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REFLECTIONS ON STATISTICAL METHODS TO DESIGN LONGITUDINAL SURVEYS

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Abstract

Statistical longitudinal surveys are subject to methodological considerations that apply to every survey, but they have an improved dimension which confers them in a wealth of additional opportunities, but also some complications and issues. Our study aims to offer an overview length on those particular issues with the hope to promote the optimal practices in design and administration of the longitudinal surveys and encouraging a clear judgement related to the many issues that a researcher needs to treat with priority. On another premises, we hope that this study will offer an incentive on future investigations on one of the fascinating methodologies for longitudinal surveys.

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1. Introduction

Basically, through a longitudinal survey data are collected from the subjects of the same sample over time. Such surveys can be performed in a wide variety of contexts and for uncountable purposes and in many situations, they have considerable analytical advantages over one-time, or cross-sectional, surveys. Over the last years, these advantages have been more and more recognized and appreciated, having as a result an increased number of longitudinal surveys. This phenomenon can be easily seen in government, academic and private sector (Lynn, 2009).

Reflecting on the raising interest for these longitudinal surveys and by acknowledging that these surveys have distinct methodological characteristics, this study is focused on several issues related to the revision of the current design and implementation techniques of the longitudinal surveys. In other words, we consider as aspects of the study process, from the design to the analysis of the data, including the major problems, such as ethical and the link between the data.

Longitudinal surveys have their significance, for both data collection and analysis, which are impossible to achieve with cross-sectional surveys or cannot be conducted with a high rate of precision. Often, these characteristics are key elements on encouraging for carrying out a longitudinal survey. It is important to distinguish between longitudinal surveys and longitudinal data (Belle, Fisher, et al., 2004).

Longitudinal surveys are a source of longitudinal data, and the results include elements that refer to different points of time. But, there are also other ways to obtain longitudinal data. This study evaluates the strengths and weaknesses of the longitudinal data, but the focus is in particular on the strengths of longitudinal surveys. The study also addresses issues referring to: history length, respondent's variability, panel conditioning, sample attrition, weighting, interval between waves, quality in longitudinal surveys, and so on (Lynn, 2009).

2. General framework and limitations

Throughout time, data is collected from the subjects of the same sample by using the statistical longitudinal survey. Longitudinal surveys can be fulfilled in various contexts and in numerous extents, but in many situations, they present considerable analytical advantages over the one-time surveys and cross-sectional surveys (Voineagu, Pisica, et al., 2012).

The advantages of the longitudinal surveys have known a growing recognition and appreciation in the last years, given the result that the number of longitudinal surveys has increased in the governmental, academic and private sectors.

The longitudinal survey represents the main instrument able to:

- capture the moving behavior of the events
- measure the changes over time from the events behavior
- to effectively capture eventual shocks.

The classification of the longitudinal surveys

The longitudinal surveys registered on the international plan, can be classified by:

- the studied population
- designed features, such as:
  - the interval between periods
  - the way that the data is collected
  - treatment of new population units.

Based on the above, the designed longitudinal surveys can be:

- surveys of business for the national or regional statistical offices, which have the role of collecting a limited range of information regarding the key economic indicators and to improve the precision of estimates for the micro-level changes;
- surveys over the scholar-leavers, the aim consisting in evaluating the educational process;
- panel surveys over households have as a general extent behavioral, attitude and circumstance data collection on a range of social and economic issues;
- birth cohort studies offer an image of the people's situation of generations and different genres at a time;
- epidemiological studies realized for the evaluation of the health condition evolution, or other health changes, wellness, disease (Korn, Graubard, et al., 1997).

Advantages of the longitudinal survey

There is a difference between the longitudinal surveys and the longitudinal data, as on one side the longitudinal surveys represent the source of the longitudinal data and on the other side the longitudinal data include elements that refer to different moments in time for accomplishing the survey.

Among the advantages of the longitudinal surveys, there can be mentioned:

- Analysis of gross change

To estimate the net change, repeated cross-sectional surveys can be used, for example change in the proportion of the employees, who regularly present themselves to work. Only a longitudinal survey can identify to which extent is this fact composed from different elements of the gross change (Caruana, Roman, et al., 2015).

For example, we can presume that the proportion of employees, who regularly present themselves to work is estimated to be the same at two points in time. However, it would be of

interest to know if it is the same set of employees in both of the instances or if they are equal and opposite flows (and, if so, how large they are and what individual characteristics are associated to each of the flows, etc.).

- Analysis of the unit-level change independent of the net change of the population

For example, the interest for the characteristics and circumstances of the divorce, regardless of the existence of the net change for the proportion of the married people.

- Aggregate measures – measures that combine observations from multiple time points

For example, the aggregation of twelve measurements for monthly expenses, in order to determine an estimation of the annual expenses.

- Measures of stability or instability – combining observations from multiple time points can offer measures of stability or instability

At individual level the change can be interpreted in the context of a considerably progressive period of time, but with a panel with many stages that collects measures of income, from each of the stage it is possible the individual recognition with different types of changing, such as: stable growth, fluctuations around a level, sudden decrease followed by stability (Lynn, 2009).

The characteristics associated with these patterns are of interest for the policy factor decisions.

Most frequent characteristics of time phenomena or circumstances are: frequency, duration and synchronization.

Example: understanding the duration of an event for a particular state and the factors associated with exiting that state are important for:

- poverty
- unemployment
- marital and partnership status
- participation in education and training
- company profitability etc.

Hazard modelling and survival analysis are techniques for better understanding the risk of changing and of the factors associated with these types of changes.

Causality identifying – most of the policies are planned to highlight changing and the impact over desired outcomes (Soloff and Fabio, 2009).

Data collections present essentials and borderlines advantages. The essential advantages are represented by the quality and quantity of the data, and the borderlines can represent the viewpoint of:

- costs
- logistics.

Some data collection advantages: length of history – it is possible to collect continuous history of events than a single event, because of the involved data volume;

- higher precision – only in cases where data is collected through a single interview. The precision increases alongside with the information improvement from a collection period to another.
- delimitation – the precise dating of the events is as important as the precise as the recall of the details. Retrospective question of recall addressed in a single interview can produce erroneous estimations of frequent and associated measures.

– the lack of ambiguity in the cases of some consecutive cycles of interviews regarding the same case (event).

Variation between respondents

In case the aim is to collect the complete activity histories over several years for a sample of people who greatly vary in their experiences (such as a cross-sectional of population), the time frame between the waves of the study will be different for unlike samples. Previous information can be used for the next interview. Interviews at time frames can be inefficient for subjects for who's conditions might barely change (for example: retired subjects or those who remain at the same job for several years) – the quantity of supplement information is minor (Berrington, Smith, et al., 2006).

Weaknesses of the longitudinal surveys

In resemblance with the estimates of the cross-sectional study, the cross-sectional estimates from the longitudinal survey (beginning with the second stage) can suffer from coverage error if the sample does not include additions to the population. Coverage error may increase for certain periods as the time from the selection of sample increases.

Analysis of the specific nature to which the estimates refer to can generate difficulties in understanding and communicating and, in consequence, difficulties in deduction.

Panel determination refers to the possibility that the given answers by an individual that took part to the previous survey might differ from the answers given by an individual that is taking part for the first time at a survey, in other words the answer can be conditioned by previous experience in survey engagement; this refers to all the collected data from longitutdinal surveys, other than the ones collected in the first wave (Dohmen, Falk, et al., 2005).

Panel conditioning can take place in two ways:

a) the way the respondents report events, behavior and characteristics that might change;
b) actual behavior might change.

Example: the survey of un-employers from two waves can highlight that most of the subjects report the search of a job in another field in the second wave than in the first one →

panel conditioning it is most likely to present itself for certain subjects and certain types of questions than for others.

Sample attrition (also, panel attrition)

It refers to the continuous loss of respondents in each wave of the longitudinal survey due to non-responses. The term of attrition can also be used to refer to a process in which some of the non-respondents change into respondents. The rate of response from a wave of the longitudinal survey can be as good as any other survey, but after five waves, for example, the proportion of units that have responded in each of the waves can be reduced, efficiency rate of response for the longitudinal survey (for the date from each of the waves is necessary) can be modest than the response rate used for the cross-sectional surveys, but after more waves there is the risk that the range of the responded sample to become unacceptably trivial (Deng, Hillygus, et al., 2013).

Initial and ongoing costs

Before the first wave, due to planning reasons, the costs are higher than the ones necessary for a cross-sectional survey.

The instrument of the first wave cannot be independently conceived from the instruments of the following waves, because there are date combinations from each of the wave that provides necessary estimates to the survey, which result in higher costs for the integrated administration of the survey (Richardson, Ampt, et al., 1995).

These considerations lead to costs for *n* waves of the longitudinal survey which exceed the cost for *n* cross-sectional survey.

Design features specific to longitudinal surveys

There are features substantial different from those of the cross-sectional survey. We are referring to the following:

Population, sampling and weight

- Population definition

For any longitudinal survey with more than two waves the studied population will depend on the waves that provide data for the estimates. Therefore, different subsets of sample units will represent different population of interest and will thus be relevant for different estimations purposes.

- Sample Design

Longitudinal surveys confront themselves with a series of unique sampling design issues. Decision must evaluate if and how to include new comers in the population studies (births), if it should be used a revolving design, if it should be used a repeated design, and if yes, repetitions should overlap or preferably it would be a devised design.

- Weighting

Many longitudinal surveys provide data with two types of values – cross-sectional values and longitudinal values. Distinction reflects a difference in the estimated population and the types of samples that may contribute to estimates (Sliwinski, Hofmann, et al., 2010).

Values are produced after each new data flow becomes available. Thus, each flow would have produced a new set of values, representing longitudinal population of all flows to date. This means that weights will be available after each attrition of the sample.

Other design issues

- Intervals between waves

Waves with higher frequency produce a higher quality of data, but a shorter interval between waves, because of many waves, can produce a higher number of non-responses. Optimal frequency will depend on information nature that need to enact.

- Duration of the survey

The longer the time to collect the longitudinal data, the more substantial and valuable the data will be. However, for some of the surveys, concentration is limited to a specified phase in the life of the sample members.

For example, defined by age, education or employment, so it could naturally involve a limited duration for the study.

An extended duration will have supplementary costs, independent of the number of signals conducted in this time (Bilsborrow and Henry, 2012).

- Respondents and study units

In most of the cases, data is collected from and about individuals, but there are cases when date is produced with reference to other entities, such as a business, farm, tuition, community or other entity.

If the units of interest are groups of individuals, such as couples, households, or groups parent – child, most of the variables at group level will be composed of elements of data from an individual level, although some may have been collected from a single individual of the group, but it refers to the entire group (Hussmanns, Mehran, et al., 1990).

- Tracking and tracing

A healthy longitudinal survey depends on maintaining each of the sample's member in each wave. This requires and administrative system and an activity schedule, that allows permanently actualization of contact data (Zeger and Liang, 1992).

- Methods

There is a wide range of methods for collecting data survey, respondents can be interviewed face to face, over the phone or through auto-completion questionnaire. Choosing the method for data collection is important, but regarding longitudinal surveys, this choice has extra dimensions:

- in the first place, it is possible a large variety to combine methods
- secondly, information can be gathered into a stream that further opens future possible flows (Fitzmaurice, Laird, et al., 2011).

Example: e-mail address can be required from respondents, enabling the possibility of e-mail approach and to be part of the next survey flow.

Error in longitudinal surveys

- Coverage errors

Aside the under-coverage error, encountered in the initial sample, which represent a common issue for all the surveys, the main under-coverage error source of longitudinal surveys can be the error of including new subjects in the sample population.

The extent to which this is a problem will depend on the definition of the study population as well as the analysis of the sampling procedures (Roberts, 2017).

- Sampling error

Design issues which affect sampling errors are not distinct for a longitudinal survey, there are considerations regarding faction and differential selection probabilities.

- Non-response error

In the longitudinal survey thematic there are some important influences over the predisposition response, that are distinct from other surveys. A unique characteristic of longitudinal surveys relevant for rejection, is that, after the first flow, sample members have already experienced the interview survey, hence they know what there is to come. For this reason, it is very important a satisfactory interview experience for the respondent, otherwise they will be reluctant to be a part of the next flow (Leeuw, Hox, et al., 2008).

- Measurement error

Measurement errors refer to the possibility that any individual observation to defer from the measured value in time of the survey.

One of the measurement errors would be the change of the survey methods (Rutter and Elashoff, 1994).

3. Examples

Examples that authenticate the practical interest for the longitudinal surveys:

✓ In Great Britain:

- in regards to birth cohort, long-term surveys with a debut in 1946, 1958, 1970, in the fourth stage there have been collected data from the period between 2001 – 2009 and began in fifth stage;
- the longitudinal study regarding households has been performed on a sample of 40000 households and the data collection began in January 2009 (www.understandingsociety.org.uk);

- the longitudinal survey of young people was accomplished through annual interviews beginning with the year 2004, based on a sample of 15000 young people born in the period of 1989-1990 and their parents (http://Isype.notlong.com);
- the study regarding offending, crime and justice began in 2003 with annual interviews, the subjects consisting in young people with ages between 10 – 25 years (Bynner, 1996).

✓ In UE:

- the survey of health, ageing and retirement in Europe began in 2004, continued in 2006 and 2008 over a sample of 30000 people with the age of 50 years old and over in 11 countries;
- the survey regarding the income and living conditions (EUSILC) panel survey of households from all of the UE countries. It began in 2004 with annual interviews and continues with a rotation model of the sample every 4 years (http://eu-silc.notbng.com) (Börsch-Supan, Brugiavini, et al., 2008).

✓ In Romania:

- apart from EUSILC, there are no other surveys known.

The reason for the absence of the longitudinal surveys consists in the higher costs and human resources deficiency; their transparency is equally to zero and the methodology is nearly unapproachable and unknown.

4. Conclusion

Longitudinal surveys are subject to methodological considerations that apply to any survey, but they have an added feature that brings a wealth of additional opportunities, but also some complications and issues.

Longitudinal studies have experienced an expansion on internationally level. Reflecting the interest on longitudinal studies and considering these studies have distinct methodological features, this study analyzes the design and implementation of longitudinal studies. All aspects of the study process are considered, from design to sample data analysis.

The purpose of designing a panel is improving the accuracy of net change estimates. The data structure is complex, involving data for each unit, for each period.

Longitudinal data assure opportunities for inference regarding the effect of an intervention or an exposure. Changes in exposure conditions can be correlated with changes in outcome conditions. Analysis of longitudinal data requires specific methods that account for the within-subject correlation of repeated measures.

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