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To misreport or not to report? The case of the Italian Survey on Household Income and Wealth

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SHIW - Survey on Household Income and Wealth

- Surveys households income, financial assets, e.g. government bonds, private bonds, shares, managed savings, and non-financial wealth
- Run every 2 years by the Bank of Italy (latest edition: 2008)
- Two stage clustered design: municipalities (Stratified πPS) are PSUs and households HHs (SRSWOR) are SSUs
- Panel component
- Face to face CAPI
- Post-stratified estimator on demographic characteristics
- Nonsampling errors:
  - Item nonresponse (negligible)
  - Measurement error and Unit nonresponse (major issues)

National Financial Accounts - NFAs

	Gov. Bonds	Private Bonds	Shares	Mutual Funds
Number of households (Millions)				
SHIW estimate	2.180	1.710	1.450	1.495
NFA estimate	1.845	4.471	2.865	2.716
SHIW/NFA	*1.182*	*0.383*	*0.506*	*0.551*
Amount held (Billions of Euros)				
SHIW estimate	65.610	61.190	31.862	50.992
NFA estimate	160.840	303.450	63.026	108.219
SHIW/NFA	*0.408*	*0.202*	*0.506*	*0.471*

Outline

- Unit nonresponse
  - Panel HHs
  - Non-panel HHs
- Measurement error for
  - 1/0 variables (possession of a financial asset)
  - continuous variables (amount held)
- Final total estimates obtained
  - via imputation
  - or via calibration
- Conclusions and points for discussion

Two major issues - 1 - Unit Nonresponse

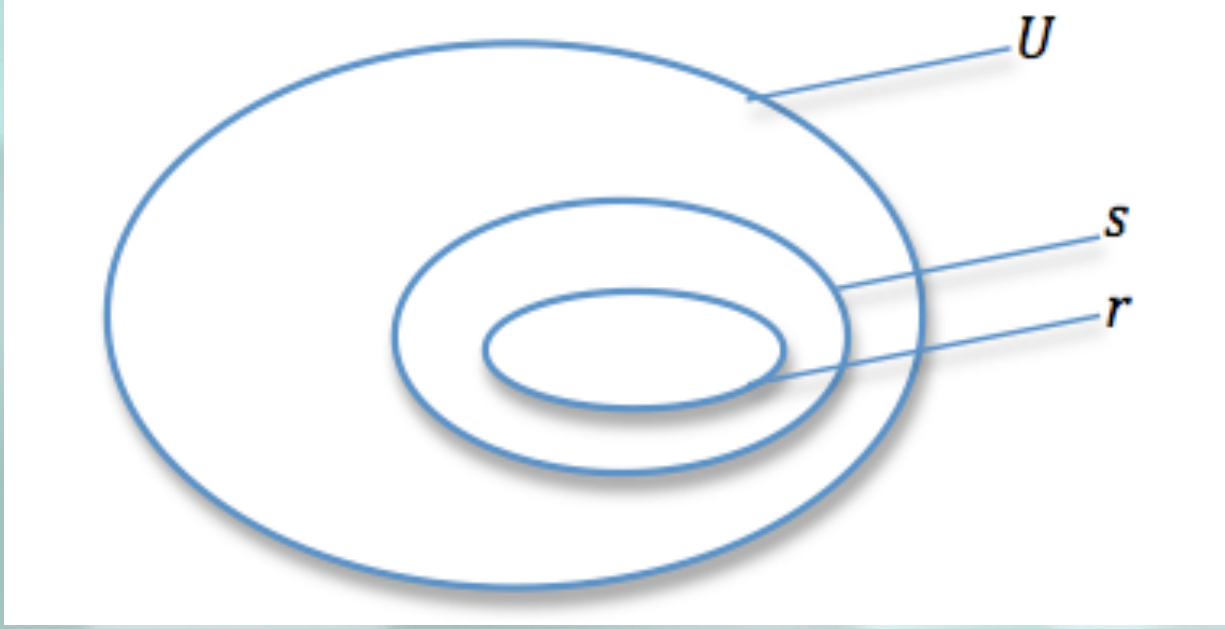
Households contacted and reasons for non-participation

	Panel		Non-panel		Total	
	number	%	number	%	number	%
Respondents	4,345	*79.3*	3,632	*41.6*	7,977	*56.1*
Refusals	1,012	*18.5*	3,589	*41.1*	4,601	*32.4*
Not at home	120	*2.2*	1,511	*17.3*	1,631	*11.5*
Total	5,477	*100.0*	8,732	*100.0*	14,209	*100.0*
Ineligible*	150	*2.7*	629	*6.7*	779	*5.2*

*Households not found at their address (wrong address, death, change of address).

Some notation

- More formally, we wish to estimate the total of a p-dimensional vector of variables of interest $\boldsymbol{y}$ for $U = \{1, \ldots, k, \ldots, N\}$, $\boldsymbol{t}_y = \sum_U \boldsymbol{y}_k$.



- sample s has dimension n; $p(s)$ has first order inclusion probabilities $\pi_k = P(k \in s)$.
- respondents set r has dimension m with $r \subseteq s$ and $m \leqslant n$.

A two phases approach for unit nonresponse

1st phase sampling design $p(s)$;

2nd phase response mechanism $q(r|s)$ with $P(k \in r|s) = \theta_k$.

$$\hat{\boldsymbol{t}}_{y,\text{2p}} = \sum_r \frac{\boldsymbol{y}_k}{\pi_k \theta_k}$$

is unbiased under $p(s)q(r|s)$ but the θ_k's are unknown.

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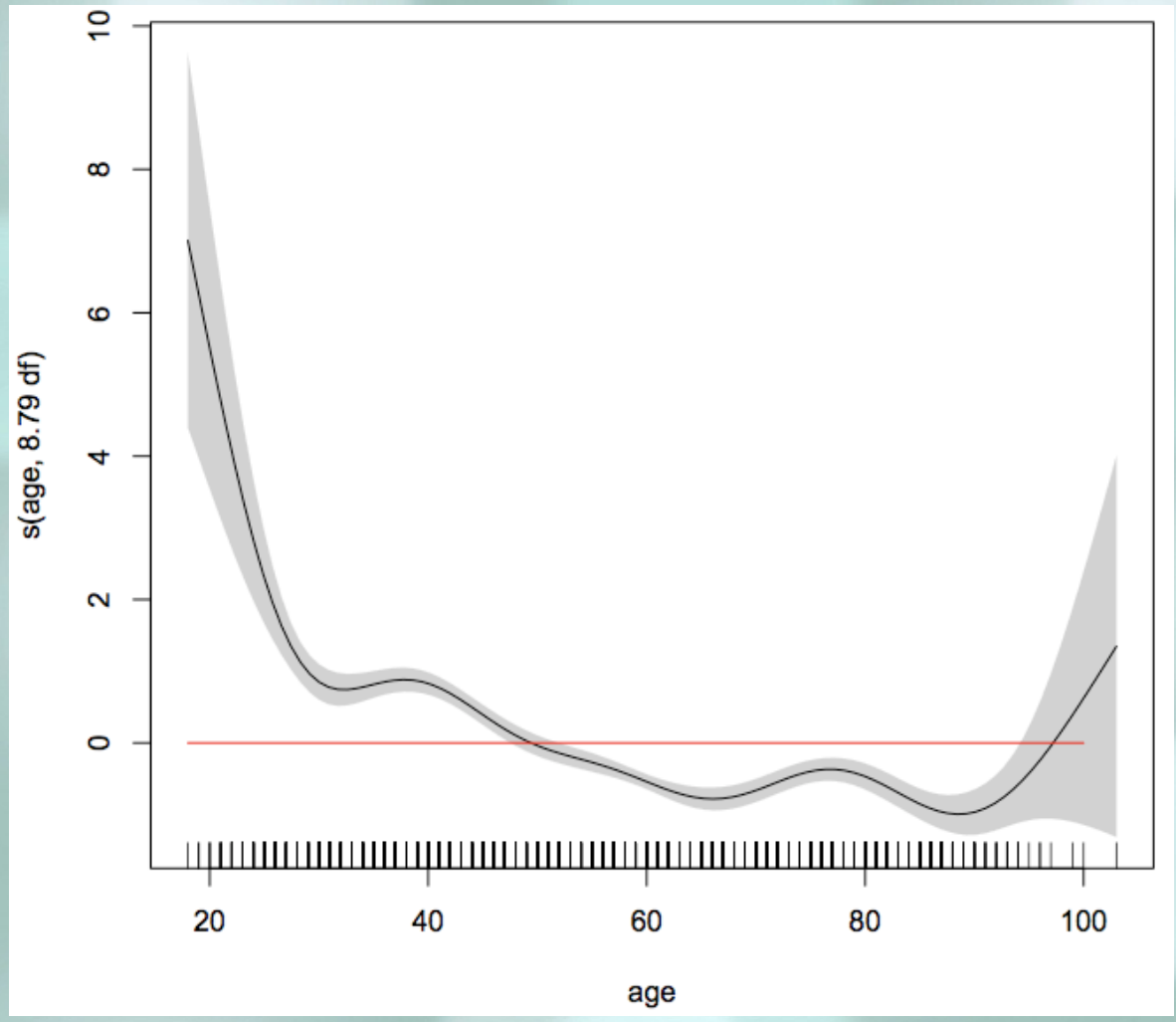
- $\theta_{kh} = \theta_h$ for each $k \in h$, $h = 1, \ldots, L \rightarrow$ post-stratification;
- logistic models for θ_k (Little, 1986; Ekholm & Laaksonen, 1991; Kim & Kim, 2007). Different models for
  - Non-panel HHs (from a subsample of nonrespondents CATI for socio-demo info)
  - Panel HHs (from previous waves)

Logistic Additive model for Non-panel HHs

Variables	coef	exp(coef)	p-value
Number of components of the HH*	-0.38	0.68	$<.0001$
Graduated head of HH	-0.48	0.62	$<.0001$
North/Centre	-0.67	0.51	$<.0001$
Self-employed head of HH	-0.60	0.55	$<.0001$
Retired head of HH	-0.35	0.70	0.0010
Home owner head of HH	-0.73	0.48	$<.0001$
Originally selected HH (vs subst.)	-0.24	0.79	$<.0001$
Intercept	1.72	5.58	$<.0001$

* quantitative variables



The estimated effect of AGE of the head of HH (and 95% confidence bounds) on the linear predictor scale

Logistic model for Panel HHs

Variables	coeff	exp(coef)	p-value
Municipalities with more than 500,000 inhabitants	-0.14	0.74	0.002
Number of components of the HH*	0.07	1.09	0.001
Number of waves HH has participated*	0.18	1.21	$<.0001$
Climate of previous interview	0.17	1.20	$<.0001$
Interviewer's age*	0.01	1.01	0.011
Number of waves (interviewer)	0.05	1.20	$<.0001$
Workload of interviewer** 21 – 100	-0.13	0.73	0.020
Workload of interviewer** 101 – 300	-0.34	0.59	$<.0001$
Workload of interviewer** $>$ 300	0.29	1.12	$<.0001$
Intercept	-1.33	0.27	$<.0001$

*quantitative variables; **baseline $<= 20$

Two major issues - 2 - Measurement Error

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Two major issues - 2 - Measurement Error

$$\hat{\boldsymbol{t}}_{y,\text{2p}} = \sum_r \frac{\boldsymbol{y}_k}{\pi_k \hat{\theta}_k}$$

Kim & Kim (27) prove design consistency for this estimator if the logistic model is well specified.

However, respondents likely report $\tilde{\boldsymbol{y}}_k \neq \boldsymbol{y}_k$. Two different types of variable of interest (see Table 2)

- Possession (1/0 variable)
- Amount held (continuous variable)

× Subsample with more accurate measures

✓ Independent sample with more accurate measures

The Extended Supplementary Sample (ESS)

- Sample of 1,681 HHs from customers of a major Bank in Italy (stratified according to geographical area of residence, municipality size, and to the financial wealth held within the Bank)
- Same questionnaire and interviewers as for SHIW
- Survey data *matched* with the Bank database containing the amounts of the assets *actually* held by the individuals selected in the sample

× Experiment run in 2003

- We will use this data to model mis-reporting for profiles of HHs and to extrapolate it to SHIW in two steps
  i. estimation of mis-reporting on the possesion;
  ii. estimation of mis-reporting on the amount held.

i. Mis-reporting models for the possession

For each of 4 financial assets (gov. bonds, private bonds, shares, mutual funds) let

$$\tau_{kj} = \begin{cases} 1 & \text{if unit } k \text{ possesses financial asset } j = 1, \ldots, 4 \\ 0 & \text{otherwise} \end{cases}$$

and

$$\delta_{kj} = \begin{cases} 1 & \text{if unit } k \text{ declares to possess financial asset } j = 1, \ldots, 4 \\ 0 & \text{otherwise} \end{cases}.$$

Then

$$\text{logit}\{P(\tau_{kj} = 1)\} = f(\delta_{kj}, \text{HH characteristics})$$

is modeled for each $j = 1, \ldots, 4$.

A brief summary of the models

Probability of possession (most significant variables)

Gov. Bonds ↑ Graduated head of HH; North-Center of Italy; Number of components with income

↓ above 3rd quartile of income

Private Bonds ↑ Graduated head of HH; Age of the head of HH; North-Center of Italy

↓ above 3rd quartile of income; Large municipality

Shares ↑ Graduated head of HH; ↓ Truthful response

Mutual Funds ↑ Age of the head of HH; North-Center of Italy

ii. Mis-reporting models for the amount held

Let

$$r_{kj} = \frac{y_{kj}}{\tilde{y}_{kj}} \quad \text{for } j = 1, ..., 4$$

be the ratio between true and declared amount held for each financial asset. Then $\log r_{kj}$ is modeled as a linear function of the amount declared and HH characteristics.

ii. Mis-reporting models for the amount held

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be the ratio between true and declared amount held for each financial asset. Then $\log r_{kj}$ is modeled as a linear function of the amount declared and HH characteristics.

Gov. Bonds ↑ Age of the head of HH

↓ Amount declared; below 1st quartile of income

Private Bonds ↑ above 3rd quartile of income;

↓ Graduated head of HH; below 1st quartile of income; Truthful response

Shares ↓ Amount declared;

Mutual Funds ↑ Graduated head of HH; Age of the head of HH;

↓ Truthful response

Alternative estimators

SHIW estimate Original design weights $1/\pi_k$ on declared variables $\tilde{\boldsymbol{y}}_k$

NR adjustment Nonresponse adjusted weights $1/\pi_k\hat{\theta}_k$ on declared variables $\tilde{\boldsymbol{y}}_k$

ME adjustment Original design weights $1/\pi_k$ on imputed variables $\hat{\boldsymbol{y}}_k$

NR+ME adjustment Nonresponse adjusted weights $1/\pi_k\hat{\theta}_k$ on imputed variables $\hat{\boldsymbol{y}}_k$

All estimators are calibrated w.r.t. demographic benchmarks (sex, age classes, geographical area, education)

Number of HHs (Millions) Possessing Financial Assets

	Gov. Bonds	*% of NFA*	Priv. Bonds	*% of NFA*	Shares	*% of NFA*	Managed savings	*% of NFA*
SHIW estimate	2.180	*118.2*	1.710	*38.2*	1.450	*50.6*	1.495	*55.0*
NR adj	2.299	*124.6*	1.769	*39.6*	1.502	*52.4*	1.601	*58.9*
ME adj	1.205	*65.3*	3.649	*81.6*	2.364	*82.5*	2.293	*84.4*
NR + ME adj	1.196	*64.8*	3.724	*83.3*	2.461	*85.9*	2.297	*84.6*
NFA estimate	1.845	*100.0*	4.471	*100.0*	2.865	*100.0*	2.716	*100.0*

Amount held (Billions of Euros)

	Gov. Bonds	*% of NFA*	Priv. Bonds	*% of NFA*	Shares	*% of NFA*	Managed savings	*% of NFA*
SHIW estim	65.610	*40.8*	61.190	*20.2*	31.862	*50.6*	50.992	*47.1*
NR adj	64.826	*40.3*	71.589	*23.6*	35.626	*56.5*	56.211	*51.9*
ME adj	69.311	*43.1*	456.435	*150.4*	53.447	*84.8*	109.373	*101.1*
NR+ME adj	66.655	*41.4*	472.852	*155.8*	56.318	*89.4*	115.219	*106.5*
NFA estim	160.840	*100.0*	303.450	*100.0*	63.026	*100.0*	108.219	*100.0*

Alternatively via (model) calibration

A more general framework provided by calibration (Deville & Särndal, 1992), model calibration (Wu & Sitter, 2001; Wu & Luan; 2003) and a combination of the two (Montanari & Ranalli, 2009)

$$\hat{\boldsymbol{t}}_{yc} = \sum_r w_k \tilde{\boldsymbol{y}}_k$$

Weights w_k are found to be as close as possible – in terms of a distance measure $\Phi(\cdot, \cdot)$ – to the NR adjusted weights $d_k = 1/\pi_k \hat{\theta}_k$ and, at the same time, to satisfy benchmark (coherence and/or efficiency) constraints:

$$\min_{w_k} \sum_r \Phi(w_k, d_k) \qquad \text{s.t.}$$

1. Vector of demographic variables: $\sum_r w_k \boldsymbol{x}_k = \boldsymbol{t}_x$
2. Vector of measurement error imputed variables $\sum_r w_k \tilde{\boldsymbol{y}}_k = \sum_r d_k \hat{\boldsymbol{y}}_k$

Number of HHs (Millions) Possessing Financial Assets again

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SHIW estimate	2.180	*118.2*	1.710	*38.2*	1.450	*50.6*	1.495	*55.0*
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ME adj	1.205	*65.3*	3.649	*81.6*	2.364	*82.5*	2.293	*84.4*
NR + ME adj	1.196	*64.8*	3.724	*83.3*	2.461	*85.9*	2.297	*84.6*
CAL adj	1.247	*67.6*	3.888	*87.0*	2.554	*89.1*	2.364	*87.0*
NFA estimate	1.845	*100.0*	4.471	*100.0*	2.865	*100.0*	2.716	*100.0*

Amount held (Billions of Euros) again

	Gov. Bonds	*% of NFA*	Priv. Bonds	*% of NFA*	Shares	*% of NFA*	Managed savings	*% of NFA*
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NR+ME adj	66.655	*41.4*	472.852	*155.8*	56.318	*89.4*	115.219	*106.5*
CAL adj	71.218	*44.3*	501.661	*165.3*	59.284	*94.1*	118.627	*109.6*
NFA estim	160.840	*100.0*	303.450	*100.0*	63.026	*100.0*	108.219	*100.0*

Conclusions and points for discussion

- ME seems to have a larger impact than NR
  - × Self selection issues in the subsample of nonrespondents
  - × Non contacts/refusal confounding
  - × Portfolio issues from time mis-alignement (2003 ESS; 2008 SHIW)
  - × Correlation between response probabilities and misclassification probabilities

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  - × Self selection issues in the subsample of nonrespondents
  - × Non contacts/refusal confounding
  - × Portfolio issues from time mis-alignement (2003 ESS; 2008 SHIW)
  - × Correlation between response probabilities and misclassification probabilities
- (Model) Calibration seems a natural environment to handle NR and ME adjustments

	Design weights $1/\pi_k$	NR adjusted weights $1/\pi_k\hat{\theta}_k$	CAL weights w_k
% CV	96.6	104.6	187.0
Q3 - Q1	2548.9	2703.7	2765.1

  - × Extreme weights due to the unrepresentativeness of the wealthiest HHs

THANK YOU!

QUESTIONS, COMMENTS, SUGGESTIONS... ??

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