goods in which we are interested.
  - The price of the n goods at time t_0 and t_1 are denoted by $p_{01}, p_{02}, \ldots, p_{0n}$ and $p_{11}, p_{12}, \ldots, p_{1n}$
  - The quantities of the n goods purchased at time t_0 and t_1 are denoted by $q_{01}, q_{02}, \ldots, q_{0n}$ and $q_{11}, q_{12}, \ldots, q_{1n}$
  - The share, s_{0j}, of good j is the total expenditure for the period,t_0, is defined as:
  - $s_{0j} = \frac{p_{0j} * q_{0j}}{\sum_{j=1}^{n} p_{0j} * q_{0j}}$, where $\sum_{j=1}^{n} s_{0j} = 1$
- Laspeyres price index, π_{01}, is defined as a weighted average of relative prices:
  - $\pi_{01} = \left(\frac{p_{11}}{p_{01}} s_{01} + \frac{p_{12}}{p_{02}} s_{02} + \cdots + \frac{p_{1n}}{p_{0n}} s_{0n} \right) * 100$

Construction Cost Indices

- Publish CCI monthly to the press and website, etc.

India

CCI – January 2017
Base - 100.00 October 2007

S. No.	Market	Building CCI	Road CCI	Bridge CCI	Dam CCI	Power CCI	Railway CCI	Mineral Plant CCI	Medium Industry CCI	Transmission CCI	Urban Infra CCI	Maintenance CCI
1	Agartala	144.36	145.07	141.26	144.25	143.34	145.2	143.19	139.44	142.07	138.32	137.16
2	Agra	146.18	147.5	142.71	146.05	144.72	146.77	144.34	140.86	143.75	139.93	138.09
3	Ahmedabad	144.02	146.51	142.98	145.87	143.45	144.56	143.88	139.36	140.79	139.39	140.77
4	Aizawl	144.64	146.62	140.83	144.5	142.8	144.95	142.12	139.07	142.13	138.29	135.75
5	Ajmer	146.76	149.32	143.95	147.52	145.95	148.11	145.42	142.11	145.12	141.25	139.04
6	Allahabad	146.19	146.81	143.09	146.08	145.17	147.07	145.07	141.21	143.88	140.1	139.03

US

Constant Quality (Laspeyres) Price Index of New Single-Family Houses Under Construction
[2005 = 100.0. Index based on kinds of houses sold in 2005]

Year	Annual		Monthly										
	Annual index	Percent change	January	February	March	April	May	June	July	August	September	October	November	December
1964	12.4	(X)	12.2	12.1	12.0	12.2	12.3	12.4	12.4	12.3	12.3	12.6	12.7	12.8
1965	12.8	3.2%	12.7	12.6	12.6	12.6	12.6	12.8	12.6	12.6	12.6	13.0	13.2	13.3
1966	13.4	4.7%	13.0	12.8	12.8	13.3	13.6	13.6	13.4	13.4	13.3	13.6	13.7	13.9
1967	13.8	3.0%	13.7	13.6	13.6	13.6	13.7	13.7	13.7	13.8	13.9	13.9	14.1	14.2
1968	14.6	5.8%	14.3	14.3	14.3	14.4	14.5	14.5	14.3	14.4	14.5	14.8	15.1	15.4
1969	15.5	6.2%	15.2	15.2	15.4	15.4	15.6	15.4	15.5	15.4	15.4	15.6	15.7	15.8

Construction Cost Indices

- Example:
- We use four main supplies for producing concrete: Cement, Coarse Aggregate, Fine Aggregate, and Water and Admixture. Assume the classes had the prices and quantities in 1996 and 2003 as shown in the Table below. Find the Laspeyres price index for 2003 with 1996 as a base.

Category	Price ($)	
	1996	2003
Coarse Aggregate	2.421	2.818
Water and Admixture	2.849	3.715
Fine Aggregate	4.926	6.404
Cement	4.608	6.263

Quantity in 1996 (Units)	
Coarse Aggregate	21.304
Water and Admixture	11.315
Fine Aggregate	19.159
Cement	31.422

Construction Cost Indices

- Solution:
- First calculate the relative prices:

Category	Price ($)		Relative Price
	1996	2003	
Coarse Aggregate	2.421	2.818	1.164
Water and Admixture	2.849	3.715	1.304
Fine Aggregate	4.926	6.404	1.300
Cement	4.608	6.263	1.359

Construction Cost Indices

- Solution:
- Next determine expenditure shares in 1996:

	Price t_0	Quantity t_0	Expenditure	Share
Coarse Aggregate	2.421	21.304	51.583	0.1597
Water and Admixture	2.849	11.315	32.235	0.0998
Fine Aggregate	4.926	19.159	94.381	0.2922
Cement	4.608	31.422	144.801	0.4483
Total			323.000	

Construction Cost Indices

- Then, Multiply the relative prices by the shares and sum.
- E.g. For Coarse Aggregate: $1.164(0.1597) = 0.186$

	Relative Price	Share	Index
Coarse Aggregate	1.164	0.1597	0.186
Water and Admixture	1.304	0.0998	0.130
Fine Aggregate	1.300	0.2922	0.380
Cement	1.359	0.4483	0.609
Total			1.305

- Laspeyres price index is 130.5

References:

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