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Modelling Optimum Response in a Longitudinal Survey

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A two-stage stratified random sampling scheme was used in selecting 750 households in Oyo town. Households were interviewed in five waves. An interviewer-administered questionnaire was used to collect data on demographic characteristics and response predictors including age, gender, educational qualification, religion, employment status, family size, and duration of interview. Demographic characteristics were analyzed using summary statistics. Incidence Rate Ratio was used to examine the response rate at various levels of response predictors. Odd ratio was used to examine the relationship between response rate and each of the response predictors.

Keywords : longitudinal survey, response predictors, non-response rate. model validation.

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MODELLING OPTIMUM RESPONSE IN A LONGITUDINAL SURVEY

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Ref

Modelling Optimum Response in a Longitudinal Survey

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Abstract - Non-response rates in surveys have been recognized as important indicators of data quality since they introduce bias in the estimates which increases the mean square error. In order to reduce this error, previous studies have examined the effects of response predictors on response rates. There is dearth of information about models which focus on the interaction effects of response predictors on response rates. The study was therefore designed to develop and validate a model which would reduce non-response and achieve optimum response by the introduction of interaction effects of the response predictors that have been broken down into levels.

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The respondents' mean age and modal family size were 51.8$\pm$6.9 and 3 respectively, 64.8% were females, 52.8% were muslims and majority (88.9%) were employed. The family size, duration of interview, education, number of visit, Language of interview, familiarity, gender, house ownership, Nationality and duration of residence in a community are positively related to the response rate. Age is negatively related to the response rate and there is no association between employment status and response rate. The developed model showed that family size (x_1), duration of interview (x_2), and their interaction (x_1x_2) significantly ($p < 0.05$) determined the response rate.

The developed model established that both main and interaction effects of response predictors play key roles in improving response rate in a longitudinal survey.

Keywords : longitudinal survey, response predictors, non-response rate. model validation.

I. Introduction

Gaining valid answers to sensitive questions, questions pertaining to private and socially frowned upon or illegal behavior is difficult. People typically underreport sensitive behavior while over-reporting socially desirable behaviors (Warner 1965). Various techniques have been developed to guarantee anonymity and minimize the respondent's feelings of jeopardy, so that more honest answers can be expected. Two such techniques are: The randomized response technique RRT Warner (1965), Fox and Tracy (1986) and

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the unmatched count technique UCT; also called item count technique, unmatched block design, or block total response Dalton et al. (1994), Raghavarao and Federer (1979).

Brunner and Carroll (1969), in their study titled the effect of prior notification on the refusal rate in surveys'. They studied the effects of survey sponsor on the response rate and they found that an advance letter printed on university stationary increased response by 30% over samples who received no advance letter, while an advance letter on stationary from a relatively unknown business decreased response rate by 6%.

Heberlein and Baumgartner (1978) worked on factors affecting response rates to mail questionnaires. They compared response rates for 98 published mail questionnaire surveys and found higher response rates for government-sponsored surveys.

Kalton et al (1978) studied the effects of general and specific questions on response rate. Respondents were asked about driving standards generally and about driving standards among younger drivers. When the general question was asked first, 34 per cent of the respondents said that general driving standards were lower than they used to be. When that question followed the more specific question about younger drivers, the corresponding percentage fell by 7 per cent.

Schuman et al (1981). studied the context effects on survey response to questions with two opinion questions on abortion and they found that the distributions of answers to the more specific questions were the same whether the specific question was asked before or after the general question, but the distributions of answers to the general questions differed according to the question position.

Groves, et al. (1992) examined the effect of interviewer interaction with the respondents on the response rate and they found that tailoring the interaction was important. However, they also found that mentioning the survey sponsor was rated as a highly efficient means of securing cooperation. Successful interviewers also felt that the agency should pay more attention to public relations and thus, "the image of the agency is seen as a tool to work with and attain a better response rate."

Harris-Kojetin and Tucker (1999) in their study titled' exploring relation of economic and political conditions with refusal rates to government survey', found that in times of more positive public opinion regarding the government and government leaders, cooperation rates were higher. Survey respondents representing establishments (such as schools, hospitals, factories, farms or other businesses) may be somewhat different from respondents representing themselves or their households. These differences may make attitudes toward the survey sponsor more important than in general household surveys.

Snijkers et al (1999) studied the tactics that high performing survey interviewers can use to gain cooperation. Similar to Groves, et al. (1992), they found that tailoring the interaction was important. However, they also found that mentioning the survey sponsor was rated as a highly efficient means of securing cooperation. Successful interviewers also felt that the agency should pay more attention to public relations and thus, "the image of the agency is seen as a tool to work with and attain a better response rate."

Mac Elroy (2000) worked on 'variable influencing drop-out rate in web based surveys. The reviewed 19 studies done by Modalis Research Technology (USA) involving business-to-business technology related decisions. He found that drop-out rates decrease with incentives and increase with questionnaire length.

Sheehan (2001) in his study 'E-mail survey response rates' he studied the influence of five factors (the year the study was undertaken, the number of questions in the survey,

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the number of pre-notification contacts, the number of follow-up contacts and survey topic salience) on response rates in 31 email surveys undertaken since 1986. She showed that the year the survey was undertaken and the number of follow-up contacts had the most influence on response rates to the survey questions: response rates decrease with time and increase with the number of follow-ups.

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Knapp and Heidingsfelder (2001) conducted research on 'Drop out analysis' he reviewed nine unrestricted self-selected surveys done by Internet Rogator (Germany) in order to identify factors influencing drop-out rates. They found that longer surveys, sensitive topics and lack of incentives lead to higher drop-out rates.

Ariel Rubinstein (2004) carried out research on response time to survey questions. Lecture audiences and students were asked to respond to virtual decision and game situation at gametheory.tau.ac.il. Several thousand observations were collected and the response time for each answer was recorded. He showed that emotional response, require less response time than choices that require the use of cognitive reasoning.

Cheti and Franco (2005) worked on survey response and survey characteristics using probit model and they found that the number of children in the household, home ownership and the length of residence at the current address were positively influenced contact of the respondents in the survey. Women, people with college education respond more to the survey questions.

Sigrid Haunberger (2006) carried out research on the effects of interviewer and respondents characteristics on response behaviour in panel surveys. The logistic regression analysis provides results that several respondents' characteristics as well as interviewer characteristics has an impact on the refusal rate. For older interviewers, female interviewer, interviewers with high experience and interviewers with higher education lower refusal rates has been found. Older respondents agreed more than the younger ones to cooperate.

Fitzgerald et al. (1998), Campanelli et al. (1997) and Lepkowski and Couper (2002), offers suggestions about which variables are likely to help to predict contact and cooperation. These variables include both survey features and household and personal characteristics.

We may distinguish between two sets of variables that explain the probability of contact: household-specific variables that are linked to the probability of contacting a household, and person-specific variables that are linked to the probability of contacting a person.

The probability of contacting a household is inversely related to its degree of geographical mobility and to the probability of finding someone at home. Moreover, because people may pretend to be absent when an interviewer knocks at the door, the contact probability may also be related to a household's willingness to cooperate.

Predictors of contact include the number of adults, number of children in a household, home ownership, year of residence, high number of visit, duration of household interview in the last wave.

Once a household has been successfully contacted, a lack of cooperation is mainly the result of a personal decision that reflects personal characteristics. The personal characteristics that we consider include age, gender, education, employment status, couple living relationship.

To capture a person's past experience with the survey, we include features of the personal interview process in the current wave, namely duration of personal interview, mode of interview, language of interview, interviewer familiarity (a person who is

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contacted by the same interviewer as in previous waves is likely to be more willing to co-operate again Groves and Couper, (1998); Laurie et al., (1999); Hox and de Leeuw (2002).

Denise and Lan (2006) modelled probability of a contact and the probability of response conditional on a contact was modeled using

$$\log\left(\sum_{m>c} \pi_{mi2}^{(s)} / \pi_{ci2}^{(s)}\right) = \beta_0 + \sum_p \beta_{cp} x_{pi} + \sum_q \delta_{cq} x_{qi1}^{*(s-1)} + \sum_r \delta_{cr} z_{ri2}^{(s)} \quad (1)$$

where

x_{pi} are fixed characteristics of subject i measured at sweep 0, p=0,.....P (x_{0i}=1 for all i)

$x_{qi,t-k}^{*}$ = time varying characteristics of subject I, measured at time t-1 (q=1.....Q and k=1....., often k will be 1)

$z_{ri,t-k.}$= time-varying characteristics of the data collection process, measured for subject i at times t-k (r =1,.....,R and k=0...;often k will be 1 but can be 0 for variables such as the number of contacts before a response is obtained)

II. Justification for the Research

Previous studies have examined the effects of response predictors on response rates. It was observed that authors examined the main effect of both extraneous response predictors and inherent response predictors on response rate. However, the existing models did not consider the interaction effect of response predictors. Hence, there is a need for a model that will capture both main and interactions effects of response predictors on response rate. This research work critically examined and provided solution to the above 'gaps' by the introduction of interaction effects of the response predictors into Denise and Lan model.

III. Choice of Response Predictors

Fitzgerald et al. (1998), Campanelli et al. (1997), and Lepkowski and Couper (2000), offered suggestions about which variables are likely to help in predicting contact and cooperation. These variables include both survey features and household and personal characteristics.

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IV. Methodology

A two-stage stratified random sampling scheme was used in selecting 750 households in Oyo town. Households were interviewed in five waves. An interviewer-administered questionnaire was used to collect data on demographic characteristics and response predictors including age, gender, educational qualification, religion, employment status, family size, and duration of interview. Demographic characteristics were analyzed using summary statistics. Incidence Rate Ratio was used to examine the response rate at various levels of response predictors. Odd ratio was used to examine the relationship between response rate and each of the response predictors. A model was developed by breaking the predictors of response into levels and their interaction effects were introduced into Denise and Lan model.

a) Model Development

The model was developed by introducing interaction of response predictors into Denise and Lan (2006) model, model (1).
The developed model is given as:

$$\pi_{ij}^{(s)} = \beta_0 + \beta_1^{(s)^{fc}} + \beta_2^{(s)^{tvs}} + \beta_3^{(s)^{tfa}} + \beta_{12}^{(s)^{fc*tvs}} + \beta_{13}^{(s)^{fc*tva}} + \beta_{23}^{(s)^{tvs*tva}} + \beta_{123}^{(s)^{fc*tvs*tva}} \quad (2)$$

where,

$$\pi_{ij}^{(s)} = \log\left(\sum_{m>c} \pi_{mi2}^{(s)} / \pi_{ci2}^{(s)}\right) \quad (3)$$

$$\beta_1{}^{(s)^{fc}} = \sum_p \beta_{cp}\, x_{pi} \quad (4)$$

$$\beta_2{}^{(s)^{tvs}} = \sum_q \gamma_{cq}\, x_{qi1}^{*(s-1)} \quad (5)$$

$$\beta_3{}^{(s)^{tvd}} = \sum_r \delta_{cr}\, z_{ri2}^{(s)} \quad (6)$$

$$\beta_{12}{}^{(s)^{fc*tvs}} = \sum_p \sum_q (\beta\gamma)_{cpq}\, x_{pi} x_{i1}^{*(s-1)} \quad (7)$$

$$\beta_{13}{}^{(s)^{fc*tvd}} = \sum_p \sum_r (\beta\delta)_{cpr}\, x_{pi} z_{ri2}^{s} \quad (8)$$

$$\beta_{23}{}^{(s)^{tvs*tvd}} = \sum_q \sum_r (\gamma\delta)_{cqr}\, x_{qi1}^{*(s-1)} z_{ri2}^{(s)} \quad (9)$$

$$\beta_{123}{}^{(s)^{fc*tvs*tvd}} = \sum_p \sum_q \sum_r (\beta\gamma\delta)_{cpqr}\, x_{pi} x_{qi1}^{*(s-1)} z_{ri2}^{(s)} \quad (10)$$

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$\beta_{cp}, \gamma_{cq}, \delta_{cr}, (\beta\gamma)_{cpq}, (\beta\delta)_{cpr}, (\gamma\delta)_{cqr}, (\beta\gamma\delta)_{cpqr}$ are the parameters of the model to be estimated.

b) Validation of the Developed Model

The developed model [model (2)] was validated and compared with the existing model [model (1)] by using a set of data collected from 750 house heads in Oyo town.

V. Discussion of Results

Table 1 : Numbers of Non-Missing Observations, Means and Standard Deviations of the Response Predictors

Response predictors	Number of non-missing observations	Mean	Standard deviation	Mode
Family size	750	3	2.0515	3
Duration of interview	750	7.2067	4.7008	11
Education	750			Secondary
Number of visit	750	2.4200	1.1068	3
Language of interview	750			English language
Familiarity with interviewer	750			Not familiar
House ownership	750			Tenants
Nationality	750			Nigerian
Duration of residence	750	10.2667	9.2357	7
Tribe	750			Yoruba
Religion	750			Muslims
Age	750	51.8	6.9	51
Gender	750			Females

a) Response Rate at Each Level of the Response Predictor

Family size was classified into six categories. Family without children, family with one child, family with two children, family with three children, family with four children and more than four children. The first category was taken as reference level and its incidence rate ratio (IRR) is 1, which was compared with other levels. Any IRR value greater than 1 means higher response rate compared with reference level and value lower than 1 implies low response rate. Response from the family with one child was 27% higher compared with the family without child, response from the family with two, three, four, and more than four were higher in the following percentage respectively, 56%, 66% 75% and 84%.

Duration of interview was classified into four levels. Respondents that were interviewed for not more than five minutes, 5-10 minutes, 11-15 minutes and more than fifteen minutes. Less than 5 minutes was taken as reference level and this was compared with other levels. The response from those that were interviewed for 5-10 minutes was 23% higher compared with those that were interviewed for less than 5 minutes. Response from 11-15 minutes was 58% higher and response from those that were interviewed for more than 16 minutes was 59% higher compared with those that were interview for less than 5 minutes.

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Among the respondents, some were living with their spouse and some were not. Non living with the spouse was taken as reference level. From the analysis, the result showed that the response rate from those that were living with their spouse is 14% higher compared with those that were not living with their spouse as at the time of interview.

Both English and Yoruba language were used during the survey. Yoruba language was taken as reference level. The response from those that were interviewed with English language is 53% higher compared with those that were interviewed with Yoruba language.

Notes

The respondents' ages were grouped into three age categories: 30-50, 51-70 and 71 and above years. 30-50 years is the reference age group and the result shows that the response from the respondents between ages 51-70 years is 94% higher compare with the response from respondents between ages 30-50 and response from the respondents between ages 71 years and above is 12% higher compare with the response from respondents between ages 30-50 (table 2). This implies that respondents at the middle age respond better to survey questions compared with youth and old age respondents.

Some respondents were familiar with the interviewer and some were not. The response rate from those that are familiar with the Interviewer is 21% higher compare with those that are not familiar with the interviewer (table 2) the more the familiarity, the higher the response rate. Levels of education were categorised into three; (primary, secondary and tertiary). Primary was used as reference level and the result showed that the response from the respondents with secondary educatiobn was 27% higher compared with those with primaty education and the response from the respondents with Tertiary educatiobn was 54% higher compared with those with primaty education.The higher the educational level, the higher the response rate.

During the survey, before the interviewer succeeded in getting response from the respondents, some respondents were visited one time, two times, three, four and five times. The response rate increased till fourth visits and at fifth visit, it declined (table 2).The response rate increased from the first to fourth visit, but at the fifth visit, the response obtained was 98% lower compared with the first visit.

Both male and female participated in the survey. Females were taken as reference level. The result of the analysis portrayed that response from the female was 15% higher than the response rate from the males.

Majority of the respondents are tenants while minorities are owner occupiers. Being a tenant was taken as reference level. The result from the analysis showed that the response rate from tenants was 7% higher than the owner occupiers.

There was no significant difference in the response rate from unemployed respondents and employed respondents. The number of years in which the respondents have been living in their communities varies. This was classified into four categories; 1-5 years, 6-10 years, 11-15 years, 16 years and above. 1-5 years was used as reference year. The response from those that have been living in their community within 6-10 years is 33% higher compared with the response from those that have been living in their community within 1-5 years. 11-15 years is 58% higher, for more than 15years is 81% higher compared with the response from those that have been living in their community within 1-5 years.The more the number of years a respondent has spent in his/her community, the more they response to survey questions.

The response from Nigerians was 52% higher compared with response from non Nigerians.

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Table 2 : Incidence Rate Ratios for Various Levels of Response Predictors

Level of family size	Incidence Rate Ratio (IRR)
One	1.27134
Two	1.564931
Three	1.664464
Four	1.75134
More than four	1.844516
Duration of interview	**Incidence Rate Ratio (IRR)**
1-5 minutes	1.0000
6-10 minutes	1.234665
11-15 minutes	1.581354
More than 15 minutes	1.5866665
Language of interview	**Incidence Rate Ratio (IRR)**
Yoruba language	1.0000
English language	1.5326667
Age categories	**Incidence Rate Ratio (IRR)**
30-50 years	1.0000
51-70 years	1.9417225
71-90 years	1.1235789
Familiarity	**Incidence Rate Ratio (IRR)**
Unfamiliar Respondents	1.0000
Familiar Respondents	— 1.209975
Level of Education	**Incidence Rate Ratio (IRR)**
Primary	1.0000
Secondary	1.2712579
Tertiary	1.5419527
Number of visit	**Incidence Rate Ratio (IRR)**
One visit	1.0000
Two visits	1.0096
Three visits	1.0030435
Four visits	1.002353
Five visits	0.1200002
Sex	**Incidence Rate Ratio (IRR)**
Female	1.0000
Male	0.854966
House ownership	**Incidence Rate Ratio (IRR)**
Tenant	1.0000
Owner occupier	0.925
Employment status	**Incidence Rate Ratio (IRR)**
Unemployed respondents	1.0000
Employed respondents	1.003194
Duration of residence	**Incidence Rate Ratio (IRR)**
1-5 years	1.0000
6-10 years	1.333665
11-15 years	1.584354
16 years and above	1.814665
Tribe	**Incidence Rate Ratio (IRR)**
Nigerian	1.0000
Non Nigerian	0.479778

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$$IRR = \frac{response\ from\ target\ population}{response\ from\ reference\ level}$$

b) Individual Effects of Response Predictors on Response Rate

The effect of the predictors of response is explained with respect to their odd ratios. Odd ratio greater than 1 means positive association, less than 1 means negative association and 1 means no association between the variables.

Notes

The family size, duration of interview, education, number of visit, Language of interview, familiarity, gender, house ownership, Nationality and duration of residence in a community are positively related to the response rate. Age is negatively related to the response rate and there is no association between employment status and response rate. See table 3.

Table 3 : Odd Ratios For Predictors Of Response

Predictors of Response and Response Rate	Odd ratios
Response rate * tribe	1.266
Response rate * age	0.7596
Response rate * language of interview	1.1411
Response rate * familiarity with interviewer	1.4064
Response rate * education	2.7511
Response rate * number of visit	2.7899
Response rate * gender	1.1853
Response rate * house ownership	1.1219
Response rate * family size	1.7402
Response rate * duration of interview	1.1185
Response rate * spouse kind of settlement	1.3298
Response rate * employment status	1.007
Response rate * year of reciding	1.137

c) Results of existing and developed Models

Table 4 compares the estimates and p-values that were obtained for two alternative models. model 1 (existing model), and model 2 (developed model) are for the probability of conditional cooperation given contact with main effects of response predictors and conditional cooperation given contact with both main and interaction effects of response predictors respectively.

The intercept α_2, and α_3 are directly interpretable as the inverse transforms of the probabilities response given contact (main effect) and response given contact (main and interaction effect) for the reference case respectively.

From model 2 (developed model), both family size and duration of interview contributed significantly ($p < 0.05$). By eliminating other response predictors from model 2, we have a parsimonious model i.e a model with least variables, but with a reasonable fit (adjusted $R^2 = 0.811$ and lack of fit insignificant at 5%), which contained family size and duration of interview with their interaction as shown in table 4.

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Table 4 : Parameter Estimate for Model 1 and Model 2

Preditor of Response	Model 1		Model 2a		Parsimonious Model	
	estimate	p-value	Estimate	p-value	estimate	p-value
Intercept	0.0291		0.0310		0.0110	
Tribe	0.2359+	0.0673+	0.1951#	0.5720		
language of interview	0.1320	0.6390	0.1053	0.0701		
familiarity with interviewer	0.3410+	0.0852+	0.2546#	0.0811		
Education	1.0120+	0.06260+	0.9022#	0.823		
number of visit	1.0260+	0.0924+	0.6366#	0.0627		
Gender	0.1700+	0.0799+	0.0040	0.0661		
house ownership	0.1150	0.0873	0.0213	0.0793		
family size	0.5540+	0.005+	1.0647#	0.026**	0.043	0.025**
duration of interview	0.1120+	0.0103+	1.0438#	0.016*	0.032	0.002*
spouse kind of settlement	0.2850+	0.0614+	0.2151#	0.7310		
year of residing	0.1284+	0.0.691+	0.1133	0.9210		
family size* duration of interview			0.9594#	0.032*	0.021	0.037*
p-value	0.042		0.036		0.024	
adjusted R^2	0.684		0.691		0.811	

- + means positive association with response given contact (main effects)
- # means positive association with response given contact (main and interaction effects)
- * means significant at 5% level of significance

VI. Conclusions

Consideration of interaction effects of response predictors is a useful technique to improve response rate in a longitudinal survey. Two major effective response predictors were identified- namely; duration of interview and family size. The developed model established that both main and interaction effects of response predictors play key roles in improving response rate.

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Notes

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