Opening Presentation
From Hypotheses to Estimands?

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From Hypotheses to Estimands

- So far, empirical social research follows a “hypotheses approach”

- Recently, Lundberg, Johnson, and Stewart suggested instead an “estimands approach” (Lundberg et al. 2021)
  - Estimand: “the thing we are estimating”
  - “Our contention is that greater attention to estimands could revolutionize substantive claims and reorient methodological guidance.”

- This presentation asks
  - Should we abandon the hypotheses approach?
  - Should we instead follow the estimands approach?

The Hypotheses Approach

- We use one/several theories to "derive" hypotheses
  - H1: D affects Y positively
  - H2: A affects Y negatively

- Then we estimate the following regression equation

$$Y = \alpha + \beta D + \gamma A$$

  - β is interpreted as effect of D on Y ("net of A")
  - γ is interpreted as effect of A on Y ("net of D")

Problem I: What is Your Estimand?

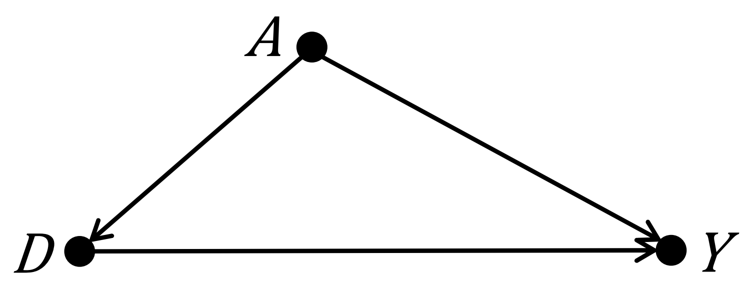
- It is unclear, what the theoretical quantity of interest is
  - What does “affect” mean?
  - A descriptive association,
    a total causal effect,
    a direct causal effect,
    … ?
- So, basically the estimands are regression coefficients
  - H1: β is (statistically significant) positive
  - H2: γ is (statistically significant) negative

- But it is unclear, which question we answer by this
  - “Productive scientific exchange is difficult when articles do not make clear what question was answered” (Lundberg et al. 2021)
  - “We’re great at giving answers without knowing the question” (Felix Elwert)

Problem II: Which Question Does Your Regression Coefficient Answer?

- The standard approach, where one regression is used to test several hypotheses, has serious drawbacks (Keele et al. 2019)
  - Regression coefficients may answer different questions
  - And it is unclear, which one
- For instance, if this is the causal structure of the data generating process

$$Y = \alpha + \beta D + \gamma A$$



  - Then β estimates the **total causal effect** of D on Y (because we control for the confounder A)
  - γ estimates the **direct causal effect** of A on Y (after controlling for the mediator D)

Problem III: What is Your Identification Strategy?

- It is unclear, how the “effects” can be identified
  - Identifying assumptions are hidden
    - “Controls” are entered without any theoretical arguments
    - Often mediators are also controlled (overcontrol bias)
    - Sometimes conditioning on a collider (endogenous selection bias)

The Estimands Approach

- Not a new method, not even a new methodology

- It is just a new style of doing/presenting research:

  Be explicit on

  What to estimate (the estimand)

  The assumptions needed to identify and estimate the estimand

Stylized Scheme of the Estimands Approach

1. Theoretical estimand: define the unit-specific quantity of interest
   - “Theoretical” because it does not refer to data
   - Discuss how the estimand relates to theory
     - Does the chosen estimand inform us about theory?
     - If one wants, one could state hypotheses about the estimand
2. Identification: link the estimand to observables in the data
   - This defines an empirical estimand
   - Discuss the identification of the empirical estimand
     - Here one needs theory about the data generating process
     - It is helpful to visualize it in the form of a DAG
   - Discuss the plausibility of the identification assumptions
3. Estimation: select a statistical model
   - Discuss how the model is able to provide an estimate of the estimand
   - Discuss estimation assumptions

Example: Causal Survey Research

- We use a theory to derive a hypothesis
  - H: D affects Y positively

1. **Estimand: Defining the theoretical estimand**
   - The estimand is the total causal effect of D on Y

$$\text{ATE} = E[Y^1] - E[Y^0] = \frac{1}{n}\sum_{i=1}^{n} (Y_i^1 - Y_i^0)$$

Mean over all German adults

Potential outcome for D=1

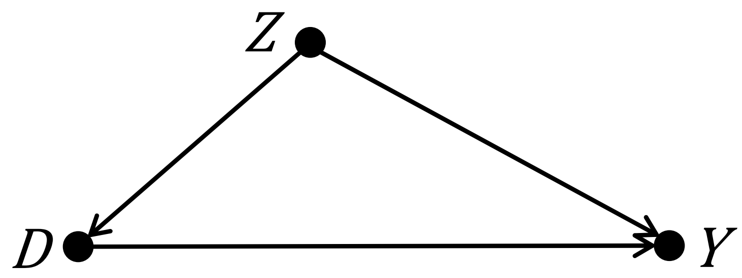
Potential outcome for D=0

Target population

Unit-specific quantity

Example: Causal Survey Research

2. **Identification: Link to an empirical estimand**
   - Our theory of the data generating process implies that we should control for confounder Z



   - Therefore, our empirical estimand (θ) is the conditional NATE

$$\theta = E[Y^1|D = 1, Z] - E[Y^0|D = 0, Z]$$

   - Note that the conditional NATE consists only of observable quantities
   - Identification assumption: there are no other confounders

Example: Causal Survey Research

3. **Estimation: Learn the empirical estimand from data**
   – Estimate the conditional means and plug them in the formula for θ

$$\hat{\theta} = \hat{E}[Y^1|D = 1, Z] - \hat{E}[Y^0|D = 0, Z]$$

   – Could be done by stratification
   - No functional form assumptions needed, fully interacted
   - But problem with the curse of dimensionality

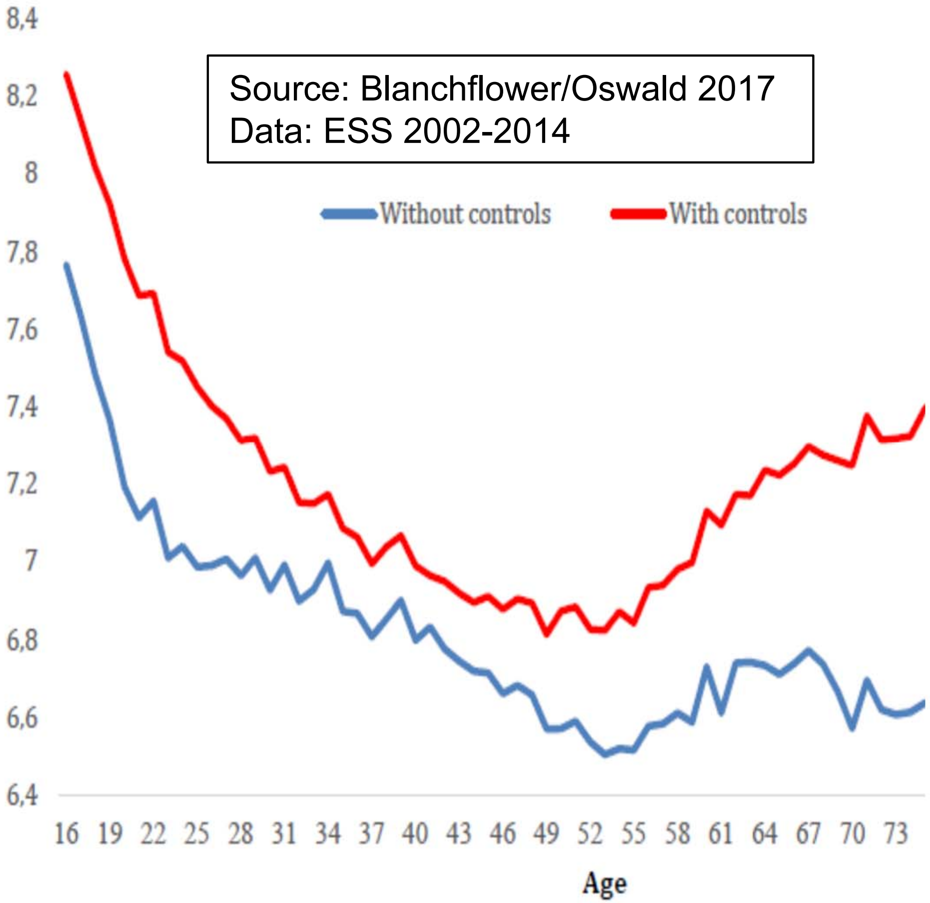
   – It has become habit, to estimate the conditional NATE by regression

$$Y = \alpha + \beta D + \gamma Z$$

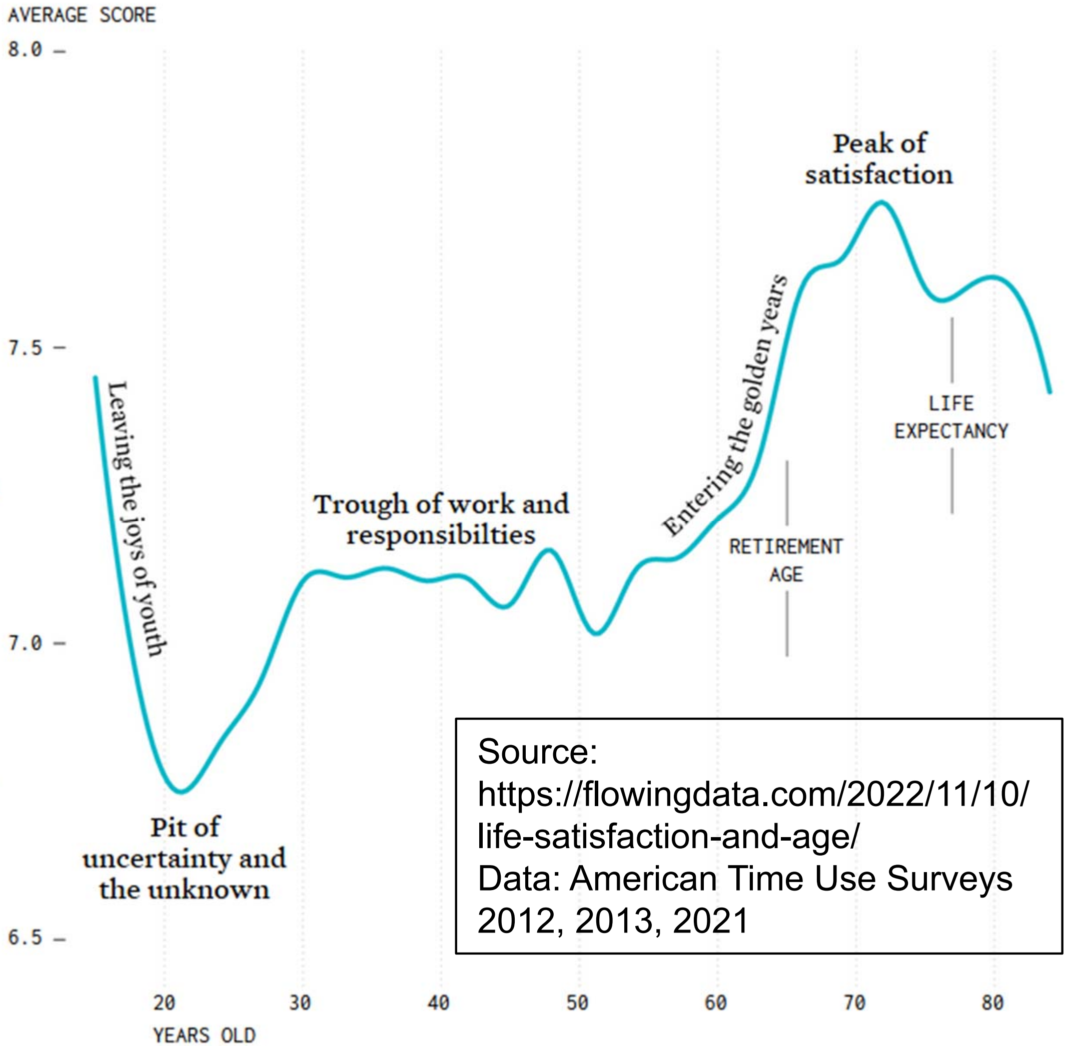
   - $\hat{\beta}$ provides an estimate of the empirical estimand
   - However, regression rests on strong assumptions concerning the data generating process, e.g., linearity with no interactions, normality, etc.

Example: Age and Happiness (Kratz/Brüderl 2021)

- Mixed evidence on the age trajectory of happiness
  - Due to questionable identification and estimation assumptions
  - Different (implicit) estimands



Source: Blanchflower/Oswald 2017
Data: ESS 2002-2014



Source: https://flowingdata.com/2022/11/10/life-satisfaction-and-age/
Data: American Time Use Surveys 2012, 2013, 2021

Example: Age and Happiness

- Theoretical estimand I (causal estimand)
  - RQ I: How does aging affect happiness?

$$\text{ATE}(a, a^*) = \frac{1}{n: l_i \geq a^*} \sum_{\boldsymbol{i=1}}^{l_i \geq a^*} [Y_i(a^*) - Y_i(a)]$$

  - Identification: no unobserved time-varying composition effects
  - Estimation: Fixed-effects regression

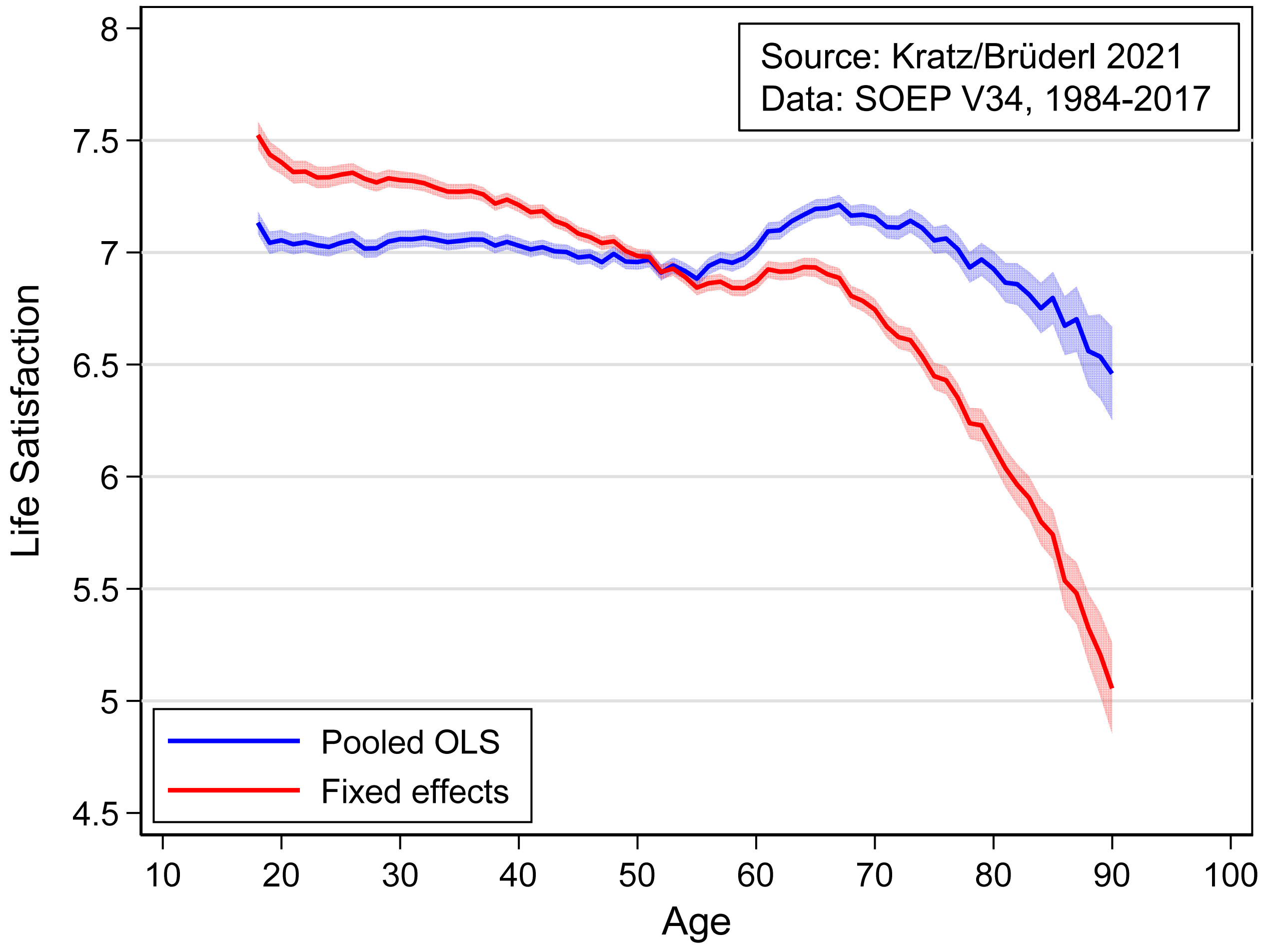
- Theoretical estimand II (descriptive estimand)
  - RQ II: How happy are people (who are still alive) at different ages?

$$\Delta(a, a^*) = \frac{1}{n} \sum_{i=1}^{n} Y_i(a^*) - \frac{1}{m} \sum_{j=1}^{m} Y_j(a)$$

  - Identification: no unobserved composition effects
  - Estimation: pooled OLS

Example: Age and Happiness

- Results with SOEP data
  - RQ II: Flat curve, increase in golden ages, slow decline in old ages
  - RQ I: Steady decline, halt during golden ages, sharp decline in old ages



Conclusion

- "So what is your estimand?"
  - "If you do not answer this question, you have missed an opportunity to clarify your contribution to knowledge."
- The estimands approach increases transparency and thereby credibility of (social) research
  - The estimands approach makes implicit decisions explicit
  - Therefore, it increases the transparency of scientific work
- Reluctance may stem from the fact that transparency lays open the weak points of ones research
  - Researchers should see this as a virtue, not as a deficit
  - Reviewers/editors should require this kind of transparency

References

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Structure of a paper following the estimands approach

- Section: Theory
  - Theoretical estimand
- Section: Data
  - Data (including target population)
  - Measures
- Section: Analytical Approach
  - Identification
  - Estimation