**Mode-effects in mixed-mode surveys: the Italian experience on social surveys using the web**

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**Abstract**

*Due to the ever-increasing penetration of the internet into the Italian population, Istat is progressively expanding the use of mixed-mode data collection involving Computer assisted web interview in social surveys. In 2017 a project was carried out on the optimal design of mixed-mode strategies to ensure high data quality levels by preventing and treating mode effects. The main result of the project is the handbook "Mode-effects in mixed-mode surveys - Theoretical issues and experimental applications on social surveys using the web", which is expected to contribute to the methodological and operational standardization of this type of social surveys. Actually, the handbook provides a conceptual reference framework in this mixed-mode data collection, as well as an overview of the main issues related to the design of mixed-mode surveys and possible methodological solutions to face them. A selection of methods for the diagnosis and the treatment of mode effects are thoroughly analysed and assessed based on experimental applications to current social surveys. The paper summaries the theoretical contents of the handbook, focusing on the main findings emerged from the analyses made.*

**Keywords:** Mixed-mode, mode effects, web, social surveys

**1. Background**

The use of efficient data collection strategies in surveys is a key element to ensure high quality statistical information. However, particularly in the area of social statistics, the reduction of data collection costs and respondents’ burden are to be properly taken into account starting from the survey design phase. In order to find an optimal trade-off between quality requirements (in terms of coverage, response rates, accuracy) and costs constraints, many National Statistical Institutes (hereafter NSIs) are progressively moving towards mixed-mode strategies which exploit the potentials of different data collection techniques. Actually, in the context of mixed-mode surveys, those involving Computer Assisted Web Interview (Cawi) are often preferred, as they are less expensive and, in many application contexts and where properly designed, they ensure high data quality levels (see for example Kreuter, 2013). However, it is well known that mixed-mode strategies usually originate specific non-sampling errors, commonly referred to as *mode effects*, which main components are *selection* and *measurement effects* (for more details, see for example De Leeuw, 2005). As a matter of fact, many methodologies and approaches have been proposed in literature to deal with mode effects and to treat their biasing effects on target estimates (among the most recent, see Buelens and Van den Brakel, 2013, Roberts and Vandeplas, 2017).

Designing efficient mixed-mode strategies is a complex task from methodological, organizational, operational, technological points of view, as the specific survey objectives, characteristics of target populations, available resources, etc. are to be taken into account together. The increasing attention at European level on the need of improving the efficiency of mixed data collection strategies on households and persons, and to develop a common architecture for European social statistics[[1]](#footnote-1) has stimulated NSIs to start of development and standardization process in this area. As for Istat, given the increasing penetration of internet in the Italian population, the joint use of the Cawi and other data collection techniques has been progressively extended in social statistics. The modernization of the Istat production system with the centralization of data collection activities in a single Department, has facilitated to start a process of analysis and development in the area of mixed-mode social surveys using the web, with the aim to provide survey managers and methodologists with support tools for the design and implementation of efficient data collection strategies. In this view, the e-book *Mode-effects in mixed-mode surveys - Theoretical issues and experimental applications on social surveys using the web* (Istat, 2017)[[2]](#footnote-2) is expected to facilitate the sharing of a common vocabulary, and the development of a common methodological and operational framework in this area. Actually, the handbook is expected to make Istat researchers more aware of quality issues related to mixed-mode strategies, of the need to prevent as much as possible mode effects at the design phase and to properly treat these effects to ensure accurate estimates. The handbook is the result of one-year project involving several Istat experts (data collection specialists, methodologists, IT-experts, subject-matter experts). Besides a conceptual reference framework, the handbook provides an overview of the methodological, operational and organizational issues related to the design of mixed-mode data collection strategies involving the web, highlighting the main risks associated to inaccurate designs. The results of experimental applications of some methodological approaches to prevent, assess and treat mode-effects are reported. Key recommendations for the methodological and operational design of efficient mixed-mode data collection strategies are also provided in the volume.

The paper contains a summary of the contents of the e-book, and is structured as follows. In Section 2 an overview of the contents and main findings of the e-book is provided. Conclusions and perspectives are summarized in section 3.

**2. The handbook**

The overall structure of the handbook is reported in Table 1. In next sub-sections an overview of the contents of each chapter of the handbook are briefly illustrated.

*2.1. Chapter 2 – Mixed-mode surveys and data quality*

Chapter 2 provides a theoretical framework in the context of mixed-mode surveys on households and persons and introduces a common terminology and basic definitions in this area. A summary of quality issues related to the data collection is provided, together with the definition of mode effects and its main components: *selection effect* (essentially due to the fact that the different techniques are characterized by different coverage and non-response rates), and *measurement effect* (due in practice to the use of different instruments to detect the same phenomenon). Moreover, as these effects are often *confounded*, specific methods are needed for eliminating their biasing effects on final estimates. The types of mixed-mode design (*Concurrent* or *sequential mixed-mode* designs) and questionnaires (*Unified mode* or *mode specific* questionnaires) are also introduced. Based on this reference framework, the other Chapters provide a thorough analysis of the various elements of mixed-mode strategies, highlighting the associated advantages and risks and the importance of their accurate design for preventing mode effects.

*2.2. Chapter 3 – The design of mixed-mode surveys*

Chapter 3 illustrates various aspects of the design of mixed-mode strategies, having in mind that the final aims are: 1) to optimize the trade-off between quality and costs through the prevention and control of the possible biasing effects resulting from the joint use of several techniques, and 2) to get useful elements to ensure the possibility of ex-post treatment of these effects. Specific attention is devoted to the criteria to be followed to select the techniques to be combined and to their joint management (sequential or concurrent). The elements for the appropriate design of both the sample and the survey questionnaire(s) are also discussed.

**Table 1- Overall structure and main contents of the handbook**

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Concerning the latter, the precautions to be taken when using different modes essentially aim to prevent mode measurement effects. In this chapter, possible strategies to maximize response rates in mixed-mode designs are discussed, such as the adoption of flexible strategies like *adaptive* and *responsive designs*, and the use of *paradata*. Given the importance of preventing mode effects, the use of pilot surveys and pre-tests are illustrated with some detail. As for pre-tests, the *cognitive interview approach* (see e.g. Willis, 1994) is indicated as one of the most useful methods for the definition of questionnaire contents and wording. Pilot-surveys have wider objectives, as they allow to test not only the questionnaire but all the survey elements (organizational aspects, the sample design, reminder strategies), with the final aim to collect as much information as possible to assess and measure mode effects and relating sources and to prevent them in actual surveys.

*2.3. Chapter 4 – Methods for the diagnosis and the measurement of mode effect*

In Chapter 4, methods for the diagnosis and the measurement of mode effects are illustrated. They are classified into: 1) methods for exploratory data analysis, 2) methods based on hypothesis testing, 3) model-based methods. The first class includes for example analysis of differences in distributions of socio-demographic variables (e.g. by data collection technique, by type of responding units, etc.), analysis of responding vs non responding units, and differences in quality indicators. In the handbook, a wide range of examples taken from both specialized literature and current Istat social surveys using combined data collection modes are reported. Concerning the second class of methods, possible ways of using classic hypothesis testing methods to verify the presence of measurement effects in case of data collected through different modes are illustrated. As for model-based methods, they basically refer to: a) methods for the assessment of selection effect, essentially based on the analysis of respondents and non-respondents; b) methods for the assessment of measurement effect, such as the *multigroup confirmatory factor analysis* (*MCFA*, see Lubke et al., 2004) and the approach based on a reference survey (Vannieuwenhuyze et al., 2012); c) methods for disentangling selection and measurement effects, such as experimental designs, data validation w.r.t. benchmark data, latent class variables models, propensity score methods. All the methods illustrated in this chapter are considered useful not only for the diagnosis and measurement of mode effects, but also to orientate the following treatment activities, and to support the revision of some critical elements of the survey design.

*2.4. Chapter 5 – Methods for the treatment of mode effects at the estimation phase*

The aim of Chapter 5 is to provide the reader with an overview of methods proposed in the vast specialized literature, which can be used at the estimation stage to adjust for the biasing effects on parameter estimates due to mode effects. It is straightforward to mention that in mixed-mode surveys, estimates accuracy depends, among other factors like coverage, nonresponse, etc., also on the validity of the equivalence assumption on measurements performed with the different data collection techniques. In addition, in order correctly define the total nonsampling error and to apply methods to adjust parameters estimates, selection and measurement effects need to be analyzed separately. Among the available methods allowing to disentangle the two effects, in the handbook those based on the theory of causal inference in a counterfactual perspective are widely discussed. This theory assumes that potential measurements exists, but they are not actually observed, and need to be estimated through the estimation of counterfactual data. A common characteristic of inferential model-based methods is that their validity strongly depends on the availability of mode-insensitive auxiliary information (i.e. not influenced by the data collection mode). In the volume, a number of existing approaches to treat mode effects/mode bias at the estimation stage are discussed, and their main advantages and drawbacks are highlighted. Among others: methods based on R-indicators to study the representativeness of the samples (Schouten et al., 2011), methods for testing the assumption of measurements equivalence across modes (Hox et al.*,* 2015); methods based on Propensity Score approach (Lee et al., 2008), methods based on multiple imputations which allow to overcome the non-ignorability of the mode selection assumption (Park et al., 2016), methods based on Calibration (Buelens and Van den Brakel 2013), aiming at defining a robust estimation procedure with respect to variations in the distribution of respondents to different techniques.

One of the main findings of the analysis performed, is that the choice of the methods to be used to deal with mode-effects at the estimation phase for a specific survey is a complex task, depending on a number of issues. First of all, the type and the characteristics of the available auxiliary information is a key aspect: as an example, in case of missing values on covariates, methods for incomplete data should be considered. Another key issue relates to total nonresponse resulting from the selection process, which cannot be addressed with usual methods: this issue is specifically discussed in the chapter.

*2.5. Chapter 6 – Analysis of mode effects in two case studies*

Chapter 6 refers to experimental applications on current social surveys of selected methods among the ones described in Chapter 4 and Chapter 5. In particular:

* exploratory data analyses and *MCFA* are applied on selected items of the Multipurpose survey on households - Citizens and leisure time (2015). The survey annually collects information on recreational and cultural activities in free time, such as sports, reading, cinema, etc. on a sample of about 24.000 households. A mixed technique using Cawi-PAPI under a sequential design was adopted;
* exploratory data analyses, *propensity score matching* and a method based on *multiple imputation* are applied on selected items of the Multipurpose survey on households - Aspects of daily life (2014). The survey annually collects information about topics related to the quality of life of people on a sample of about 24.000 households. The application has been performed on data of two independent samples, interviewed using Cawi and PAPI through the same questionnaire.

The above applications are actually the first ones performed at Istat in which not only complex methodologies to assess and treating mode effects are evaluated, but also traditional exploratory analysis are used in a substantially standard way. As the applications have been performed in not experimental situations, the obtained results depend on factors that are not completely under the control of the statisticians, and the validity of assumptions made needs to be supported by further studies and analysis. However, some important results have been obtained from the applications: 1) a deeper knowledge of the methodologies evaluated in terms of complexity of their usage in real situations; 2) a greater awareness of the importance of the proper methodological design of surveys jointly using different data collection modes; 3) a greater awareness of the methodological complexity and costs of the required analyses and developments, which can be time consuming and burdensome also in terms of amount and quality of the auxiliary information needed.

*2.6. Chapter 7 – Summary and general recommendations*

The final chapter of the e-book contains a number of general recommendations for the design and the implementation of efficient mixed-mode data collection strategies for social surveys involving the web. Recommendations are based on the analyses and the application results illustrated in the other chapters of the handbook. For the purposes of this paper, recommendations are only summarized, separately by the issue they mainly are referred to *Design* and *Methods to deal with mode effects*.

**Design**: the underlying idea of recommendations in this case is that the accurate design of the data collection strategy highly contributes to quality of final results through error prevention. Recommendations relate mainly to the following aspects:

* the selection of the techniques to be combined, that must aim to maximize quality under cost and time constraints, and that can be driven by the type of nonsampling error to be prevented with priority (coverage errors, nonresponse, etc.);
* the identification of the best organizational strategy: e.g. how to contact people, soliciting non-respondents, re-interview sub-samples of units, etc.;
* the design of pre-tests and/or pilot surveys: particularly the latter allows to fine-tune many elements of the survey design (organizational and operational aspects, selection of techniques, etc.). It is also recommended to use pre-test and/or pilot surveys for questionnaire design (structure, wording, etc.) taking into account the potentials of each technique, the characteristics of target (sub)populations, etc.;
* the sample design, which is strictly related to the type of selected techniques, on the way they are combined (concurrent or sequential strategies), etc.

**Methods to deal with mode effects**: in this context recommendations rely on the assumption that in mixed-mode surveys the estimates accuracy depends not only on traditional elements such as coverage, response rates, etc., but also on additional requirements. In this view, recommendations relate mainly to the following aspects:

* the use of all the information available from other methodological experiences and from exploratory data analysis to select the appropriate methodological solutions to deal with mode effects in the specific survey;
* the identification of the appropriate methodological solution taking into account the specific information context (characteristics of the survey design, available mode-insensitive auxiliary information, availability of a reference survey, etc.), as well as the possibility of verifying the validity of the assumptions required;
* the selection of items (e.g. the sensitive ones) to be treated more accurately to assess the possible presence of significant mode effects; actually, these analyses are fundamental for the choice of the appropriate methodologies to be adopted to deal with selection and/or measurement effects at the estimation stage.

**3. Conclusions and future work**

The handbook “*Mode-effects in mixed-mode surveys-Theoretical issues and experimental applications on social surveys using the web*” is the result of a complex research activity carried out at Istat in 2017. Such activities have been facilitated by the new organization of Istat due to the modernization process carried out since 2016, which has determined the centralization of data collection activities in a unique Department. In the area of mixed-mode social statistics, this context is facilitating the integrated re-design of surveys in a standardization perspective. Actually, Istat is investing lot of resources on the efficient design (in terms of trade-off between quality and cost) of mixed-mode data collection strategies, as well as on the operational and technical management of the data collection processes for the prevention and the treatment of mode effects and the associated biasing effects on estimates. The main expected result from the dissemination of the handbook is the sharing of a common vocabulary, definitions, key issues and possible solutions in the area of mixed-mode social surveys across the various sectors of the Institute, and the progressive development of common view on the topics covered in thee-book. The handbook will be translated in English by the end of 2018. Future activities will focus on the ex-ante optimal design of mixed-mode surveys, and on further assessment of methods to cope with such effects and adjust for their biasing effects on estimates. These activities will be also carried out within the European Grant MIxed MOde Designs for Social Surveys (MIMOD), which is coordinated by Istat[[3]](#footnote-3).

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1. See for example: the “Wiesbaden Memorandum”, September 2011 (https://www.destatis.de/EN/AboutUs/Events/DGINS/Document\_Memorandum.pdf;jsessionid=250B3BD806299841B8D924749F4908E2.cae4?\_\_blob= publicationFile ), and the results of the Essnet on data collection for social surveys using multi-modes (Dcss) (Eurostat, 2014). [↑](#footnote-ref-1)
2. The Author thanks all the Istat researchers who collaborated in the preparation of the e-book: M. Signore, M.C. Romano, S. Macchia, M. Murgia, G. Fazzi, C. De Vitiis, F. Inglese, A. Guandalini, M. Terribili, R. Varriale, I. Vannini, S. Montecolle, E. Bologna, G. Della Rocca. [↑](#footnote-ref-2)
3. For more details on this project, refer to the Q2018 Special Session: Improving the quality of multi-mode data collection. The European MIMOD project (<https://www.q2018.pl/session-34/> ) [↑](#footnote-ref-3)