CER Issues And Solutions

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- Views expressed are strictly and solely those of the author!
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Objective

- Become aware of probable problems with the use of Cost Estimating Relationships (CERs) and potential remedies

\[ y = \beta_0 + \beta_1 x \]

- \( y \) = estimated cost
- \( \beta_0 \) = \( y \)-intercept (vertical calibration)
- \( \beta_1 \) = coefficient of \( x \) (constant change in cost per constant in \( x \))
- \( x \) = independent variable (cost driver)
Background

- The use of CERs is a widely accepted method of creating estimates.

- There are some issues regarding CER development and their application in the estimate which need to be addressed:
  - They should not be accepted blindly.
  - Some concerns are interrelated and not mutually exclusive.

- Being cognizant of some common shortcomings and being familiar with CER creation and usage may mitigate these shortcomings – there are ways to make the appropriate adjustments.
Issues And Solutions

Issue: Normalization (To constant year dollars)

- The actual impacts of inflation or escalation that has occurred is not really known
- Future escalation is also a matter of conjecture
- Arbitrary factors without solid substantiation are often applied in CER development
- “Blanket” overarching factors are frequently used
- Future inflation in estimates is not always uniform with the de-escalation used in determining T1

Solution(s):

- Consider that inflation is an unknown and treat it as an uncertainty in creating CERs and in cost modeling
- Use escalation and de-escalation factors derived from programs that are as similar as possible (BLS [Bureau of Labor Statistics], CPI [Consumer Price Index], etc.) and break out by labor types and material constituents
- Apply future escalation consistently with the method used in developing the CER
Issue: Improvement (or learning) Curve Applications

- Improvement Curves are utilized in CER development and application
- Slopes and curve type (Unit, Cumulative) are assumed and/or are averages
- Are often arbitrary and not necessarily based on data in their derivation
- The slope and curve type may not be consistently applied with the methodology used in creating T1s and the CER expression

Solution(s):

- Consider that the Improvement Curve is an unknown and treat it as an uncertainty in creating CERs and in cost modeling
- Use slopes and curve types derived from actual program history or from programs that are as similar as possible
- Project Improvement at the lowest level possible or practical
- Apply future improvement consistent with the slope and curve type employed in developing the CER
Issues And Solutions (Continued)

Issue: History Used

- May be incomplete
- Not all programs are included - Programs that are cancelled, that have aberrations, or are incomplete aren’t used
  - A complete picture of the past and present is not presented
- “Outliers” are excluded
  - ‘Unusual’ events have a likelihood of reoccurring
- Estimates To Complete (ETCs) often don’t include the “tail-up” impact
  - Problems are left until the end of the project to resolve

Solution(s):

- Include all possible history and incomplete program projections in creating CERs and in cost modeling
- Don’t dismiss outliers
- Project the upswing in costs as the project nears completion
- The uncertainty reflected in the CER expression should accommodate a complete chronicle of past occurrences
  - In this way “Known” and “Unknown” Unknowns are included
Issues And Solutions (Continued)

Issue: Lack of Trend Projections
- CERs tend to address only what has happened in the past and not what will occur in the future
- Old experience is used as a baseline without adjusting for the future (Moore’s Law or the opposite)
- The present and beyond is frequently not projected
- Changes in effort (cost or labor) through time as technology evolves and economics change is not considered
- We extend what has previously happened and not what may occur

Solution(s)
- Employ time trend lines of effort changes and project it to the program being estimated Period of Performance (PoP)
- Technology changes impacting time, materiel, and cost trends with associated CER growth or reduction can also be determined by:
  - Exploring product line experience through time
  - Developing trend profiles which will project or modify CER(s) for the time in the future when the activity will occur
  - Determine changes to methods and resultant cost impact
  - Apply the possible outcome as an unknown
Issues And Solutions (Continued)

Issue: Technical Parameter Accuracy

- Objective items such as historical weights, software lines of code, Bills of Material, reuse factors, power, and the like used in CER development may not be accurate
  - Often derived from estimates or proposals rather than actual data
- Subjective factors (team make-up, TRL levels, etc.) are open to interpretation and optimism
- Schedule realism
- Task description inconsistencies

Solution(s)

- Use real measurements
- Solicit impartial and unbiased opinions from a variety of sources
- Define tasks carefully
- Employ uncertainty
Issues And Solutions (Continued)

Issue: Accounting of Quantities

• Quantities don’t always reflect total experience or may be optimistic
  ▪ All past lots and those currently in production
  ▪ Partial completions
  ▪ Concurrent Production
  ▪ Commonality with other products
  ▪ Spares
  ▪ Interim production between now and the planned item

Solution(s):

• Be thorough and attentive in accounting for the items above in establishing CERs when normalizing for quantity
• Include any such planned activities when placing the program being estimated on an improvement curve
• Incorporate uncertainty when quantities are unknown
• Account for partial quantities, commonality, and spares through the use of equivalent units (i.e., If 10 spares each weighing 1/10 of a complete unit have been manufactured, consider them to be equivalent to a unit of production) in CERs and estimates
Issue: Other Considerations

- Many CERS are lognormal with definite end points which may be outside the parameters of the estimated task
- Descriptors often are inconsistent - Not all items of a certain nomenclature are the same with regards to technology and cost
- Out of scope changes are not defined or incorporated in the CER
- Is it more appropriate to work at the system level or a lower level?
- Etc.

Solutions:

- Whenever possible incorporate CERs with ranges encompassing the quantity of the project being estimated
- Each element needs to be approached and defined meticulously
- Estimate at the most appropriate Work Breakdown Structure (WBS) level
- Accommodate any known scope changes
- Incorporate uncertainties both in developing and applying CERs
Summary and Conclusions

- These are a few common pitfalls with CERs
- Developing suitable CERs and applying them properly is tough
- There are always constraints in creating CERs and estimating in terms of time and information ("Better can be the enemy of good enough")
- Best practices:
  - Make allowances for the issues mentioned
  - Utilize due diligence to the maximum extent practical
  - Understand the CER and its derivation
    - May be difficult to impossible with "Black Box" models and pre-packaged CERs
  - Incorporate uncertainty in the CER and Modeling whenever there are unknowns
  - Calibrate and Validate estimates CERs to ensure credibility
  - Understand and analyze the program being estimated
  - Don’t take anything at face value – examine critically
- Use of CERs is still the best and usually most the accurate technique available
Questions and Comments

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