Inference in surveys with sequential mixed-mode data collection

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Introduction

- Mixed-mode strategy Statistics Netherlands
- Problem with repeated surveys:
  - Mix of modes not constant
  - Different modes induce different measurement bias
  - Measurement bias not constant
  - Hampers comparability of statistics over time
- Purpose: inference method that stabilizes the measurement bias

Inference

- Generalized regression (GREG) estimator

$$\hat{t}_y = \sum_{i \in s} w_i y_i$$

- Weights w_i are derived from:
  - Sample design
  - Auxiliary information (linear model $y_i = \boldsymbol{\beta}' \mathbf{x}_i + e_i$)

$$\hat{\mathbf{t}}_{\mathbf{x}} = \sum_{i \in s} w_i \mathbf{x}_i = \mathbf{t}_{\mathbf{x}}$$

Inference

Measurement error model

$$y_{im} = u_i + b_m \delta_{im} + \varepsilon_{im}, \qquad m = 1,\ldots p, \qquad E_m(\varepsilon_{im}) = 0$$

$$\delta_{im} = \begin{cases} 1 & \text{if } i \text{ responds through } m \\ 0 & \text{otherwise} \end{cases}$$

GREG estimator under measurement error model

$$E_m \hat{t}_y = E_m \sum_{i \in s} w_i y_i = \sum_{i \in s} w_i (u_i + b_m \delta_{im}) = \hat{t}_u + \sum_{m=1}^{p} b_m \hat{t}_m$$

Inference

Mutations over time

$$\hat{t}_y^{(1)} - \hat{t}_y^{(2)} = \hat{t}_u^{(1)} - \hat{t}_u^{(2)} + \sum_{m=1}^{p} b_m (\hat{t}_m^{(1)} - \hat{t}_m^{(2)})$$

Requirement: $\hat{t}_m^{(1)} = \hat{t}_m^{(2)}$

Calibrate the sample to fixed distribution over the modes, i.e.

$$\hat{t}_m^{(x)} = \sum_{i \in s} w_i \delta_{im} = \Gamma_m, \; m = 1,\ldots,p, \; x = 1,2$$

using arbitrarily chosen calibration levels Γ_m

Assumptions and risks

- Correcting for measurement bias: $\hat{t}_y \neq \hat{t}_y^c$ under the assumption that $\hat{t}_u = \hat{t}_u^c$
- Assumption: Auxiliary variables other than mode correct for selection bias
- How to check:
  - For additional register variables (z): $\hat{t}_z \approx \hat{t}_z^c \approx t_z$
  - Apply different calibration levels for Γ_m and analyze the effect on $\hat{t}_y^{(1)} - \hat{t}_y^{(2)}$

Simulation

- population N=100,000
- subpopulations, x=1 en x=2, equal size
- Target variable: u

  u(x=1)~N(20,3)   u(x=2)~N(30,3)
- 2 response modes m (m=1 en m=2)
- Selective nonresponse depends on mode and strata
  - p(respons=1 | m=1, x=1) = 0,8
  - p(respons=1 | m=2, x=1) = 0,2
  - p(respons=1 | m=1, x=2) = 0,4
  - p(respons=1 | m=2, x=2) = 0,6

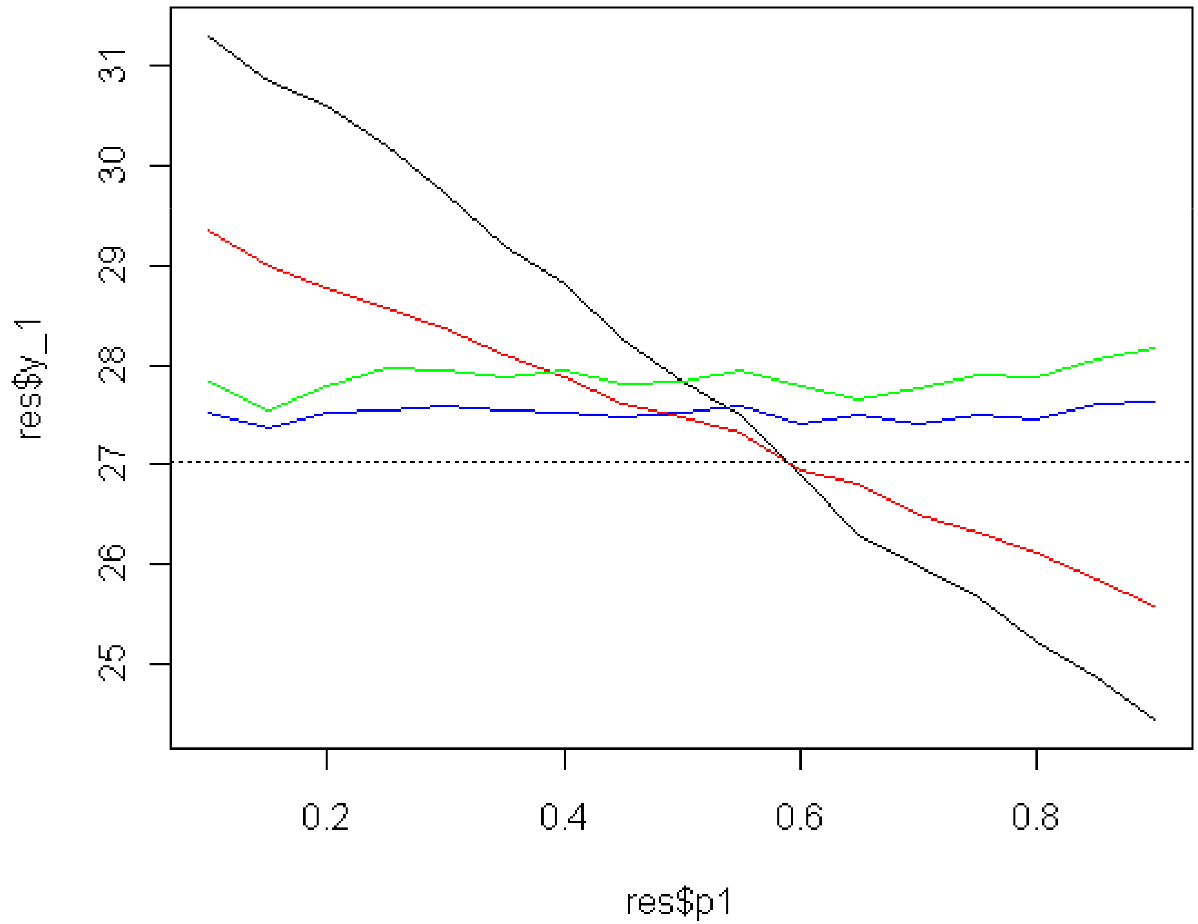
Simulation

- y measurement for u, with measurment bias:
  m=1: y=u,   m=2: u = u + 5
- Sampling under varing mode distributions:

  Proportions m=1 / m=2:
  5% / 95%, 10% / 90%, … , 95% / 5%
- For each sample 4 estimators
  for population mean:
  1. unweighted
  2. weighting model: ~ x
  3. weighting model: ~ x + m   (m1=50%, m2=50%)
  4. weighting model: ~ m

Simulation

Estimation results y



Black: ~ 1
Red: ~ x
Blue: ~ x + m
Green: ~ m
(dotted: pop. y)

Integrated Safety Monitor (ISM)

Survey design

- National sample of SN:
  - Yearly sample size: 19,000 respondents
  - Data collection: CAWI/PAPI, after 2 reminders CATI/CAPI
- Additional regional samples:
  - On request of local regional authorities, optional
  - Yearly sample size varies between 20,000 and 180,000 persons
  - Data collection: CAWI/PAPI and after 2 reminders CATI
- Official releases: total sample

Integrated Safety Monitor (ISM)

Results data collection

		2008	2009	2010
SN-sample	sample size	17,000	19,200	19,200
	WI	40%	47%	49%
	PAPI	15%	16%	13%
	CATI	34%	26%	24%
	CAPI	11%	11%	14%
ISM-total	sample size	62,800	201,200	39,200
	WI	56%	69%	61%
	PAPI	11%	12%	12%
	CATI	27%	17%	20%
	CAPI	6%	2%	7%

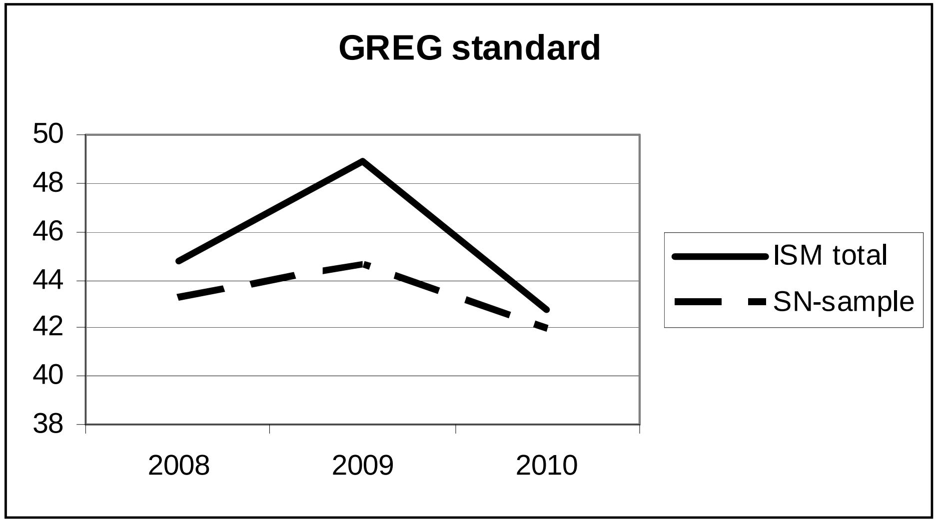
Integrated Safety Monitor (ISM)

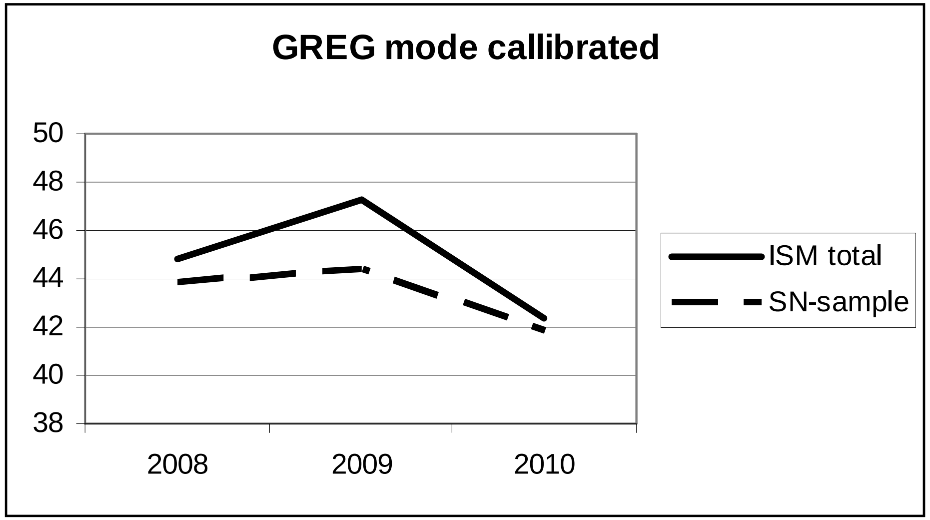
Mode calibration

- Cross mode with strata (25 police regions)
- Collapse four modes in two classes
  - Interviewer administered modes
  - Modes without interviewer
- Levels based on the expected distribution of Statistics Netherlands' national sample:
  - 40% capi/cati
  - 60% cawi/papi
- Weighting model extended with:
  - Mode(2)*Strata(25)

Integrated Safety Monitor (ISM)

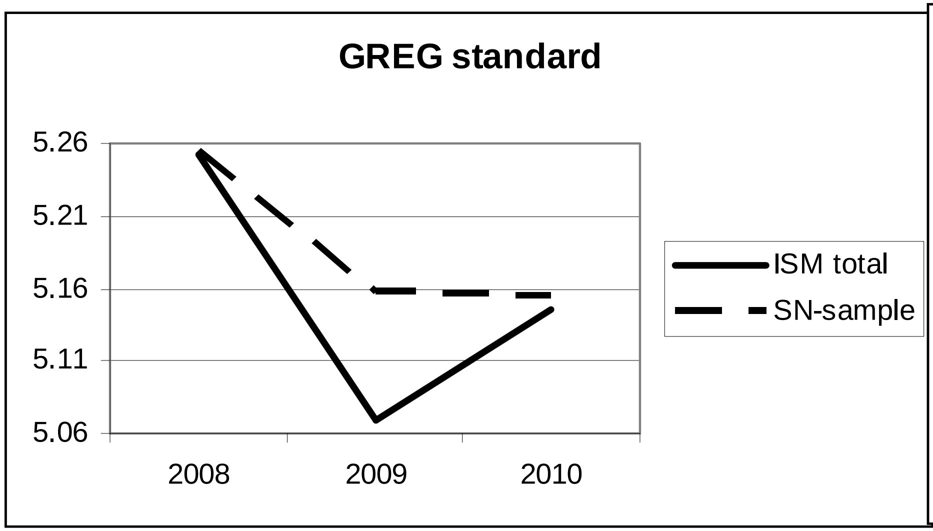
Results Offences

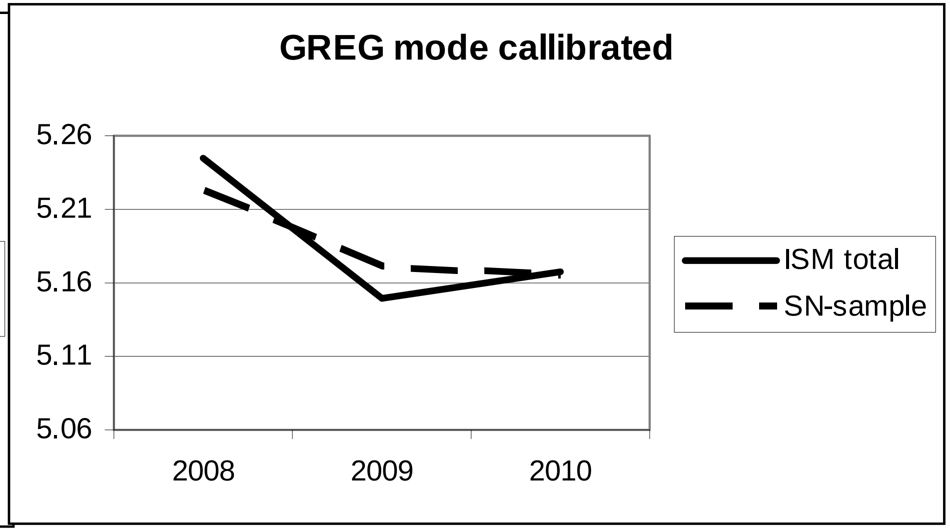




Integrated Safety Monitor (ISM)

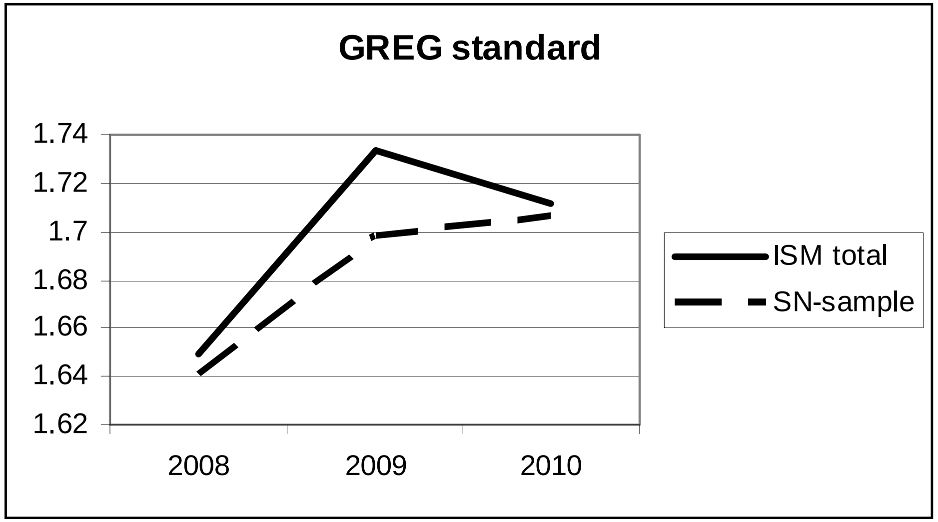
Results Satisfaction police functioning

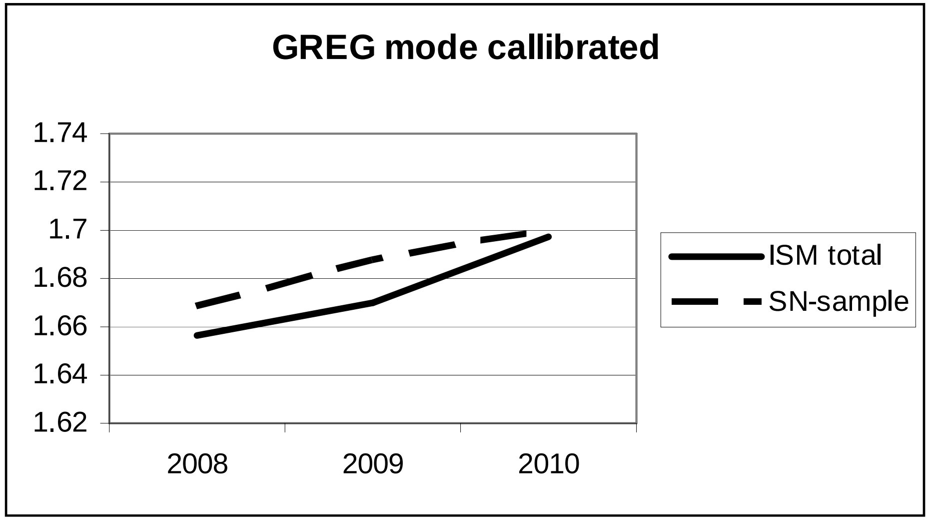




5. Integrated Safety Monitor (ISM)

Results Anti social behavior



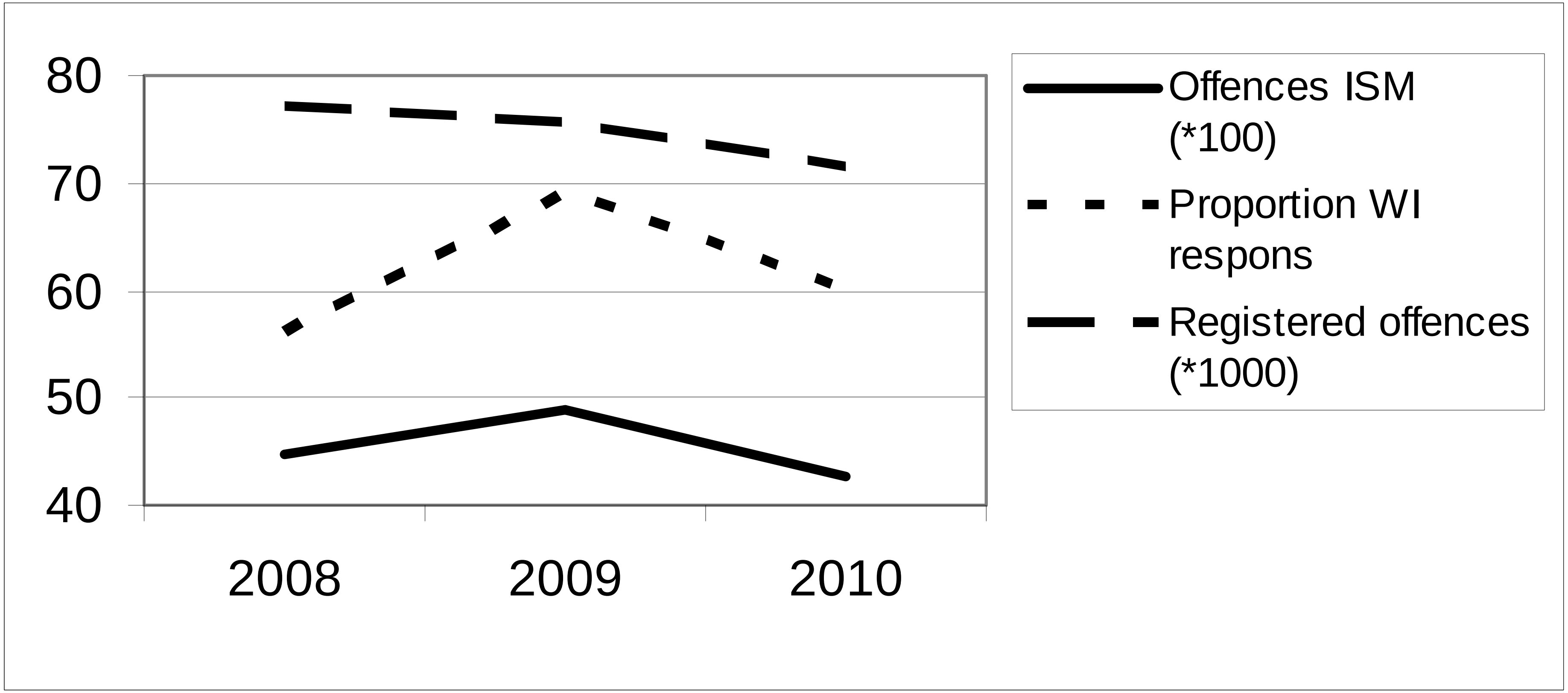


Discussion

- Calibrate the response in sequential mixed modes designs to fixed mode distributions to remove variation in measurement bias
- Assumptions:
  - model removes selection bias
  - partially tested with correlated register variables
  - motivated with a simulation
- Evidence that mode calibration stabilizes estimated mutations of the ISM
- Used to produce official statistics in the ISM and household transportation survey

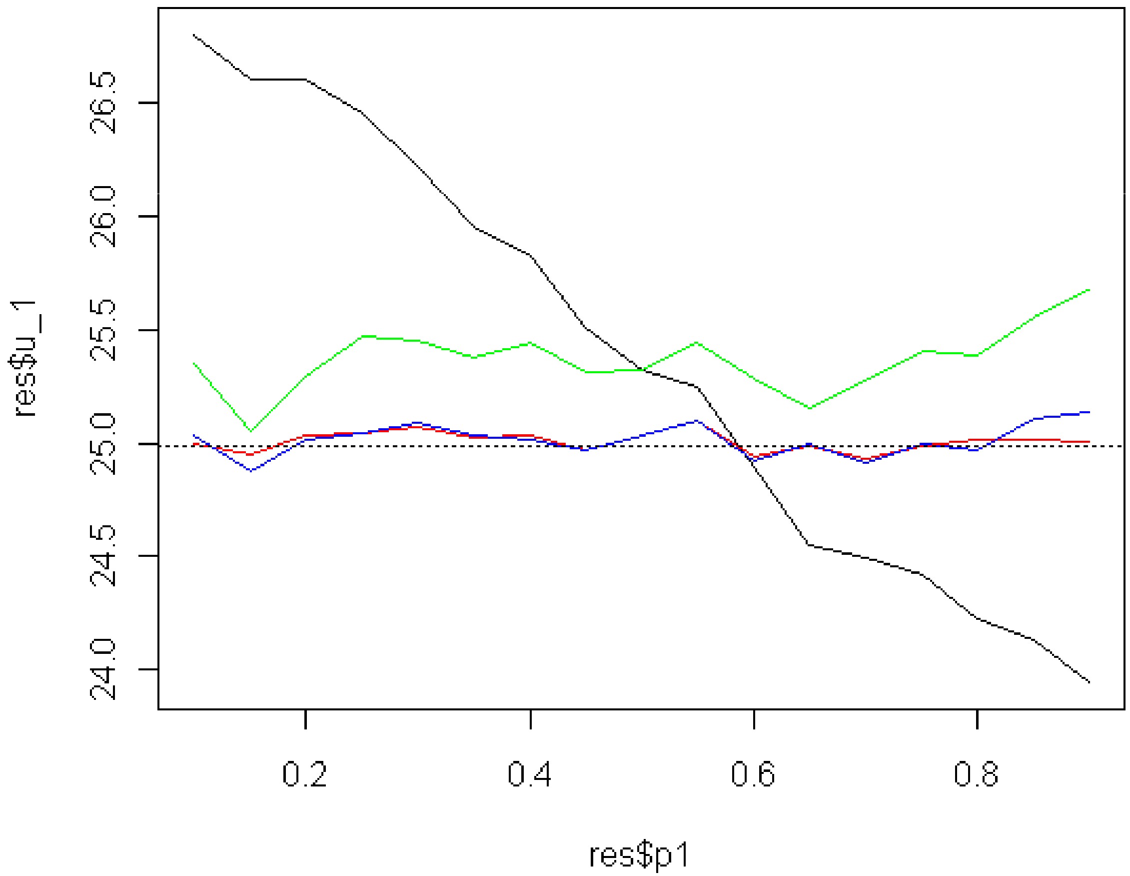
Thank you for your attention

Relation offences and prop. WI in the Dutch safety monitor



Simulation

Estimation results u (no measurement bias)



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