CAN PARTICIPATING IN A PANEL SAMPLE INTRODUCE BIAS INTO TREND ESTIMATES?

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Studies that seek to monitor trends and measure change over time typically use independent probability samples or panel sample designs. If one is interested in quarterly estimates, independent quarterly samples can be drawn, or a panel sample can be selected at the first quarter and used for subsequent quarters. To simplify the discussion, we will deal with the case of two quarterly estimates, that is, we seek to measure the difference in means between two quarters.

The variance of the difference in means for independent samples is equal to the sum of the two quarterly variances. For a panel sample design, the variance of the difference in means equals the sum of the two quarterly variances minus a covariance term, that arises from the taking of two measurements on a single sample. For a fixed sample size, the panel sample design will generally have a lower variance of differences than independent samples. This is one of the primary reasons for using a panel sample. A second reason for using a panel sample is that data collection costs may be lower when compared with independent samples.

The specific study design that we will examine is a national random-digit-dialing sample of households containing one or more children age 19 to 35 months. The survey collects information from parents on the vaccination status of their young children. The outcome measures relate to the percent of children who have received the correct number of vaccinations in the DTP, polio, and MMR shot series. To be considered up-to-date a child should have 4 DTP vaccinations, 3 polio vaccinations, and 1 MMR vaccination.

Approximately 5 percent of telephone households in the U.S. contain one or more age-eligible children according to the 1990 Census. For independent RDD quarterly samples, one needs to sample 20 households to reach one eligible household. Thus a sample of 1,000 eligible children would require the selection of 20,000 households. Over time, the target population does not remain static, because children age out of the 19 to 35 month range, and a new cohort of children move into the eligible age range. For a panel sample design, one would select an RDD sample for the first quarter with 20 households sampled to reach one eligible household. At the second quarter, one could recontact those first-quarter households containing a child age 22 to 35 months, and add an RDD sample of newly age-eligible children (i.e., children age 19 to 21 months). Assuming a uniform distribution across the 17 months in the 19 to 35 month eligible age range, the eligibility rate for the RDD sample of children age 19 to 21 months would be 0.88%. This means that we would still need to sample 20,000 households to obtain the needed sample of 176 (1,000 x 3/17) children age 19-21 months.

A modification to the panel sample design would entail the identification of children age 16 to 18 months in the first quarter. The households containing these children would then be recontacted at the second quarter to form the sample of children age 19 to 22 months. This modification eliminates the need to do any additional screening to incorporate children age 19 to 22 months into the second quarter. The panel sample design and the above modification would however need to deal with the problem of households moving between the first and second quarters. Noncoverage bias would be a concern because children in mobile households have a lower vaccination coverage level than children who do not move.

Although the modified panel sample design can lead to some data collection cost savings, the primary advantage of the panel sample design is the reduced variance of differences. However, this needs to be examined in the light of the potential bias, from participation in a panel sample, that could be introduced into the estimate of change between the two quarters. Specifically, the impact of panel conditioning may bias the second quarter estimate to a sufficient degree to introduce a nontrivial bias into the difference in means between the two quarters. Panel conditioning might occur in the following manner. The RDD survey in the first quarter asks parents to indicate the number of vaccinations their young children have received. The interview itself may influence the subsequent behavior of the parent because having a child who is up-to-date on all recommended childhood immunizations is widely viewed as medically and socially desirable. Thus, the parent of a child who may be behind the schedule for the recommended vaccinations could contact their doctor after the interview to inquire about the immunization status of their child. At the second quarter, the child would then be reported as being up-to-date, if they receive the required additional vaccinations within the 90 period between the two quarters. If this occurs for even a relatively small percent of the sample, the estimates of change in immunization levels between the two quarters will be biased upwards.

Silberstein and Jacobs (1989), Corder and Horvitz (1989), and Waterton and Lievesly (1989) have all investigated the conditioning of respondents as a direct result of repeated interviewing. Holt (1989) indicates that these authors do not find evidence of strong panel conditioning effects, but that the survey designs used are not ideal for attempting to disentangle the various factors affecting the quality of the survey data.

The National Immunization Survey (NIS) incorporates some design features that make it possible to more directly examine the occurrence of panel conditioning. The NIS uses independent quarterly RDD samples to survey households containing children age 19 to 35 months and collects information on vaccinations received by the child. The Centers for Disease Control and Prevention in Atlanta is identified as the sponsor of the survey. Approximately 8,600 interviews are conducted per quarter across 78 geographic areas that cover the entire United States.

The NIS uses a two-phase sample design to improve the accuracy of the vaccination coverage estimates. For a subset of the RDD children, vaccination providers are contacted to report on the dates of all vaccinations received by the child. The provider information is collected for a subset of the children in the RDD sample because Zell et al. (1995) have shown that household reporting of vaccination status is subject to considerable response bias, both for respondents who report vaccinations from memory and for respondents who use immunization records (i.e., a shot card) during the interview.

For the first four quarters of the NIS, providers filled out mail questionnaires 4 to 10 months after the RDD interview for the child occurred. Providers therefore had the opportunity to report vaccinations given after the interview date.

This design offers a fairly unique opportunity to use the provider information to assess the frequency with which the administration of the immunization interview influences behavior. Vaccinations occurring within three months of the interview date are likely to reflect the influence of the household interview. Children who receive sufficient vaccinations to become up-to-date in the 90 days following the first quarter RDD interview, would then be reported as being up-to-date in the second quarter when their parents are recontacted. There are however two situations that our study design cannot directly account for: 1) some children who are not 4:3:1 up-to-date will eventually become fully vaccinated regardless of participation in the NIS, and 2) if the contacted provider, of a child reported as being not up-to-date, informs the parent that the child is actually up-to-date on all vaccinations, the parent will report the child as being up-to-date in the second quarter. The first situation causes the panel conditioning effects to be overstated, while the second situation causes an understatement.

A total of 33,876 RDD interviews were conducted in the first four quarters of the NIS. 13.7% of these children did not have sufficient information in the RDD interview to determine their 4:3:1 up-to-date status. 60.1% of the remaining children were reported 4:3:1 up-to-date and 39.9% were not 4:3:1 up-to-date based on the RDD interview

Provider vaccination dates are available for 11,868 of these children. 14.7% of these children did not have sufficient information in the RDD interview to determine their 4:3:1 up-to-date status. 5,057 (49.9%) of the remaining children were reported as not being 4:3:1 up-to-date in the RDD interview, and 5,069 (50.1%) were reported as being 4:3:1 up-to-date.

Of the 5,069 up-to-date children, 128 (2.5%) received one or more vaccinations within 90 days following the RDD interview. For the 1,742 children with an unknown 4:3:1 up-to-date status, 128 (7.3%) received one or more vaccinations within 90 days following the RDD interview. Among the 5,057 children who were reported as not being 4:3:1 up-to-date in the RDD interview, 463 (9.2%) received one or more vaccinations within 90 days of the RDD interview date. 47.7% of these 463 children who were not up-to-date received a sufficient number of vaccinations to become 4:3:1 up-to-date when the post interview vaccinations are added to the vaccinations reported in the RDD interview.

To asses the impact of the post interview vaccinations on the estimate of change between the two hypothetical quarters, we assume that the 4:3:1 vaccination coverage level in the population remains constant over time at 60%. 9.2% on the children that are not 4:3:1 up-to-date in the first quarter RDD interview would be expected to receive one or more additional vaccinations within 90 days of the interview date. Of the children receiving one or more vaccinations, 47.7% can be expected to change from not being 4:3:1 up-to-date to being 4:3:1 up-to-date when the post-interview vaccinations are taken into account. At the second quarter when reinterviews are conducted for children age 22 to 35 months, 4.5% of the children who were not 4:3:1 up-to-date would be reported as being 4:3:1 up-to-date by their parents. The overall impact would therefore be to raise the 4:3:1 coverage estimate from 60% to 62%, even though the coverage rate in the population remained steady over time at 60%.

The impact of panel conditioning is likely to be larger if estimates of change are also desired for subdomains of the population. Table 1 compares the demographic and socioeconomic characteristics of the 5,057 not up-to-date children by whether they received one or more vaccinations within 90 days of the RDD interview. Panel conditioning appears strongest for children with lower education mothers, children in families with an annual income of $20,000 or less, and children with a mother who is not married.

Our analysis indicates that a panel conditioning effect would occur in a vaccination survey covering young children. Panel conditioning would cause a small upwards bias in the estimate of change between the two quarters. If one is however designing a study to detect small changes in the quarterly vaccination coverage levels, this bias would be an important concern. The methodological research that has been conducted around the National Immunization Survey indicates that the accuracy of the vaccination coverage estimates is most affected by response bias in the household reports of vaccination received by the child (Zell et al., 1995), and that panel conditioning would have less of an impact on the accuracy of the estimates. The use of a two-phase sample design that collects vaccination information from households, and vaccination information from providers for a subset of the children in the sample is therefore viewed as the single most important design aspect if high quality vaccination coverage estimates are desired.

References:

Corder, L. S. & Horvitz, D. G. (1989), "Panel Effects in the National Medical care Utilization and Expenditure Survey," in Panel Surveys (D. Kasprzyk, G. J. Duncan, G. Kalton & M. P. Singh, eds.), John Wiley & Sons, New York, pp. 304-318.

Holt D. (1989), "Panel Conditioning: Discussion," in Panel Surveys (D. Kasprzyk, G. J. Duncan, G. Kalton & M. P. Singh, eds.), John Wiley & Sons, New York, pp. 340-347.

Silberstein, A. R. & Jacobs, C. A. (1989), "Symptoms of Repeated Interview Effects in the Consumer Expenditure Interview Survey," in Panel Surveys (D. Kasprzyk, G. J. Duncan, G. Kalton & M. P. Singh, eds.), John Wiley & Sons, New York, pp. 289-303.

Waterton, J. & Lievesley, D. (1989), "Evidence of Conditioning Effects in British Social Attitudes Panel," in Panel Surveys (D. Kasprzyk, G. J. Duncan, G. Kalton & M. P. Singh, eds.), John Wiley & Sons, New York, pp. 319-339.

Zell, E. R., Ezzati-Rice, T. M. & Hoaglin, D. C. (1995) "Adjusting for Respondent Bias on Vaccination Status in a Telephone Survey," 1995 proceedings of the Section on Survey Research Methods, American Statistical Association, Alexandria, VA, pp. 684-689.

Table 1: Percent of Not Up-to-Date Children With Vaccinations After the RDD Interview

Characteristic:	1+ Shots after the RDD Interview (n=463)	No Shots after the RDD Interview (n=4,594)
Education of Mother:		
12 years or less	57.7%	48.0%
More than 12 years	42.3%	52.0%
Race/Ethnicity of Mother:		
Hispanic	10.4%	10.1%
White, nonHispanic	71.3%	71.0%
Black, nonHispanic	15.8%	14.4%
Asian, nonHispanic	1.5%	2.7%
Other races, nonHispanic	1.1%	1.8%
Family Income:		
<= $20,000	28.1%	23.7%
> $20,000 to $50,000	40.2%	38.3%
> $50,000	17.3%	23.7%
Unknown	14.5%	14.3%
Marital Status of Mother:		
Married	70.4%	74.9%
Never married, divorced, separated,	28.3%	24.2%
Unknown	1.3%	1.0%