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Module 2: Introduction to ERP Statistical Concepts and Tools

Common Measures Training
Chelmsford, MA
September 28, 2006

Overview

- Why ERP uses statistics
- How ERP measurement works
- Who gets inspected
- Key statistical concepts
- ERP statistical resources
- Tour of ERP spreadsheet tools
- Hands-on exercises: Single-sample analysis

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Why ERP Uses Statistics

- Statistics are valuable whenever it's too costly or inefficient to look at everything of interest– whether widgets or dry cleaners
- Random samples of facilities provide a picture of everyone's performance, *with measurable uncertainty*
- Uncomfortable? What are the alternatives?
  - Census of all facilities
  - Doing things the old way, with no idea about how accurate the data are

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How ERP Measurement Works

- **Inspect random sample of all facilities, as baseline**
- Certification & compliance assistance
- Targeted follow-up & facility return-to-compliance
- **Inspect random sample of all facilities, to measure change**

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How ERP Measurement Works

- Evaluation is largely based upon random, *inspector-collected* data
- Recognize that baseline inspections may have an effect on performance; it's part of what you are measuring

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Who Gets Inspected?

- Mandatory certification programs
  - Random sample of all facilities (baseline and post-certification)
- Voluntary certification programs
  - Baseline: Random sample of all facilities
    - You don't know who the volunteers are
  - Post-certification: Two usual options
    - One random sample of all facilities, or
    - One random sample of volunteers and one random sample of non-volunteers (stratified sample)

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Who Gets Inspected? (Cont.)

- Take care in comparing groups (apples with apples)
- Quality issues with just sampling volunteers:
  - missing the big picture,
  - self-selection bias, and
  - potential to miss spillover effects

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Two Main ERP Analyses

- Current state of performance
  - Looking at a single random sample
- Difference over time
  - Looking at 2 random samples
  - Difference between states is very similar

Module 2 covers one-sample analyses
Module 3 covers two-sample analyses

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Key Concepts: One-Sample Analysis

- Margin of error/confidence interval
- Confidence level
- Standard deviation

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Margin of Error/Confidence Interval

- Random sample provides "point estimates" of facility performance
  - E.g., 30% of gas stations in the sample are in compliance with leak detection requirements
  - That's accurate if we are only talking about the sample

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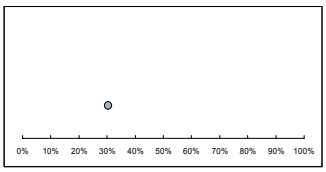
Margin of Error/Confidence Interval

- Example: 30% of gas stations *in the sample* are in compliance with leak detection requirements



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Margin of Error/CI (Cont.)

- For the population as a whole, there's error associated with the point estimate
- E.g., let's say margin of error is +/- 10%; confidence interval is 20%
- Then, we believe the percentage of *all* gas stations in compliance with leak detection requirements is between 20% and 40%.

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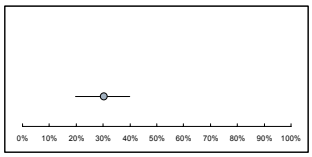
Margin of Error/CI (Cont.)

- 30% of gas stations in the population as a whole, +/- approximately 10%, are in compliance with leak detection requirements



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Margin of Error/CI (Cont.)

- **Questions to think about:** Confidence interval may seem to be a wide range, but tight enough to make decisions? Would your actions be different if it was 20% versus 40%?
- Which reminds me of a story…

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The Flexible Confidence Interval

Confidence intervals can be established for many kinds of measures and levels of analysis. E.g.,

- **Means** (covered in next two slides)
- **Indicator score**
  - E.g., average facility performed 78% of indicator practices, +/-12%
- **Certification accuracy**
  - E.g., 68%-76% of certification responses agreed with inspector findings
- **Outcome measure**
  - E.g., 20 tons of VOC emissions from auto body shops, +/-2 tons

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Confidence Intervals for Means

- Proportions used for yes/no questions
  - E.g., 30% compliance, +/-10%
  - For simplicity, our training focuses on proportions
- Means (a.k.a. averages) used for quantities
  - E.g., 1.4 pounds of dental amalgam removed per year, +/-0.35 pounds
  - Mean = total pounds / facilities in sample

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Standard Deviation (for Means)

- Confidence interval for mean requires:
  - Mean (average) of all sample observations
  - Standard deviation of all sample observations
- Standard deviation is a measure of variability among observations
  - Tightly packed around the mean? Or widely distributed?
  - Easily calculated in Microsoft Excel or stat packages

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Confidence Level

- Confidence you have that the interval includes the true population performance
- E.g., that the percentage of all gas stations in compliance with leak detection requirements is actually between 20% and 40%
- You choose the level you want: 90% (?) or **95%** or 99% (!)

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Confidence Level

- In our example, we might say…
  - "We have 95% confidence that the number of gas stations in compliance with leak detection requirements is 30%, +/-10%."

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Confidence Level (Continued)

- **90%** means the interval for 9 out of 10 samples will include the true answer
  - Wrong 10% of the time
- **95%** means the interval for 19 out of 20 samples will include the true answer
  - Wrong 5% of the time
  - Twice as accurate
  - Most ERPs use 95% confidence level

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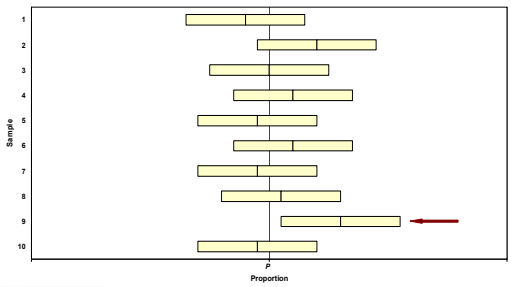
90% Confidence Level



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Statistical Points to Remember

- Statistics has economies of scale
- Higher confidence requires more inspections

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Statistics' Economies of Scale

- For a given margin of error and confidence level (say, +/-10% and 95%)…

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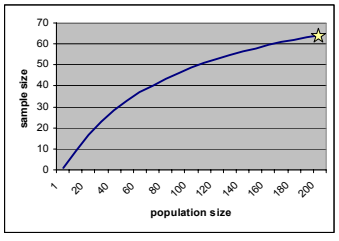
Economies of Scale (Cont.)

- A population of 200 requires a sample size of 65



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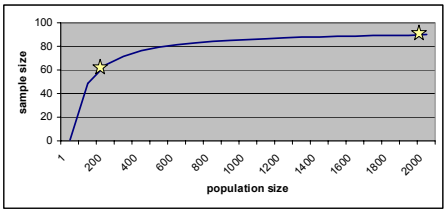
Economies of Scale (Cont.)

- A population of 200 requires a sample size of 65
- A population of 2000 requires a sample size of 90



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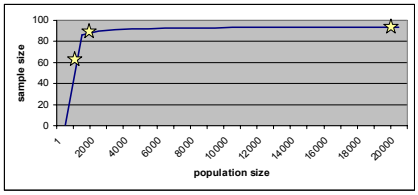
Economies of Scale (Cont.)

- A population of 200 requires a sample size of 65
- A population of 2000 requires a sample size of 90
- A population of 20,000 requires a sample size of 94



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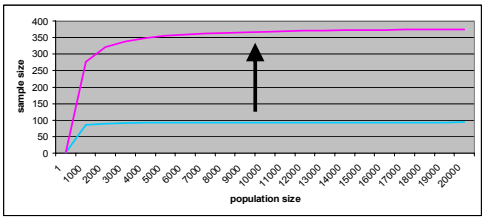
More Confidence, More Inspections

- Reducing the desired margin of error (here, from +/- 10% to +/-5%) means bigger samples



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ERP Statistical Tools Intent

- **Learn while playing with the numbers**
- Answer real questions people ask in ERP
- User-friendly for novice
- Ubiquitous platform: no purchase required
- Conservative assumptions
- Spreadsheets can be readily retrofitted and automated for a particular state (e.g., Vermont)

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ERP Stat Tools: Questions

- **Sample Planner**
  - **Q:** How many inspections do I need to do?
  - **Q:** How confident will I be in data from X inspections?

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ERP Stat Tools: Questions

- **Results Analyzer**
  - **Q:** What's the confidence interval around my result?
    - Compliance proportions, means, certification accuracy, "EBPI scores"
  - **Q:** Did performance improve over time? How much?
  - **Q:** Is volunteer performance in one round any better than non-volunteer performance in the same round?
  - **Q:** How are facilities in my state performing relative to another state?

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ERP Statistical Tools Tour

- Let's take a tour of the one-sample pages…

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For more information…

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