

Using Call Records to Study Sources of Nonresponse Bias in Consumer Expenditure Surveys.

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Introduction

The Consumer Expenditure Surveys (Quarterly and Diary) are household surveys which provide part of the "market basket" of consumer expenditures which are the basis of the CPI as well as other indices. Selected housing units of the Quarterly remain in sample during a 5 quarter period. The households are interviewed for 5 consecutive quarters. These interviews are referred to as "time-in-sample" (TIS) 1 to 5. The Diary households are interviewed for each of two consecutive weeks.

Matching households between times allows an analysis of the relationship between nonresponse and estimates of the proportions of expenditures. Since change in expenditures may be related to the household's participation, the estimates of the "market basket" may be affected. Recent studies of a different survey by Tucker and Kojetin (1997) and Dixon (2001) showed that unemployment rates were related to nonresponse in the CPS. "Converts" (households that do not participate in the prior month) do not completely make up for the number of "Attriters" (households that do not participate in the following month), so their relative effect may not be offset. Moreover, they may differ on important characteristics, e.g.; race, age, or gender. A related study (Dixon, 2002), was extended for the current study. The current study examines the nature of this relationship through an analysis of call records and, demographics and nonresponse and their resulting effect on estimates of the proportions of expenditures in the Consumer Expenditure Surveys.

Gross Flows

In this study "gross flows" uses the availability of information on one time to contrast the estimates from another time. For example, expenditure estimates in quarter 2 are contrasted based on whether a household responded in quarter 3, and similarly, quarter 3 estimates are contrasted based on whether a household responded in quarter 2. This allows an examination of the effect of "attrition" and "conversion". For example; if the expenditure

pattern for quarter 2 is different for households who continued to respond in quarter 3 compared to those who did not respond, and this was not balanced by a difference in the other direction for estimates from quarter 3 who did not respond in quarter 2, then some the estimates would be biased due to nonresponse.

Design

The CEQ is a household expenditure survey for the United States conducted by the U.S. Census Bureau for the U.S. Bureau of Labor Statistics. Approximately 8,910 eligible addresses are sampled each quarter, with 6,160 completed interviews typical. Households (or more correctly: consumer units) were matched for the years 1997 through 1999. The response rate is usually in the range of 80-83 percent. In this study 5112 households were matched across the 5 quarters, although only times 2 and 3 are used here.

The measures of consumer expenditures for the Quarterly are divided up into 12 categories: Housing, Food, Transportation, Personal Insurance, Entertainment, Apparel, Education, Tobacco, Personal Care, Miscellaneous, Alcoholic Beverages, and Reading. Medical expenditures were left out of the analysis.

The Diary consists of two panels recording expenditures for each of two consecutive weeks. The sample is typically 6300 households. Compared to the Quarterly, the Diary has shorter memory demand and is easier to use receipts. The Diary emphasizes small items: Clothes, Meals eaten out, Food (grocery items), other. The nonresponse rate (type A) is often over 20%. The measures of consumer expenditures for the Diary are divided up into Food, Apparel, Miscellaneous, and Other.

Analysis

The estimates used are based on the proportions of expenditures for a household. Since the proportions add up to 100%, the data is of a "compositional" nature (Aitchison, 1986). The centered log transform is used with these data to make the assumptions of linear models more realistic. The analysis begins with a multivariate analysis of variance contrasting two

time periods; households which consistently responded to those which had nonresponse in the prior or subsequent time. Univariate analyses examine which consumer categories contributed to the overall test. The nonresponse is further broken into refusal and noncontact, attrition and conversion, and the analyses repeated. The type of nonresponse is indicated by “II” for respondents in both times, “IR” for respondents who subsequently refused (attrition), “IN” (noncontact attrition), “RI” (refusal conversion), and “NI” (noncontact conversion). Covariates and interactions are added to the model to see what household characteristics may be related to bias effects. Call records are the covariates of principle interest.

Results

Quarterly survey

Table 1 in Appendix A shows the mean proportions for the CEQ by those who were interviewed compared to those who were converted from the 2nd quarter and those who dropped out in the 3rd quarter. The overall MANOVA was significant ($p < .0001$) indicating that the pattern of expenditures was different for the nonresponders compared to the responders. The MANOVA and the univariate ANOVAs were based on the centered logs, but the table shows the mean proportions for ease of interpretation. The “housing” category showed the largest effect, with nonresponders having higher expenditures. Other categories which had higher expenditures were “food” and “apparel”. This was counterbalanced by lower expenditures in “personal insurance”, and “miscellaneous”.

Diary Survey

Table 12 in Appendix B shows the mean proportions for the CED by those who were interviewed compared to those who were not responders for the first or second diary. The overall MANOVA was significant ($p < .0001$). The nonresponders spent proportionately more on clothing. While not significant, they also spent more on meals and food and less on other expenses.

Household and Interview Characteristics

Quarterly survey

Consumer unit size, respondent age, expenditure amount, tenure, number of children, respondent gender, race, population density, respondent education, and multi-unit structure were examined in a series of 12 MANOVAs. The interview characteristics (mostly from call records) were; interview length, number of phone calls, number of trips, total number of contacts,

travel time, type of call records, phone or visit to collect data, phone for visit to schedule data collection, and phone or visit for other purposes. These were analyzed with an additional 12 MANOVAs. The results for nonresponse can be seen in Tables 3 and 4. All of the covariates were related to expenditure patterns (the covariate effect in Tables 3 and 4, but only those which affected interview status either through an interaction or by making the interview status non-significant (suppressor effect) will be discussed in this paper.

Total expenditures interacted with interview status. Nonresponding households with higher total expenditures had relatively higher food and tobacco expenditures, while alcohol, education and personal insurance were relatively lower (Figures 1 through 5). NOTE: figures and tables are available in the complete paper.

Education level of the respondent interacted with interview status. Higher educated respondents spent relatively less on personal care and relatively more on personal insurance than nonrespondents (figure 6 and 7).

The age of the respondent interacted with interview status in terms of higher age nonresponders spending less on apparel, reading material and relatively more on education and personal insurance (figures 8-11).

Family income interacted with interview status in terms of higher income families who didn't respond spent less on education, miscellaneous and more on tobacco and personal insurance (figures 12-14).

Urban/Rural interacted with interview status for nonresponding rural households having relatively higher alcohol and personal care expenditures, with lower apparel expenditures. Overall rural had lower expenditures (Table 5).

Multiple unit structures (such as apartments) interacted with interview status for nonresponding households in multiunit structures having relatively higher expenditures for apparel and reading, and relatively lower for housing. Overall, multiunit households also had lower housing expenditures (Table 6).

Homeowners spent more on entertainment and miscellaneous. Ownership interacted with interview status such that for nonresponding households which owned their home spent relatively less on apparel and miscellaneous, but more on food, housing, and entertainment (Table 7) compared to responders.

The length of interview interacted with nonresponse with longer interviews for responding households associated with relatively

lower expenditures on apparel (figure 16). Households which needed more visits to schedule data collection and responded spent relatively more on transportation and less on personal insurance (figures 17 and 18).

Diary Survey

The MANOVAs for the diary were the same as for the quarterly survey. Total expenditures interacted with interview status with nonrespondents spending proportionately more on food as total expenditures increased (Figure 37) and less on other (Figure 39).

Nonrespondents with lower education spent relatively more on clothing (Figure 41) but less on food (Figure 43).

Nonresponding households which took more phone calls to collect data spent proportionately more on meals (Figure 45).

Type of Nonresponse

Quarterly survey

Table 2 shows the same effects separated by type of nonresponse. The higher proportions for "housing" came from refusals (IR and RI vs. II) and "food" (RI, IR, and NI vs. II), while for "apparel" it was limited to converted refusals (IR vs. II, with IR lowest). The lower proportions came from converted refusals for "personal insurance" (RI vs. II), and from refusals (RI and IR) and attrition noncontact (IN) for "miscellaneous".

The higher proportions of nonresponse for Urban dwellers came from noncontact and refusal conversion, slightly offset by lower rates due to refusal attrition (Table 8). Urban refusers spent relatively more on personal care which was offset by noncontacts spending less.

Higher nonresponse for multiple unit structures came from noncontact and attrition refusal (Table 9). Attrition was associated with lower relative housing expenditures.

Ownership was associated with lower nonresponse except for refusal conversion. Owners spent less on housing, but noncontacted attrition owners spent more while refuser owners spent less. Owners spend proportionately less on apparel, but refusal conversions spent notably less on apparel (Table 10).

Diary Survey

Total expenditures interacted with interview status with nonrespondents spending proportionately more on food as total expenditures increased (Figure 38) for refusal attrition and noncontact conversion, but the opposite for the other nonresponse types. The lower spending on other was due to noncontact conversion, all the other types of nonresponse

were higher (Figure 40). Nonrespondents with lower education spent relatively more on clothing (Figure 42) except for refusal conversion. Lower spending on food was due to noncontact attrition and to a lesser extent both types of conversion (Figure 44).

The effect of nonresponding households which took more phone calls to collect data spent proportionately more on meals was due to all forms of nonresponse, particularly refusal conversion (Figure 46).

Discussion

The most striking finding of this study was the lack of effects due to call record data. An optimistic interpretation would be that patterns of interviewer behavior captured by call record data have no biasing impact on the data collected.

The nonrespondents on the quarterly survey had higher relative expenditure estimates for housing, food, and apparel, offset by lower expenditures for personal insurance and miscellaneous expenditures. The nonresponders in the diary survey also spent more on apparel and food. This suggests there may be a format effect. The magnitude of the bias depends on how similar the attrition and conversion groups are to those who never responded. Swanson (2002) found that "the nonresponses of the intermittent responders appear to have a relatively small effect on the CEQ's published expenditure estimates." The methods of this study differed from Swanson's in that the relative expenditure between categories was examined, rather than the expenditure amount.

This study found the age of the reference person was related to slight bias due to nonresponse on the Quarterly, but not the Diary. Swanson (2002) found "the average age of the reference person in complete responder CU's is greater (50.6 versus 40.9)". This agreed with Groves and Couper (1998) for refusal, but older households had greater noncontact. Since the CEQ has proportionately more refusal this is consistent. Similarly, Tucker (1992) found younger respondents had more item nonresponse in the Consumer Expenditure Diary survey. This study also had younger nonresponders.

Swanson also found for complete responders: "the average quarterly expenditure per CU on all items is greater (\$8981 versus \$7,504), and the average expenditure per person is greater (\$3,442 versus \$3,212) than for intermittent responders". This study found the relative expenditure for alcohol, education, and personal insurance were higher for complete responders with higher

incomes, offset by relatively lower food and tobacco expenditures on the Quarterly. On the Diary complete responders with higher income spent relatively less for food. Further bias research would be useful to determine if the measures of the sources of income, their overall amounts, household composition, and age interact. A much larger sample size would be necessary.

“Complete responder CU’s are also more likely to have both husbands and wives present in the household (57.2% versus 39.8%), less likely to be single consumers (25.3% versus 37.5%)” (Swanson, 2002). Groves and Couper (1998) and Tucker and Dixon (2000) found larger households were more likely to be nonresponders (due to noncontact), which would seem to disagree with the finding for single consumer units. Since much of the nonresponse in the CEQ is due to refusal rather than noncontact, the difference in household characteristics may not be so different. This study found size of household may be non-significantly related to nonresponse bias for the Quarterly survey, with nonresponding households being smaller. This may be related to the age effect. No effect was found for the Diary.

Swanson found complete responders were “more likely to be homeowners (73.2% versus 41.0%), and more likely to have only one CU living in the household (98.3% versus 87.3%).” Similar to household size, Groves and Couper found homeowners less likely to have noncontact, but more likely to have refusal. This study found that homeowners spent more on entertainment and miscellaneous. Ownership interacted with interview status so that responders spent relatively more on apparel and miscellaneous, but less on housing, food, and entertainment. This may be related to income.

Children present was related to complete responders in Swanson’s (2002) study, and lower refusal and noncontact in Groves and Couper (1998, p.92) The effect may disappear or reverse if adjusted for other variable (p.113). Tucker and Dixon (2000) found lower probability of noncontact even adjusting for other variables (although the model was different). This study found no interaction with interview status.

The gender of the respondent didn’t relate to nonresponse bias in this study. Although there seemed to be a difference in expenditures (Table 3) there wasn’t either a suppressor effect or an interaction with nonresponse. Tucker and Dixon

(2000) found males more difficult to contact and more likely to refuse.

Multi-unit structures had been associated with higher refusal and nonresponse by both Groves and Couper (1998) and Tucker and Dixon (2000). In this study multi-unit households spent more on housing, but nonrespondents from those households spent relatively more on apparel and reading, making up for it by spending relatively less on housing. With a larger sample size it would be interesting to see if there is an interaction with age. There wasn’t an effect found in the Diary survey.

The type of nonresponse seemed to make a difference. Attrition noncontact showed little biasing effects except for “miscellaneous”. The effects of refusal were strongest in housing and food. The other effects tended to counterbalance one another (for example: alcohol had higher expenditures for refusal attrition but lower for refusal conversion). Nonresponse on the Diary was associated with higher spending except for the “other” category. The effect was consistent for different types of nonresponse, except for conversion noncontact for clothes and attrition noncontact for food, but the effects were slight.

The call record variables on the Quarterly survey showed little bias effects. Longer interviews associated with nonresponse showed lower expenditures on apparel. Since nonresponse is associated with age, home ownership, multiunit dwellers, and urban areas it would be interesting to see the profile of apparel spending broken down by these variables in terms of length of interview. This would be best done with a larger sample size. The effect of more visits for nonresponding households associated with higher transportation spending may relate to demographic characteristics associated with contactability (possibly such as younger renters not being at home). The effect in the Diary of more phone calls for nonresponding households associated with higher spending on meals eaten out may similarly be associated with some demographics (possibly such as younger, apartment dwellers).

Limitations and Future Research

There are two methodological issues future research should address. A larger sample size would allow more study of interactions. The distributions of several of the expenditures (tobacco and medical in particular) and covariates need to be further explored. While the “compositional analysis” method was interesting, it didn’t adjust for all the features of the data.

The effect of time in sample should be examined. Since attrition and conversion occur at relatively high rates there is some rotation of the sample between interview periods. The bias doesn't seem to change overall, but refusals seem to have a varied pattern.

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Appendix A Quarterly Consumer Expenditure Survey
Table 1 Gross Flows due to nonresponse for the CEO.

| | | II | NR | All | p-value |
|-----------|--------|-------|-------|-------|---------|
| Food | Mean | 0.196 | 0.212 | 0.198 | <.0001 |
| | StdErr | 0.001 | 0.004 | 0.001 | |
| Alcohol | Mean | 0.009 | 0.009 | 0.009 | 0.7263 |
| | StdErr | 0.000 | 0.001 | 0.000 | |
| Housing | Mean | 0.379 | 0.397 | 0.381 | <.0001 |
| | StdErr | 0.002 | 0.006 | 0.002 | |
| Apparel | Mean | 0.041 | 0.042 | 0.041 | <.0001 |
| | StdErr | 0.001 | 0.002 | 0.000 | |
| Transport | Mean | 0.180 | 0.175 | 0.179 | 0.3826 |
| | StdErr | 0.002 | 0.006 | 0.002 | |
| Entertain | Mean | 0.051 | 0.047 | 0.051 | 0.1264 |
| | StdErr | 0.001 | 0.002 | 0.001 | |
| Personal | Mean | 0.012 | 0.013 | 0.012 | 0.0740 |
| | StdErr | 0.000 | 0.001 | 0.000 | |
| Reading | Mean | 0.005 | 0.005 | 0.005 | 0.0787 |
| | StdErr | 0.000 | 0.000 | 0.000 | |
| Education | Mean | 0.014 | 0.013 | 0.014 | 0.0737 |
| | StdErr | 0.001 | 0.002 | 0.001 | |
| Tobacco | Mean | 0.014 | 0.011 | 0.013 | 0.9153 |
| | StdErr | 0.000 | 0.001 | 0.000 | |
| Misc | Mean | 0.011 | 0.010 | 0.011 | 0.0003 |
| | StdErr | 0.001 | 0.002 | 0.000 | |
| Insurance | Mean | 0.088 | 0.068 | 0.086 | <.0001 |
| | StdErr | 0.001 | 0.003 | 0.001 | |
| All | N | 6801 | 920.0 | 7721 | <.0001 |

Table 2: CEO Type of Nonresponse

| . | . | II | IN | IR | NI | RI | All |
|-----------|--------|-------|-------|-------|-------|-------|-------|
| Food | Mean | 0.196 | 0.184 | 0.207 | 0.205 | 0.230 | 0.198 |
| | StdErr | 0.001 | 0.010 | 0.007 | 0.009 | 0.007 | 0.001 |
| Alcohol | Mean | 0.009 | 0.010 | 0.008 | 0.008 | 0.011 | 0.009 |
| | StdErr | 0.000 | 0.002 | 0.001 | 0.001 | 0.002 | 0.000 |
| Housing | Mean | 0.379 | 0.388 | 0.402 | 0.354 | 0.412 | 0.381 |
| | StdErr | 0.002 | 0.017 | 0.010 | 0.014 | 0.009 | 0.002 |
| Apparel | Mean | 0.041 | 0.049 | 0.037 | 0.044 | 0.043 | 0.041 |
| | StdErr | 0.001 | 0.006 | 0.003 | 0.005 | 0.003 | 0.000 |
| Transport | Mean | 0.180 | 0.198 | 0.174 | 0.196 | 0.158 | 0.179 |
| | StdErr | 0.002 | 0.020 | 0.009 | 0.018 | 0.008 | 0.002 |
| Entertain | Mean | 0.051 | 0.048 | 0.045 | 0.062 | 0.042 | 0.051 |
| | StdErr | 0.001 | 0.005 | 0.003 | 0.007 | 0.002 | 0.001 |
| Personal | Mean | 0.012 | 0.009 | 0.015 | 0.010 | 0.014 | 0.012 |
| | StdErr | 0.000 | 0.001 | 0.001 | 0.001 | 0.001 | 0.000 |
| Reading | Mean | 0.005 | 0.006 | 0.005 | 0.005 | 0.004 | 0.005 |
| | StdErr | 0.000 | 0.001 | 0.001 | 0.001 | 0.000 | 0.000 |
| Education | Mean | 0.014 | 0.013 | 0.012 | 0.017 | 0.012 | 0.014 |
| | StdErr | 0.001 | 0.005 | 0.003 | 0.007 | 0.003 | 0.001 |
| Tobacco | Mean | 0.014 | 0.012 | 0.010 | 0.011 | 0.011 | 0.013 |
| | StdErr | 0.000 | 0.002 | 0.001 | 0.003 | 0.001 | 0.000 |
| Pmisc1_m | Mean | 0.011 | 0.005 | 0.009 | 0.015 | 0.009 | 0.011 |
| | StdErr | 0.001 | 0.002 | 0.002 | 0.006 | 0.003 | 0.000 |
| Insurance | Mean | 0.088 | 0.079 | 0.076 | 0.073 | 0.053 | 0.086 |
| | StdErr | | | | | | |

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|-----|--------|-------|-------|-------|-------|-------|-------|
| . | StdErr | 0.001 | 0.007 | 0.005 | 0.008 | 0.005 | 0.001 |
| All | N | 6801 | 116.0 | 331.0 | 137.0 | 336.0 | 7721 |

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Table 3 CEO – MANOVA p-values for nonresponse and covariates

| Covariate Name | Interview Status | Covariate | Interaction |
|-------------------------|------------------|-----------|-------------|
| Total expenditures | <.0001 | <.0001 | <.0001 |
| Place size | <.0001 | <.0001 | 0.1411 |
| Education | 0.0171 | <.0001 | 0.0152 |
| Age | <.0001 | <.0001 | 0.0067 |
| Household size | <.0001 | <.0001 | 0.2903 |
| Household income | <.0001 | <.0001 | <.0001 |
| Number of Children | <.0001 | <.0001 | 0.1339 |
| Multiple Unit structure | <.0001 | <.0001 | <.0001 |
| Own home | <.0001 | <.0001 | <.0001 |
| Urban | <.0001 | <.0001 | 0.0087 |
| Sex | <.0001 | <.0001 | 0.6026 |
| Race | 0.0004 | <.0001 | 0.0778 |
| Interview length | <.0001 | <.0001 | 0.0055 |
| Number of phone calls | <.0001 | <.0001 | 0.2967 |
| Number of contacts | <.0001 | <.0001 | 0.1318 |
| Number of trips | <.0001 | <.0001 | 0.0755 |
| Phone collect data | <.0001 | <.0001 | 0.8315 |
| Phone other | <.0001 | <.0001 | 0.1212 |
| Phone schedule | <.0001 | <.0001 | 0.3819 |
| Travel time | <.0001 | <.0001 | 0.1815 |
| Type of call records | <.0001 | <.0001 | 0.0761 |
| Visit to collect data | <.0001 | 0.0003 | 0.5699 |
| Visit other | <.0001 | <.0001 | 0.2529 |
| Visit schedule | <.0001 | <.0001 | 0.0008 |

Table 4

| . | II | NR | All |
|---------------|--------------|--------------|--------------|
| Total spent | 8691(81.17) | 8859(284.6) | 8710(79.02) |
| size | 11.23(0.095) | 11.84(0.264) | 11.30(0.089) |
| Education | 12.96(0.023) | 12.99(0.064) | 12.96(0.022) |
| Age | 49.44(0.211) | 48.32(0.558) | 49.31(0.198) |
| Cusize | 2.594(0.018) | 2.448(0.046) | 2.577(0.017) |
| Family income | 35180(548.6) | 25822(1429) | 34108(513.5) |
| Kids | 0.804(0.013) | 0.697(0.035) | 0.792(0.013) |
| Multiple unit | 0.267(0.005) | 0.304(0.015) | 0.271(0.005) |
| Own | 0.698(0.006) | 0.670(0.016) | 0.695(0.005) |
| Ncalls | 2.472(0.033) | 2.596(0.105) | 2.487(0.031) |
| Ncontacts | 4.493(0.045) | 4.837(0.143) | 4.532(0.043) |
| Ntravel | 2.067(0.027) | 2.307(0.085) | 2.095(0.026) |
| Nvisits | 2.020(0.027) | 2.241(0.086) | 2.045(0.026) |
| Pcollect | 0.472(0.012) | 0.541(0.036) | 0.480(0.012) |
| Pother | 0.715(0.022) | 0.848(0.071) | 0.730(0.021) |
| Pschedule | 1.286(0.023) | 1.207(0.075) | 1.277(0.022) |
| travel time | 91.59(1.144) | 116.4(3.827) | 94.30(1.107) |
| vcollect | 0.815(0.012) | 0.731(0.035) | 0.806(0.012) |
| Vother | 0.956(0.021) | 1.086(0.064) | 0.971(0.020) |
| Vschedule | 0.249(0.010) | 0.424(0.042) | 0.269(0.010) |

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