Calculating Standard Errors

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Statistical Significance

- Tells us if a particular difference is relatively large in relationship to an error (or uncertainty) expected by chance
- Depending on our interests, priorities and consequences of the decisions that would be made, the threshold to consider something large or small varies
- We usually assume a normal distribution of the error

Statistical Significance

- It assumes that if we take two samples from populations that are equal, they will not always be exactly the same, but on average they will (Null Hypothesis)
- If the difference is “relatively” large, then we suspect these two samples were not drawn from populations that are equal (Alternative Hypothesis)

Statistical Significance

- We say a difference is statistically significant when, based on a pre-established criteria, it is unlikely the observed difference is the result from samples taken from populations that are equal

Statistical Significance

- Calculated dividing the difference of interest by the error, or uncertainty of the difference, and comparing it to a critical value or threshold
- If the difference is “small” relative to the error, we say it IS NOT statistically significant
- If the difference is “large” relative to the error, we say that it IS statistically significant

Statistical Significance

- The criteria or threshold to say a difference is large or small depends on two main issues:
  - ✓ The directionality of our hypothesis
  - ✓ The tolerance level or acceptance

Statistical Significance: Decisions

- Directionality
  - ✓ Decided based on the hypothesis you are investigating
  - ✓ Bilateral: Are there differences between A and B?
  - ✓ Unilateral: Is A larger than B?
- Tolerance or acceptance level
  - ✓ Given statistical theory about distribution of differences, how many times would I accept rejecting the null hypothesis and be wrong?
  - ✓ 1 out of 100? 5 out of 100?
  - ✓ What are the consequences of such mistake?

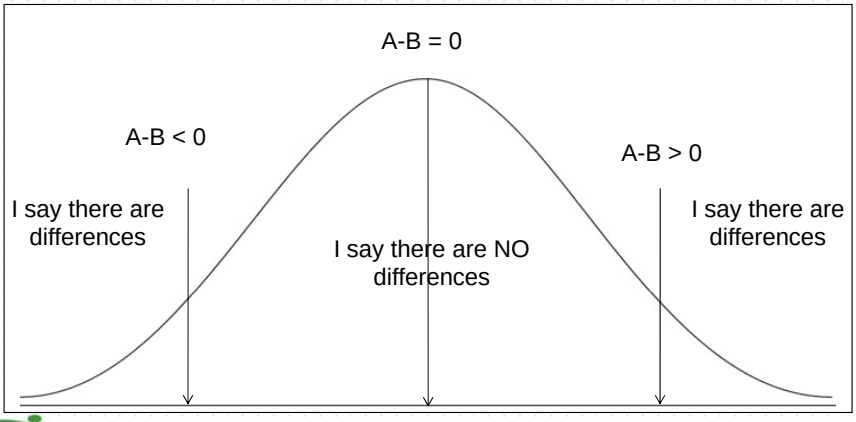
Statistical Significance: Decisions

		Populations are Different	
		Yes	No
Did I find Differences?	Yes	Correct	Error
	No	Error	Correct

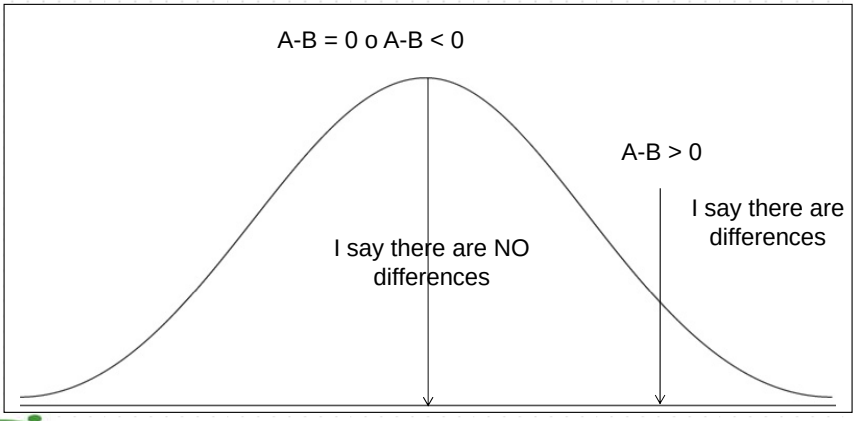
Statistical Significance: Decisions

		Directionality	
		One-tail	Two-tail
Probability of rejecting by error	More	+/- 1.64	+/- 1.96
	Less	+/- 2.33	+/- 2.58

Statistical Significance: Decisions



Statistical Significance: Decisions



Sources of Error

- Sample selection
  - ✓ Calculated using replications
  - ✓ Systematically change the overall contribution from different units within the sample, recalculate the results, and summarize according to formula
- Measurement
  - ✓ Calculated using plausible values
  - ✓ Compute the results with EACH plausible value, and calculate the variance of these estimates

Sources of Error

- Some formulas…

$$SE_{\bar{\varepsilon}} = \sqrt{\left[\sum_{p=1}^{P}\left(f * \sum_{r=1}^{R}\left(\varepsilon_{r,p} - \varepsilon_{0,p}\right)^2\right) * \frac{1}{P}\right] + \left[\left(1+\frac{1}{P}\right) * \frac{\sum_{p=1}^{P}\left(\varepsilon_{0,p} - \bar{\varepsilon}_{0,P}\right)^2}{P-1}\right]}$$

Sampling Variance + Measurement Variance

- Where
  - ✓ When JK1, *f=(nreps-1)/nreps*
  - ✓ When JK2, *f=1.0*

Types of Samples

- Independent
  - ✓ The units do NOT come from the same sampling frame
  - ✓ Errors are not correlated
  - ✓ Example:
    - Comparing results from one year to the next
    - Comparing results between countries

Types of Samples

- Dependent
  - ✓ The units come from the same sampling frame
  - ✓ The errors are correlated
  - ✓ Example:
    - Comparing any variable within a country
    - Comparing results from a country with an international or composite estimate
  - ✓ We need to take the dependency into account

Calculating Error of a Difference

- Between independent samples:

$$SE_{(a-b)} = \sqrt{SE_a^2 + SE_b^2}$$

  - ✓ Calculate the statistics with corresponding error
  - ✓ Use the formula above
  - ✓ The comparison value is:

$$t = \frac{(a-b)}{SE_{(a-b)}}$$

Calculating Error of a Difference

- Between dependent samples WITHOUT plausible values:

$$SE_{(a-b)} = \sqrt{\left[f * \sum_{r=1}^{R} \left((a_r - b_r) - (a_0 - b_0) \right)^2 \right]}$$

- Between dependent samples WITH plausible values:

$$SE_{(a-b)} = \sqrt{\left[\sum_{p=1}^{P} \left(f * \sum_{r=1}^{R} \left((a_{r,p} - b_{r,p}) - (a_{0,p} - b_{0,p}) \right)^2 \right) * \frac{1}{P} \right] + \left[\left(1 + \frac{1}{P} \right) \frac{\sum_{p=1}^{P} \left((a_{0,p} - b_{0,p}) - (\bar{a}_{0,P} - \bar{b}_{0,P}) \right)^2}{P-1} \right]}$$

Calculating Error of a Difference

- In regression models we have that…

$$y = a + r_1 x$$

- When "*x*" takes on values of 1 or 0, we have the following property:
  - ✓ When *x=0*, we have that *y=a*
  - ✓ When *x=1*, we have that *y=a+(b-a)*
- For dependent samples, we can use the regression approach

$$SE_{(a-b)} = SE_{r_1}$$

Calculating Error of a Difference

- Careful coding of categorical/grouping variables in combination with Regression statistics
  - ✓ Dummy Coding
  - ✓ Effect Coding
  - ✓ Contrast Coding

Error of Difference with Composite

- The error of the difference between a national statistic and the international (composite) one is:

$$SE_{(\alpha-a)} = \sqrt{SE_{\alpha}^2 + \left(\frac{(C-1)^2 - 1}{C^2}\right) SE_a^2}$$

- We divide the difference by the error

Thank you!

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