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Evaluation of the impact of mixed mode design on the quality of the estimates of the survey “Aspects of Daily Life”

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- Showing the framework for the analyses carried out to assess the impact of Mixed Mode on Aspect of Daily Life household survey, switched from single to mixed mode
 - ✓ Experimental setting (parallel samples single/mixed mode)
 - ✓ Analysis of the reasons that explain significant differences in the estimates obtained with the two designs
 - ✓ Focus on the analysis of impact of mixed mode on univariate distributions and multivariate structure of the data

Mixed mode in ISTAT social surveys

- Mixed mode** is the combined use of different data collection techniques in one survey, MM is spreading especially in social surveys, to contrast declining response rates and coverage, reducing also the total cost of the surveys
- ✓ The use of different data collection techniques helps in contacting different types of respondents in the most suitable way for each of them, so allowing a gain in population coverage and response rate
 - ✓ It is not a new way of data collection for ISTAT surveys but its treatment has been faced recently

In ISTAT several situations have occurred so far

- ❑ Mixed mode used primarily to address coverage issues of previously single mode CATI surveys (-> web/CATI)
- ❑ Mixed mode in longitudinal household surveys to reduce cost and burden (CAPI/CATI) – Eu-silc and LFS
- ❑ Mixed mode used primarily to reduce survey cost whereas expanding population coverage, through the introduction of web technique in traditionally PAPI surveys
 - “Multipurpose survey on households: Citizens and leisure time” - 2015”, web/PAPI
 - “Multipurpose survey on households: Aspects of daily life - 2017”: sequential web/PAPI with a control single mode sample PAPI

Mode effect in mixed mode survey (1)

Which drawbacks has this choice?

The difficulty of controlling over **mode effect** and the **confounding** between **selection** and **measurement** effects (especially in sequential designs) (De Leeuw, 2005)

- ❑ **Mode effect** refers strictly to **measurement error** differences due to the mode of survey administration (error of observation)
- ❑ A **selection effect** occurs due to the differences in the distributions of the respondents to the alternative modes, (error of observation, desirable aspect of MM strategy)

How and when dealing with mode effect?

- ❑ Mainly in the planning of the survey (questionnaire and survey design) to limit measurement error
- ❑ In the estimation phase
 - ✓ to evaluate the accuracy of the estimates over time - the estimates must be consistent and comparable with the analogue ones obtained in the previous survey editions, for ensuring that any changes in the time series are exclusively due to real changes of the observed phenomenon
 - ✓ to adjust mainly the selection effect, while estimating the measurement effect

Theoretical framework

- ❑ From an inferential point of view the **selection and measurement effects** need to be investigated separately, to obtain a correct formulation of the total non-sampling error and to apply methods to adjust the estimates of the parameters of interest for the bias effects
- ❑ The problem of the **confounding** between the two effects is the central theme of the theory of **causal inference** (*Pearl, 2009*)
 - The **measurement error** is conceptualized as a **causal effect** of the mode on the survey variable, while the **selection effect** is seen as a spurious correlation between the target variable and the mode
 - For the estimation of the two effects causal inference is used according to a **counterfactual perspective**: the existence of a potential result not really observed (the value that the respondent would have provided with the other mode) is hypothesized
- ❑ An alternative approach is based on the use of **instrumental variables**, when a benchmark survey is available (*Vannieuwenhuyze et al. 2010*)

The sample survey “Multipurpose survey on households: Aspects of daily life”

- ❑ Collects information about recreational and cultural activities in free time, such as sports, reading, cinema, music, the Internet, social relations, issues for the quality of people life
- ❑ Based on a sample of about 24.000 households, selected through a two stage sample design (municipalities/households) from the centralized municipal register (LAC)
- ❑ Mixed technique: sequential web-PAPI
 - ✓ A self-compiled questionnaire (web) proposed in the inviting letter sent by ISTAT and after, on non respondent households, direct interview with a questionnaire on paper with an interviewer (PAPI)
- ❑ In 2017 **experimental set up: sequential web/PAPI (MM)** with a **control single mode (SM)** sample PAPI
- ❑ The selected **sample** of individuals was **linked to an administrative data base** (Archimede Project) through the individual code available from the selection frame to obtain external auxiliary variables

Survey settings and analysis framework (2)

Response rates for ADLs in the SM and MM surveys by geographical area

Geographical area	Response rates		
	SINGLE MODE/PAPI	MIXED MODE	
		web	final
North West	65.9%	32.5%	71.2%
North East	70.2%	36.0%	73.6%
Center	68.6%	27.8%	70.2%
South	79.3%	17.7%	79.4%
Islands	71.3%	17.3%	74.2%
ITALY	71.0%	26.8%	74.0%

Survey settings and analysis framework (3)

Summary scheme of the experimental context and analyses

Parallel independent samples (SM/MM)	Mixed-mode: Sequential web-PAPI; Control sample: Single mode (PAPI)
Main goal of the analyses	<ul style="list-style-type: none">– Evaluation of the impact of the switching from single to mixed mode– Evaluation of total non-sampling error components (measurement)
Theoretical context	Instrumental/Counterfactual approaches
Available auxiliary information	Register demo-social covariates
Phases of the analyses (target variables)	<ul style="list-style-type: none">– Comparison between the SM and MM samples<ul style="list-style-type: none">▪ <u>tests</u> on the <u>differences</u> in the estimates SM and MM▪ <u>study of the total nonresponse bias</u>– Analyses on the univariate distributions and multivariate structure of data– Assessment of the mode effect, disentangling selection and measurement (propensity score and instrumental variable)
Phases of the adjustment	<ul style="list-style-type: none">– Adjusting for selection effect in the MM design through weighting (standard calibration, fixed mode proportions and propensity score)

The assessment of the introduction of the mixed mode (1)

The auxiliary variables available for the following analyses and models

Auxiliary mode-insensitive variables in ADL survey at household level:

- ✓ Household type: one-component under 55, one-component over 54, couple with children at least one under 25, couple with children without under 25, couple without children, one parent at least one under 25, one parent without under 25, other types
- ✓ Higher education level: below/equal/above high school diploma
- ✓ Occupation type: Prevalence of: employed, self employed, not in labor age, mixed types
- ✓ Municipal type: Metropolitan cities, metropolitan area, other municipalities <2000, 2000-10000, 10000-50000, >50000
- ✓ Geographical area (North, Center, South and Islands)
- ✓ Income class: 5 quintiles (€ 11.955, 20.892, 30.028, 46.119)
- ✓ Citizenship (nationality): Italian/Foreign household

Analysis of total nonresponse bias – R-indicators

- R-indicators (Schouten et al., 2011) are based on a measure of the variability of the response propensity and describe how the sample of respondents to a survey reflects the population of interest with respect to certain characteristics

$$R(\rho_X) = 1 - 2S(\rho_X)$$

- At national level MM sample deviates less from the representative response with respect to the SM sample – MM sample is more representative

R-indicators in SM and MM samples

	R_Indicator	SM sample	MM sample
response models defined at national level	Italy	0.812	0.852
response models defined for each geographical area	North	0.847	0.840
	Center	0.752	0.842
	South and Islands	0.840	0.907

The impact of MM on the univariate and multivariate structure of data

Users' interest is generally the relations among variables, studied through statistical models

- **What is the impact of data collection design on distributions and/or associative structure of the variables? (*Martin and Lynn, 2011*)**

Univariate analysis - impact of mixed-mode design (SM/MM) on the distributions of ADL variables

- ❑ Regression models, with the survey variable as the dependent variable and a dummy variable “survey design” as the independent variable
 - ✓ appropriate statistical models and tests to evaluate if the distributions are significantly different

Multivariate analysis - impact of mixed-mode design (SM/MM) on the estimation of models

- ❑ Regression models, with interaction effects between “survey design” and auxiliary socio-demographic variables to estimate the association
 - ✓ appropriate statistical models and tests to evaluate the statistical significance of the interaction effects

- Significant interaction effects would show different relations among structural and target variable depending on the survey design

The impact of MM on the univariate and multivariate structure of data (2)

Results – regression model with independent variable “survey design”

VARIABLE	Category	coefficient		p-value		ANOVA
		Intercept	Survey design	Intercept	Survey design	p-value
Frequency of seeing friends (Everyday)	Sometimes a week	0,500	-0,050	0,000	0,111	0,000
	Once a week	0,204	-0,039	0,000	0,241	
	Sometimes a month	0,175	-0,139	0,000	0,000	
	Sometimes a year	-0,407	-0,317	0,000	0,000	
	Never	-1,114	-0,165	0,000	0,002	
	No friends	-2,167	-0,281	0,000	0,001	
	NR	-2,411	-0,458	0,000	0,000	
Performing physical activity (NO)	Sometimes a week	-0,828	0,189	0,000	0,000	0,000
	Sometimes a month	-1,643	-0,124	0,000	0,006	
	Sometimes a year	-1,527	-0,248	0,000	0,000	
	NR	-2,588	-0,025	0,000	0,702	
Playing sports, with continuity (NO)	Yes	-1,117	0,097	0,000	0,000	0,000
	NR	-3,835	-0,134	0,000	0,117	
Playing sports, occasionally (NO)	Yes	-1,926	0,013	0,000	0,719	0,345
	NR	-3,312	-0,097	0,000	0,168	
Hospitalized, in last 3 months (NO)	Yes	-3,427	-0,009	0,000	0,871	0,061
	NR	-3,923	-0,184	0,000	0,020	

The impact of MM on the univariate and multivariate structure of data (3)

Results – regression model with interaction effects between “survey design” and auxiliary variables

VARIABLE	Category	Single effect
Performing physical activity (NO)	Sometimes a week	Sex, Age class, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	Sometimes a month	Age class, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	Sometimes a year	Survey design, Age class, Citizenship, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	NR	Age class, Citizenship, Educational level, Municipal type
Frequency of seeing friends (Everyday)	Sometimes a week	Sex, Age class, Educational level, Occupation type, Geographical Area, Municipal type
	Once a week	Survey design, Sex, Age class, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	Sometimes a month	Survey design, Sex, Age class, Citizenship, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	Sometimes a year	Sex, Age class, Citizenship, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	Never	Sex, Age class, Citizenship, Income class, Geographical Area, Municipal type
	No friends	Sex, Age class, Citizenship, Income class, Occupation type, Geographical Area, Municipal type
Playing sports, with continuity (NO)	NR	Sex, Age class, Educational level, Occupation type, Geographical Area, Municipal type
	Yes	Survey design, Sex, Age class, Citizenship, Educational level, Income class, Occupation type, Geographical Area, Municipal type
	NR	Survey design, Sex, Age class, Citizenship, Income class, Occupation type, Municipal type

The impact of MM on the univariate and multivariate structure of data (4)

Results – regression model with interaction effects between “survey design” and auxiliary variables

VARIABLE	Category	Interaction effects: survey design
Performing physical activity (NO)	Sometimes a week	Age class, Geographical Area
	Sometimes a month	Sex
	Sometimes a year	Citizenship
	NR	Geographical Area
Frequency of seeing friends (Everyday)	Sometimes a week	Sex, Educational level, Geographical area
	Once a week	Age class, Municipal type
	Sometimes a month	Age class
	Sometimes a year	Age class, Geographical area, Municipal type
	Never	Sex, Age class
	No friends	-
	NR	-
Playing sports, with continuity (NO)	Yes	Age class, Educational level, Geographical area
	NR	Age class, Educational level, Income class, Occupation type, Geographical area, Municipal type

The estimate of mode effects (selection and measurement)

Selection and measurement effects estimated through different approaches

Estimates of selection and measurement effects - Instrumental variable (SM/MM samples)

Variable	Category	Selection effect	Measurement effect
Reading books in the last 12 months	No	0,1478	-0,0727
	Yes	-0,1767	0,0416
	NR	0,0288	0,0311

Estimates of selection and measurement effects - Propensity Score Subclassification (MM sample)

Variable	Category	Weighted Web mean	Web mean	PAPI mean	Selection effect	Measurement effect
Reading books in the last 12 months	No	0.485	0.451	0.618	0.034	-0.132
	Yes	0.432	0.508	0.347	-0.075	0.085
	NR	0.043	0.041	0.035	0.002	0.007

Methods for adjusting selection effect - Weighting methods

- ❑ Propensity score, calibration of weights modified through the correction factors (*Rosenbaum and Rubin, 1983 - Vandenplas et al., 2016*)
- ❑ Standard calibration on demographic totals
- ❑ Calibration on fixed levels of mode proportions (method proposed by *Buelens and Van den Brakel, 2015*), to stabilize the selection effect in repeated surveys, assuming the invariance of measurement effect, with the aim to obtain reliable changes over time
- ✓ Assuming the hypothesis of ignorability of the selection effect and absence/stability of measurement effect

The adjustment of selection effect with different methods (2)

Comparison of the estimates deriving from the application of different methods

Methods based on **calibration** on distributions of the same socio-demographic totals (age class, sex, educational level) at geographical area level, but different for other aspects:

- 1) only socio-demographics;
- 2) socio-demographics and observed fixed levels of mode proportions by six municipal typologies;
- 3) socio-demographics and hypothesized fixed levels of mode proportions by six municipal typologies;
- 4) socio-demographics with sampling weights corrected for the web selection effect through correction factors w_k (propensity score)

Estimates of “reading books in the last 12 months” with different methods

Variable	Category	Estimate (%)			
		Meth. 1	Meth. 2	Meth. 3	Meth. 4
Reading books in the last 12 months	No	59,82	58,88	58,54	59,81
	Yes	36,51	37,47	37,76	36,46
	NR	3,67	3,65	3,70	3,73

Final considerations

- ❑ For the Aspect of Daily Life survey
 - ✓ the introduction of mixed mode has an **important impact** both on the composition of the sample (and its **representativeness**) and on several indicators, whose quality seems to be affected by **measurement effect** which cannot be always easily assessed
 - ✓ MM seems to have an impact on simple and complex analyses as well
 - ✓ the application of all the presented methods is subject to the **validity of the hypotheses** underlying all these methods and that need to be verified by the researcher as far as possible
- ❑ The set of the analyses presented and applied in a specific survey context can be considered as a **possible checklist**, a **sequence of steps** usable by researchers of other NSIs to carry out an assessment of mode effect in similar situations
- ❑ Generally the underlying effort is hardly compatible with the usual resources and the timing of a statistical process: in general situations an accurate planning of the data collection phase is more advisable, in order to limit as far as possible ex-ante the measurement effect, which is the main drawback of the mixed mode

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Thank you for your attention !