Survey analysis
week 38

Decomposing error and bias
“Total Survey Error”

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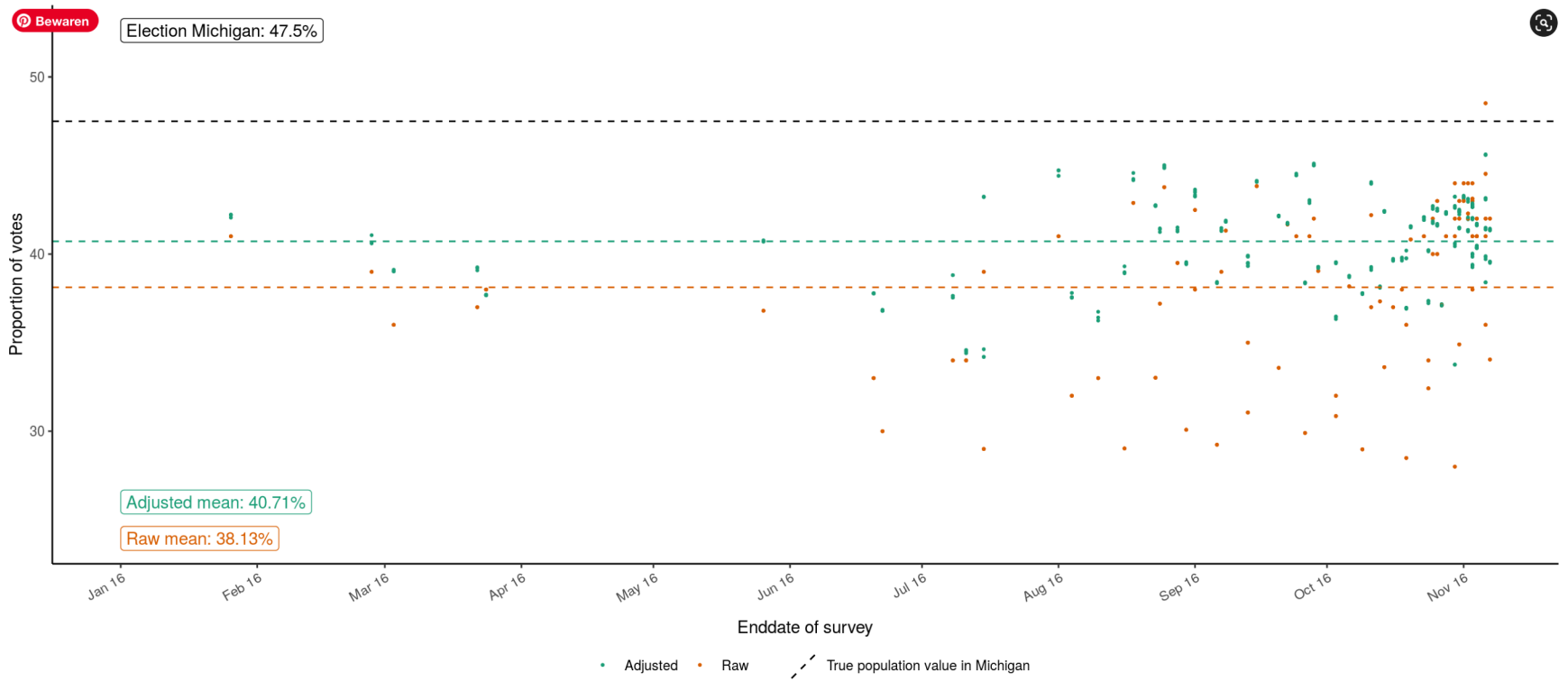
Today

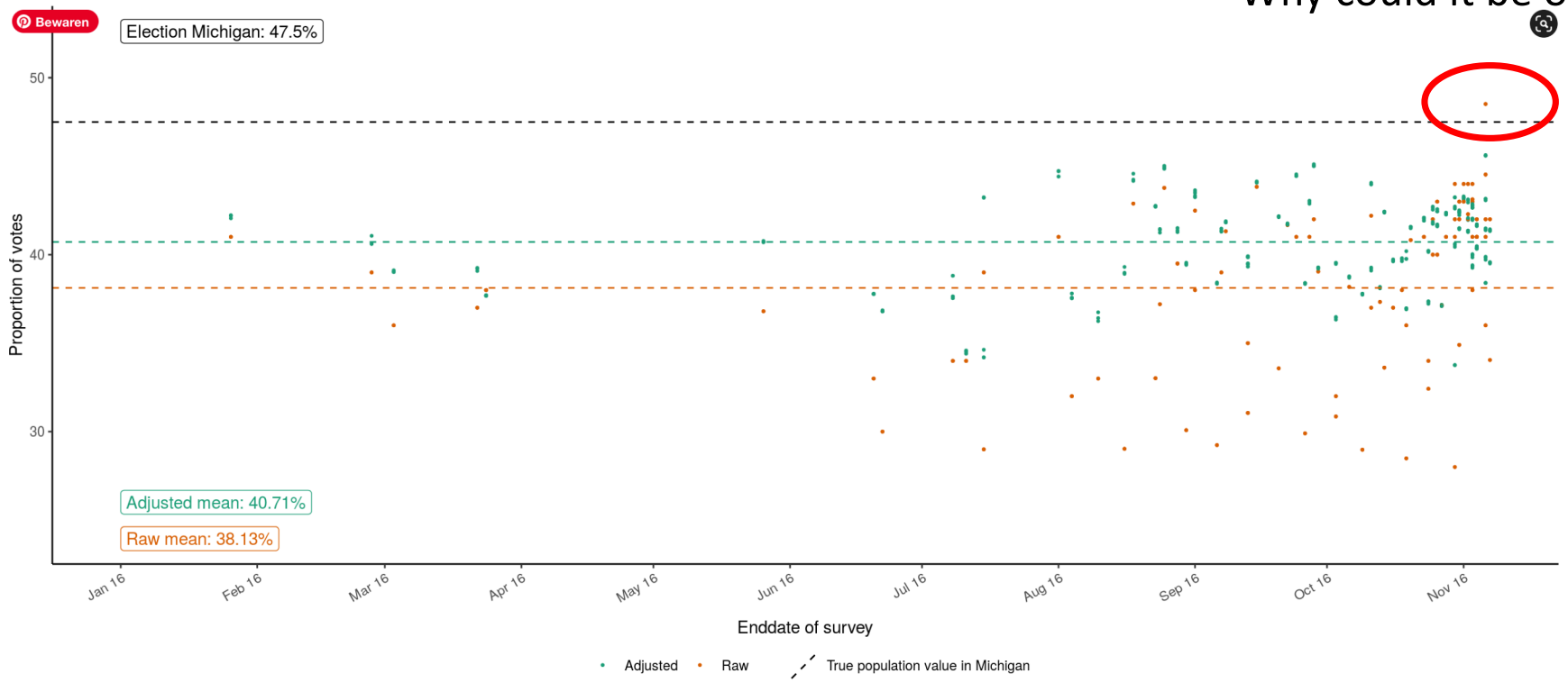
- Bias, error and MSE
- Total Survey Error (TSE)
- Total data error (TDE)
- How survey design affects error
  - The central role of survey modes

Class exercise week 1



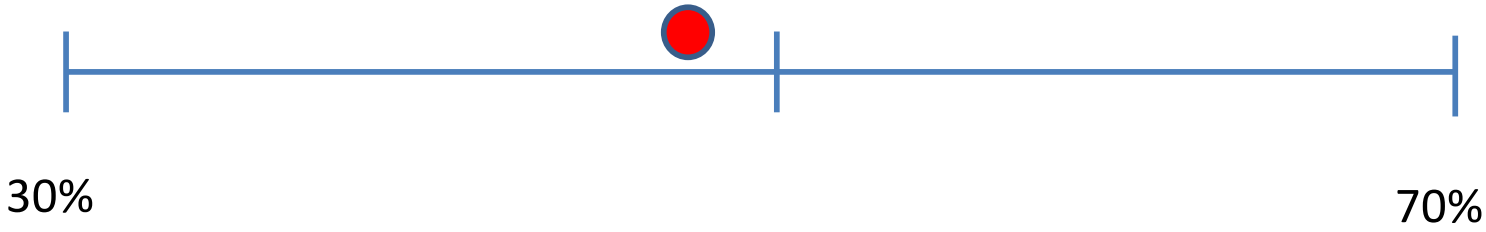
Class exercise week 1

Let's focus on 1 sample:
Why could it be off?



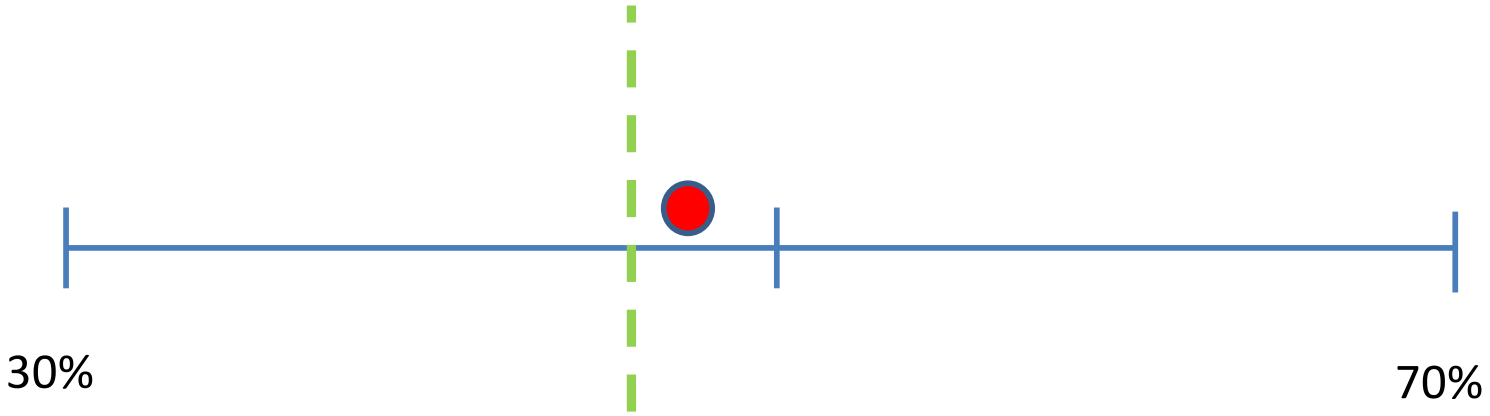
1 sample in Michigan: point estimate

- Estimate: 48%
- n= 1000



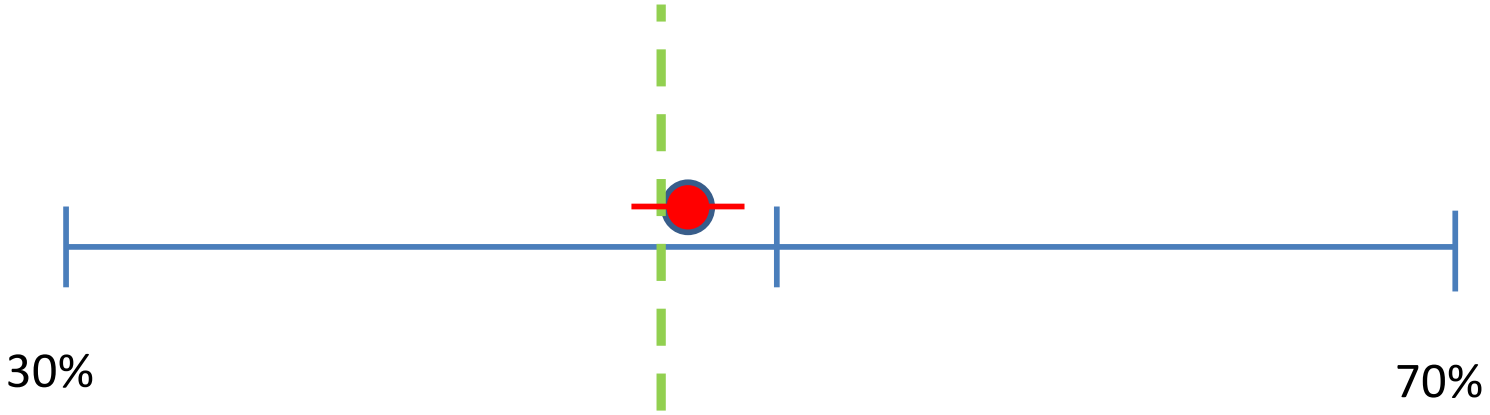
1 sample: bias

- Estimate: 48%
- True value: 47.5%
- Bias: 48-47.5 = 0.5% $\widehat{B} = \bar{y}_R - \bar{\mu},$ (biemer, 2010)



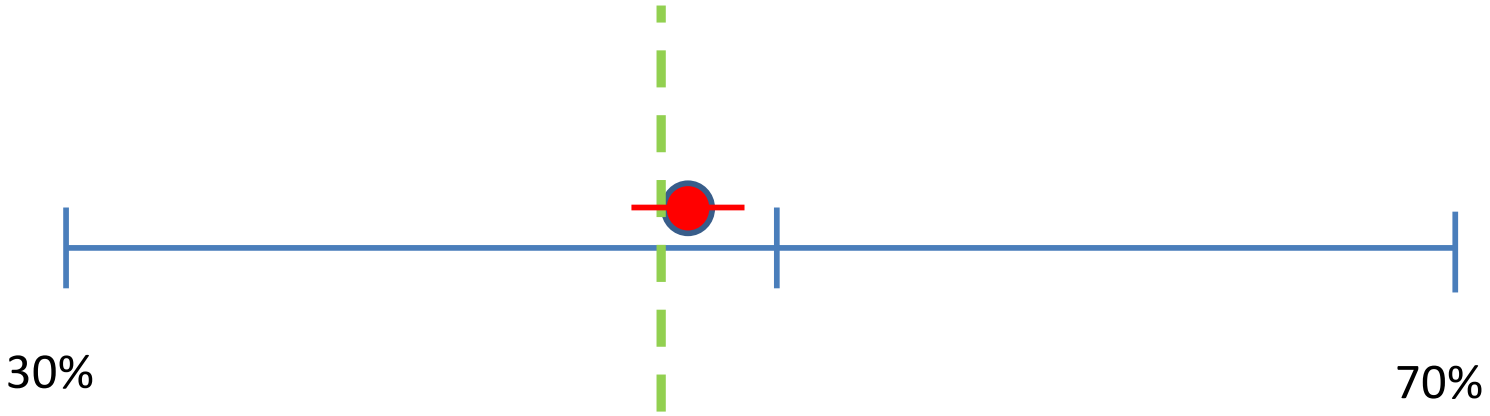
1 sample: error

- Point estimate: 48%
- Standard error (Se)r = $\sqrt{p(1-p)/n}$.
- Se(r): sqrt(.48*.52)/ 1000 = .016
- Confidence interval: [.45 - .51]
  - [p +- 1.96 * se]
- Is error or bias a bigger problem?



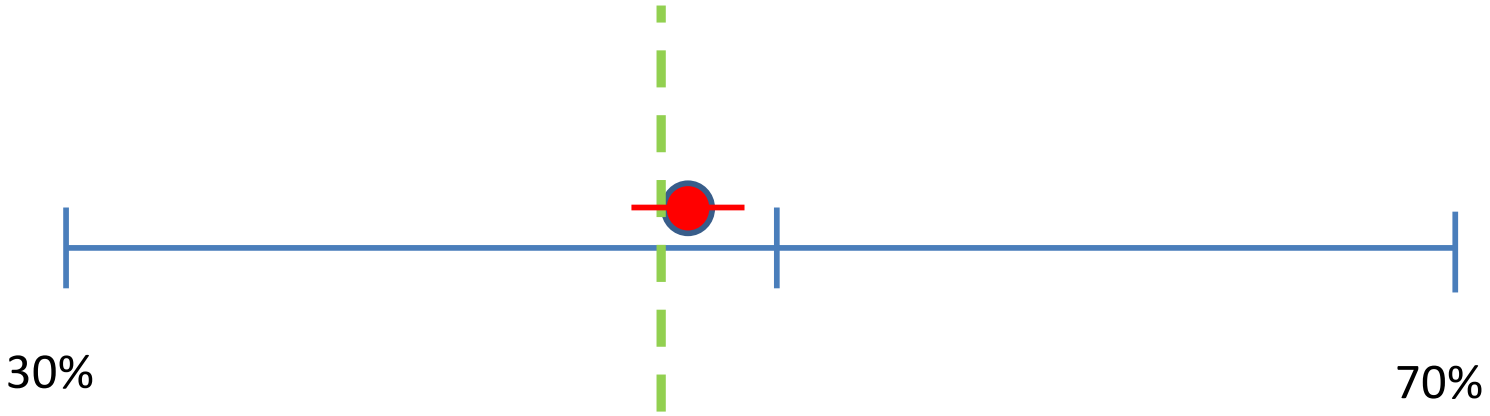
Estimate + error + bias

- True value is within confidence interval!
- So, we have to assume there is bias
  - Or, is the bias we see higher than expected error?
  - Next week, more on bias and error in samples
- Mean Squared error (MSE): $bias^2$ + error



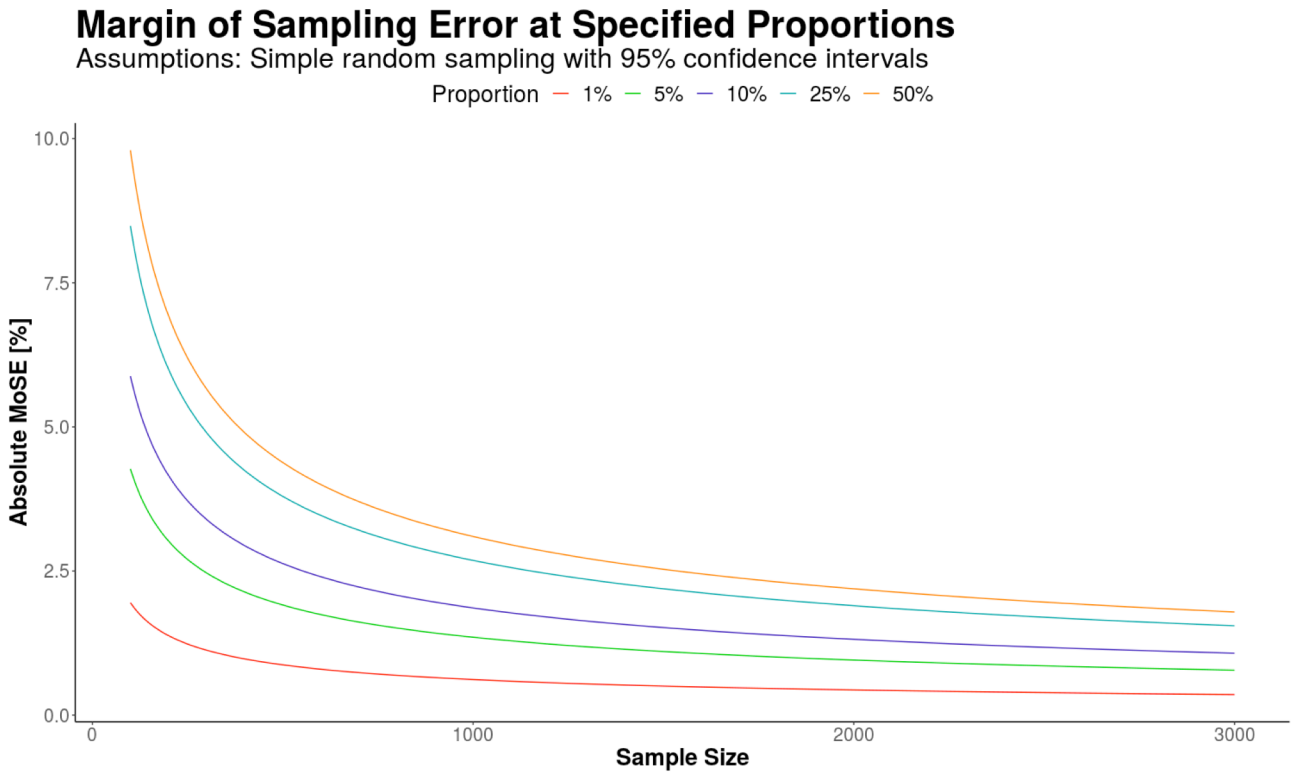
Mean square error

- MSE = $.005^2$ + .016 = .000025 + .016 = .016025
- Sampling error seems larger problem
- Biemer: a bit more complicated as true value also has a variance $\widehat{MSE}(\bar{y}_R) \doteq \hat{B}^2 - v(\bar{\mu}) + 2\sqrt{v(\bar{y}_R)v(\bar{\mu})},$
  - Estimating population variance in mean tricky…

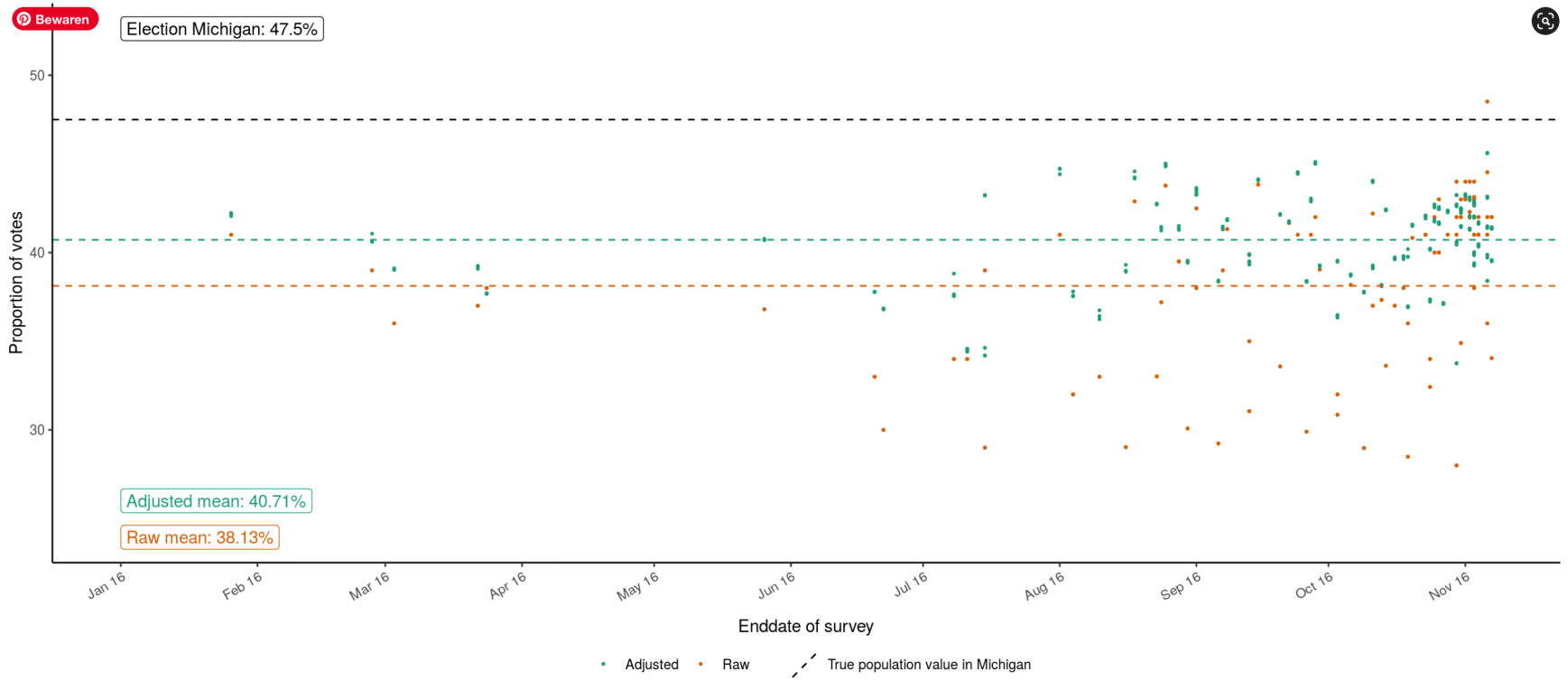


Survey design

- What if we increase sample size?
  - 10000 instead of 1000?
  - Se(r): sqrt(.48*.52)/ 10000 = .005



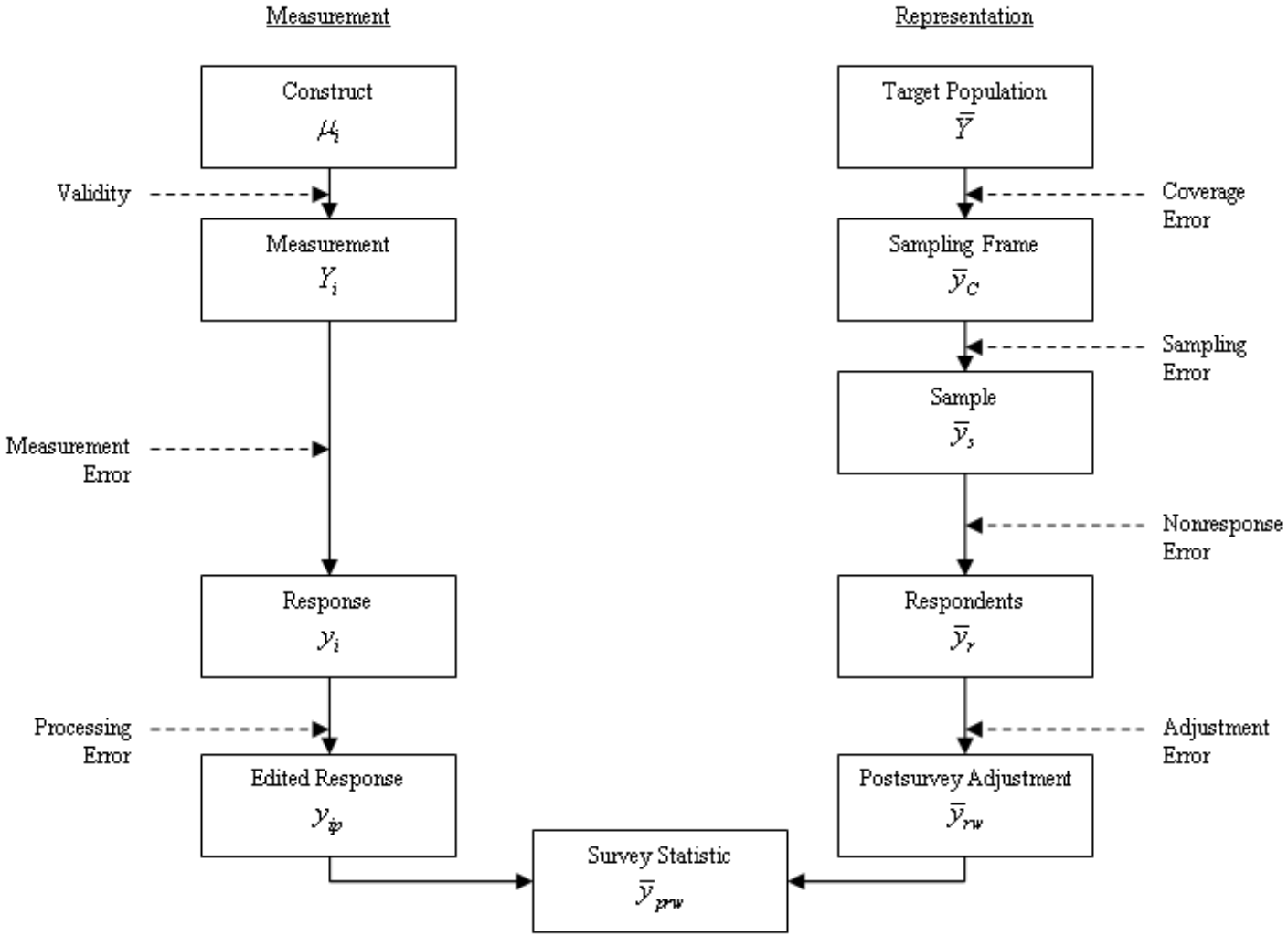
Why we still worry about bias



Bias and error in more detail

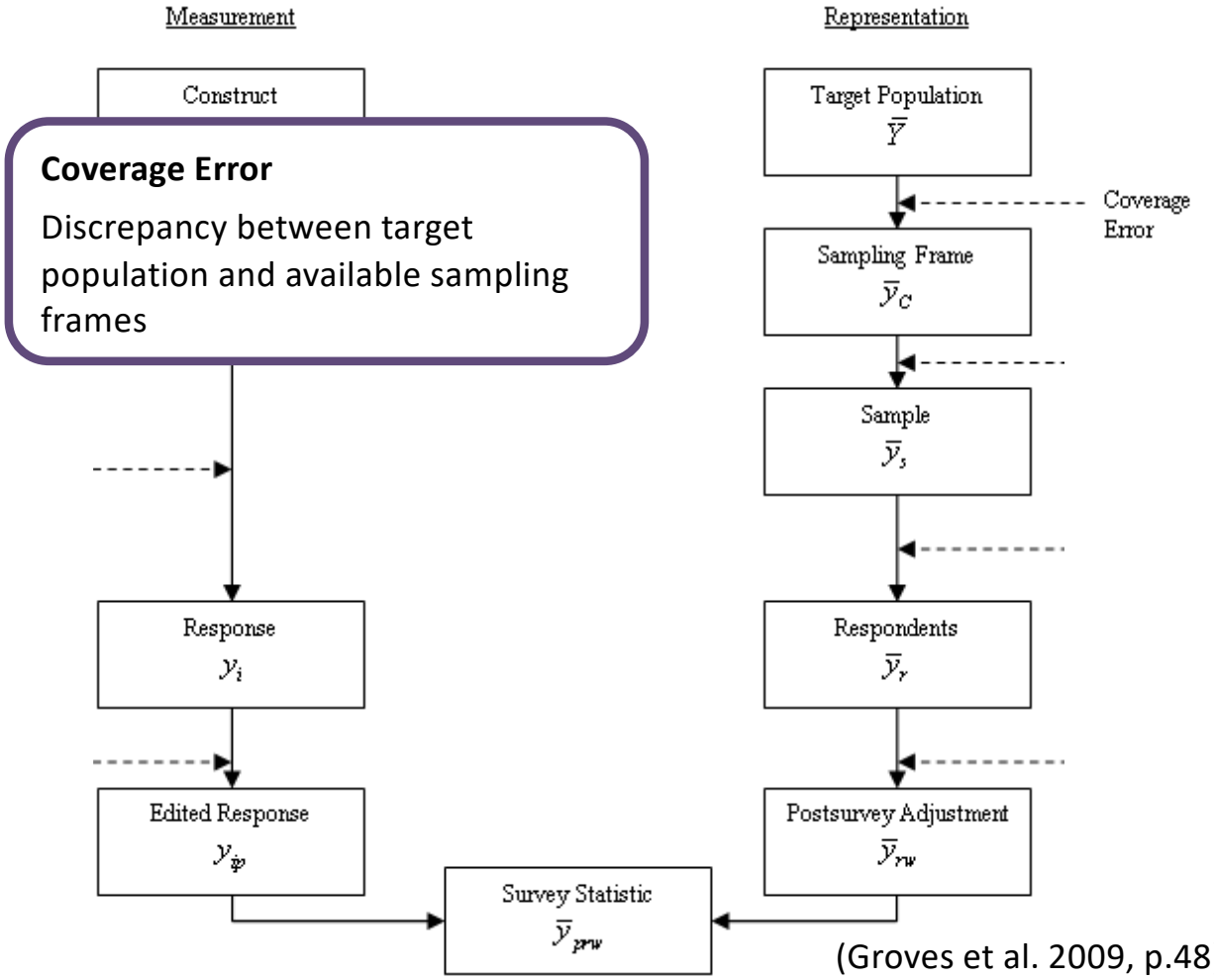
Total Survey Error

Total Survey Error Framework



(Groves et al. 2009, p.48)

Total Survey Error (TSE) Framework



(Groves et al. 2009, p.48)

Terminology: coverage error

- (target) Population: group of units (people, companies, households, etc.) you are studying
- Sampling frame: list containing population elements
- Undercoverage: should be on, but is not
  - Not have an address, telephone, e-mail
- Overcoverage: should not be on, but is
  - Two phones, multiple e-mail, has died, has moved

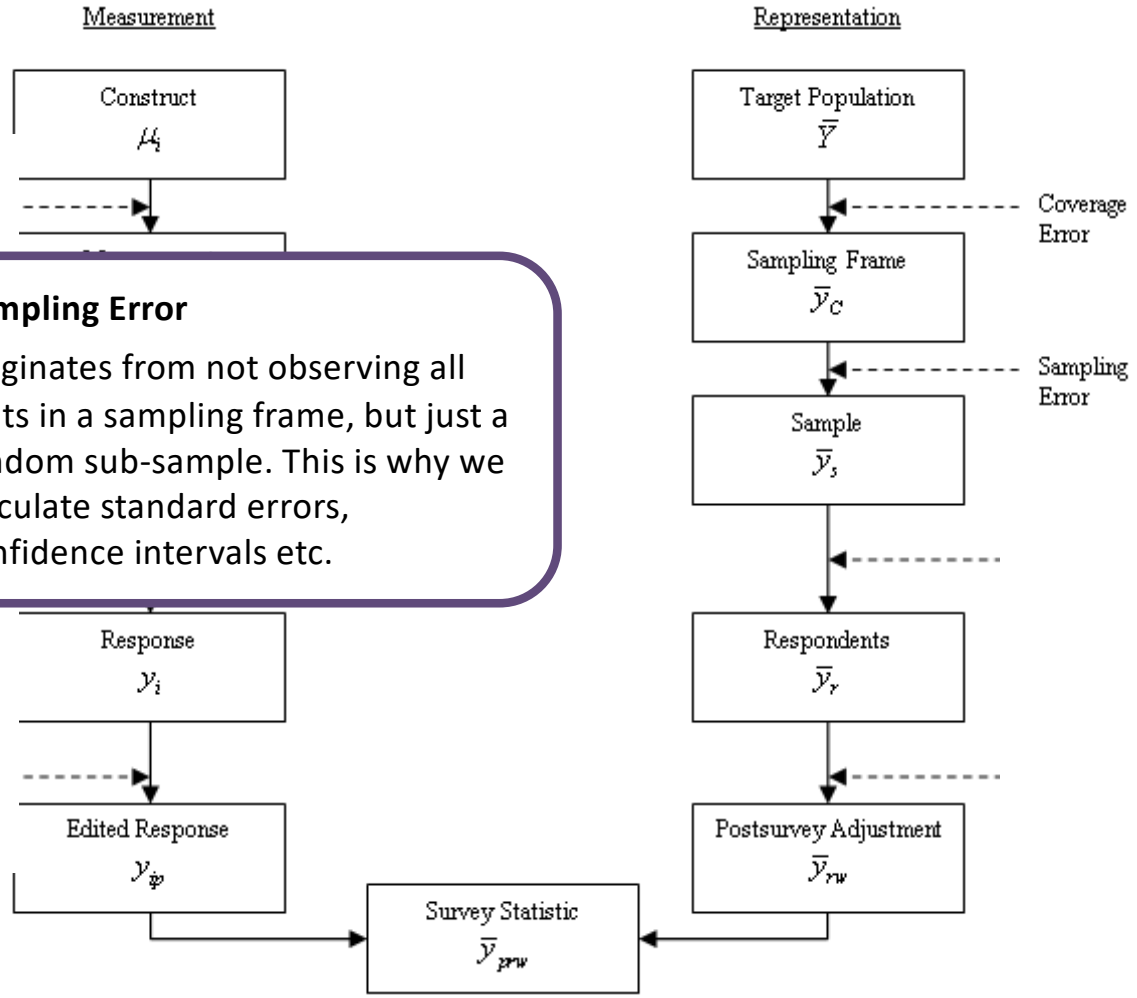
- From: population register, schools, health records

Coverage error and modes

- Modes:
  - Web: no lists of e-mailadresses (unless special population) ☹
  - Paper: invitations by mail to households ☹
  - face-to-face: Use list addresses or random walk ☹
  - Telephone: Random Digit Dialing, mobile phones ☹

- Lists are seldom up-to-date
  - Really….

TSE – sampling error



Sampling Error

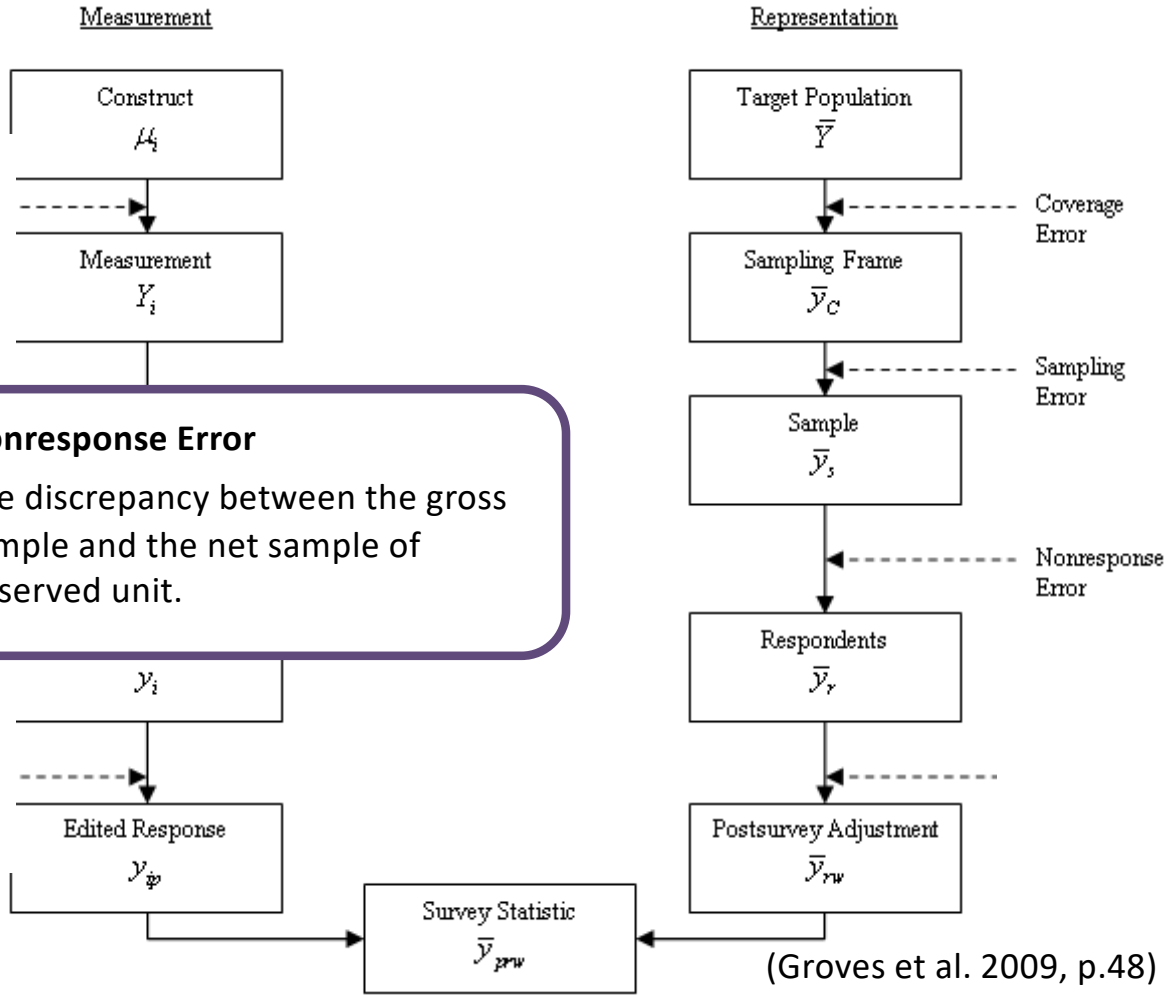
Originates from not observing all units in a sampling frame, but just a random sub-sample. This is why we calculate standard errors, confidence intervals etc.

Terminology: sampling error

- Sampling unit: collection of units to be sampled from your frame
- Sample: the actual units you sample
- Respondents: the people out of the sample who participate

- Sampling can introduce bias and error!
  - Selecting people within households
  - Villages, hospitals, etc, etc.

TSE – nonresponse error



Nonresponse Error

The discrepancy between the gross sample and the net sample of observed unit.

(Groves et al. 2009, p.48)

Nonresponse error and bias

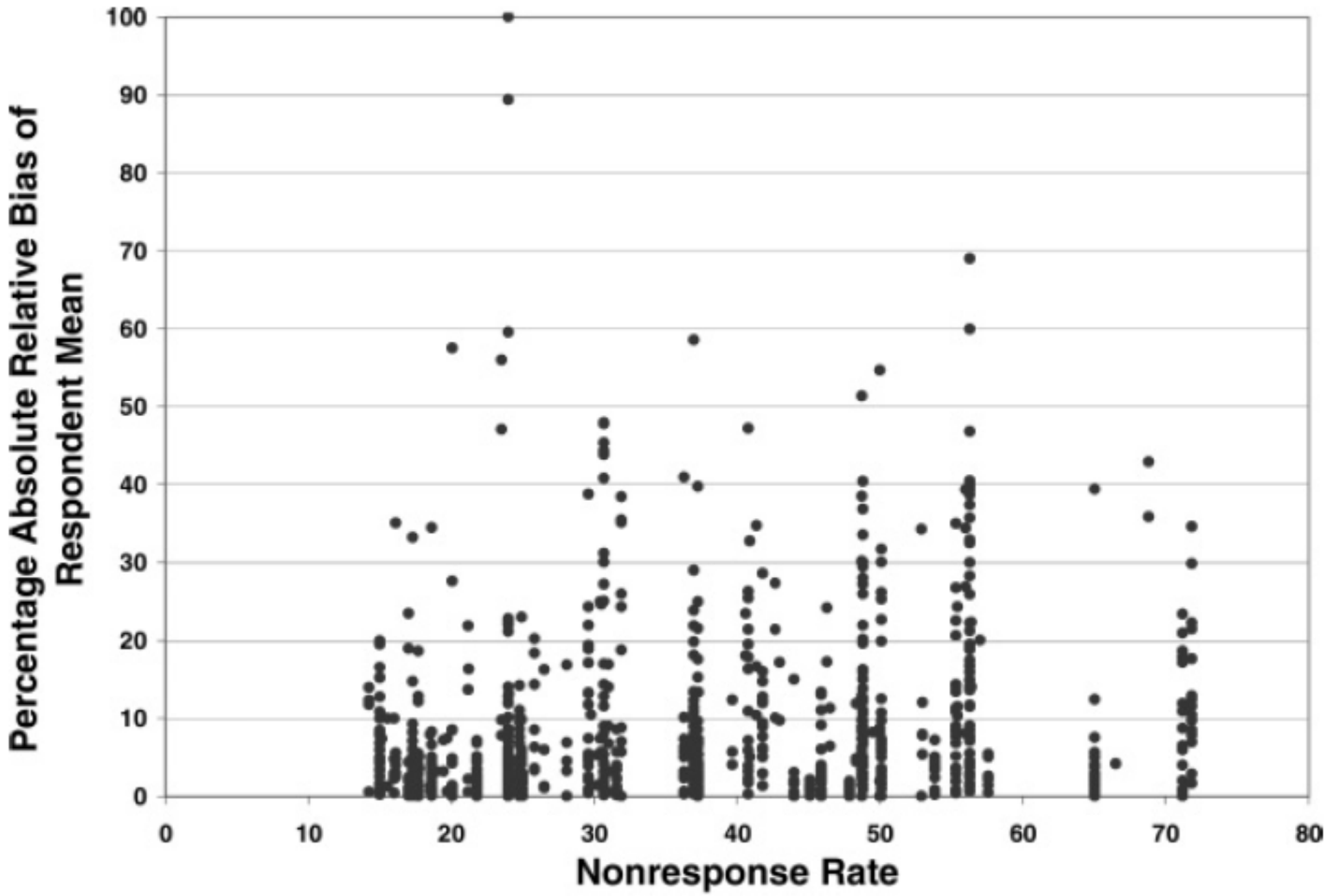
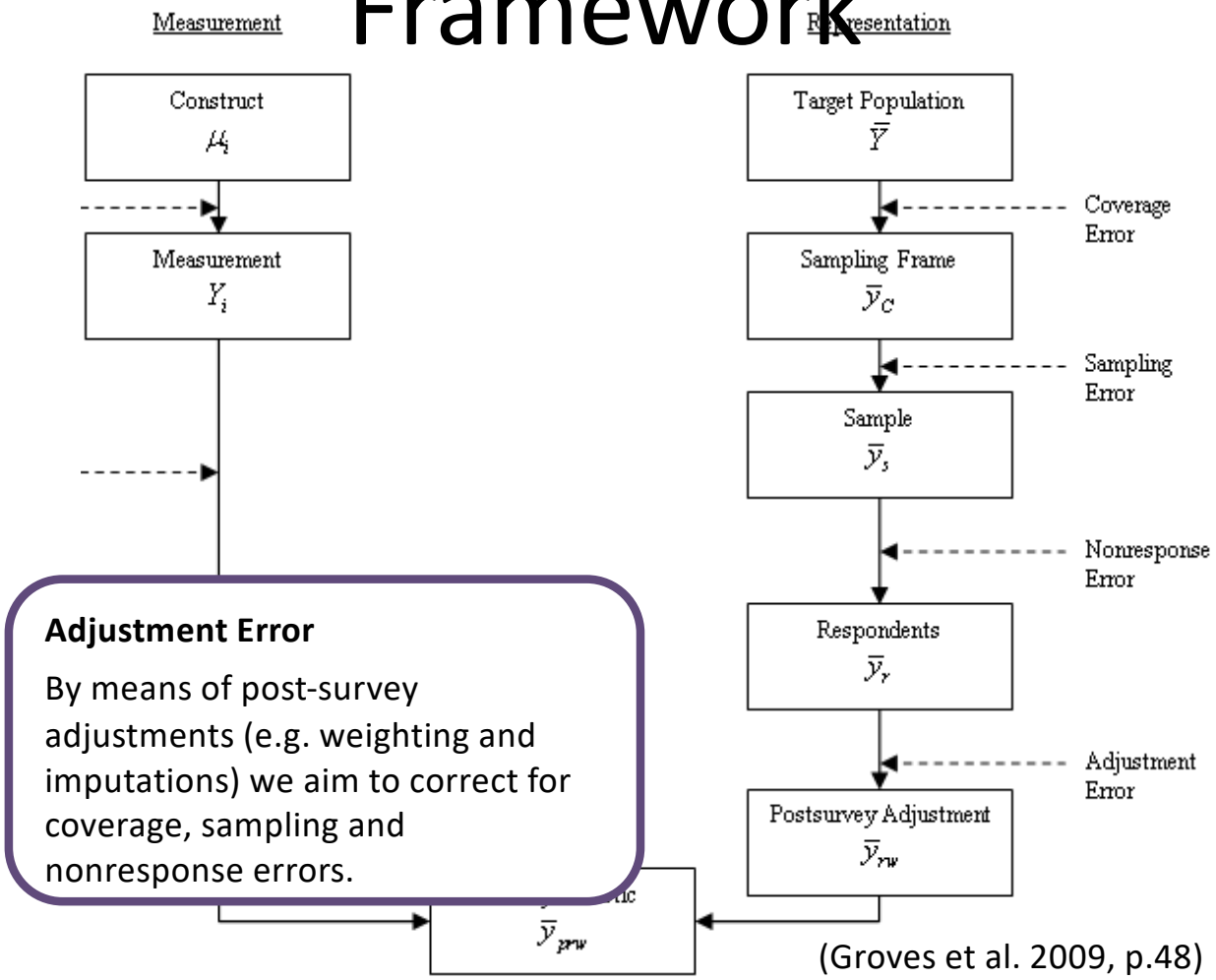


Figure 2. Percentage Absolute Relative Nonresponse Bias of 959 Respondent Means by Nonresponse Rate of the 59 Surveys in Which They Were Estimated.

Source: Groves, R. M., & Peytcheva, E. (2008). The impact of nonresponse rates on nonresponse bias: a meta-analysis. *Public opinion quarterly*, *72*(2), 167-189.

Total Survey Error (TSE) Framework

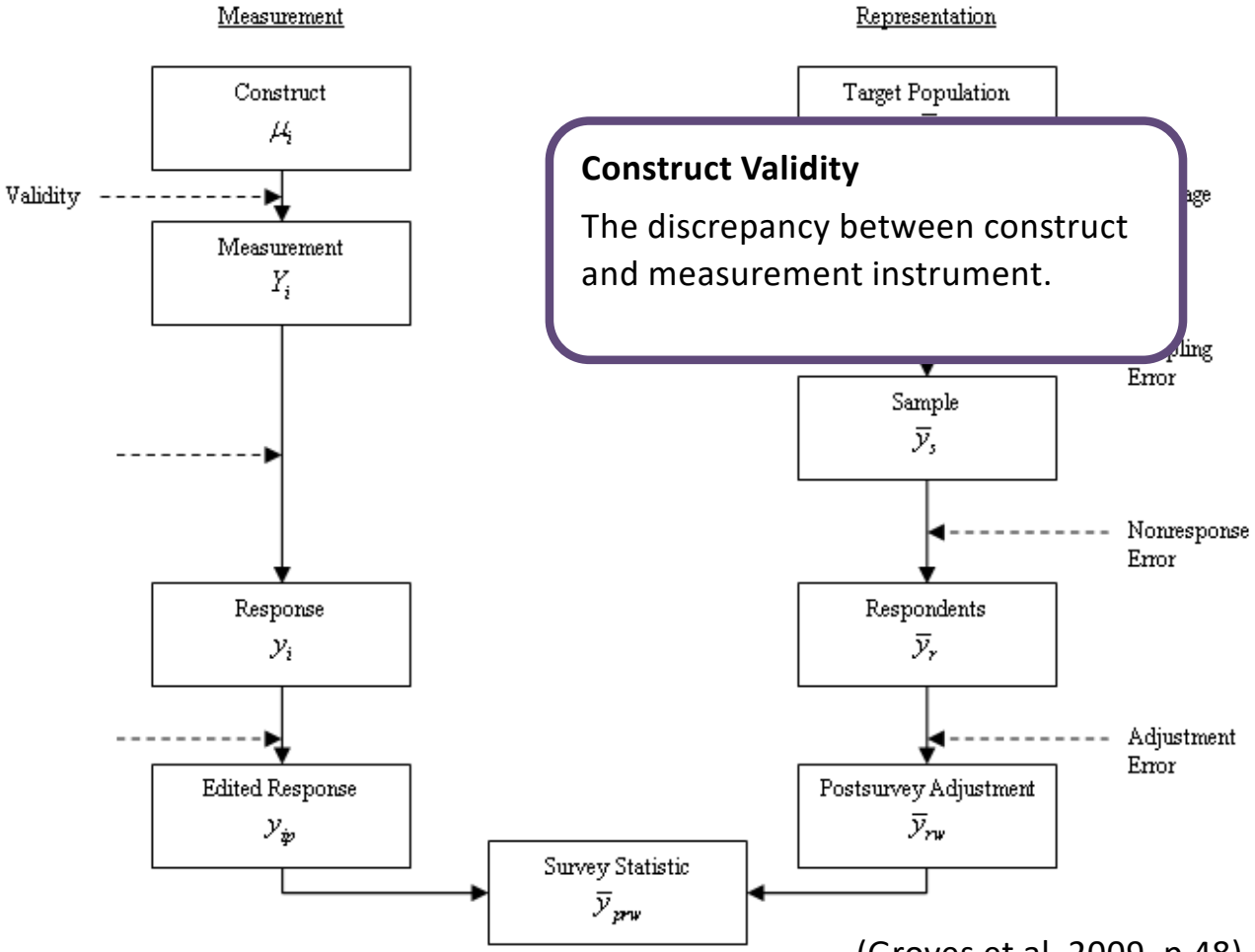


Adjustment Error

By means of post-survey adjustments (e.g. weighting and imputations) we aim to correct for coverage, sampling and nonresponse errors.

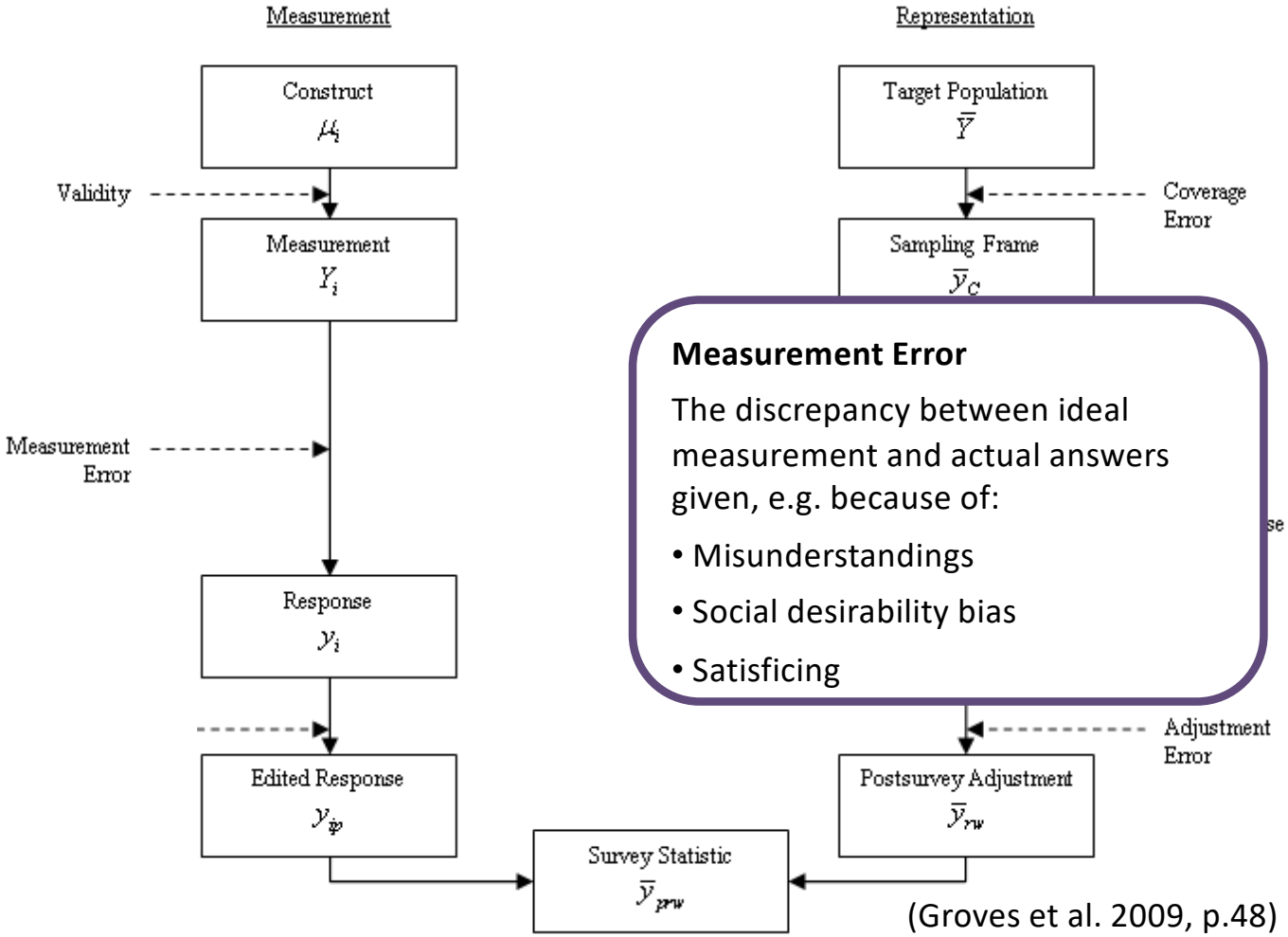
(Groves et al. 2009, p.48)

TSE – construct validity



(Groves et al. 2009, p.48)

TSE – measurement error



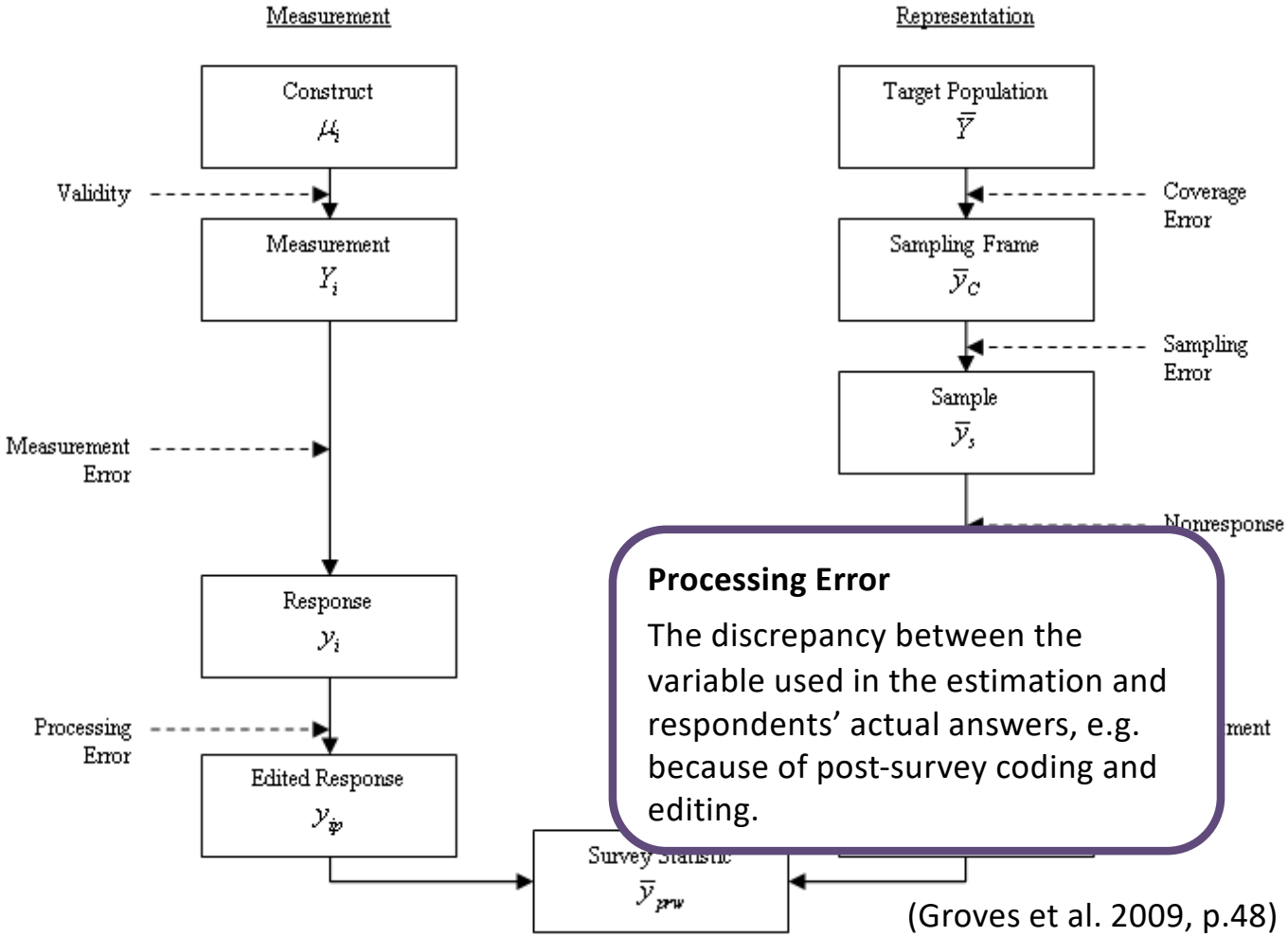
Measurement Error

The discrepancy between ideal measurement and actual answers given, e.g. because of:

- Misunderstandings
- Social desirability bias
- Satisficing

(Groves et al. 2009, p.48)

TSE – processing error



Processing Error

The discrepancy between the variable used in the estimation and respondents' actual answers, e.g. because of post-survey coding and editing.

(Groves et al. 2009, p.48)

In sum

- In design-based surveys:
  - Sampling error only error we know
  - We can control **by increasing sample size**
  - But many more sources of error/bias
    - Hard to always quantify exactly
- It is not strange polls are off!
- Key question in Survey design:
  - In order to minimize MSE:
  - Do we invest in larger sample, or more nonresponse follow-ups? Incentives, etc?

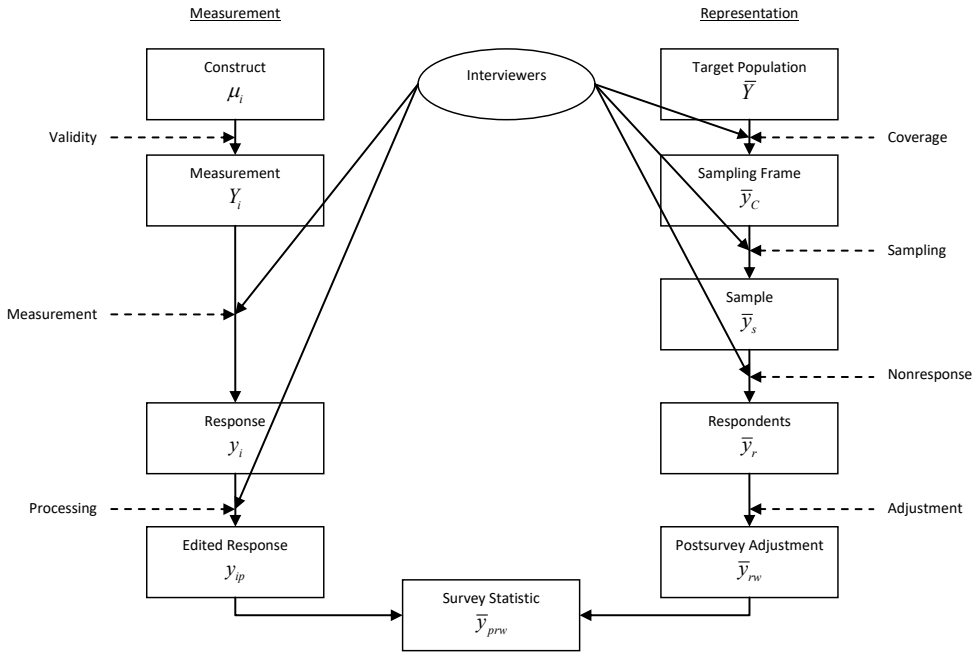
Exercise 1a (and then break)

Form pairs and tell (and ask!):

1. What is the name of your survey?
2. What is the population of the study?
3. How are individuals selected to be invited for the survey? (sampling design)
4. What is the sample size?
5. What survey mode is being used?
6. What methods to prevent nonresponse?
7. What are the central concepts that are measured in the survey?

TSE and survey design

- Design aspects greatly affect survey errors
  - Invitation mode
  - Administration mode
  - Interviewers
  - Incentives
  - Questionnaire length
  - Etc.



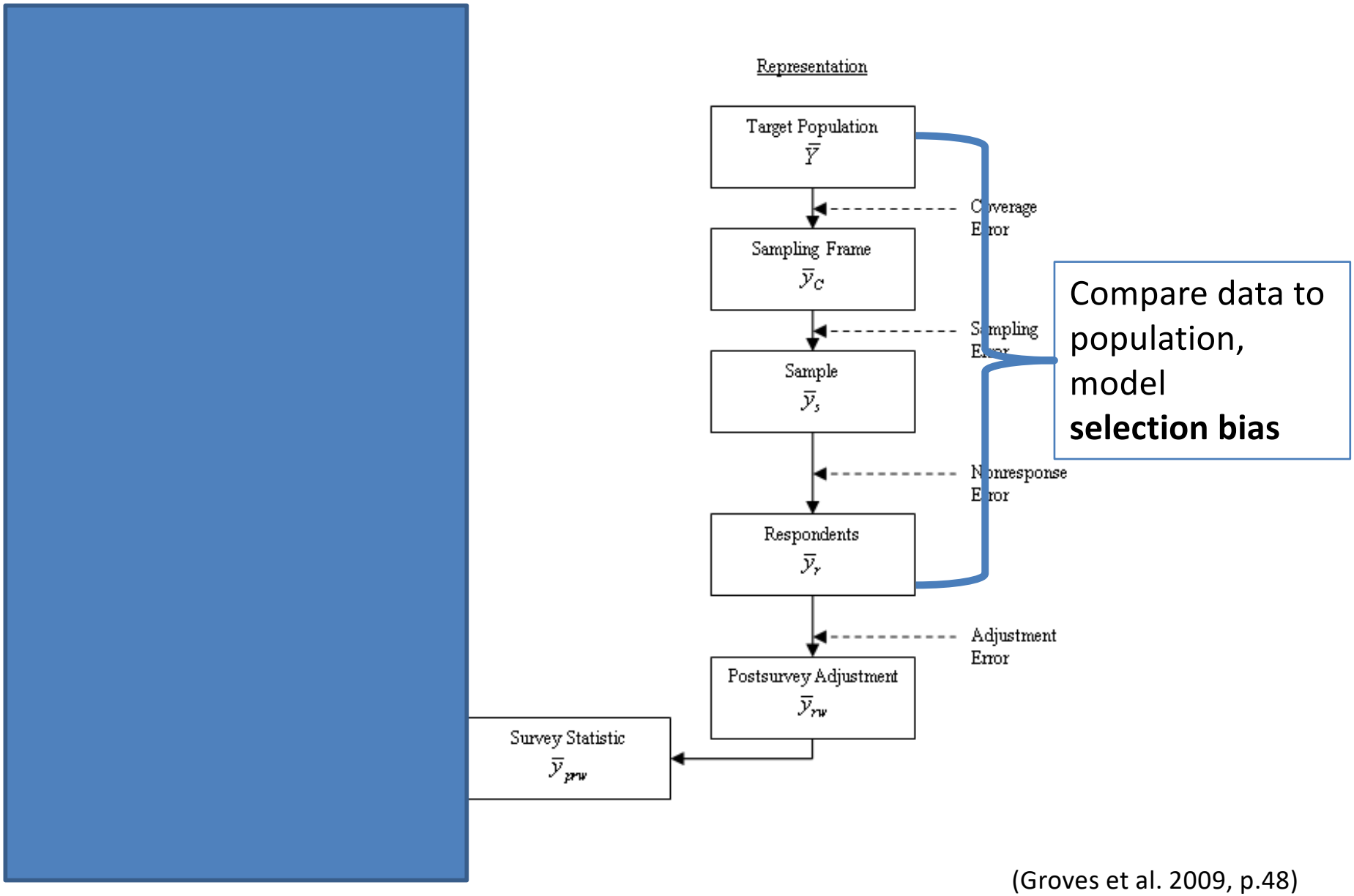
Groves and Lyberg (2010)

- History of the TSE framework
- There are extensions to
  - comparative surveys (Smith 2010),
  - longitudinal surveys (Lynn and Lugtig 2017),
  - analytic error (West and Saskhaug 2018)
  - … and Total Data error (other data sources)
    - Administrative, sensor, social media, etc.
    - See also weeks 49,50

TSE and model-based inference

- Convenience samples
- Volunteer opt-in panels
- (Quota samples)
- Lab-studies (psychology), organic data, social media, etc.

Model-based inference



(Groves et al. 2009, p.48)

Exercise 1b (and then break)

Form pairs and discuss

1. What do you think is the biggest source of error in your chosen survey?
   - choose 1!

Exercise 1b

- Noncoverage error
- Sampling error
- Nonresponse error
- Adjustment error
- Validity
- Measurement error
- Processing error

In sum: How much to worry about each?

	Bias	Error
Coverage error	**	
Sampling error	*	***
Nonresponse error	***	*
Adjustment error		*
Validity of measurement	***	
Measurement error	**	**
Processing error		*

In sum: How much to worry about each?

	Bias	Error
Coverage error	**	
Sampling error	*	***
Nonresponse error	***	*
Adjustment error		*
Validity of measurement	***	
Measurement error	**	**
Processing error		*

Exercise: survey design

- Survey design. Think about:
  - 1. the list you could use (coverage error)
  - 2. the mode of the invitation
  - 3. The mode of survey administration
  - 4. Nonresponse error
  - (i.e. do not think about sample size)
- 15 minutes and report back

Class Exercise 2: group 1

- A researcher would like to know to what extent neighbours in high-rise flats (over 8 floors tall) in Utrecht help eachother out. She suspects that people help eachother mainly if they have the same ethnic and socio-economic background.

Class Exercise 2: group 2

- A researcher would like to study employee satisfaction in the Netherlands. The researcher is interested to study satisfaction in companies of different sizes (small/medium/large), and in different types of trade (services/government/industry/agriculture). The budget for the study is limited, so that the researcher can only include about 100 companies in the study.

Class Exercise 2: group 3

- A researcher would like to do a survey among homosexual muslims in the region of Utrecht to find out how the families of these men and women deal with this.

Class Exercise 2: group 4

- For the next elections for the European parliament, a market research firm with offices in all EU countries would like to do a pan-EU survey among the EU electorate to
- a) predict the outcome of the election in every country and
- b) compare the attitudes of people in different countries towards the European Parliament.

Class Exercise 2: group 5

- A researcher would like to do a survey among elderly people (age 70+) who group in shopping centres (malls) in the USA during the day. She is interested to find out why those elderly people choose to convene in malls, and not in any different place.

Class Exercise 2: group 6

- A researcher would like to better understand how patients who developed Covid-19 in the spring of 2020 (March-april) in Italy are now recovering from their illness. There is no central registry of patients in Italy; these are kept at hospitals, and if you want to reach these patients it is necessary to collaborate with individual hospitals in Italy.
- In the survey you want to ask questions about phsyical and mental wellbeing, as well as the effects Covid-19 has had on relations with household members (children, partner).

Next week

- Prepare
  - 1. Read Stuart (see e-mail last week)
    - Simple Random sampling
  - 2. Do THE exercise 2 (sampling)
- Lecture on Simple Random Samples