Data Collection and Normalization

How to get the data and how to normalize it

"The Government are very keen on amassing statistics. They collect them, add them, raise them to the nth power; take the cube root and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance from the village watchman who puts down what he damn well pleases."
-Josiah Charles Stamp, 1st Baron Stamp, Bt, GCB, GBE, FBA

http://en.wikipedia.org/wiki/Josiah_Stamp,_1st_Baron_Stamp

Acknowledgments

- ICEAA is indebted to TASC, Inc., for the development and maintenance of the Cost Estimating Body of Knowledge (CEBoK®)
  - ICEAA is also indebted to Technomics, Inc., for the independent review and maintenance of CEBoK®
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- Module 4 Data Collection and Normalization
  - Lead authors: Donald S. Ellis, R. Alex Wekluk, Michael T. Yanavitch
  - Assistant authors: Charles E. Casserly
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  - Managing editor: Peter J. Braxton

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Unit Index

Unit I – Cost Estimating

Unit II – Cost Analysis Techniques

4. *Data Collection and Normalization*
5. Inflation and Index Numbers

Unit III – Analytical Methods

Unit IV – Specialized Costing

Unit V – Management Applications

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Data Collection Overview

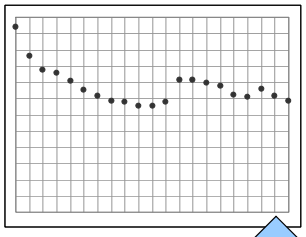
- Key Ideas
  - Cost as empirical measurement
  - Idiosyncratic accounting
  - Normalization to create "apples-to-apples" costs
  - Painful but vitally important process
- Practical Applications
  - CER Development
  - Cost and Technical Database Development
- Analytical Constructs
  - Transformations
  - Reversible operations
- Related Topics
  - Inflation 5
  - Data Analysis 6
  - Learning Curve 7

Data Collection and Normalization Within The Cost Estimating Framework

v1.2

Past

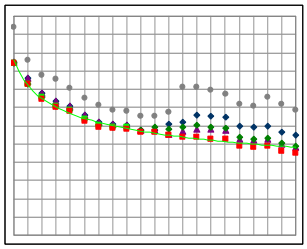
Understanding your historical data



Raw data, un-normalized

Present

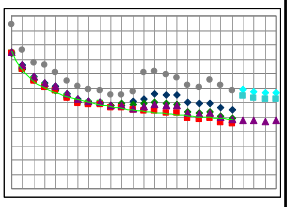
Developing estimating tools



Defensible and traceable normalization

Future

Estimating the new system



Normalization steps reversed

7

Data Collection Outline

v1.2

- Core Knowledge
  - Importance of Data
  - Types of Data
  - Considerations
  - Data Collection Process
  - Sources of Data
  - Data Normalization
- Summary
- Resources
- Related and Advanced Topics

v1.2

Importance of Data

- Historical data are the backbone of a good estimate
  - They provide credibility, accuracy, and defensibility
- Cost analysts must be able to discern data quality
- Data collection is a top priority for cost estimators
  - Not necessarily so for resource managers
  - Need to put forth maximum effort to obtain good data ("beg, borrow, and steal")

1

"Shrimpin' is tough!"
Tom Hanks as Forrest Gump,
Forrest Gump

Data collection and methods development require significant investment

v1.2

Data Key Principles

- Estimates must be consistent with cost collection methods
- Don't just collect cost data
  - Schedule, technical, performance, programmatic, and operational
  - Risk data for all of the above
    - Initial estimates and final values (actuals)

4

- Contextual completeness is crucial
- Any normalization step you take with historical data, you must be able to re-apply in estimating
  - Whatever you take out, you gotta put back in!
- Normalization is essentially an estimating step, so must be defensible
  - Never "assume away" cost
- Data collection, normalization, and analysis are iterative
  - Make them part of "business as usual"
- Large, homogeneous data sets are preferred

Aircraft Example: Introduction

v1.2

1

- Case Study: Estimate commercial aircraft
- Data Sources
  - Manufacturers A and B
  - Federal Aviation Administration (FAA)
- Possible Factors Driving Cost
  - Number of seats
  - Dry weight
  - Composite materials
  - Amount of automation
- WBS from MIL-HDBK-881A
  - MIL-HDBK-881A is superseded by MIL-STD-881C

1.1	Air Vehicle (AV)
1.1.1	Airframe
1.1.2	Propulsion
1.1.3	AV Applications Software
1.1.4	AV System Software
1.1.5	Communications/Identification
1.1.6	Navigation/Guidance
1.1.7	Central Computer
1.1.8	Fire Control
1.1.9	Data Display and Controls
1.1.10	Survivability
1.1.11	Reconnaissance
1.1.12	Automatic Flight Control
1.1.13	Central Integrated Checkout
1.1.14	Antisubmarine Warfare
1.1.15	Armament
1.1.16	Weapons Delivery
1.1.17	Auxiliary Equipment

v1.2

Types of Data

4

- Cost, Technical, and Programmatic
- Primary versus Secondary
- Data Quality of Cost Types
- Quantitative versus Qualitative
- Objective versus Subjective

Data – Cost, Technical, Programmatic

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- Cost Data
  - Represents costs (in a specified type of dollars) and hours associated with activities (labor) or materials
  - Cost (or price) is the primary issue, so focus on this
  - Be sure to note cost or price, and what's included (e.g., direct, OH, G&A, fee)
- Technical Data
  - Derived from requirements or physical characteristics of systems, may drive cost
    - Ex: Size, weight, MTBF, MTTR, R&M, special security requirements, payload requirements, etc.
  - Includes performance and operational parameters (speed, crew composition, activity rates, deployment plans, etc.)
- Programmatic Data
  - Program parameters that explain and drive cost
    - Ex: Schedule, quantity, value chain structure, multi-year procurement, contract type, sole source vs. competitive acquisition, etc.

5 11 14 15

Performance and Operational Data (subset of Technical) and Schedule Data (subset of Programmatic) should also be collected

Data – Primary vs. Secondary

v1.2

- Primary Data
  - Obtained from Original Source
  - Unaltered or unchanged
  - Most defensible, best quality
  - Ex: BOM, test results, actual man-hours
- Secondary Data
  - Derived from Primary Source
  - Changed or sanitized
  - Lesser overall quality, good for cross-check
  - Ex: Factors, studies, other estimates

4 8

Data – Quality of Data Types

v1.2

- Actuals for completed programs/contracts

  are better than

- Estimates at Complete (EACs) for contracts greater than 90% complete

  are better than

  16

- Contract line item prices from Section B

  are better than

  14

- Historical budget data

Data – Quantitative vs. Qualitative

v1.2

- Quantitative Data
  - Ordinal – order only
  - Interval – relative scaling
    - Celsius temperature, e.g.
  - Ratio – absolute scaling
    - Kelvin temperature, e.g.
  - Usually Objective, but can be Subjective
- Qualitative Data
  - Categorical (nominal)
  - Often Subjective, but can be Objective

"Nominal, ordinal, interval, and ratio typologies are misleading," P.F. Velleman and L. Wilkinson, *The American Statistician*, 1993, 47(1), 65-72

Data – Objective vs. Subjective

v1.2

Tip: To be considered objective, similar scores must be obtained in independent trials

- Objective Data
  - Usually Quantitative (e.g., costs, weights)
    - Could be Qualitative (e.g., U.S. vs. Soviet fighters)
  - Collected through formal data collection process
  - Ex: Staff hours, SLOC, Function Points, End Items

12

- Subjective Data
  - Based on judgment – a "feeling" or "understanding" of a characteristic or condition
  - Can be Qualitative (e.g., High Risk) or Quantitative (e.g., 30% more complex)
  - Ex: Complexity, Level of Difficulty, TRL

2

6

Look to gather data from all credible sources, but **Primary**, **Quantitative**, and **Objective** data are best.

Aircraft Example: Data Types

v1.2

- Data Types

Data point	Primary	Secondary	Objective	Subjective
1	Mfr A	FAA Study	Dry weight	Complexity
2	Mfr B	Internet search	Max. speed	Construction Quality

- What to Get:
  - Cost (Resource) Data
    - Labor hours/component
    - Ratio of development to production
  - Technical Data
    - Weight, speed, power requirements, fuel consumption
  - Programmatic Data
    - Schedule, contract type

Good Contextual Completeness

v1.2

Quantity and specific model plus accessories are identified

5

- Procurement of one 1998 Dodge Ram 1500 regular cab ST 4x4 truck in standard configuration with 40/60 split cloth seats, optional power package, optional tow package and manual transmission for $18,500 in March 1998 excluding shipping and destination costs ($750).

Costs identified with year in which spent.

Good Contextual Completeness

v1.2

Specific activity and manufacturer is identified.

- To fabricate a specific sub-assembly, "XYZ" manufacturer required
  - 99.5 labor hours to complete the 1st unit
  - 5th unit required 89 labor hours
  - 10th unit required 84 hours
  - Material costs were constant at $2350 (FY01$) per assembly

Labor hours identified with the production unit number.

What "easy answer" can you get from the second and third data points?

Unit material costs shown with year in which spent.

v1.2

Poor Contextual Completeness

What are the utilities for? Where? For what period of time? 1 yr? 1 mo?

- O&M utilities cost $36,500.

Year of dollars? BY00? Then Year?

Which utilities? Gas? Electric? Water? Internet?

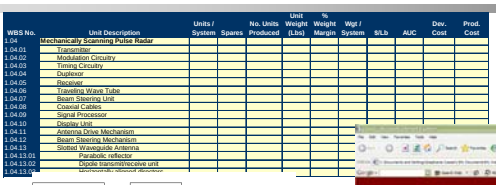
- Navy ships consume 50,000 barrels of fuel per day

What kind of ships? Only for ships that are underway?

What kind of fuel? JP5? Does this include embarked aircraft?

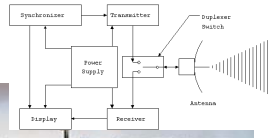
v1.2

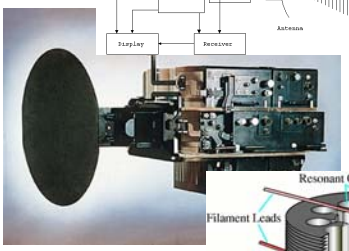
Technical Data Examples

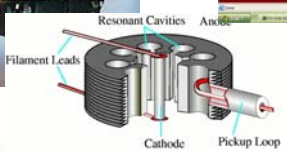


WBS No.	Unit Description	Units / System	Spares	No. Units Produced	Unit Weight (Lbs)	% Weight Margin	Wgt / System	$/Lb	AUC	Dev. Cost	Prod. Cost
1.04	Mechanically Scanning Pulse Radar										
1.04.01	Transmitter										
1.04.02	Modulation Circuitry										
1.04.03	Timing Circuitry										
1.04.04	Duplexor										
1.04.05	Receiver										
1.04.06	Traveling Wave Tube										
1.04.07	Beam Steering Unit										
1.04.08	Coaxial Cables										
1.04.09	Signal Processor										
1.04.10	Display Unit										
1.04.11	Antenna Drive Mechanism										
1.04.12	Beam Steering Mechanism										
1.04.13	Slotted Waveguide Antenna										
1.04.13.01	Parabolic reflector										
1.04.13.02	Dipole transmit/receive unit										
1.04.13.03	Mechanically Steered Reflector										

Programmatic Information	
Organization	
Program Name	
Highest Classification Level	
Office Phone	
Program Manager	
Office Phone	







v1.2

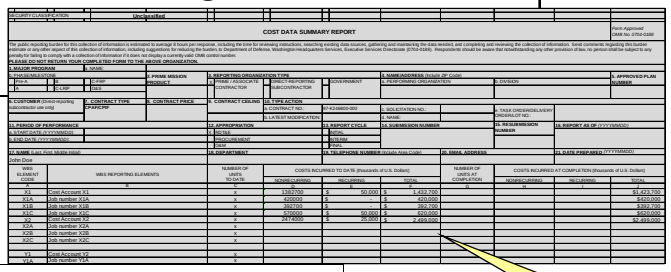
Cost Data Example

2 **Raw Cost Data**

	Direct Hours	Direct $	OHD $	Material $	Subc $	G&A $	Total $
WBS X	13150	1,320,250	1,980,375	75,000	160,000	396,075	3,931,700
Cost account X1	5150	440,250	660,375	50,000	150,000	132,075	1,432,700
Job number X1A	1500	150,000	225,000			45,000	420,000
Job number X1B	1650	140,250	210,375			42,075	392,700
Job number X1C	2000	150,000	225,000	50,000	150,000	45,000	620,000
…							
Cost account X2	8000	880,000	1,320,000	25,000	10,000	264,000	2,499,000
Job number X2A							
Job number X2B							
Job number X2C							
WBS Y							
Cost account Y1							
Job number Y1A							

1

11



COST DATA SUMMARY REPORT

3 **Time Phased Data**

	CY95	CY96	CY97	CY98	CY99	CY00	Total $
Program Total							
WBS X							
Cost account X1	143,270	286,540	429,810	429,810	71,635	71,635	1,432,700
…							
WBS Y							
Cost account Y1							

Form 1921
CCDR

v1.2

18

Considerations

- Availability
- Accessibility
- Validity
- Constraints
- Pitfalls

Considerations – Availability/Accessibility

v1.2

- Availability - does it exist?
  - Never collected
  - Insufficient granularity or detail
    - Ex: Have summary-level cost, but need sub-element breakout
  - Partial or incomplete
    - Ex: Have costs for the individual integrated circuits and components that go onto the motherboard, but not for the motherboard itself
  - Wrong "format"
    - Ex: Cost for an activity is in dollars, but need it in hours
- Accessibility - can I get to it?
  - Data exists but can not be used
    - Security classification
    - Competition sensitive
    - Proprietary use – may need non-disclosure agreement (NDA)
    - International Trafficking in Arms Regulation (ITAR) controlled
  - Electronic or hard copy?

7

Warning: "Data denial" is a common defensive tactic

Considerations - Validity

v1.2

- Relevancy / Currency
  - Recent enough
- Applicability
  - Comparable program/system
- Cross-check
  - Arrive at similar solution from multiple data sources
- Sanity check
  - Does it make sense? Does is pass the "reasonable person test"?
  - Compare to rules of thumb and experience

2

13

Warning: These issues are often used to disable analysis

Considerations – Constraints

v1.2

- Time Constraints
  - Data gathering is time intensive
  - Collection efforts are typically ongoing
- Estimate Requirements
  - What is the purpose or intended use of estimate?
  - What is the purpose of the specific data source?
  - Does data require normalization?

3

Considerations – Pitfalls and Special Data Needs

v1.2

- Pitfalls
  - Data definitions vary
    - Different sources - different descriptions
    - Same sources - definitions change over time
  - Processes are dynamic
  - Businesses consolidate or divest
- Special data needs
  - New technology/materials
  - Aggressive schedule
  - Manufacturing process changes
  - Cost reduction initiatives

2

17

9

11

16

Aircraft Example: Considerations

v1.2

- Availability
  - Non-standard accounting system
  - No development/production split
- Accessibility
  - Manufacturer A may not give the data
- Relevancy / Currency
  - Most available data are from the 1950s – Relevant?
- Time Constraints
  - Need estimate to support budget decisions *now*
- Estimate Requirements
  - No idea how estimate will be used – What to collect?

Data Sources

v1.2

19

- Requirements Documents (ICD, CDD, CPD)
- Baseline Descriptions (CARD, ICBD)
- Technical Databases (Satellite Crosslinks Database, etc.)
- Contractor-Provided Documentation (data sheets, etc.)
- Contractor Accounting System and Cost Reports (CPR, C/SSR, CFSR, C/SCSC, CCDR)
- DACIMS for CCDRs and software metrics (SRDRs)
- DoD Historical Databases (VAMOSC, AFTOC, OSMIS, AF C3I H/W Maint Database, Navy OARS, JCARD, etc.)
- SARs and DAES for high-level schedule, technical and cost data, and particularly for changes to the program
- Labor Rate data from FPRAs, DCAA, DCMA

Data Sources (cont'd)

- Automated Cost Database (ACDB), an ACE-IT database for government users
- Other Organizations (FFRDCs, sister agencies)
- Other Information Systems (cost studies, GSA catalogs, documented cost estimates, etc.)
- Contracts and Cost Proposals
- President's Budget (PB)
- Testimony of Functional Specialists (SMEs)
- Competitive Intelligence, Market Analysis, Benchmarking
- The Internet! (Caveat Browsor [*sic*])

Data Normalization

- Cost, Quantity and Sizing
- Content
- State of Development
- Key Groupings

11

20

How are you measuring?

What are you measuring?

When (and whom) are you measuring?

Which are you measuring?

"What's in the number?"
-Rick Collins [attributed]

v1.2

Normalization – Cost, Quantity, and Sizing

- Cost Units
  - Corrected for price level changes associated with inflation (escalated)
  - Cost vs. price (and inclusion of burdens like OH or G&A)
  - Labor or material
  - $M vs. $K
  - Same year dollars
- Quantities
  - Unit or lot build
  - Flight, qualification, engineering model or spare
- Sizing Units
  - Weight
  - Density or volume
  - For software, physical vs. logical SLOC, DSLOC vs. ESLOC, counting methods, etc.

5

7

Cf. State of Development

v1.2

Normalization Example: Escalation

Current Year to Base Year 2000 Dollars Conversion

5

You collect the following historical primary data:

Procurement cost for an AN/ARC-164 radio for a comparable aircraft shows actual costs to be $50,000 based on a May 1994 Bill of Materials.

Your estimate is being developed in Base Year 2000 dollars. Before you can use this data, it must be normalized.

The actual value you will want to use is $52,247 (BY2000$) for the radio.

Using the Air Force Procurement Appropriation index, what would $50K in 1994 CY$ be equivalent to in 2000 BY$?

The Answer: $50,000 / 0.957 = $52,247 (BY2000$)

v1.2

Normalization Example: Unit Conversion

Technical Sizing Data Conversion

9

You collect the following primary data:

Optical cable type 1: 5 Pounds Sterling (British) / meter
Optical cable type 2: $2.50 / linear foot

Since the tools you plan on using rely on $ per foot data, the above pieces of data need to be converted to $ per foot:

Normalized Result:
Cable type 1: $2.67 / foot
Cable type 2: $2.50 / foot

Assume 1 Pound Sterling = $1.75 (U.S.)
1 meter = 39.37 inches
1 foot = 12 inches

Warning: Even NASA has had an issue with unit conversion, resulting in the loss of a Mars Orbiter

http://www.cnn.com/TECH/space/9909/30/mars.metric.02/

v1.2

Normalization - Content

- Cost Types
  - Recurring vs. Non-Recurring Costs
  - Fixed vs. Variable Costs
    - Helps account for:
      - Production quantity impacts
      - Time-phased impacts
- Adjust End Items for Homogeneity
  - Account for content differences in the end items
  - Missing or absent elements
  - Excess or inapplicable elements

4

v1.2

Normalization – State of Development

- State-of-Development Variables
  - Technology Readiness Level (TRL) 1-9 **4**
  - Concept or Technology Demonstration Phase
  - Prototype and EMD
  - Beta I or II Test
  - Low Rate Initial Production (LRIP) or Full Rate Production (FRP) **11**
    - Production units must be normalized to a consistent first unit (T1) or k^{th} unit

Note: Many of these terms are DoD distinctions but all development events have maturity stages related to production rates

v1.2

Normalization – Key Groupings

- Products by Mission Application
  - Similar missions
  - Similar characteristics and traits
- By Operating Environment
  - Manned space
  - Unmanned space
  - Aerospace
  - Shipboard
  - Commercial systems

Aircraft Example: Normalization

v1.2

- Cost Units
  - Data from different years inflated to common year
- Sizing Units
  - Data units are consistent; i.e., miles/hour vs. kilometers/hour
- End Items for Homogeneity
  - Tailor end items for jet engine – remove propeller costs
- State-Of-Development Variables
  - Was new product state-of-the-art, or just a small upgrade?
- Key Groupings
  - Classify according to jumbo jet, propeller, etc.
  - Note environment: turbine blades wear faster in desert sand
  - Costs incurred from development or production?

Data Collection Summary

v1.2

- Data are the lifeblood of cost estimating
- Different types of data for different purposes
- Data Collection follows a process
- Consistency, Comparability, Usability
- Where do you go for data?

What's in the number?

Inflation and Index Numbers

How to adjust for the general rise in prices over time

"Inflation is when you pay fifteen dollars for the ten-dollar haircut you used to get for five dollars when you had hair."
-Sam Ewing, humorist

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  - Managing editor: Peter J. Braxton

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Unit Index

Unit I – Cost Estimating

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4. Data Collection and Normalization
5. *Inflation and Index Numbers*

Unit III – Analytical Methods

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Unit V – Management Applications

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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)

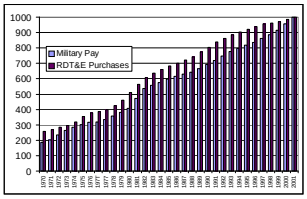
13

Inflation Within The Cost Estimating Framework

v1.2

Past

Understanding your historical data



Prices over time *for like items*

Present

Developing estimating tools

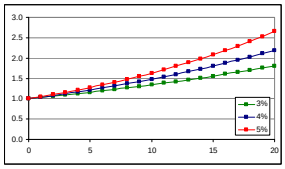
CIV PAY
INFLATION INDICES
BASE YEAR: MID-FY2001

FISCAL YEAR	INFLATION RATE %	RAW INDEX	WEIGHTED INDEX	BUDGET YEAR MULTIPLIER
1995	1.5000	0.8256	0.8256	0.8256
1996	2.0000	0.8421	0.8421	0.8421
1997	2.7500	0.8653	0.8653	0.8653
1998	2.8500	0.8900	0.8900	0.8900
1999	3.4000	0.9202	0.9202	0.9202
2000	4.5100	0.9617	0.9617	0.9617
2001	3.9800	1.0000	1.0000	1.0000
2002	3.6300	1.0363	1.0363	1.0363
2003	3.8300	1.0760	1.0760	1.0760
2004	3.9000	1.1180	1.1180	1.1180
2005	3.9000	1.1616	1.1616	1.1616
2006	3.9000	1.2069	1.2069	1.2069
2007	3.9000	1.2539	1.2539	1.2539
2008	3.9000	1.3028	1.3028	1.3028
2009	3.9000	1.3536	1.3536	1.3536

Escalation tables (index numbers)

Future

Estimating the new system



Projected inflation rates

Inflation Outline

v1.2

- 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

v1.2

Inflation: Gotta Get It Right!

- 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

v1.2

Inflation Concepts and Index Numbers

v1.2

What Is Inflation?

- Inflation is a sustained increase in the general level of prices in the economy

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- 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

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Costs of Inflation

- Decrease in purchasing power
  - Lower standard of living
    - If wages don't keep pace
- Unexpected redistribution of income and wealth
  - Nominal interest rates rise with inflation
  - **Debtors gain** and **creditors lose**
    - **Debtor**: Home owner with a low, fixed mortgage
      - Repays loan with an interest rate less than nominal market rate
    - **Creditor**: Owner of fixed-income securities such as Treasuries, munis, or corporate bonds
      - Receiving coupon payments at less than nominal market ROI
      - Bond prices fall, too
- Uncertainty
  - Consumers and corporations
    - Confusion cost

Value of $100

Annual Inflation Rate	1%	2%	5%	10%	30%
	Stable Prices		Inflationary environment		
1 year later	99.0	98.0	95.2	90.9	76.9
2 years later	98.0	96.1	90.7	82.6	59.2
3 years later	97.1	94.2	86.4	75.1	45.5
4 years later	96.1	92.4	82.3	68.3	35.0
5 years later	95.1	90.6	78.4	62.1	26.9
6 years later	94.2	88.8	74.6	56.4	20.7
7 years later	93.3	87.1	71.1	51.3	15.9
8 years later	92.3	85.3	67.7	46.7	12.3
9 years later	91.4	83.7	64.5	42.4	9.4
10 years later	90.5	82.0	61.4	38.6	7.3

Cost of a $10 CD

Annual Inflation Rate	1%	2%	5%	10%	30%
	Stable Prices		Inflationary environment		
1 year later	10.1	10.2	10.5	11.0	13.0
2 years later	10.2	10.4	11.0	12.1	16.9
3 years later	10.3	10.6	11.6	13.3	22.0
4 years later	10.4	10.8	12.2	14.6	28.6
5 years later	10.5	11.0	12.8	16.1	37.1
6 years later	10.6	11.3	13.4	17.7	48.3
7 years later	10.7	11.5	14.1	19.5	62.7
8 years later	10.8	11.7	14.8	21.4	81.6
9 years later	10.9	12.0	15.5	23.6	106.0
10 years later	11.0	12.2	16.3	25.9	137.9

Dr. Paul Krugman: "… generate modest inflation to gradually reduce the … burden of debt" [NY Times; 30 April 2012]

NEW!

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Inflation and Cost Estimating

- 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
  - The **Base Year** of the CER

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

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Base-Year Estimating Paradigm

- 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

- Out-year inflation rates are usually estimated assuming constant values for future years' inflation
  - Often close to the current year's rate or last estimated 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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Constant Inflation

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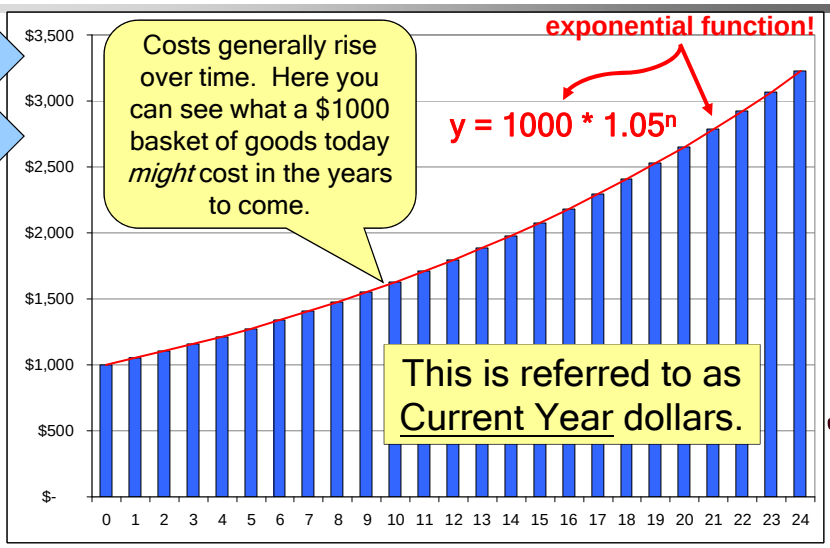

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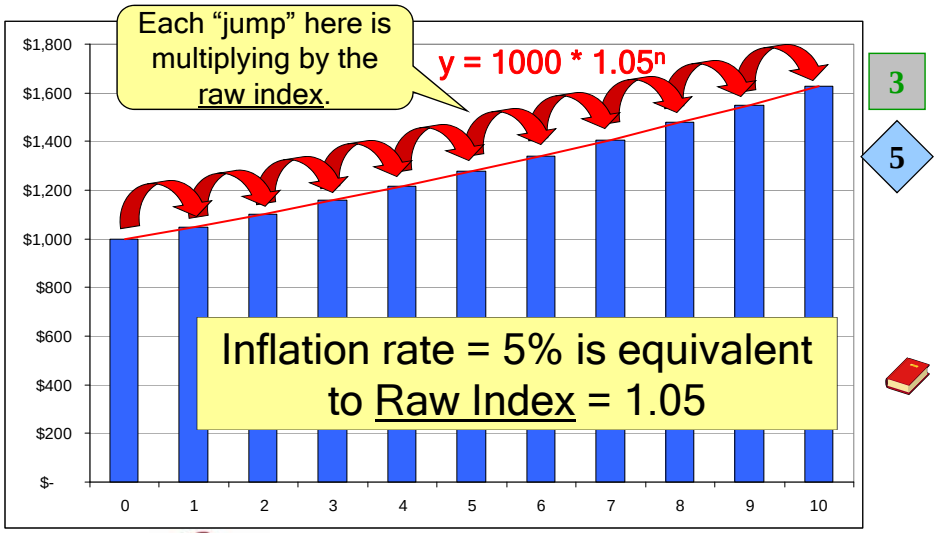
Inflation Rate and Raw Index



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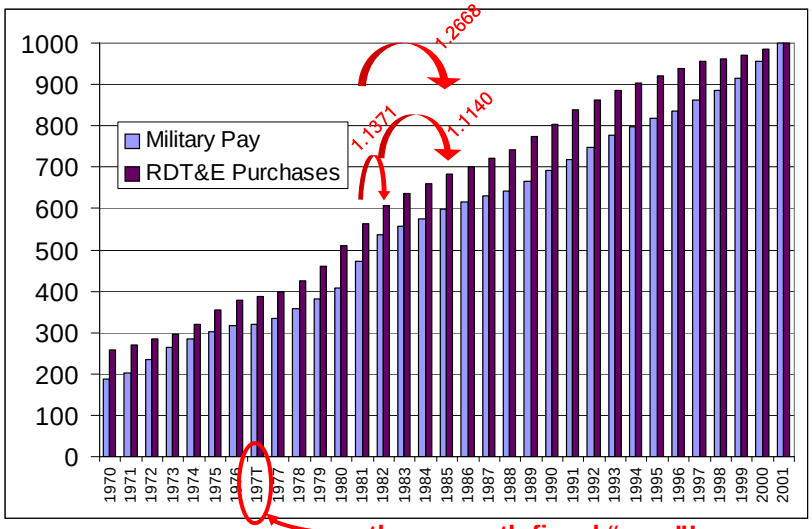
Non-Constant Inflation



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Consumer Price Index (CPI)

- Change in prices paid for a market basket of goods and services
  - Consumption sector of economy
    - Sales tax included; income tax excluded
    - Investment items excluded
      - Stocks, bonds, houses
- Three main indices published
  - CPI-U (All Urban Consumers)
    - Covers 87% of population
    - Excludes farm families, military families, and those living in institutions (prisons, mental hospitals)
  - CPI-W (Wage Earners and Clerical Workers)
    - Covers 32% of population
  - Chained CPI-U, or C-CPI-U
    - Captures consumers' behavior as they respond to relative price changes

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Official CPI-U

Year	'82 to '84 = 100
1982	96.5
1983	99.6
1984	103.9
1985	107.6
1986	109.6
1987	113.6
1988	118.3
1989	124.0
1990	130.7
1991	136.2
1992	140.3
1993	144.5
1994	148.2
1995	152.4
1996	156.9
1997	160.5
1998	163.0

v1.2

Inflation Tables and Escalation Procedures

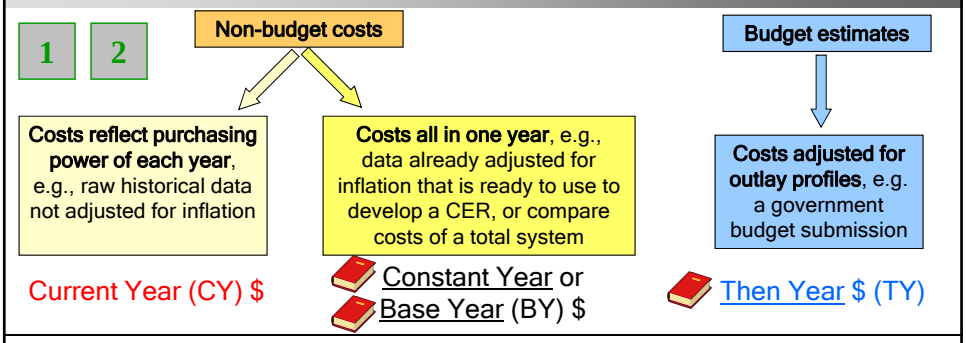
Escalation Procedures Overview

v1.2

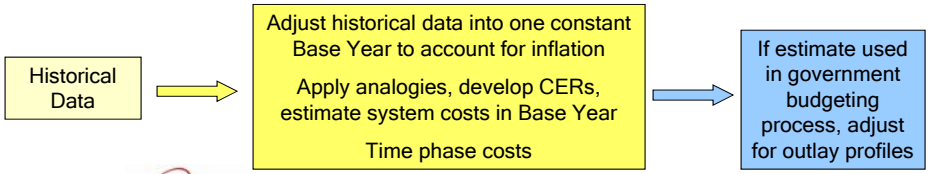
- Two goals of this section:
  - Provide a conceptual understanding of how to adjust for inflation correctly
  - Provide a desktop reference with step-by-step directions for all inflation conversions
- Outline
  - Terminology
  - Inflation index tables structure and use
  - Basic principles of escalation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

Inflation Terminology

v1.2



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

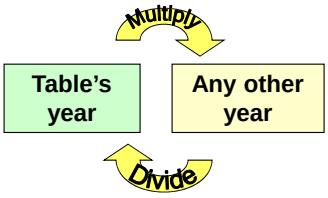
4

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

v1.2

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

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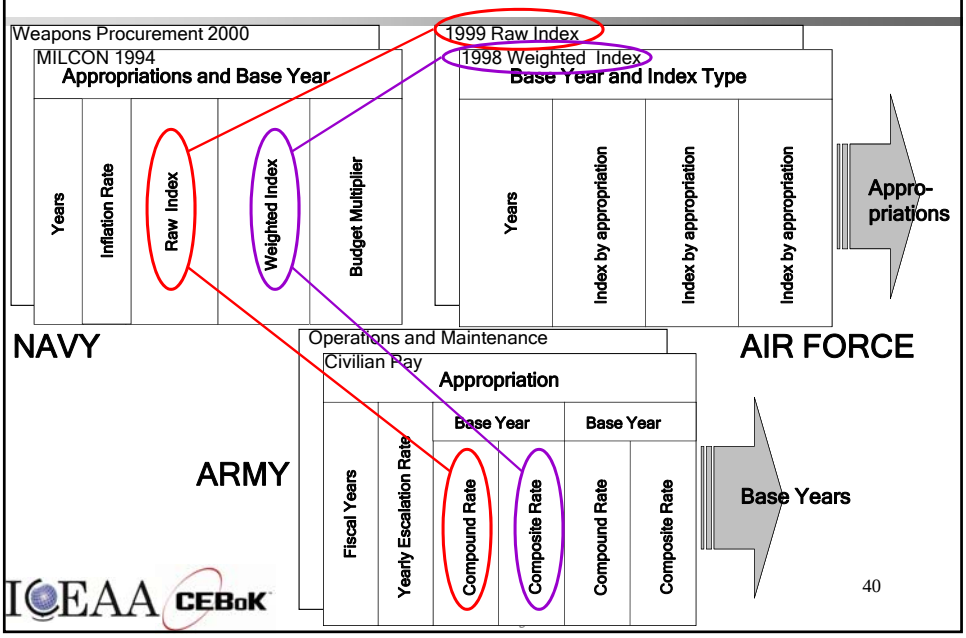

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Base-Year Estimating and Time Phasing

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- 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
- Midpoint 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

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Unit II - Module 5

41

Escalation Procedure

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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

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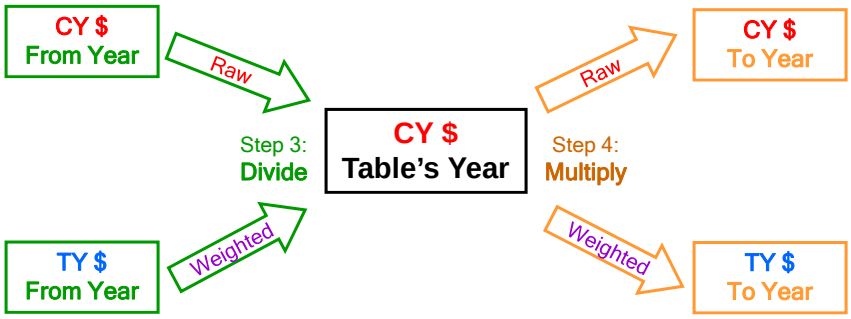

Escalating Constant Year to Constant Year Example

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Index Table "Appropriation"

Table's Year

Civ pay = Civilian Payroll for all relevant appropriations (OSD Cost Element)				
Base Year = 2010				
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index
2006	3.2%	0.896	0.896	0.896
2007	2.4%	0.918	0.918	0.918
2008	3.2%	0.947	0.947	0.947
2009	3.0%	0.976	0.976	0.976
2010	2.4%	1.000	1.000	1.000
2011	2.3%	1.023	1.023	1.023
2012	2.3%	1.047	1.047	1.047
2013	2.3%	1.071	1.071	1.071
2014	2.3%	1.095	1.095	1.095
2015	2.3%	1.120	1.120	1.120
2016	2.3%	1.146	1.146	1.146
2017	2.3%	1.173	1.173	1.173
2018	2.3%	1.200	1.200	1.200
2019	2.3%	1.227	1.227	1.227
2020	2.3%	1.255	1.255	1.255

- **Problem:** Estimate the annual cost of one Navy civilian in 2018, using FY07 cost of $100K
- Step 1: Need to go from CY07$ to CY18$
- Step 2: Choose Civ Pay index table, Table's Year is 2010

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Escalating Constant Year to Constant Year Solution

v1.2

Civ pay = Civilian Payroll for all relevant appropriations (OSD Cost Element)				
Base Year = 2010				
Fiscal Year	Inflation Rate %	Raw Index	Weighted Index	Budget Year Index
2006	3.2%	0.896	0.896	0.896
2007	2.4%	0.918	0.918	0.918
2008	3.2%	0.947	0.947	0.947
2009	3.0%	0.976	0.976	0.976
2010	2.4%	1.000	1.000	1.000
2011	2.3%	1.023	1.023	1.023
2012	2.3%	1.047	1.047	1.047
2013	2.3%	1.071	1.071	1.071
2014	2.3%	1.095	1.095	1.095
2015	2.3%	1.120	1.120	1.120
2016	2.3%	1.146	1.146	1.146
2017	2.3%	1.173	1.173	1.173
2018	2.3%	1.200	1.200	1.200
2019	2.3%	1.227	1.227	1.227
2020	2.3%	1.255	1.255	1.255

Step 3:

- Convert CY07$ to CY10$ (the Table's Year CY $)
- Divide by the 2007 raw index
- $100K CY07 / 0.918 = $108.9K CY10

Since going from another year to the table's year (de-escalation)

Since CY to CY

Step 4:

- Convert the CY10$ to CY18$ (the year you're going to)
- Multiply by the 2018 raw index
- $108.9K CY10 · 1.200 = $130.7K CY18

Since going from the table's year to another year (escalation)

Since CY to CY

Inflation Summary

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- 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