R-indexes as a complementary measure of data quality? Application to the Swiss ESS 2010 data

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Overview

- Survey data quality indicators and nonresponse bias
- R-indicator and Maximal Absolute Bias
- Application to ESS data
- (Partial R-indicators)

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Survey data quality indicator and nonresponse bias

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Survey data quality indicator

- Response rates as only data quality indicator
  - + One indicator for the whole survey
  - + Relatively easy to calculate
  - + Does impose an **upper bound** on the maximum possible nonresponse bias (100% response rate →no nonresponse bias)
- BUT..
  - – Only concern is the nonresponse bias (noncoverage, measurement error, data processing error)
  - – Response rates have a low correlation with the **actual** nonresponse bias

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Nonresponse Bias and Response Rates

- Nonresponse Bias is defined as the difference between the estimated and the 'real' population (sampled) parameter (e.g. mean of some variables y) :

$$B(\bar{y}) = \bar{y} - \hat{\bar{y}} = \bar{y} - \bar{y}_R$$

- Or, equivalently, the nonresponse rate times the difference between respondents and nonrespondents:

$$B(\bar{y}) = \frac{m}{N}(\bar{y}_{NR} - \bar{y}_{R)}$$

Nonresponse Bias and Response Rates

- Sample: 10 people, 5 men and 5 women

- After 1 week, worse case scenario:

→RR:60%, Estimate: 83.3% Women, maximum bias 33.3%

- Respondent after extra fieldwork effort:

-> RR:80%, Estimate: 55.6%,maximum bias: 5.6%

Nonresponse Bias and Response Rates

- EX: Sample: 10 people, 5 men and 5 women

- Respondent after 1 week:

→RR: 60%, Estimate: 50% Women, no bias

- Respondent after extra fieldwork efforts:

→ RR:80%, Estimate: 55.6%, bias

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The “hunt” for new quality indicators

- Difficulty in finding a precise measure of nonresponse bias

  →Lack of information about nonrespondents (certainly on key variables)

- Possible sources of information on nonrespondents:
  - Frame data, ex. data from SFSO register
  - Contact data, fieldwork data, ex. number of contacts needed, interviewers’ observation of the neighbourhood
  - Nonresponse Follow-Up surveys
- Indicators involving sampling frame data and paradata (Wagner, 2012)
  - Coefficient of variation of response rate of subgroups
  - R-indicators (http://www.risq-project.eu, Schouten, Cobben and Bethelhem, 2009)

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R-indicator and Maximal Absolute Bias

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R-indicators

- General idea: measuring the representativity of
  - the respondent group
  - compared to the sample
  - based on auxiliary variables available for all sample units
- Criticism:
  - Sampling frame variables and paradata are often socio-demographic variables and can have a low correlation with key variables
- But…
  - One step away from only response rate towards a more detailed indicator

R-indicator: what does representative mean?

- "Absence of selective force"
- Closely related to the MCAR and MAR
- Definition of representative response subset:
  - Strong: A response subset is representative with respect to the sample if the response propensities ρ_i are the same for all units in the population.
  - Weak: A response subset is representative for a categorical variable *X* with H categories if the average response propensity over the categories is constant:

$$\bar{\rho}_h = \frac{1}{N_h}\sum_{k=1}^{N_h} \rho_{hk} = \rho, \quad for \;\; h = 1,2,\cdots,H$$

Where N_h *is the population size of category h,* ρ_{hk} is the response propensity of unit k in class h and summation is over all the units in this category.

R-indicator: theoretical definition

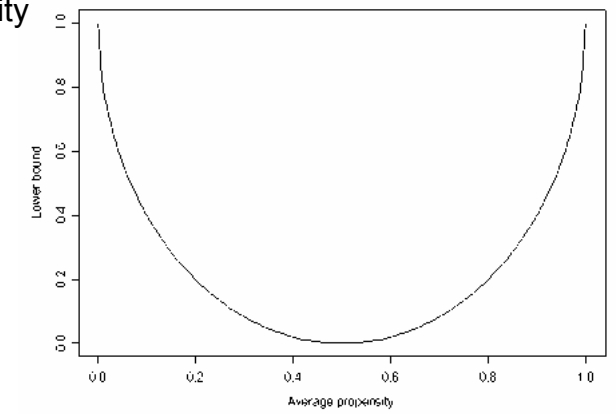
- R-indicator is a measure of the amount of variation in the response propensity of the sample units
- It is based on the standard deviation of the response propensity of all units in the population

$$S(\rho_1, \rho_2, .., \rho_N) = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(\rho_i - \bar{\rho})^2}$$

- For the R-indicator to take values between 0 and 1, we define it as

$$R(\rho_1, \rho_2, .., \rho_N) = 1 - 2\,S(\rho_1, \rho_2, .., \rho_N)$$

Minimum value of R-indicator as function of average response propensity



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R-indicators: how do we calculate them?

- In practice, response propensity are unknown

1. Estimate propensity score by logistic regression model (or classification tree) based on the available auxiliary variables.
2. Estimate the average of the response propensities (in case of a simple random sample, this is nothing else than the response rate)
3. Replace the R-indicator $R(\rho_1, \rho_2, .., \rho_N)$ by its estimate:

$$\hat{R}(\hat{\rho}_1, \hat{\rho}_2, .., \hat{\rho}_N) = 1 - 2\sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\frac{\delta_i}{\pi_i}(\hat{\rho}_i - \hat{\bar{\rho}})}$$

R-indicator: simple examples

Representative respondent group

Response Propensity	Male	Female
Young	0.5	0.5
Old	0.5	0.5

Response rate=50%
Standard deviation of the response propensity=0
R-indicator=1

Not representative respondent group

Response Propensity	Male	Female
Young	1	1
Old	0	0

Response rate=50%
Standard deviation of the response propensity=0.5
R-indicator=0

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Maximal Absolute Bias

- Because **socio-demographic variables** lack correlation with **key survey variables**, one of the criticisms of any quality indicator based on those variables is that they **poorly predict nonresponse bias**
- R-indicator, even if they don't have a direct link with nonresponse bias, offer a upper bound on it
- Indeed, it can be shown that
  - If *y* is a 0-1 dummy variable and we are interested in the percentage of 1

$$\left|\frac{B(\hat{\bar{y}})}{S(y)}\right| \leq \frac{1 - R(\rho_1, \rho_2, .., \rho_N)}{2\ \bar{\rho}}$$

Maximum Absolut Bias

- In other words, the response rate together with the R-indicator impose an upper bound on the nonresponse bias.
- We define this upper bound as the Maximal Absolute Bias:

$$MAB = \frac{1 - R(\rho_1, \rho_2, .., \rho_N)}{2\ \bar{\rho}}$$

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R-indicator and MAB: simple examples

Representative respondent group

Response Propensity	Male	Female
Young	0.5	0.5
Old	0.5	0.5

Response rate=50%
Standard deviation of the response propensity =0
R-indicator=1
Maximum Absolute Bias=0

Not representative respondent group

Response Propensity	Male	Female
Young	1	1
Old	0	0

Response rate=50%
Standard deviation of the response propensity =0.5
R-indicator=0
Maximum Absolute Bias=1/2

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R-indicator and monitoring fieldwork efforts

- In Switzerland, like in many other countries, different type of fieldwork effort have been set in place to increase response rates:
  - Extra contact attempts
  - Refusal conversion
- There is a serious concern that this pursuit of response rate threshold actually increases the nonresponse bias
  - By bringing more “similar” people in the response group (socio-demo, opinion, etc) and exacerbating the difference between respondents and non-respondents

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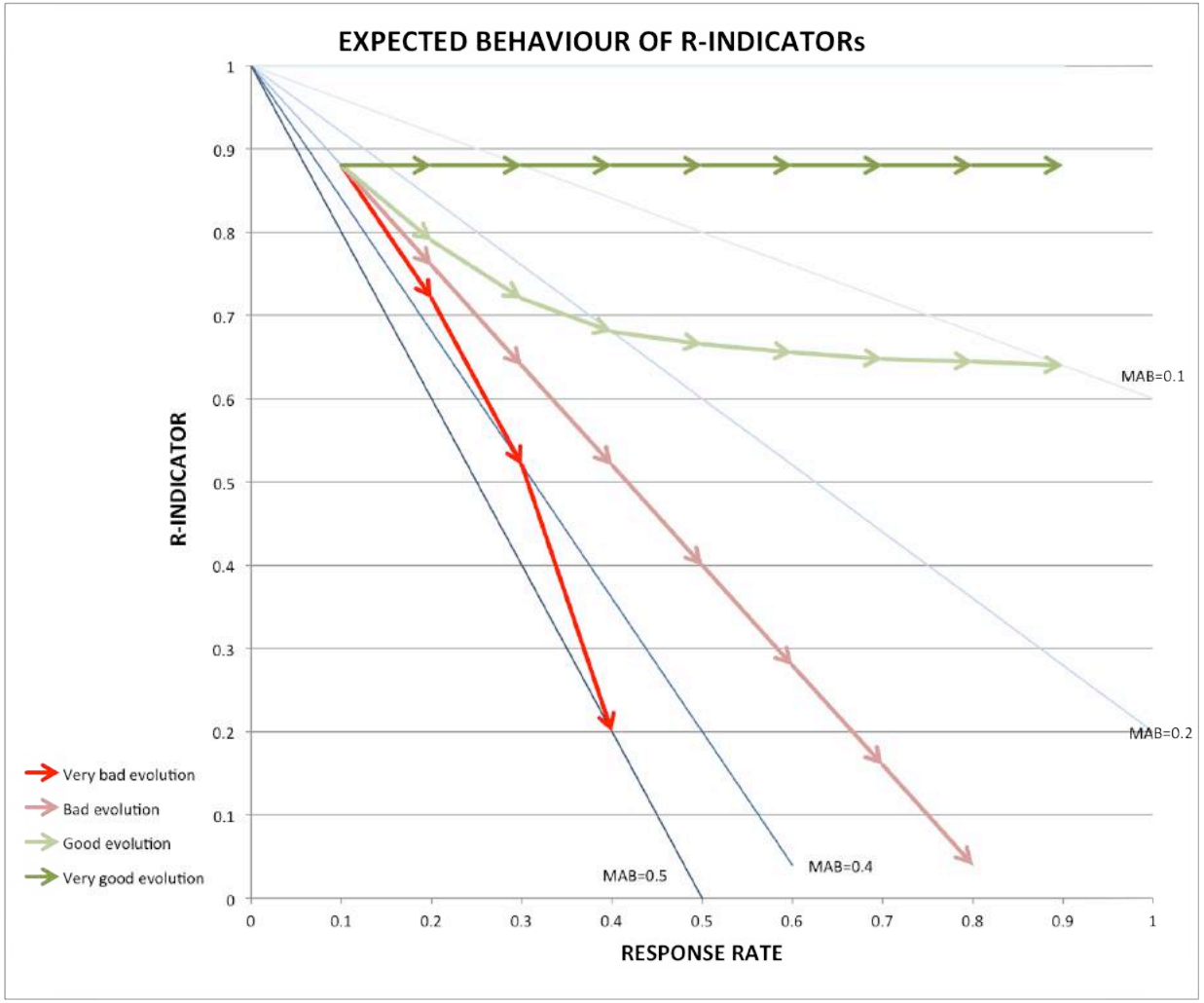
R-indicator and monitoring fieldwork efforts

- Because of the relation between R-indicator and the Maximum Absolute Bias, R-indicator can be used to monitor fieldwork effort.
- The goal is to obtain decreasing Maximum Absolute Bias
- As the response rate definitely goes up, we want the R-indicator to behave in such a way that the Maximum Absolute Bias keeps on decreasing

R-indicator and monitoring fieldwork efforts



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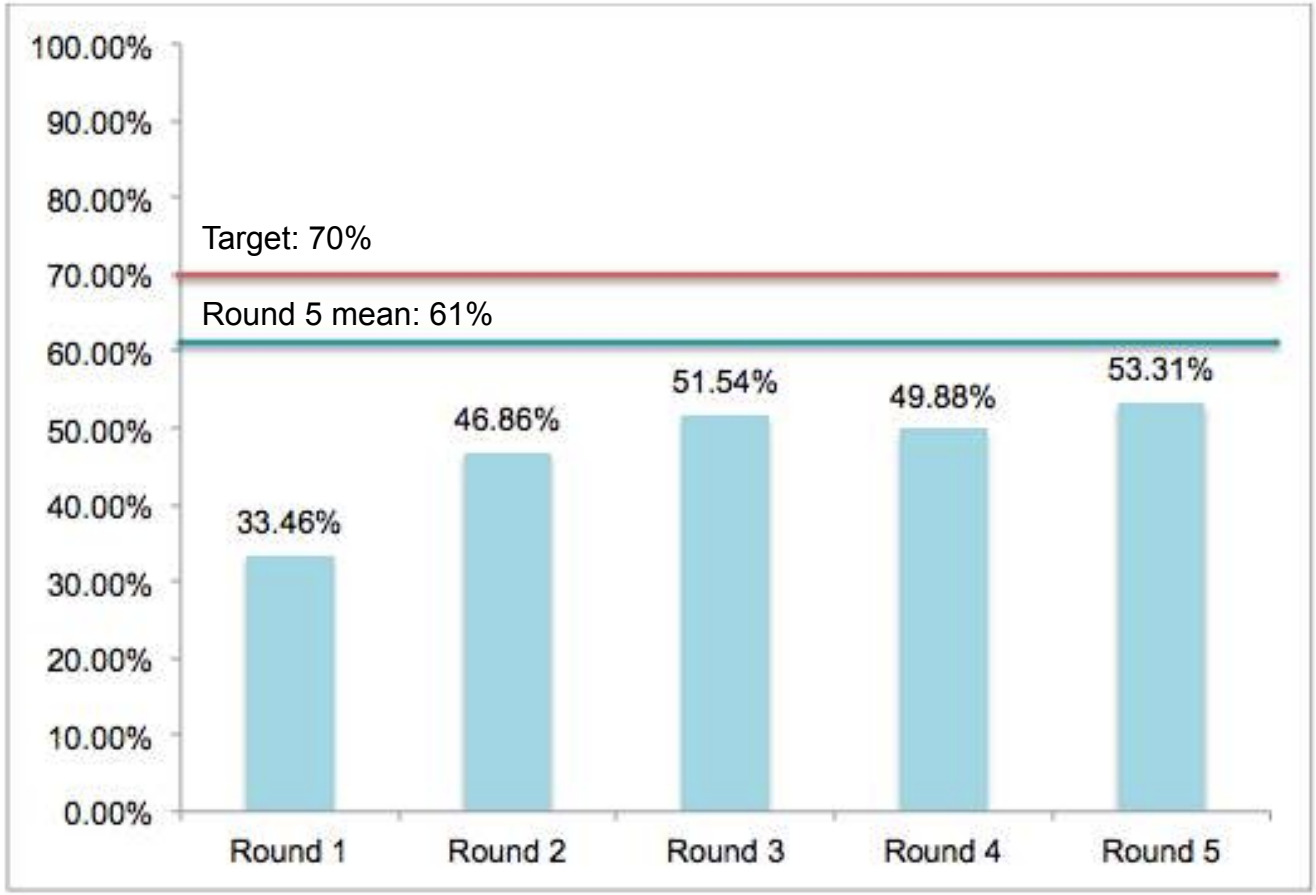
Application to ESS data

ESS Target Response Rates

- European Social Survey specifications for participating countries (Round 6):

"The proportion of non-contacts should not exceed 3 per cent of all sample units, and the minimum target response rate - after discounting ineligibles (and other 'deadwood', as defined by the CCT (…)) - should be 70%. As in previous rounds, this figure is likely to be exceeded in certain countries. Countries that participated in Round 5 and achieved lower response rates will still be expected to aim for the same 70% target in Round 6. Survey organisations should thus cost their surveys with this response rate in mind and consider what steps may be required to achieve it."

ESS Switzerland: Response Rates



What impact do efforts to improve response rates have on survey quality?

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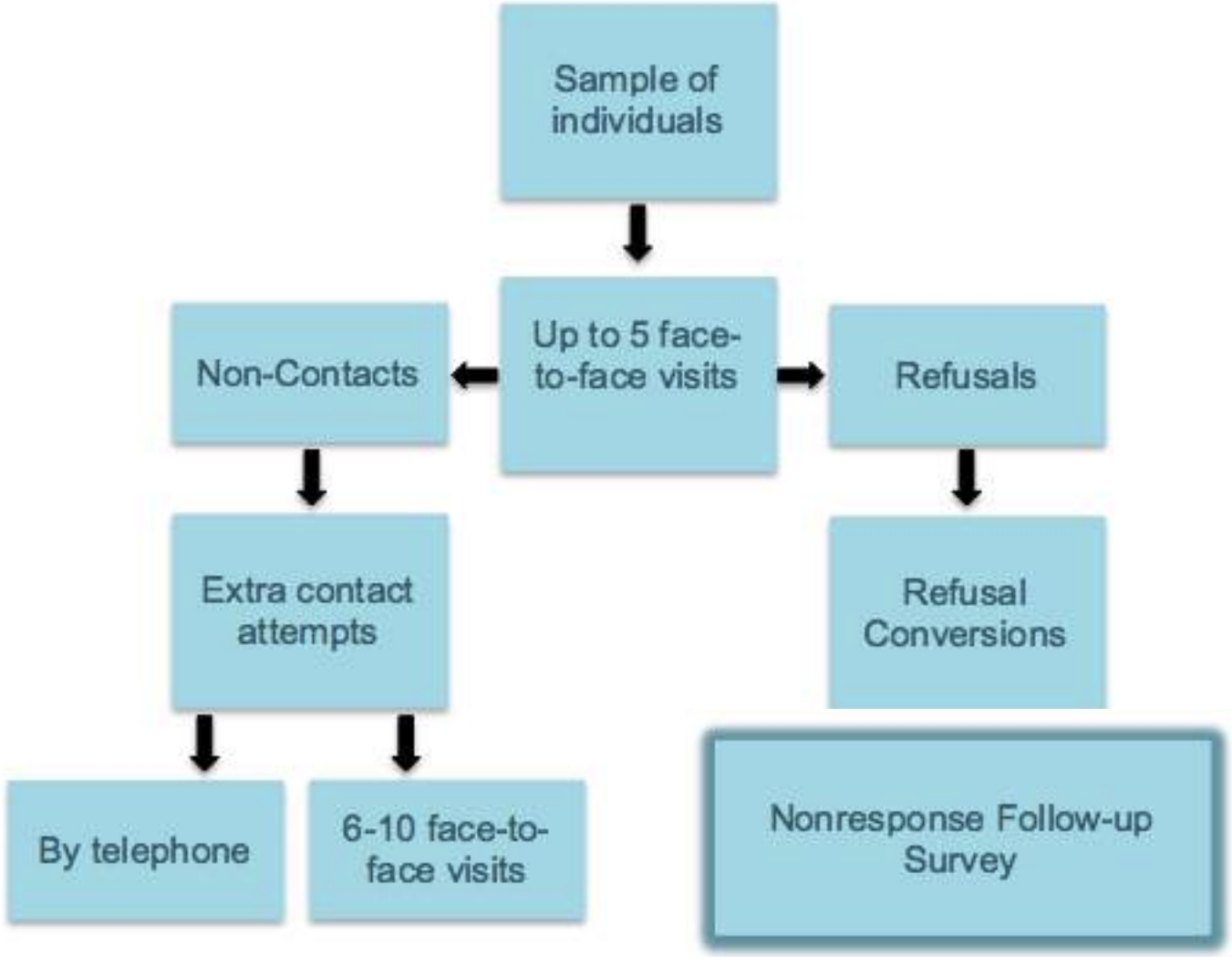
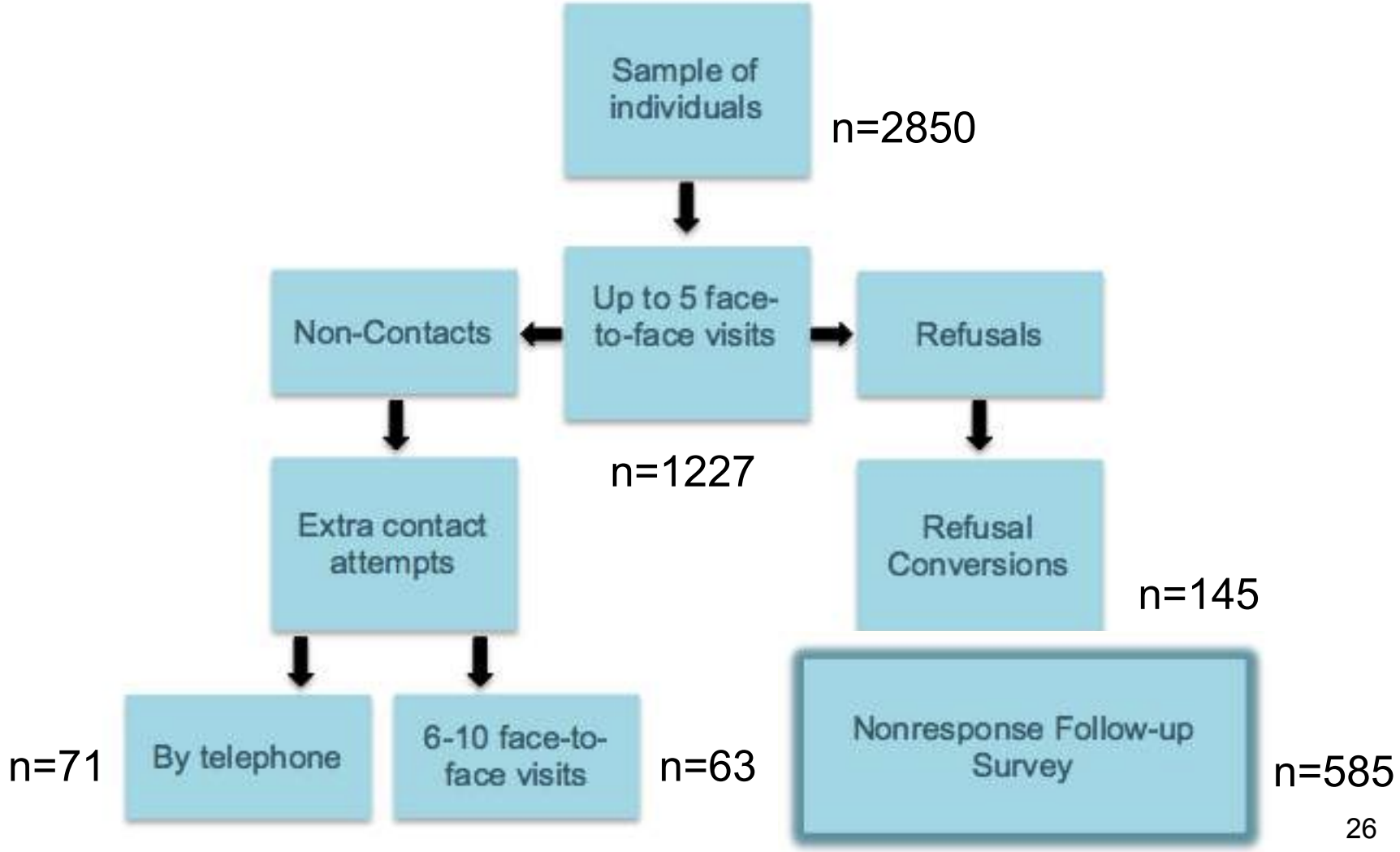
ESS5 Data

- Sample of individuals (n=2850) aged 15 and over, from the SFSO's register sampling frame (stratified by 7 NUTS regions)
- Automated matching to telephone numbers from a private database (AZ Direct): 61% with numbers
- Fieldwork by M.I.S. Trend SA – October 2010 – March 2011
- Response rate 53.3% (n=1506)

Overview of fieldwork efforts



Completed interviews by fieldwork effort



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How does fieldwork effort affect sample representativity and nonresponse bias?

Building the R-indicator

- Available variables from the sampling frame and survey specific variables:
  - sex, age*** (<30, 31-44, 45-64, 65+), marital status** (not married, married or legal partner), nationality*** (Swiss, border country, other), linguistic region' (German, French, Italian), Urbanization ***(urban, rural)
  - Whether respondent received conditional or unconditional incentive**
  - Whether telephone number was obtained from matching***

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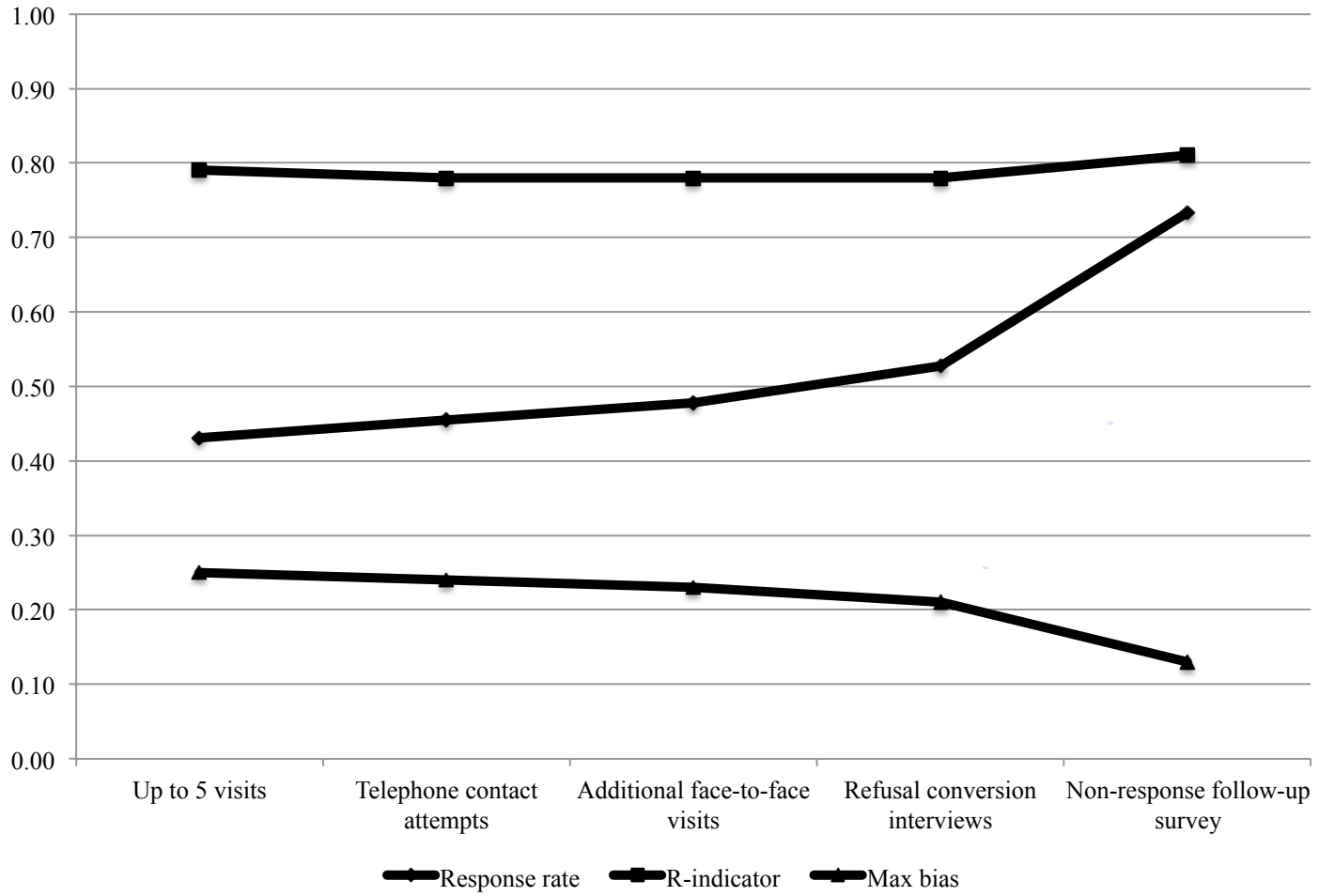
Fieldwork effort & representativeness

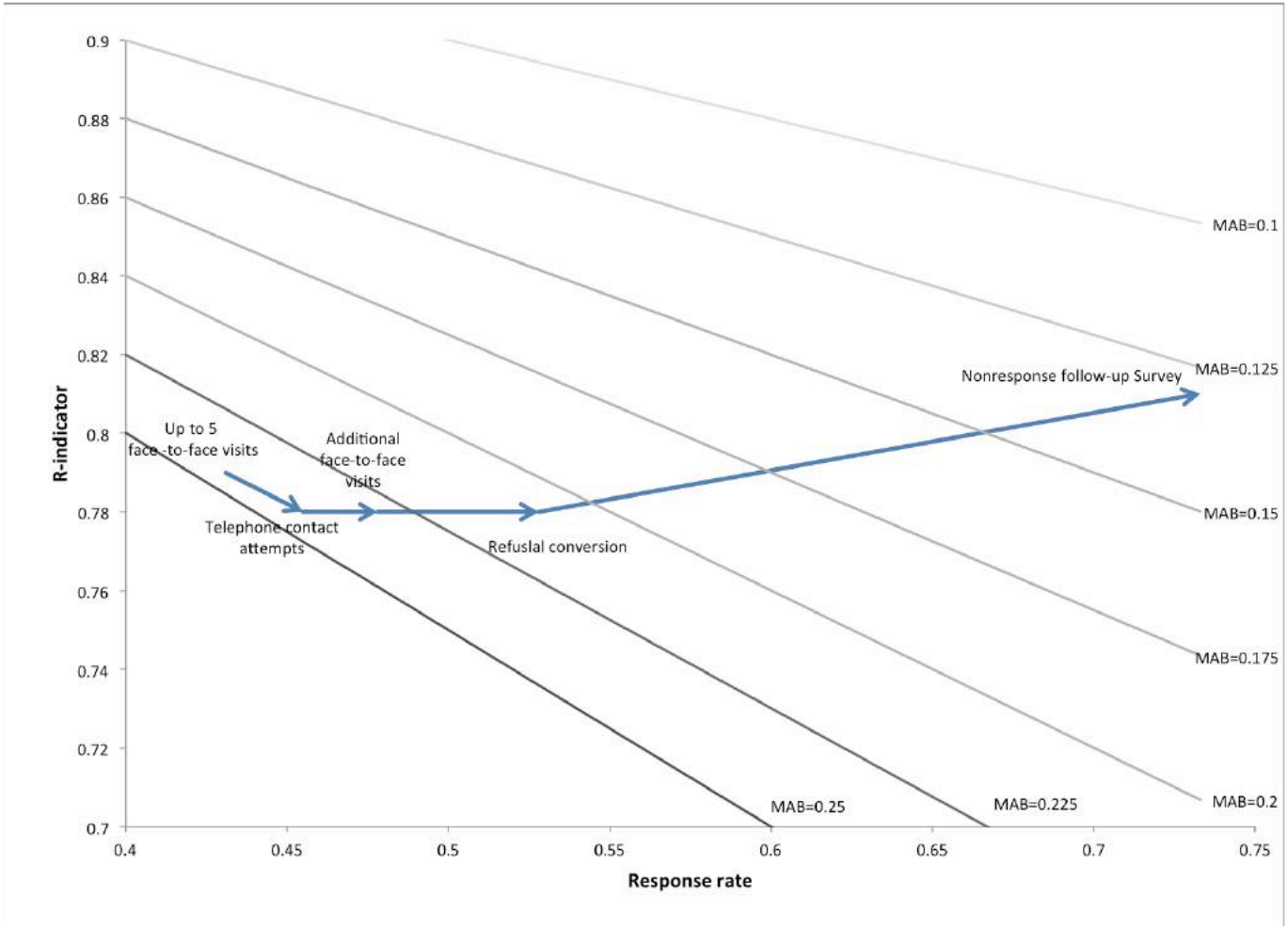
	Up to 5 visits	Telephone contacts	Extra visits	Refusal Converts	NRFU
Response Rate	43.1%	45.5%	47.8%	52.8%	73.3%
R-indicator	0.79	0.78	0.78	0.78	0.81
Confidence Interval	(0.75-0.82)	(0.75-0.82)	(0.75-0.82)	(0.74-0.81)	(0.78-0.85)
Maximal Absolute Bias	0.25	0.24	0.23	0.21	0.13
N	1227	1298	1361	1506	2089

(R-indicator based on logistic regression using frame & survey variables described earlier)

Response rates, R-indicators and Max Absolute Bias



Response rates, R-indicators and Max Absolute Bias



ESS 2010 - Fieldwork effort & representativity

- Response rate:
  - improve only marginally with each fieldwork effort:
    - Telephone contacts: 2.4%
    - Extra face-to-face visits: 2.3%
    - Refusal conversion: 5%
  - But did help bring the response rate higher than in previous round
- Representativity:
  - Does not improve:
    - Goes down (not statistically significant) after **telephone contacts**
    - Stay the same for the remaining main survey fieldwork effort
  - This is a good result, as what we want is to not loose “too much” representativity by pursuing the response rate threshold

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ESS 2010 - Fieldwork effort & representativity

- Maximal Absolute Bias goes down!
- Nonresponse follow-up surveys is the most efficient at
  - Increasing response rate
  - Increasing representativity
  - Decreasing the Maximal Absolute Bias
  - But…
- More detailed information necessary to
  - better understand the nonresponse mechanism
  - Possibly develop targeted fieldwork
- What are the problematic auxiliary variables?
- Which categories are over/underrepresented?

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Partial R-indicators

Partial R-indicator

- Unconditional partial R-indicator at the variable level
  - Measures the variation between the mean response propensity of the H categories of auxiliary variable X:

$$P_U(X) = \sqrt{\frac{1}{N}\sum_{h=1}^{H} n_h(\bar{\rho}_h - \bar{\rho})^2}$$

- The larger the value of the unconditional partial R-indicator the stronger the impact in nonresponse

Unconditional partial R-indicator at the variable level – ESS 2010

	Up to 5 visits	Telephone contacts	Extra visits	Refusal Conversion	NRFU
Marital Status	0.018	0.018	0.013	0.018	0.018
Gender	0.021	0.021	0.019	0.010	0.007
Incentives	0.036	0.038	0.037	0.026	0.006
Linguistic regions	0.037	0.034	0.038	0.052	0.018
Urbanisation	0.043	0.043	0.042	0.045	0.038
Telephone	0.043	0.050	0.047	0.061	0.045
Age	0.047	0.046	0.049	0.041	0.031
Nationality	0.064	0.068	0.068	0.072	0.080

Partial R-indicator

- Unconditional partial R-indicator at the category level
  - Measures the deviation of the mean response propensity of category h to the mean response propensity:

$$P_U(X,h) = \sqrt{\frac{n_h}{N}}(\bar{\rho}_h - \bar{\rho})$$

- A positive, resp. negative, value of the unconditional partial R-indicator means that the category is overrepresented, resp. underrepresented

Unconditional partial R-indicator at the category level – ESS 2010

Variable Nationality

	Up to 5 visits	Telephone contacts	Extra visits	Refusal Converts	NRFU
Swiss citizens	0.023	0.031	0.031	0.032	0.036
Non Swiss-bordering countries	-0.034	-0.033	-0.033	-0.033	-0.033
Non Swiss citizens-others	-0.046	-0.051	-0.051	-0.055	-0.064

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ESS 2010 - Fieldwork effort & representativity

- Thanks to the partial R-indicator, we have identified the most problematic variables for the representativity after each type of fieldwork effort:
  - 5 face-to-face: Nationality, Age, Telephone
  - Telephone contacts: Nationality, Telephone, Age
  - Extra face-to-face: Nationality, Age, Telephone
  - Refusal Conversion: Nationality, Telephone, Urbanisation
  - Nonresponse follow-Up: Nationality, Telephone, Urbanisation
- The fieldwork efforts sometimes
  - Help reduce the variation between the categories: gender, age, incentives,
  - Increase the variation between the categories: nationality, telephone, linguistic regions
  - Have little effect on the variation: Marital status

ESS 2010 - Fieldwork effort & representativity

- Another step is necessary to understand which category is underrepresented and would maybe need extra attention during the fieldwork process.
- Example: nationality:
  - Swiss citizens are more and more overrepresented
  - Non-Swiss citizens from bordering countries are underrepresented but this is not better or worse depending on the fieldwork effort.
  - Non-Swiss citizens from other countries are more and more underrepresented.

Thank you!

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