v1.1

Inflation and Index Numbers

How to adjust for the general rise in prices over time

"In 1978, a commercial flight between New York and Paris cost around $900 and took seven hours. If the principles of Moore's Law had been applied to the airline industry the way they have to the semiconductor industry since 1978, that flight would now cost about a penny and take less than one second."

"Moore's Law in perspective," Intel Corporation, 2005, http://www.intel.com.

v1.1

Inflation Overview

- Key Ideas
  - Inflation = rising prices over time
  - Basket of goods
  - Base-year estimating
- Practical Applications
  - Budget Estimates
  - Custom indices
  - Forward Price Rate Agreements (FPRAs)
  - Price deflation and technology inflation
- Analytical Constructs
  - Exponential functions
    - Growth and decay
    - Compounding
    - Inverse = logarithms
  - Percent rates ≈ factors
  - Geometric and harmonic means
  - Weighted average
- Related Topics
  - Time phasing
  - Budgeting
  - Discounting and Economic Analysis (EA)

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Inflation Outline

v1.1

- Core Knowledge
  - Inflation Concepts
  - Inflation and Cost Estimating
  - Index Numbers
    - Raw Indices
    - Composite Indices
    - Weighted Indices
  - Inflation Tables and Escalation Procedures
- Summary
- Resources
- Related and Advanced Topics

Inflation: Gotta Get It Right!

v1.1

- Inflation can be taught in many different ways
  - Different agencies and organizations use different terminology
  - Index tables can look very different
- The key concepts of inflation remain the same
- Applying inflation incorrectly or ignoring it can be embarrassing and even fatal to credibility

VDOT understated project cost estimates by $236.5 million because it did not include estimates for ***known and planned costs***, such as . . . **$44 million for inflation**

"Audit of the Springfield Interchange Project" (IN-2003-003), Federal Highway Administration, November 22, 2002

Tip: While inflation can be difficult, resources are available

What Is Inflation?

v1.1

- Inflation is defined as an increase in the volume of money and credit relative to available goods and services resulting in a continuing rise in the general price level
  - Inflation is an external economic effect
    - Not all prices rise at the same rate – in fact, some could fall or stay even
    - The inflation rate is used to measure this rise (or fall) of the price level

Warning: *Inflation* and *escalation* are often used interchangeably

- Escalation is adjusting a dollar amount to account for the effects of inflation

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- De-escalation is removing inflation effects from a dollar amount

Prices go up – Money loses value

Inflation and Cost Estimating

v1.1

- When using historical costs to estimate current or future purchases, costs must be escalated to adjust for change in purchasing power (inflation)
- When developing CERs, historical costs should be represented in one **Constant Year** in order to normalize for inflation

2

3

  - The **Base Year** of the CER

When doing a cost estimate, *like* costs must be used

Base-Year Estimating Paradigm

v1.1

- Paradigm for estimates that use historical data and span multiple years
- Base-Year Estimating procedure:
  - Adjust all historical data into one Base Year
  - Estimate all costs in this Base Year
  - Time-phase estimate across span of estimated schedule using an expenditure or obligation profile
  - Escalate time-phased estimate to **Current Year** or **Then Year** $ for each individual year
    - Using Raw or Weighted Indices, respectively

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Inflation Impacts on Estimates

v1.1

- Out-year inflation rates are usually estimated assuming constant values for future years' inflation
  - Often close to the current year's rate
  - If inflation rates turn out to be *less* (decreasing inflation rates), assuming constant inflation causes estimate to be *too high*
  - If inflation rates turn out to be *greater* (increasing inflation rates), assuming constant inflation causes estimate to be *too low*
- Future inflation rates are themselves estimates
  - Though often taken as a given from sources such as DoD guidance or the Bureau of Labor Statistics (BLS), inflation rates should not be blindly accepted
  - As a cost estimator you should consider their accuracy and adjust accordingly
  - One way to improve inflation accuracy is to create custom indices
  - Another way is to capture the uncertainty of inflation through sensitivity analysis or carry as a risk factor

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"Inflation Risk - Assessing Inflation Risk in Multi-Year Proposals," C. J. Leonetti, E. R. Druker, P. J. Braxton, B. A. Welsh, R. L. Coleman, B. L. Cullis, SCEA/ISPA, 2008

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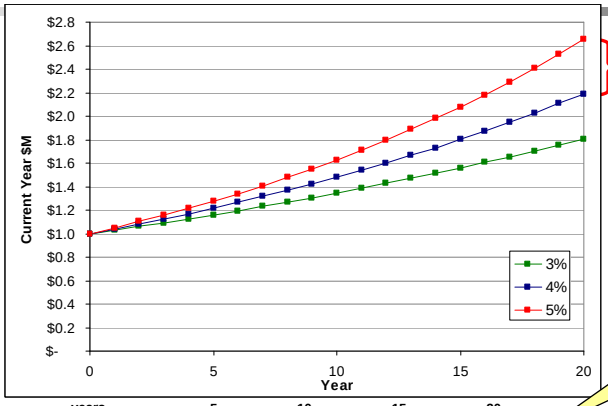
Inflation Impacts Illustrated



In 20 years, a one-percentage-point difference equates to $462K on a $1M Base Year estimate!

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Note that due to compounding, effects are not symmetric

	years	5	10	15	20
lower rate	annual difference	$ (57,379)	$ (136,328)	$ (242,976)	$ (385,012)
	cumulative difference	$ (164,566)	$ (678,556)	$ (1,667,650)	$ (3,292,716)
higher rate	annual difference	$ 59,629	$ 148,650	$ 277,985	$ 462,175
	cumulative difference	$ 168,937	$ 720,436	$ 1,832,961	$ 3,750,050

Tip: Inflation rates are like mortgage rates: Never round!

NEW!

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Constant Inflation

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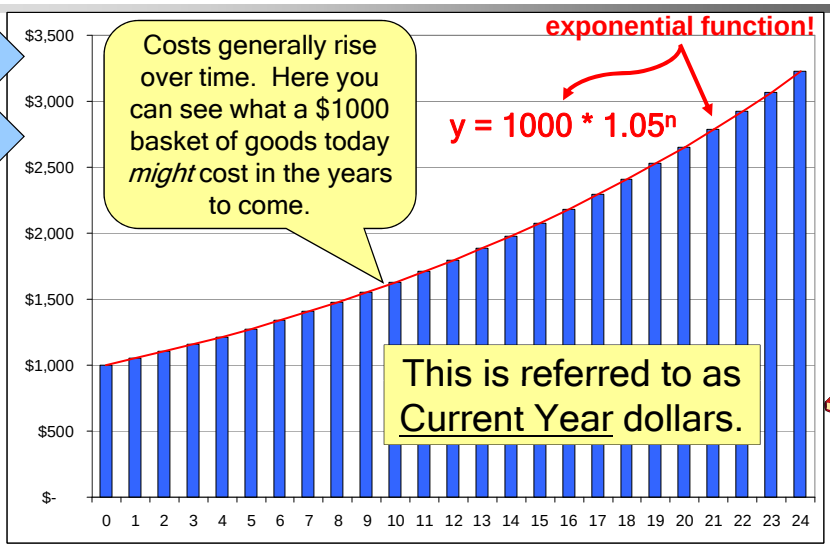
Costs generally rise over time. Here you can see what a $1000 basket of goods today *might* cost in the years to come.



This is referred to as Current Year dollars.

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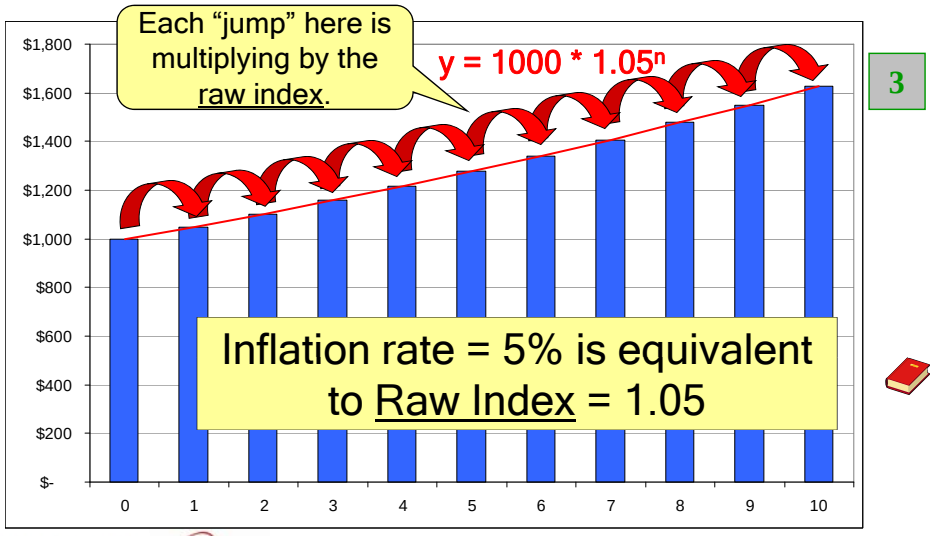
v1.1

Inflation Rate and Raw Index



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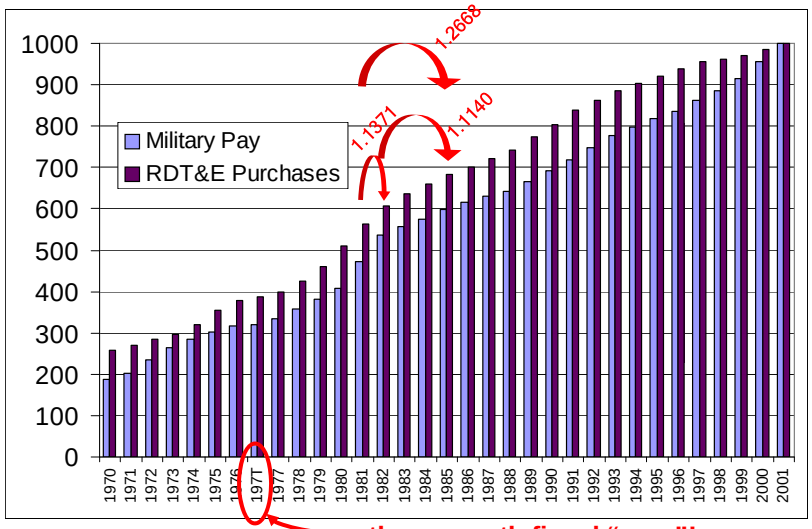
v1.1

Non-Constant Inflation



Consumer Price Index (CPI)

v1.1

- The CPI show the prevailing prices for a variety of commodities in a given time period
- The table below shows the prices for one pound of ground coffee

Original Data Value

Series Id: APU0000717311
Area: U.S. city average
Item: Coffee, 100%, ground roast, all sizes, per lb. (453.6 gm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	2.95	2.97	2.89	2.92	2.88	2.87	2.81	2.72	2.69	2.71	2.67	2.63
1992	2.67	2.69	2.63	2.61	2.66	2.63	2.65	2.61	2.54	2.49	2.39	2.36
1993	2.35	2.45	2.46	2.48	2.51	2.53	2.55	2.5	2.49	2.42	2.43	2.48
1994	2.53	2.53	2.52	2.52	2.54	2.6	3.34	4.48	4.46	4.45	4.48	4.38
1995	4.4	4.23	4.11	4.08	4.07	4.06	4.03	4.05	4	3.87	3.81	3.75
1996	3.58	3.59	3.55	3.53	3.44	3.44	3.38	3.39	3.33	3.34	3.28	3.31
1997	3.3	3.32	3.51	3.89	4.11	4.43	4.63	4.67	4.62	4.39	4.3	4.16
1998	4.03	3.97	4.03	3.96	3.88	3.79	3.77	3.7	3.62	3.5	3.48	3.45
1999	3.44	3.43	3.48	3.47	3.5	3.42	3.42	3.43	3.39	3.48	3.34	3.35
2000	3.54	3.68	3.63	3.58	3.53	3.43	3.45	3.44	3.34	3.32	3.24	3.21
2001	3.22	3.22	3.21	3.13	3.1	3.16	3.1	3.05	3.03			

CPI Example – Gasoline

v1.1

Original Data Value

Series Id: APU0000717311
Area: Washington-Baltimore, DC-MD-VA-WV
Item: Gasoline, unleaded regular, per gallon/3.785 liters

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1998	1.15	1.1	1.05	1.05	1.06	1.07	1.07	1.06	1.03	1.03	1.01	0.97
1999	0.95	0.93	0.95	1.06	1.09	1.1	1.14	1.18	1.23	1.26	1.27	1.28
2000	1.3	1.35	1.52	1.54	1.54	1.59	1.62	1.59	1.57	1.56	1.53	1.5
2001	1.48	1.48	1.47	1.57	1.71	1.69	1.58	1.46	1.44			

Inflation: (1.44-1.15) /1.15 = 25.2%

Index: 1.44/1.15 = 1.252

Annualized Inflation: 1.252 ^ [1/(44/12)] = 1.063 = 6.3%

Composite Inflation Indices

v1.1

- Composite inflation indices capture in a single number the effects of different amounts of inflation varying by appropriation or commodity
- Composite inflation indices are essentially a weighted average, computed as follows:
  - Determine the proportion (percent) of costs associated with each inflation index
  - Multiply each index by its corresponding percent
  - Sum these to get the composite index

Warning: *Composite* and *weighted* are often used interchangeably

Example: Composite Index

v1.1

- Suppose your cost will be escalated and you have the following information available

Steel
Auto.
Mach.

Total Cost is comprised of 3 Commodities, steel, automotive, and machinery.

Steel comprises 20% of the cost with an escalation rate of 5.6%.

Automotive comprises 35% of the cost with an escalation rate of 6.2%.

Machinery comprises 45% of the cost with an escalation rate of 5.7%.

What would the composite escalation rate be for this example?

v1.1

Example: Composite Index

- We multiply each rate (or index) by the appropriate percentage and sum:

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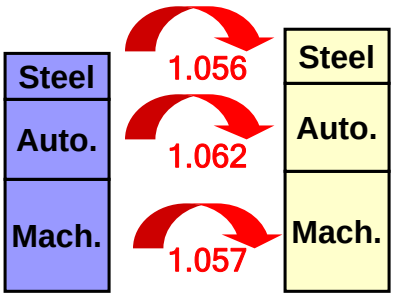


0.2*(5.6%) + 0.35*(6.2%) + 0.45*(5.7%) = 5.855%

0.2*1.056 + 0.35*1.062 + 0.45*1.057 = 1.05855

v1.1

Appropriations to Expenditures

- Escalation addresses the issue that costs tend to rise from one period of time to the next
  - Expenditures = the actual payment of funds
- But what happens when costs are spent over a period of time?
  - Outlay profiles determine how appropriated funds are expended – when and in what proportion funds are spent over time
    - Commitment = administrative reservation of funds authorizing the creation of an obligation
    - Obligation = responsibility to pay for future goods or services to be received
    - Expenditure = charge against available funds or the actual payment of funds

Tip: Appropriations, obligations, and commitments are a government estimate-only concern

Outlay Profiles and Appropriation Types

v1.1

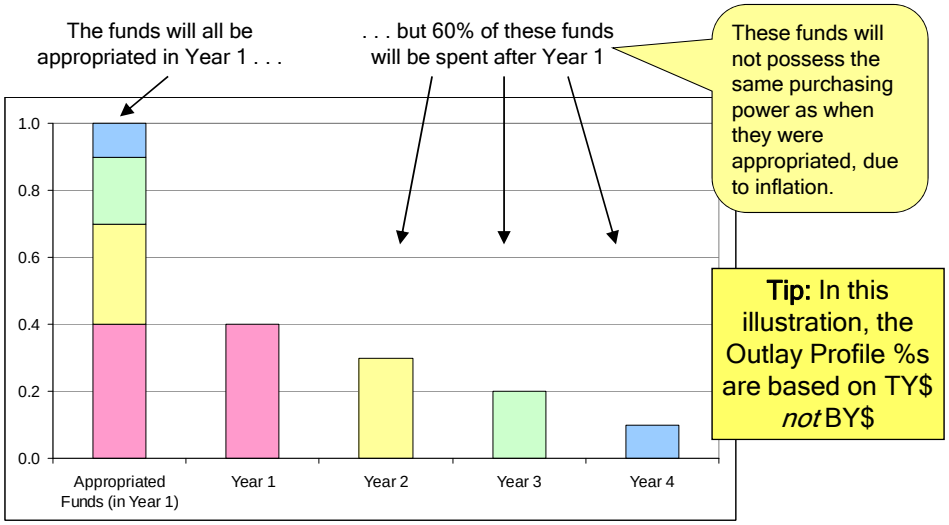
- Funds are not necessarily obligated and then expended in the year they are appropriated
- Outlay profiles show how funds are spent over time
  - Specific to type of appropriation
  - Typically based on historical averages
    - Programs are often measured on "promptness" of outlays
- Outlay profiles are shown as the percentage of funds spent in the appropriation year and each "out year"

AKA Color of Money

NEW!

Outlay Profile Illustrated

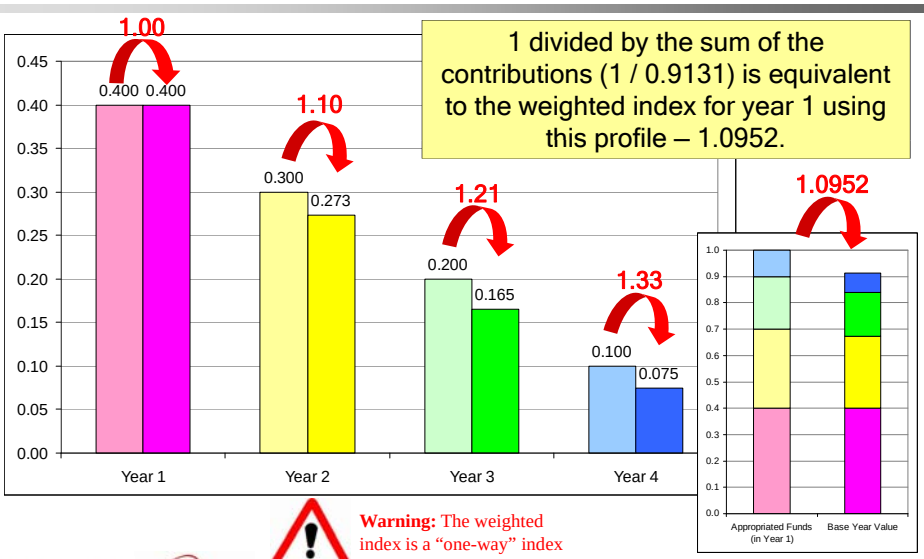
v1.1



Tip: In this illustration, the Outlay Profile %s are based on TY$ *not* BY$

Weighted Index Calculation: De-escalation

v1.1

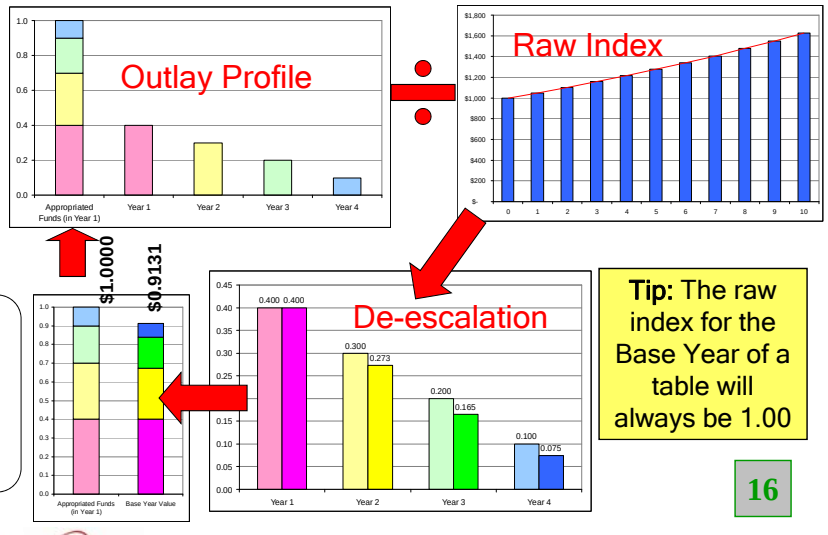


1 divided by the sum of the contributions (1 / 0.9131) is equivalent to the weighted index for year 1 using this profile – 1.0952.

Warning: The weighted index is a "one-way" index

Weighted Index – The Steps

v1.1



Weighted Index: $1.0000 $0.9131 = 1.0952

Tip: The raw index for the Base Year of a table will always be 1.00

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Example: Two Outlay Profiles

v1.1

FY 2001 OUTLAY PROFILE FACTORS
RDT&EN (PURCHASES)
BUDGET YEARS

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
52.33%	36.10%	5.79%	3.93%	1.85%	0.00%	0.00%
1.0000	1.0160	1.0323	1.0539	1.0761	1.0987	1.1217

Raw indices

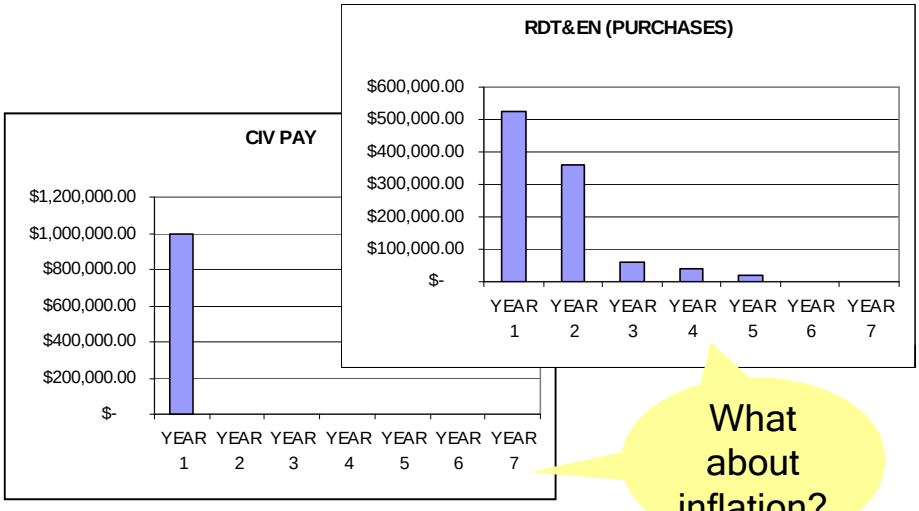
FY 2001OUTLAY PROFILE FACTORS
CIV PAY
BUDGET YEARS

YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

So what would happen to $1,000,000 in these 2 cases?

Example: Obligations and Outlays

v1.1

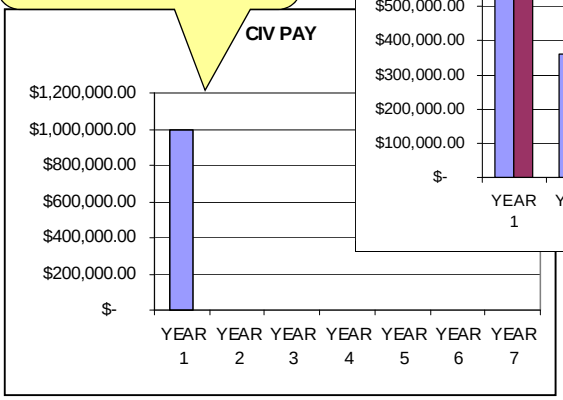


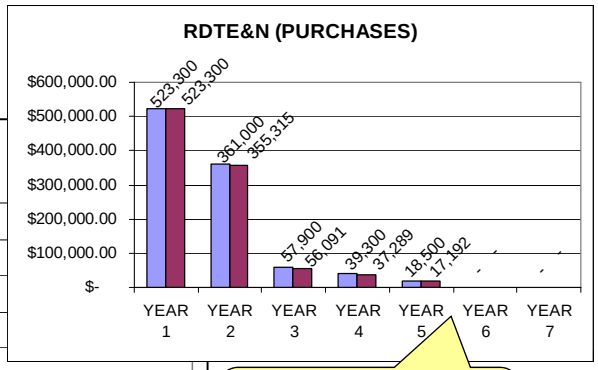
What about inflation?

v1.1

Example: Outlays and Inflation

Since all the money is spent in the current year, there is no inflation.





Inflation reduces the *value* of each outyear expenditure

v1.1

Inflation Tables and Escalation Procedures

Escalation Procedures Overview

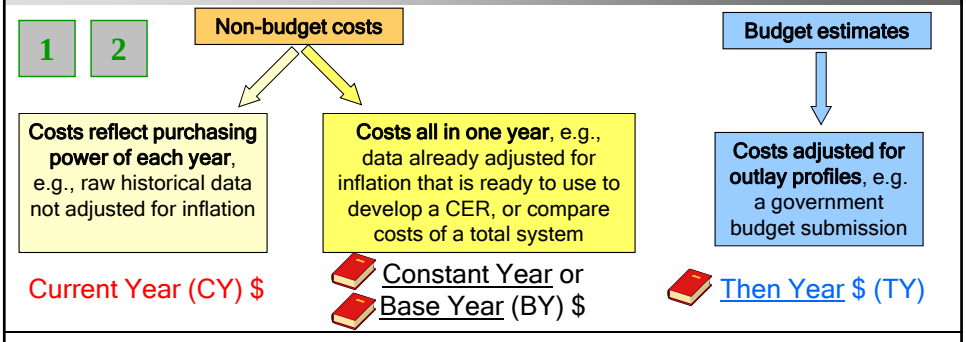
v1.1

- Two goals of this section:
  - Provide a conceptual understanding of how to adjust for inflation correctly
  - Provide a desktop reference with step-by-step directions for all inflation conversions
- Outline
  - Terminology
  - Inflation index tables structure and use
  - Basic principles of escalation calculations
  - Step-by-step instructions, with examples
    - Current Year $ to Current Year $
    - Current Year $ to Then Year $
    - Then Year $ to Current Year $
    - Then Year $ to Then Year $

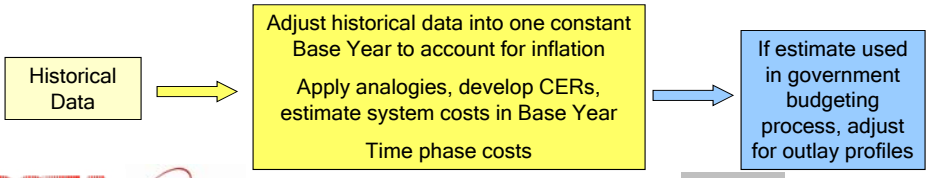
NEW!

Inflation Terminology

v1.1



Base Year Estimating Paradigm



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Inflation Indices

Current Year = Constant Year for purposes of calculations

- Two main types of indices
  - Raw indices: Used for Constant Year to Constant Year conversions
  - Weighted indices: Used for Constant Year to Then Year conversions (and vice-versa)
- For both raw and weighted indices, specific indices exist for different appropriations
  - The raw and weighted indices are specific to the item estimated (e.g. fuel, aircraft, overall O&M)
  - For weighted indices, the outlay profile for the appropriation is also factored in
- For both raw and weighted indices, the appropriations type changes the values of how much inflation is expected
- See Advanced Topics for instructions on how to create your own index table

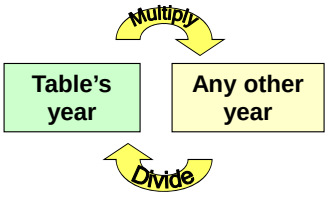
4

Constant Year		Then Year
Expenditures	Exp. ↔ Obl.	Obligations
CY ↔ CY	CY ↔TY	TY ↔TY
Raw Indices	Weighted Indices	Budget Year Multipliers

v1.1

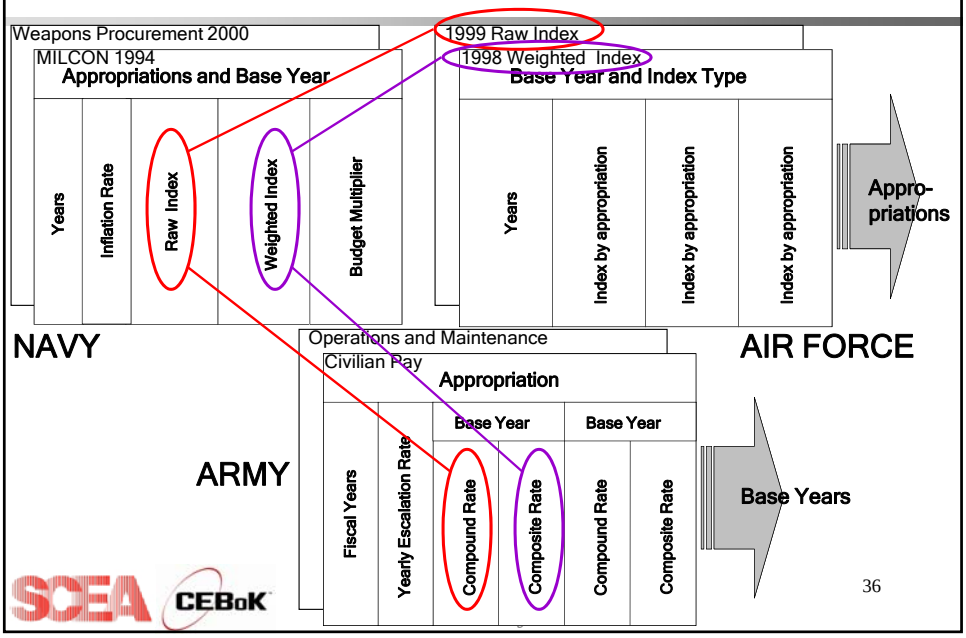
Inflation Index Tables

- The type of computation (CY → CY or CY ←→ TY) determines which type of indices you use
  - What year you are going to determines whether you multiply or divide by these indices
- The key value of the table is the Base Year of the table (table's year)
- With the table's year in mind, an index table can be used in two ways
  - From the table's year to any other year: **MULTIPLY** by indices
  - From any other year to the table's year: **DIVIDE** by indices



Index Table Layout

v1.1



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Base-Year Estimating and Time Phasing

v1.1

- Order of operations:
  - Estimate all costs in one common Base Year
  - Time-phase estimate across span of estimated schedule using an expenditure or obligation profile
  - Escalate time-phased estimate to **Current Year** or **Then Year** $ for each individual year
- Mid-point method can be used on historical data that spans multiple years where the expenditure/obligation profile is not known
  - Treat entire amount as a lump sum that "acts" at a single point in time
  - *Do not use* arithmetic mean to compute a midpoint from Current-Year or Then-Year dollar amounts

5

Unit II - Module 5

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Escalation Procedure

v1.1

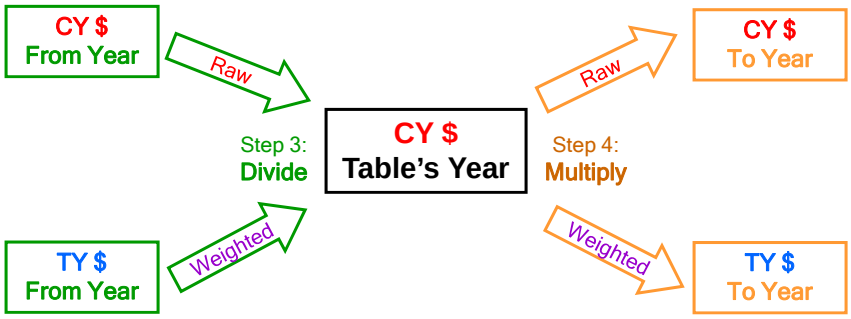
Step 1: Determine type of dollars starting from (CY/TY and year), and what type of dollars going to (CY/TY and year)

Step 2: Choose appropriate index table

Step 3: Divide by the index in the "From Year" row

Step 4: Multiply by the index in the "To Year" row

15



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Escalating Constant Year to Then Year Example

v1.1

- **Problem:** Estimate a future Air Force software development effort that will be similar to an USAF program that cost $10M in FY06. The funds for the new effort will need to be obligated in 2015.
- Step 1: Need to go from CY06$ to TY15$
- Step 2: Choose RDT&E appropriation in both the raw and weighted tables, Table's Year is 2015

USAF Raw Inflation Indices
Base Year (FY) 2015

Fiscal Year	Operations & Maint. Non-Pay, Non-POL (3400)	Research, Develop., Testing, Evaluation (3600)	Military Construct. (3300)
2004	0.785	0.785	0.785
2005	0.807	0.807	0.807
2006	0.832	0.832	0.832
2007	0.854	0.854	0.854
2008	0.871	0.871	0.871
2009	0.888	0.888	0.888
2010	0.906	0.906	0.906
2011	0.924	0.924	0.924
2012	0.942	0.942	0.942
2013	0.961	0.961	0.961
2014	0.980	0.980	0.980
2015	**1.000**	**1.000**	**1.000**
2016	1.020	1.020	1.020

RDT&E Appropriation

USAF Weighted Inflation Indices
Base Year (FY) 2015

Fiscal Year	Operations & Maint. (3400)	Research, Develop., Testing, Evaluation (3600)	Military Construct. AF (3300)
2004	0.796	0.797	0.818
2005	0.825	0.818	0.841
2006	0.845	0.843	0.862
2007	0.866	0.864	0.881
2008	0.883	0.881	0.899
2009	0.901	0.898	0.917
2010	0.919	0.916	0.935
2011	0.937	0.935	0.954
2012	0.956	0.953	0.973
2013	0.975	0.972	0.992
2014	0.994	0.992	1.012
2015	**1.014**	**1.012**	**1.032**
2016	1.035	1.032	1.053

6

10

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Escalating Constant Year to Then Year Solution

v1.1

Step 3:

- Convert CY06$ to CY15$ (the Table's Year CY$)
- Divide by the 2006 raw index
- $10M CY06 / 0.832 = $12.0M CY15

Since CY to CY

USAF Raw Inflation Indices
Base Year (FY) 2015

Fiscal Year	Operations & Maint. Non-Pay, Non-POL (3400)	Research, Develop., Testing, Evaluation (3600)	Military Construct. (3300)
2004	0.785	0.785	0.785
2005	0.807	0.807	0.807
2006	0.832	0.832	0.832
2007	0.854	0.854	0.854
2008	0.871	0.871	0.871
2009	0.888	0.888	0.888
2010	0.906	0.906	0.906
2011	0.924	0.924	0.924
2012	0.942	0.942	0.942
2013	0.961	0.961	0.961
2014	0.980	0.980	0.980
2015	**1.000**	**1.000**	**1.000**
2016	1.020	1.020	1.020

Step 4:

- Convert the CY15$ to TY15$ (the year you're going to)
- Multiply by the 2015 weighted index
- $12.0 CY15 * 1.012 = 12.2M TY15

Since CY to TY

USAF Weighted Inflation Indices
Base Year (FY) 2015

Fiscal Year	Operations & Maint. (3400)	Research, Develop., Testing, Evaluation (3600)	Military Construct. AF (3300)
2004	0.796	0.797	0.818
2005	0.825	0.818	0.841
2006	0.845	0.843	0.862
2007	0.866	0.864	0.881
2008	0.883	0.881	0.899
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2011	0.937	0.935	0.954
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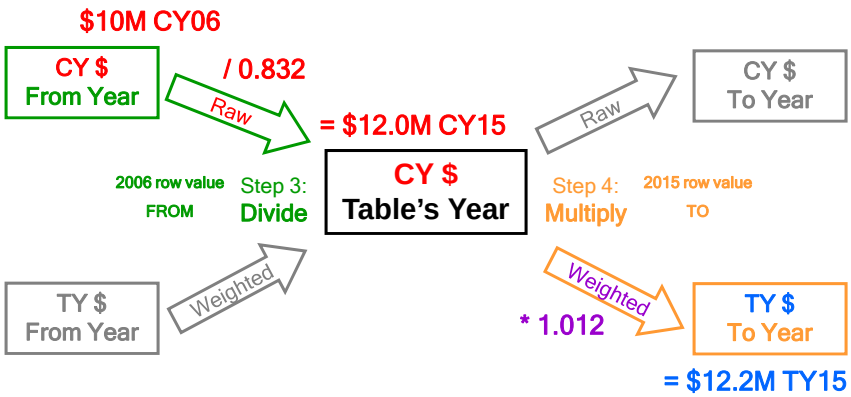
2014	0.994	0.992	1.012
2015	**1.014**	**1.012**	**1.032**
2016	1.035	1.032	1.053

Escalating Constant Year to Then Year Illustrated

v1.1

Step 1: Need to go from CY06$ to TY15$

Step 2: Choose RDT&E appropriation in both the raw and weighted tables, Table's Year is 2015



v1.1

Escalation Procedures Mnemonic

APN = Aircraft Procurement, Navy (1506)

Base Year = 2006 1/24/2007

Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index	Budget Year Inflation Rate %
1990	4.00%	0.7339	0.7791	0.7575	3.45%
1991	4.30%	0.7655	0.8015	0.7793	2.87%
1992	2.80%	0.7869	0.8195	0.7968	2.25%
1993	2.70%	0.8082	0.8347	0.8116	1.86%
1994	2.00%	0.8243	0.8502	0.8267	1.85%
1995	1.90%	0.8400	0.8639	0.8400	1.61%
1996	2.00%	0.8568	0.8760	0.8518	1.40%
1997	1.80%	0.8722	0.8835	0.8591	0.86%
1998	0.70%	0.8783	0.8938	0.8691	1.16%
1999	0.80%	0.8854	0.9053	0.8802	1.28%
2000	1.40%	0.8977	0.9173	0.8919	1.33%
2001	1.80%	0.9139	0.9281	0.9024	1.18%
2002	0.80%	0.9212	0.9397	0.9137	1.25%
2003	1.00%	0.9304	0.9580	0.9315	1.95%
2004	2.00%	0.9490	0.9815	0.9543	2.45%
2005	2.80%	0.9756	1.0057	0.9778	2.46%
2006	2.50%	1.0000	1.0285	1.0000	2.27%
2007	2.20%	1.0220	1.0507	1.0217	2.17%
2008	2.20%	1.0445	1.0731	1.0434	2.13%
2009	2.10%	1.0664	1.0958	1.0654	2.11%
2010	2.10%	1.0888	1.1192	1.0882	2.14%
2011	2.10%	1.1117	1.1435	1.1119	2.17%
2012	2.20%	1.1361	1.1687	1.1363	2.20%
2013	2.20%	1.1611	1.1944	1.1613	2.20%
2014	2.20%	1.1867	1.2207	1.1869	2.20%
2015	2.20%	1.2128	1.2475	1.2130	2.20%

FROM

TABLE

TO

1. Divide by the index from the FROM row
   - Raw if from CY
   - Wtd if from TY
2. Multiply by the index from the TO row
   - Raw if to CY
   - Wtd if to TY

Tip: This "trick" uses the Table's Year (Base Year) CY$ as the intermediate step.

NEW!

v1.1

Inflation Summary

- Know the Math!
  - Easier to remember application
  - Confidence in answers
- Use intuition, but don't rely on it…
  - Inflation = prices rise over time
  - Weighted Indices = takes more "budget" dollars than "regular" dollars
- Inflation Terminology is not always consistent
  - Learn the local dialect
  - Ask for clarification
- Gotta get it right!
  - Look it up, follow the directions
  - Inflation can be a difficult topic – use your resources!
- As long as the appropriation is correct, any calculation can be done from any given index table, regardless of its Base Year

Tip: Inflation is conceptually easy, but even experienced estimators go back to the basic guide and follow it step by step