# Probability and non-probability sampling

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| | Sampling | Interviews | Data environment |
|---|---|---|---|
| 1st era | Area probability | Face-to-face | Stand-alone |
| 2nd era | Random digital dial probability | Telephone | Stand-alone |
| 3rd era | Non-probability | Computer-administered | Linked |

# Probability Samples

$$P(u_i) = \frac{p_i}{(N-1)\cdots(N-n+1)}\binom{N-1}{n-1}(n-1)! + \sum_{j\neq i}^{N}\frac{p_j}{(N-1)\cdots(N-n+1)}\binom{N-1}{n-1}(n-1)!\frac{n-1}{N-1},$$

which upon simplification becomes

$$P(u_i) = \frac{N-n}{N-1}p_i + \frac{n-1}{N-1}, \qquad (i = 1, 2, \cdots, N). \tag{19}$$

Similarly, it may be shown that for this case

$$P(u_i u_j) = \frac{n-1}{N-1}\left[\frac{N-n}{N-2}(p_i + p_j) + \frac{n-2}{N-2}\right], \qquad (i \neq j: i, j = 1, 2, \cdots, N). \tag{20}$$

# Non-Probability Samples


http://www.chicagotribune.com/news/nationworld/politics/chi-chicagodays-deweydefeats-story-story.html

## Probability Samples

unknown sampling process
weighting based on unverifiable assumptions

## Non-Probability Samples

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- Probability sample (roughly): every unit from a frame population has a known and non-zero probability of inclusion

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- Not all probability samples look like miniature versions of the population
- But, with appropriate weighting, probability samples can yield unbiased estimates of the frame population

Main insight from probability samples:

- How you collect your data impacts how you make inference
- Focus on properties of estimators not properties samples

$$\hat{\bar{y}} = \frac{\sum_{i \in s} y_i / \pi_i}{N}$$

where $\pi_i$ is person $i$'s probability of inclusion

Sometimes called:

- Horvitz-Thompson estimator
- $\pi$ estimator

# Inference from probability samples in theory

respondents
known information about sampling
} estimates

## Inference from probability samples in theory

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## Inference from probability samples in practice

$$\left.\begin{array}{r}\text{respondents}\\ \underbrace{\text{estimated information about sampling}}_{\text{auxiliary information + assumptions}}\end{array}\right\} \text{ estimates}$$

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## Inference from non-probability samples

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$$\hat{\bar{y}} = \frac{\sum_{i \in s} y_i / \hat{\pi}_i}{N}$$

where $\hat{\pi}_i = \frac{n_g}{N_g} \quad \forall \quad i \in g$ (estimated probability of inclusion)

Requires:

- auxiliary information ($N_g$)
- ability to place respondents in groups
- assumptions

- Key to many adjustment methods is to use external information and make assumptions

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- If external information is incorrect or assumptions are wrong, then you can make things worse (but it usually seems to make things better)

Imagine that you want to estimate the average height of Princeton students.

- Assume 50% are male and 50% are female
- You stand outside Lewis Library and recruit 60 Princeton students
- Males (n= 20): Average height: 180cm
- Females (n=40): Average heigh: 170cm

What is your estimate of the average height? (think-pair-share)

- sample mean $= 173.3$cm $(\frac{180*20+170*40}{20+40})$

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How could this go wrong?

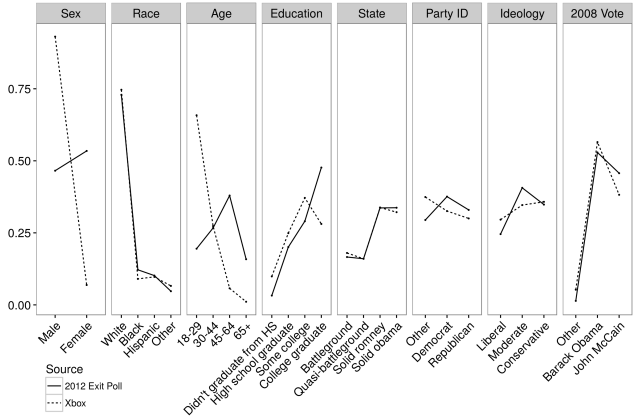
# Forecasting elections with non-representative polls

Wei Wang [a,*], David Rothschild [b], Sharad Goel [b], Andrew Gelman [a,c]

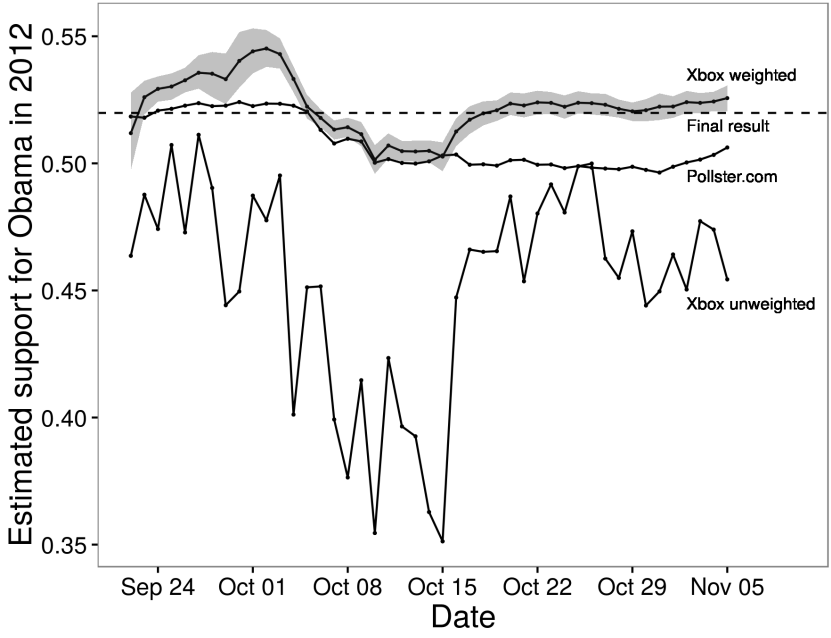
[a] *Department of Statistics, Columbia University, New York, NY, USA*

[b] *Microsoft Research, New York, NY, USA*

[c] *Department of Political Science, Columbia University, New York, NY, USA*




- about 750,000 interviews
- about 350,000 unique respondents


Estimated support for Obama in 2012
0.55
0.50
0.45
0.40
0.35
Sep 24
Oct 01
Oct 08
Oct 15
Oct 22
Oct 29
Nov 05
Date
Xbox weighted
Final result
Pollster.com
Xbox unweighted

# Online, Opt-in Surveys: Fast and Cheap, but are they Accurate?

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David Rothschild
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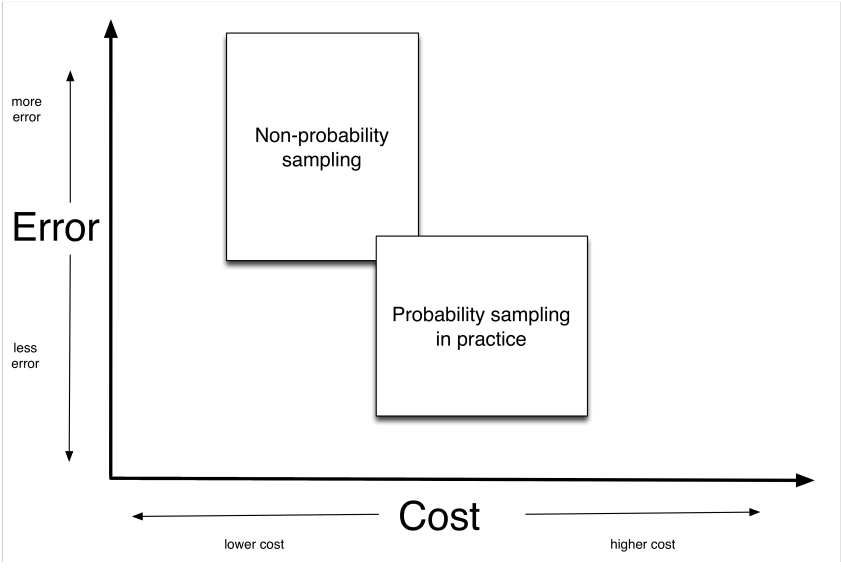
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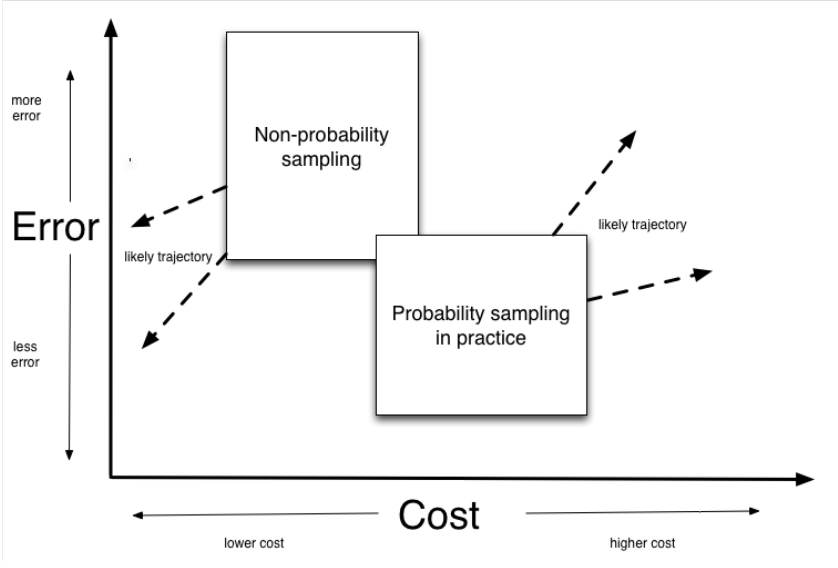
Error
less
error
Non-probability
sampling
Probability sampling
in practice
Cost
lower cost
higher cost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- Samples don't need to look like mini-populations
- Key to making good estimates is for estimation process to account for the sampling process
- There is not a bright-line difference between probability sampling in practice and non-probability sampling
- To learn more: Lohr (2009) or Sandal et al (2013)