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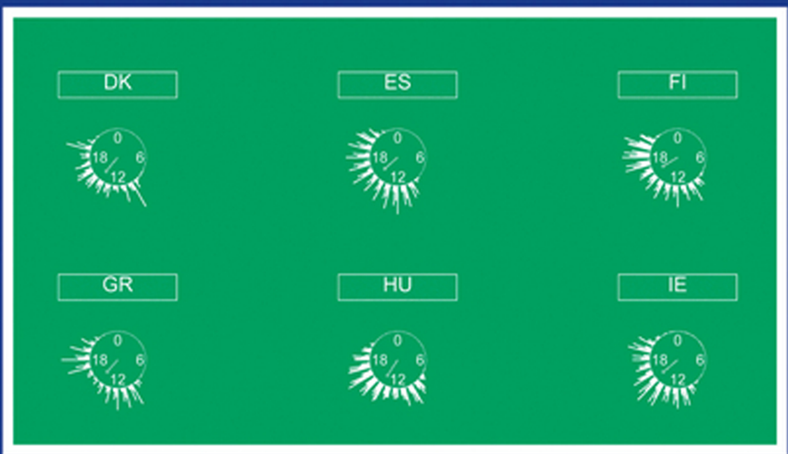
Analytic Uses of Process Information



Edited by

Frauke Kreuter

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WILEY SERIES IN SURVEY METHODOLOGY

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IMPROVING SURVEYS WITH PARADATA
Analytic Uses of Process Information

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PART I PARADATA AND SURVEY ERRORS

PREFACE

Newspapers and blogs are now filled with discussions about “big data,” massive amounts of largely unstructured data generated by behavior that is electronically recorded. “Big data” was the central theme at the 2012 meeting of the World Economic Forum and the U.S. Government issued a Big Data Research and Development Initiative the same year. The American Statistical Association has also made the topic a theme for the 2012 and 2013 Joint Statistical Meetings.

Paradata are a key feature of the “big data” revolution for survey researchers and survey methodologists. The survey world is peppered with process data, such as electronic records of contact attempts and automatically captured mouse movements that respondents produce when answering web surveys. While not all of these data sets are massive in the usual sense of “big data,” they are often highly unstructured, and it is not always clear to those collecting the data which pieces are relevant, and how they should be analyzed. In many instances it is not even obvious which data are generated.

Recently Axel Yorder, the CEO of the company Webtrends, pointed out that just as “Gold requires mining and processing before it finds its way into our jewelry, electronics, and even the Fort Knox vault [. . .] data requires collection, mining and, finally, analysis before we can realize its true value for businesses, governments, and individuals alike.”[1] The same can be said for paradata. Paradata are data generated in the process of conducting a survey. As such, they have the potential to shed light on the survey process itself, and with proper “mining” they can point to errors and breakdowns in the process of data collection. If captured and analyzed immediately paradata can assist

[1] `http://news.cnet.com/8301-1001_3-57434736-92/big-data-is-worth-nothing-without-big-science/`

with efficiency during data collection field period. After data collection ends, paradata that capture measurement errors can be modeled alongside the substantive data to increase the precision of resulting estimates. Paradata collected for respondents and nonrespondents alike can be useful for nonresponse adjustment. As discussed in several chapters in this volume, paradata can lead to efficiency gains and cost savings in survey data production. This has been demonstrated in the U.S. National Survey of Family Growth conducted by the University of Michigan and the National Center for Health Statistics.

However, just as for big data in general, many questions remain about how to turn paradata into gold. Different survey modes allow for the collection of different types of paradata, and depending on the production environment, paradata may be instantaneously available. Fast-changing data collection technology will likely open doors to real-time capture and analysis of even more paradata in ways we cannot currently imagine. Nevertheless some general principles regarding the logic, design, and use of paradata will not change, and this book discusses these principles. Much work in this area is done within survey research agencies and often does not find its way into print, thus this book also serves as a vehicle to share current developments in paradata research and use.

This book came to life during a conference sponsored by the Institute for Employment Research in Germany, November of 2011 when most of the chapter authors participated in a discussion about it. The goal was to write a book that goes into more detail than published papers on the topic. Because this research area is relatively new we saw the need to collect information that is otherwise not easily accessible and to give practitioners a good starting point for their own work with paradata. The team of authors decided to use a common framework and standardized notation as much as possible. We tried to minimize overlap across the chapters without hampering the possibility for each chapter to be read on its own. We hope the result will satisfy the needs of researchers starting to use paradata as well as those who are already experienced. We also hope it will inspire readers to expand the use of paradata to improve survey data quality and survey processes. As we strive to update our knowledge on behalf of all authors, I ask you to tell us about your successes and failures in dealing with paradata.

We dedicate this volume to Mick Couper and Robert Groves. Mick Couper coined the term “paradata” in a presentation at the 1998 Joint Statistical Meeting in Dallas where he discussed the potential of paradata to reduce measurement error. For his vision regarding paradata he was awarded the American Association for Public Opinion Research’s Warren J. Mitofsky Innovators Award in 2008. As the director of the University of Michigan Survey Research Center and later as Director of the U.S. Census Bureau, Robert Groves implemented new ideas on the use of paradata to address nonresponse, showing the breadth of applications paradata have to survey errors and operational challenges. After a research seminar in the Joint Program in Survey Methodology on this topic, I remember him saying: “You should write a book on paradata!” Both Mick and Bob have been fantastic teachers and mentors for most of the chapter authors and outstanding colleagues to all. Their perspectives on Survey

Methodology and the Total Survey Error Framework are guiding principles visible in each of the chapters.

I personally also want to thank Rainer Schnell for exposing me to paradata before they were named as such. As part of the German DEFECT project that he led, we walked through numerous villages and cities in Germany to collect addresses. In this process we took pictures of street segments and recorded, on the first generation of handheld devices, observations and judgments about the selected housing units. Elizabeth Coutts, my dear friend and colleague in this project, died on August 5, 2009, but her ingenious contributions to the process of collecting these paradata will never be forgotten.

We are very grateful to Paul Biemer, Lars Lyberg and Fritz Scheuren for actively pushing the paradata research agenda forward and for making important contributions by putting paradata into the context of statistical process control and the larger metadata initiatives. This book benefitted from discussions at the International Workshop on Household Survey Nonresponse and the International Total Survey Error Workshop and we are in debt to all of the researchers who shared their work and ideas at these venues over the years. In particular, we thank Nancy Bates, James Dahlhamer, Mirta Galesic, Barbara O'Hare, Rachel Horwitz, François Laflamme, Lars Lyberg, Andrew Mercer Peter Miller and Stanley Presser for comments on parts of this book. Our thanks also goes to Ulrich Kohler for creating the cover page graph.

The material presented here provided the basis for several short courses taught during the Joint Statistical Meeting of the American Statistical Association, continuing education efforts of the U.S. Census Bureau, the Royal Statistical Society, and the European Social Survey. The feedback I received from course participants helped to improve this book, but remaining errors are entirely ours.

On the practical side, this book would not have found its way into print without our LaTeX wizard Alexandra Birg, the constant pushing of everybody involved at Wiley, and the support from the Joint Program in Survey Methodology in Maryland, the Institute for Employment Research in Nuremberg, and the Department of Statistics at the Ludwig Maximilian University in Munich. We thank you all.

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ACRONYMS

AAPOR	American Association for Public Opinion Research
ACASI	Audio Computer-Assisted Self-Interview
ACS	The American Community Survey
AHEAD	Assets and Health Dynamics Among the Oldest Old
ANES	American National Election Studies
BCS	British Crime Survey
CAI	Computer-Assisted Interviewing
CAPI	Computer-Assisted Personal Interviews
CARI	Computer-Assisted Recording of Interviews
CASRO	Council of American Survey Research Organizations
CATI	Computer-Assisted Telephone Interviews
CE	Consumer Expenditure Interview Survey
CHI	Contact History Instrument
CHUM	Check for Housing Unit Missed
CPS	Current Population Survey
CSP	Client-side Paradata
ESOMAR	European Society for Opinion and Market Research
ESS	European Social Survey
FRS	Family Resources Survey
GSS	General Social Survey
HINTS	Health Information National Trends Study
HRS	Health and Retirement Study
IAB	Institute for Employment Research
IVR	Interactive Voice Response System
KPI	Key Performance Indicators

LAFANS	Los Angeles Family and Neighborhood Study
LCL	Lower Control Limits
LFS	Labour Force Survey
LISS	Dutch Longitudinal Internet Studies for the Social Sciences
LMU	Ludwig Maximilian University Munich
NCHS	National Center for Health Statistics
NHANES	National Health and Nutrition Examination Survey
NHEFS	The NHANES Epidemiologic Follow-up Study
NHIS	National Health Interview Survey
NSDUH	National Survey of Drug Use and Health
NSFG	National Survey of Family Growth
NSHAP	National Social Life, Health, and Aging Project
NSR	Non-self Representing
OMB	Office of Management and Budget
PASS	Panel Study of Labour Market and Social Security
PDA	Personal Digital Assistant
PSU	Primary Sampling Units
RDD	Random Digit Dial
RECS	Residential Energy Consumption Survey
RMSE	Root Mean Squared Error
RO	Regional Office
SCA	Survey of Consumer Attitudes
SCF	Survey of Consumer Finances
SHS	Survey of Household Spending
SPC	Statistical Process Control
SQC	Statistical Quality Control
SR	Self-Representing Areas
UCL	Upper Control Limits
UCSP	Universal Client Side Paradata

CHAPTER 1

IMPROVING SURVEYS WITH PARADATA: INTRODUCTION

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1.1 INTRODUCTION

Good quality survey data are hard to come by. Errors in creating proper representation of the population and errors in measurement can threaten the final survey estimates. Survey methodologists work to improve survey questions, data entry interfaces, frame coverage, sampling procedures, respondent recruitment, data collection, data editing, weighting adjustment procedures, and many other elements in the survey data production process to reduce or prevent errors. To study errors associated with different steps in the survey production process, researchers have used experiments, benchmark data, or simulation techniques as well as more qualitative methods, such as cognitive interviewing or focus groups. The analytic use of paradata now offers an additional tool in the survey researcher's tool box to study survey errors and survey costs. The production of survey data is a process that involves many actors, who often must make real time decisions informed by observations from the ongoing data collection process. What observations are used for decision making and how those decisions are made are currently often outside the researchers' direct control. A few examples: *Address listers* walk or drive around neighborhoods, making decisions about the inclusion or exclusion of certain housing units based on their perceptions of the housing and neighborhood characteristics. *Field managers* use personal experience and subjective judgment to instruct interviewers to intensify or reduce their efforts on specific cases. *Interviewers* approach households and conduct interviews in idiosyncratic ways; doing so they might use observations about the sampled households to tailor their approaches. *Respondents* answer survey questions in settings unknown to the researcher but which affect their responses; they might be interrupted when answering a web survey, or other family members might join the conversation the respondent is having with the interviewer. Wouldn't we like to have a bird's eye

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view to know what was going on in each of these situations? What information does a particularly successful field manager use when assigning cases? Which strategy do particularly successful interviewers use when recruiting respondents? What struggles does a respondent have when answering a survey question? With this knowledge we could tweak the data collection process or analyze the data differently. Of course, we could ask each and every one of these actors involved, but aside from the costs of doing so, much of what is going on is not necessarily a conscious process, and might not be stored in a way that it can be easily recalled (Tourangeau et al., 2000).

At the turn of the twenty-first century much of this process information became available, generated as a by-product of computer-assisted data collection. Mick Couper referred to these data as "paradata" in a presentation at the Joint Statistical Meeting in Dallas (Couper, 1998). Respondents in web surveys leave electronic traces as they answer survey questions, captured through their keystrokes and mouse clicks. In telephone surveys, automated call scheduling systems record the date and time of every call. In face-to-face surveys, interviewers' keystrokes are easily captured alongside the interview and so are audio or even video recordings of the respondent–interviewer interactions. Each of these is an example of paradata available through the computerized survey software.

Some survey organizations have collected such information about the data collection process long before the rise of computer-assisted interviewing and the invention of the word paradata. However, a rapid growth in the collection and use of paradata can be seen in recent years (Scheuren, 2005). It is facilitated first, by the increase in computer-aided data collection around the world, second, by the increasing ease with which paradata are accessed, and third, by an increasing interest among survey sponsors in process quality and the quantification of process errors. Thus, while process quality and paradata are not new, a more structured approach in choosing, measuring, and analyzing key process variables is indeed a recent development (Couper and Lyberg, 2005). This book takes this structured approach and provides a summary of what we know to date about how paradata should be collected and used to improve survey quality, in addition to introducing new research results.

The chapters in the first part of this book review the current use of paradata and make general suggestions about paradata design principles. The second section includes several case studies for the use of paradata in survey production, either concurrently or through post hoc evaluations of production features. Chapters in the last section discuss challenges involved in the collection and use of paradata, including the collection of paradata in web surveys.

Before reading the individual book chapters, it is helpful to discuss some common definitions and to gain an overview of the framework that shaped the structure of this book and the write-up of the individual chapters.

1.2 PARADATA AND METADATA

There is no standard definition in the literature of what constitutes paradata. Papers discussing paradata vary in terminology from one to another (Scheuren, 2000; Couper and Lyberg, 2005; Scheuren, 2005; O'Reilly, 2009), but for the purpose of the book we define paradata as additional data that can be captured during the process of producing a survey statistic. Those data can be captured at all stages of the survey process and with very different granularities. For example, response times can be captured for sets of questions, one question and answer sequence, or just for the answer process itself.

There is some debate in the literature over how paradata differ from metadata. Metadata are often described as data about data, which seems to greatly overlap with our working definition of paradata. Let us step back for a moment and consider an analogy to digital photography which may make the paradata–metadata distinction clearer. Digital information such as the time and day a picture was taken is often automatically added by cameras to the file. Similarly, the lens and exposure time and other settings that were used can be added to the file by the photographer. In the IT setting, this information is called metadata or data about data.

Paradata are instead data about the process of generating the final product, the photograph or the survey dataset. In the photography example, the analogy to paradata would be data that capture which lenses were tried before the final picture was taken, information about different angles the photographer tried before producing the final shot, and the words she called out before she was able to make the subject smile.

In the digital world, metadata have been a common concept for quite a while. In the social sciences, the interest in metadata is newer but heavily promoted through efforts like the Data Documentation Initiative or DDI (`http://www.ddialliance.org/`), which is a collaboration between European and U.S. researchers to develop standards for social science data documentation. Metadata are the core of this documentation and can be seen as macro-level information about survey data; examples are information about the sampling frame, sampling methods, variable labels, value labels, percentage of missing data for a particular variable, or the question text in all languages used for the survey. Metadata allow users to understand the structure of a dataset and can inform analysis decisions.

Paradata capture information about the data collection process on a more micro-level. Some of this information forms metadata if aggregated, for example, the response rate for a survey (a piece of metadata) is an aggregated value across the case-level final result codes. Or, using the examples given above, time measurements could be aggregated up to become metadata. Paradata that capture the minutes needed to interview each respondent or even the seconds it took to administer a single question within the survey would become the metadata information on the average time it took to administer the survey.

1.3 AUXILIARY DATA AND PARADATA

Paradata are not the only source of additional data used in survey research to enrich final datasets and estimates. Researchers also use what they call 'auxiliary data', but the definition of this term has not quite been settled upon. The keyword auxiliary data has been used to encompass all data outside of the actual survey data itself, which would make all paradata also auxiliary data. Also contained under auxiliary data are variables from the sampling frame and data that can be linked from other sources. The other sources are often from the Census or American Community Survey, or other government agencies and private data collectors. They are typically available on a higher aggregate level than the individual sampling unit, for example, city blocks or block groups or tracts used for Census reports or voting registries. Unlike paradata, they tend to be fixed for a given sampling unit and available outside of the actual data collection process. A typical example would be the proportion of minority households in a given neighborhood or block according to the last Census.

Paradata, as we define them here, are not available prior to data collection but generated within, and they can change over the course of the data collection. A good example is interviewer experience within the survey. If the sequence of contact attempts is analyzed and interviewer experience is added to the model, it would form a time varying covariate, for the experience changes with every case the interviewer worked on. Data on interviewer demographic characteristics are not always easily classified as either paradata or auxiliary variables. Technically, those data collected outside the survey are auxiliary data that can be merged to the survey data. However, if we think of the process of recruiting respondents, there might be changes throughout the survey in which cases are re-assigned to different interviewers, so the characteristics associated with the case (which include interviewer characteristics) might change because the interviewer changes.

A large set of different auxiliary data sources available for survey researchers was discussed at the 2011 International Nonresponse Workshop (Smith, 2011), where paradata were seen as one of many sources of auxiliary data. In the context of this book, we focus on paradata, because compared to other auxiliary data sources, their collection and use is more likely under the control of survey practitioners.

1.4 PARADATA IN THE TOTAL SURVEY ERROR FRAMEWORK

Paradata can help researchers understand and improve survey data. When we think about the quality of survey data, or more specifically a resulting survey statistic, the Total Survey Error Framework is a helpful tool. Groves et al. (2004) visualized the data collection process in two strands, one reflecting steps necessary for representation, the other steps necessary for measurement (see Figure 1.1). Each of the steps carries the risk of errors. When creating a sampling frame, there is a chance to miss some members of the population or to include those that do not belong, both of which can lead to coverage error. Sampling errors refer to the imprecision resulting from surveying only a sample instead of the population, usually reflected in standard error estimates. If selected cases refuse to participate in the survey, methodologists talk about nonresponse error, and any failure to adjust properly for such selection processes will result in adjustment error. On the measurement side, if questions fail to reflect the underlying concepts of interest, they suffer from low validity. Even when questions perfectly measure what is of interest to the researcher, failures can occur in the response process, leading to measurement error. Survey production often includes

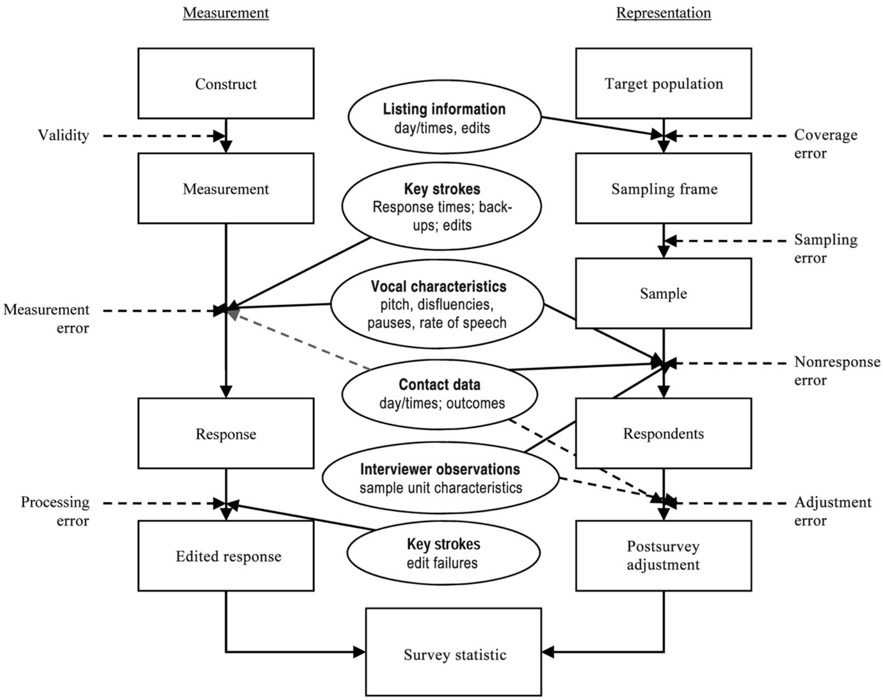

FIGURE 1.1 Survey process and process data collected to inform each of the total survey error components (graph modified from Groves et al. (2004), and expanded from Kreuter and Casas-Cordero (2010)). Solid lines mark paradata collected at a particular step; dashed lines (leaving the ovals) indicate that paradata are used to evaluate errors at the particular step, even though they are not collected during this step.

a phase of editing involving important consistency checks, and things can go wrong at this step too. Paradata can inform researchers about such errors that can happen along the way. In some instances, they can point to problems that can be solved during data collection; in other instances, paradata capture the information needed to model the errors alongside the actual survey data. Figure 1.1 depicts, within the survey data production process and the associated survey errors, some examples of paradata that are either collected at the respective steps (marked with a solid arrow) or used to evaluate a given error source (marked with a dashed arrow).

The chapters in the first section of this book are designed to introduce paradata within the Total Survey Error Framework. So far, paradata related to nonresponse are featured most prominently in the survey literature. The findings in these areas are discussed in detail by Frauke Kreuter, Kristen Olson, Bryan Packhurst, and Ting Yan. Paradata which inform us about coverage error are of increasing interest in a world with multiple frame creation methods, and are discussed by Stephanie Eckman. Unfortunately, the literature on paradata to inform data processing and related errors is very sparse so far. Thus, there is no chapter addressing this error source, though the general logic of designing and capturing paradata for the other error sources applies here too. Sampling errors and adjustment errors have been widely discussed in the literature, but as with coverage error, much less is done in terms of evaluating the process of sampling or adjustment through paradata. The same holds for the issue of validity, though one could imagine process information about questionnaire creation.

1.5 PARADATA IN SURVEY PRODUCTION

Paradata are not just used to evaluate survey errors after data collection is done. In some instances, paradata are available during data collection and can be used to monitor and inform the collection process in (almost) real time. Survey methodologists have started to explore using paradata to guide data collection procedures, a process called responsive or adaptive design. The chapter by Nicole Kirgis and James Lepkowski shares experiences using such an approach in the National Survey of Family Growth. Similar in spirit is the use of paradata to predict responses to within-survey requests, suggested by Joseph Sakshaug in Chapter 8. James Wagner reports paradata-driven experiments he carried out to try to increase response rates in both telephone and face-to-face surveys.

In order to monitor incoming data and to make useful design decisions, the field needs tools that display and summarize the large amount of incoming information. Some survey organizations, including the U.S. Census Bureau, have applied theories and methods from the quality control literature to their survey processes. These efforts are summarized in Chapter 9 by Matt Jans, Roby Sirkis, and David Morgan. Statistics Netherlands is now heavily engaged in using metrics to monitor representativeness in respondent composition as Barry Schouten and Melania Calinescu explain in Chapter 10.

1.6 SPECIAL CHALLENGES IN THE COLLECTION AND USE OF PARADATA

Despite the promise and hope of paradata, this new data source does present several challenges with which researchers are grappling. A few are mentioned here and are discussed in detail in the respective chapters. Others can only be touched on in this book, but are equally important.

1.6.1 Mode-Specific Paradata

The type of paradata that can be collected in a given survey or that is already available for a particular survey varies with the survey mode. Most examples discussed throughout this edited volume come from face-to-face surveys, and some from telephone surveys. Most self-administered surveys involve no interviewers and thus are stripped of one important vehicle for paradata collection. This is, however, not to say that self-administered surveys cannot be paradata rich. Web surveys, for example, are rich in paradata for measurement error evaluation, as Chapter 11 by Mario