Institute of Applied Statistics

CESS BAMBERG 2018
CONFERENCE OF EUROPEAN STATISTICS STAKEHOLDERS

Bamberg, 10-18-2018

STS03: Protection of Privacy in Public Surveys

The two Different Aspects of Privacy Protection in Indirect Questioning Designs

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The theory of indirect questioning (IQ) techniques has been developed for different population characteristics, types of variables, and probability sampling schemes (Chaudhuri and Christofides 2013, Chaudhuri et al. 2016)

Their practical use is well documented (Gonzales-Ocantos et al. 2012, Moshagen et al. 2012, Kirchner et al. 2013, De Hon 2014, Malesky et al. 2015, or Corbacho et al. 2016)

Their effect was also investigated in several studies (cf. Lensvelt-Mulders et al. 2005, 2006, Holbrook and Krosnick 2010, Coutts et al. 2011, Krumpal 2012, Jann et al. 2012, Wolter and Preisendörfer 2013, Rosenfeld et al. 2016, Höglinger and Diekmann 2017)

An implementation of Warner's randomized response (RR) technique (1965), of which respondents understand the instructions for use better than of others (Höglinger et al. 2014, 24), is the crosswise model (Yu et al. 2008):

Q1 (the randomizing question): Think of a person, whose birth date you know. Is the birth date within the interval from … to … (design probability p)? [yes/no]

Q2 (the sensitive question): Are you a member of group A? [yes/no]

The answer the respondent has actually to provide is:

Are your answers on Q1 and Q2 the same? [yes/no]

Understanding of the principle correlates significantly with the development of trust in the strategy’s privacy protection (Höglinger et al. 2014, 25)

One can choose the design probability *p* according to own preferences, experiences, assumptions of the sensitivity level of the variable under study, and recommendations from the literature (cf. Greenberg et al. 1969, Fidler and Kleinknecht 1977, Soeken and Macready 1982, Edgell et al. 1982, 95f, Quatember 2009, Höglinger and Diekmann 2017, Online Appendix)

The design probability *p* determines how strong the privacy of respondents is objectively protected

Objectively offered privacy protection

In the literature:

… technique grants respondents full response privacy

… answer to the sensitive question remains completely private

… embarrassing fact in a completely secret way

… the procedure guarantees anonymity …

… a given answer does not reveal the true answer …

… the design protects the anonymity of respondents’ answers

… the respondent’s anonymity is guaranteed

… these surveys guarantee respondent confidentiality …

… the respondent can reveal critical information without fear

Objectively offered privacy protection / accuracy

In the literature:

… technique grants respondents full response privacy

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… these surveys guarantee respondent confidentiality …

… the respondent can reveal critical information without fear

NOT TRUE

Of course, privacy is not protected completely, but at a certain level!

Q1 (the randomizing question): Think of a person, whose birth date you know. Is the birth date within the interval from 1st of January to 30th of December ($p \approx 0.997$)? [yes/no]

Q2 (the sensitive question): Are you a member of group *A*? [yes/no]

The answer the respondent has actually to provide is:

Are your answers on Q1 and Q2 the same? [yes/no]

Of course, privacy is not protected completely, but at a certain level!

Q1 (the randomizing question): Think of a person, whose birth date you know. Is the birth date within the interval from 1st of January to 19th of October ($p \approx 0.800$)? [yes/no]

Q2 (the sensitive question): Are you a member of group *A*? [yes/no]

The answer the respondent has actually to provide is:

Are your answers on Q1 and Q2 the same? [yes/no]

A measure of privacy protection should be considered

Such a measure with respect to a "yes"-answer (z_k = 1) of respondent *k* may be given by

$$P_{1k} = \frac{\min[\Pr("yes" | k \in A), \Pr("yes" | k \in A^C)]}{\max[\Pr("yes" | k \in A), \Pr("yes" | k \in A^C)]}$$

Regarding a "no"-answer, the measure yields

$$P_{0k} = \frac{\min[\Pr("no" | k \in A), \Pr("no" | k \in A^C)]}{\max[\Pr("no" | k \in A), \Pr("no" | k \in A^C)]}$$

($\mathbf{0} \leq P_{ik} \leq \mathbf{1}$; $i = 0,1$; $k \in U$)

For our strategy, it applies for all $k \in U$ that

$$P_{1k} = P_1 = \frac{1-p}{p} = P_{0k} = P_0$$

Q1 (the randomizing question): Think of a person, whose birth date you know. Is the birth date within the interval from 1st of January to 30th of December ($p \approx 0.997$)? [yes/no]

$$P_1 \approx \frac{0.003}{0.997} \approx 0.003$$

For our strategy it applies for all $k \in U$ that

$$P_{1k} = P_1 = \frac{1-p_1}{p_1} = P_{0k} = P_0$$

Q1 (the randomizing question): Think of a person, whose birth date you know. Is the birth date within the interval from 1st of January to 19th of October ($p \approx 0.800$)? [yes/no]

$$P_1 \approx \frac{0.2}{0.8} = 0.25$$

A level of around 0.25 corresponds to results from experiments with respect to the maximum avoidance of refusals and untruthful answering

Under the assumption of full cooperation, it can be shown that the increase of variance V_+ compared to the direct questioning only depends on the level of privacy protection

For SI sampling and Warner's strategy:

$$V_+ = f(P_1) = \frac{1}{n} \cdot \frac{P_1}{(1-P_1)^2}$$

($P_1 \neq 1$; Quatember 2018)

Subjectively perceived privacy protection

The privacy protection objectively measured may differ from the privacy protection subjectively perceived by the respondents (Chaudhuri and Christofides 2013, 169):

> "*Common sense mandates that the perceived protection of privacy is crucial in deciding to participate in a survey dealing with sensitive issues. In fact it is gaining ground the opinion that the perception of privacy protection should also be considered when the protection of privacy offered by various indirect questioning techniques is examined*"

Crosswise model of Warner's RR design:

Q1 (the randomizing question): Throw three dice. Is their sum within the set {8,9,10,11,12,13,14,15,17}? [yes/no]

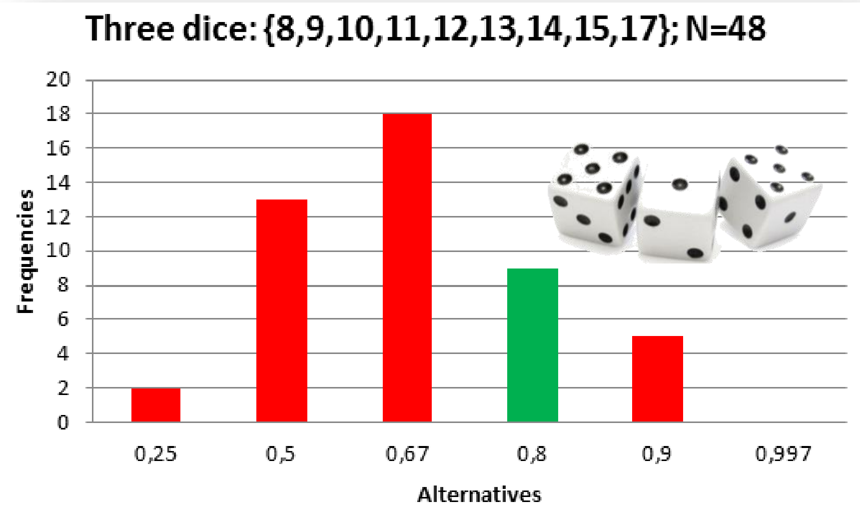
The true design probability p equals 0.81 and the objectively measured privacy protection PP_1 results in

$$P_1 = (1 - p)/p \approx 0.24$$

Crosswise model of Warner's RR design:

Q1 (the randomizing question): Throw three dice. Is their sum within the set {8,9,10,11,12,13,14,15,17}? [yes/no]

Respondents k who would erroneously derive the probability p by observing that 9 of 16 possible outcomes are elements of this set, might think that $pp_k = 9/16 \approx 0.56 < 0.81 = p$



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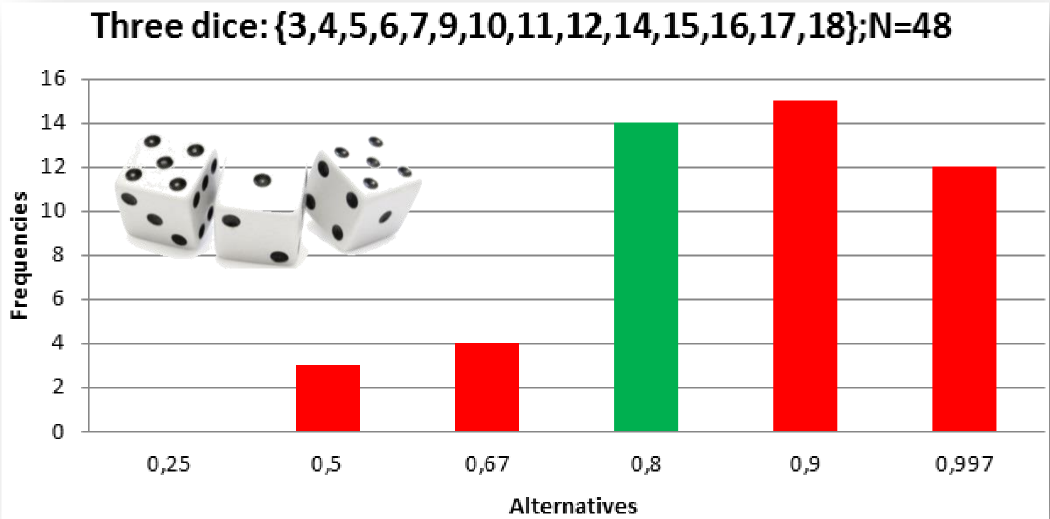
For such survey units, the subjectively perceived privacy protection PP_{1k} may be calculated by

$$PP_{1k} = (1 - pp_k)/pp_k \approx 0.78 >> 0.24 = P_1$$

In such a case, the respondent should have a higher response propensity

The randomization instruction might also work in the opposite direction, when a respondent perceives a lower privacy protection compared to the real one!

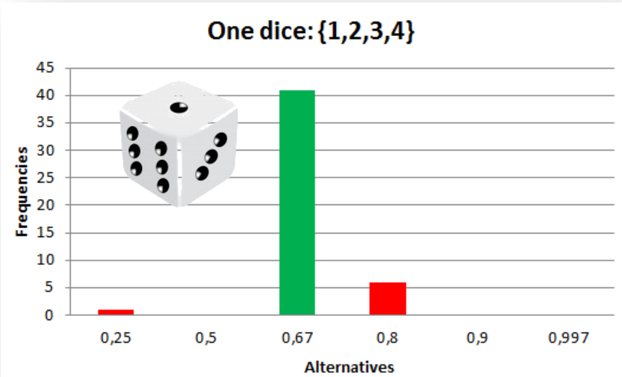


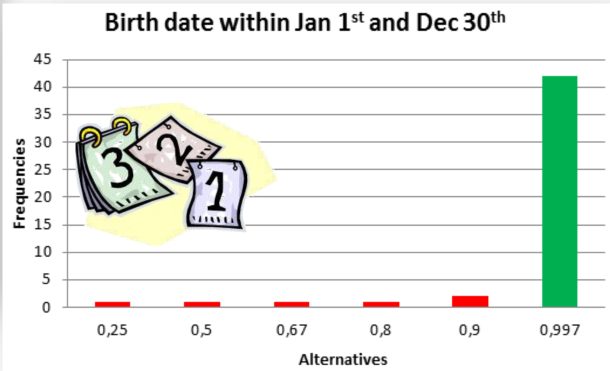
For respondent *k*, these differences can be formalized:

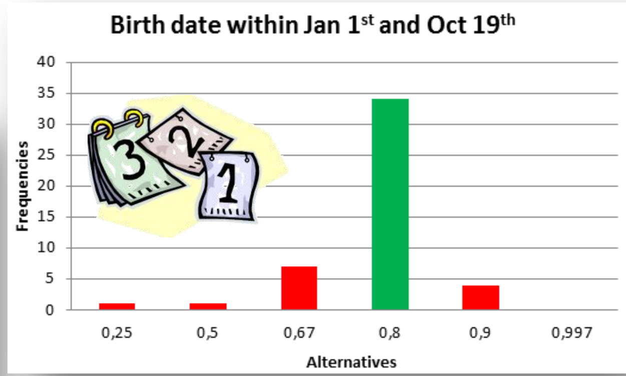
$$\Delta_{1k} = \Delta_{0k} = PP_{1k} - P_1$$

Assuming that the objective measure P_1 was reasonably fixed to allow maximum cooperation and high estimation efficiency, Δ_{1k} must not be negative for any $k \in U$

$\Delta_{1k} = 0$ might always apply when the possible randomization outcomes are uniformly distributed (one dice, birth dates)







Conclusion

The general point is that

- the privacy protection objectively offered by a questioning design directly affects the efficiency of the estimation,
- the privacy protection subjectively perceived by the respondents affects the survey units' willingness to cooperate

That is what indirect questioning designs are all about

Therefore, users have to pay attention to this fact, when choosing adequate randomization instructions to avoid that $\Delta_{1k} = P_{1k} - P_1 < 0$ and/or $\Delta_{0k} = PP_{0k} - P_0 < 0$ applies

Q1 (the randomizing question): Is your birth date within the interval from 1st of January to 19th of October? [yes/no]

Q2 (the sensitive question): Do you feel that this talk was interesting? [yes/no]

The answer you really have to provide is:

Are your answers on Q1 and Q2 the same? [yes/no]

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Thank you for your appreciated attention!