A FRAMEWORK FOR PRIORITY CONTACT OF NON RESPONDENTS

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ABSTRACT

Businesses which have not replied to a mail survey are generally subject to intensive follow up (IFU), by telephone or other means, to obtain a response. As this contact is expensive, strategies may be used to determine which businesses are given priority for contact. This paper presents a theoretical framework for developing and assessing priority IFU procedures. The situation is described by a set of respondents to the initial mail survey, models for the probability of response with and without IFU for the set of non respondents (ie the remainder of the sample) at a particular point in time, and models for the reported and imputed values for this set of non respondents. A score function is derived which, for a fixed number of contacts, maximises the expected improvement in accuracy. The framework is then modified for practical implementation, and a case study presented on its application to the ABS Survey of Employment and Earnings. The views expressed in this paper are those of the author and do not necessarily reflect those of the Australian Bureau of Statistics.

1. INTRODUCTION

There has been a focus in the literature in recent years of applying models based on sound mathematical principles to enable the efficient use of survey resources for respondent follow up action in establishment surveys. Some good examples include the work of Latouche and Berthelot (1992), Lawrence and McDavitt (1994) and Granquist and Kovar (1997). This work, however, has focused on making rational decisions on whether system generated queries on data received from respondents (referred to as 'edit' queries) are worth following up in a cost benefit sense. In this paper, we present a mathematical framework to aid in making rational decisions on the extent to which businesses, which are non-respondents to establishment surveys, should be followed up to elicit a response. This framework is then adapted to enable practical application through making a series of assumptions, and its effectiveness is then evaluated in a case study. The term IFU is used regularly in this paper, and refers to the process of continually recontacting a business (by phone or other means) to elicit a response to a mail based establishment survey.

2. ESTABLISHING THE BASIS FOR THE FRAMEWORK

Businesses, which have not responded to a mail establishment survey, will be imputed for in some way in the estimation process. Therefore a realistic aim for the IFU process is to minimise the non-response bias in survey estimates. In this paper we develop a framework for prioritising IFU such that the non-response bias in survey estimates is minimised, assuming the estimated quantity to be a simple level estimate. Our aim is to describe the benefit from undertaking the IFU process as an objective function to be optimised, subject to a constraint based on the resources available for performing IFU.

3. OUTLINE OF A PRIORITY IFU FRAMEWORK FOR THE ONE VARIABLE CASE

In this paper we describe a priority IFU framework for the one variable case, e.g. for a survey variable Y, with values Y_i for each unit i in the population. We assume a true superpopulation model ξ for Y_i , which may depend on auxiliary information, denoted as $\mathbf{x}_i$. In practice ξ is unknown and working models ζ have to be used. Different classes of units may have different auxiliary information available for use leading to a different working model being associated with each class.

3.1. A model for priority IFU

We define the following notation for an establishment sample survey:

S	Set of units chosen in the sample.
R	Set of respondents to a survey prior to performing IFU i.e. received after initial mailout
NR	Set of initial non-respondents to the survey prior to performing IFU. Note that $S = R \cup NR$.
C	Set of initial non-respondents (i.e units in NR) that will be contacted as part of IFU.
NC	Set of initial non-respondents that will not be contacted as part of IFU. Note that $NR = C \cup NC$.
CR	Set of units in C that respond as a result of IFU being performed.
CNR	Set of units in C that do not respond as a result of IFU being performed. Note that $C = CR \cup CNR$.

NCR Set of units in NC that respond even though no IFU was performed e.g. may be late respondents.
NCNR Set of units in NC that do not respond.

We assume explicit non-response imputation in the framework which follows:

Let $Y_i^{\#}$ be a random variable which represents the data we would use in estimation prior to performing IFU for the i^{th} unit and define it to be:

Y_i : if the unit is a respondent

$Y_{i\,\{R\}}$: if the unit is a non-respondent

(this notation has been adopted to indicate that the imputed value may be dependent on the members of R)

Let $Y_i^{\#\#}$ be a random variable which represents the effect on $Y_i^{\#}$ of the IFU process and define it to be:

Y_i : if the unit responds from IFU, responds late without IFU or was a respondent before IFU

$Y_{i\,\{R \cup CR \cup NCR\}}$: otherwise

(the imputed value may depend on the new receivals and original respondents)

Define $F_i = 1$ for units who receive IFU, 0 otherwise. Thus F_i is a deterministic variable which we control by our IFU strategy. Also define $\mathcal{I}_i$ to be the random variable which indicates whether unit i responds ($\mathcal{I}_i = 1$), or fails to respond ($\mathcal{I}_i = 0$). Let $\mathcal{I}_i\{C\}$ indicate that unit i was an initial non-respondent included in the IFU process, which can therefore be described as a Bernoulli random variable with probability of response parameter $p_i\{C\}$. Let $\mathcal{I}_i\{NC\}$ indicate that unit i was an initial non-respondent not included in the IFU process, which can also be described as a Bernoulli random variable with a different probability of response parameter $p_i\{NC\}$.

3.2. The effect of IFU in terms of our model

The following algebra expands an expression for the non-response bias remaining after the IFU process to include the quantities defined in section 3.1. This is necessary to express the framework in a manner which relates to the outcomes of the IFU process, which will facilitate assumptions being made to eventually simplify the framework to enable practical implementation.

The non-response bias remaining after the IFU process is given by:

$$\left|\sum_{i \in NR} w_i \times (Y_i - Y_i^{\#\#})\right| \qquad (w_i \text{ is the estimation weight for unit i})$$

$$= \left|\sum_{i \in NR} w_i \times F_i\,[\mathcal{I}_i\{C\}(Y_i - Y_i) + (1 - \mathcal{I}_i\{C\})(Y_i - Y_{i\,\{R \cup CR \cup NCR\}})] + \sum_{i \in NR} w_i \times (1 - F_i)\,[\mathcal{I}_i\{NC\}(Y_i - Y_i) + (1 - \mathcal{I}_i\{NC\})(Y_i - Y_{i\{R \cup CR \cup NCR\}})]\right|$$

$$= \left|\sum_{i \in NR} w_i \times [Y_i - Y_{i\,\{R \cup CR \cup NCR\}}] \times [F_i(1 - \mathcal{I}_i\{C\}) + (1 - F_i)(1 - \mathcal{I}_i\{NC\})]\right| \qquad (1)$$

Introducing the notion of a constraint, we would like to minimise (1) subject to $\sum F_i$ [m or $\sum K_i F_i$ [K. That is, for a fixed number of units (m), or a known unit IFU cost (K_i) and total resources available for IFU (K), minimise the non-response bias remaining after IFU. This is a difficult 0-1 integer programming problem, as $Y_{i\,\{R \cup CR \cup NCR\}}$ will depend on all of the F_i in a nonlinear fashion. If, however, we assume $|Y_{i\{R \cup CR \cup NCR\}} - Y_{i\,\{R\}}|$ is small compared to $|Y_i - Y_{i\,\{R\}}|$, and note that:

$$(Y_i - Y_{i\,\{R \cup CR \cup NCR\}}) = (Y_i - Y_{i\,\{R\}}) + (Y_{i\,\{R\}} - Y_{i\,\{R \cup CR \cup NCR\}}), \text{ then}$$

$$(1) \not\subset \left|\sum_{i \in NR} w_i \times [Y_i - Y_{i\,\{R\}}] \times [(1 - \mathcal{I}_i\{NC\}) - F_i(\mathcal{I}_i\{C\} - \mathcal{I}_i\{NC\})]\right| \qquad (2)$$

This assumption essentially means that we don't expect the imputation error incurred from imputing for an outstanding unit to change much once additional units have responded as a result of performing IFU. We revisit this assumption when describing the case study of practical implementation in section 5.

3.3. Deriving unit level scores and the notion of a benefit function

The aim of the following algebra is to define a unit level score function that can be evaluated for all non-respondents in a survey, which enables non-response bias to be minimised through the use of IFU. To facilitate this, we apply the triangle inequality to (2). This redefines the problem to one which limits (rather than minimises) the remaining non-response bias:

$$(2)\ [\ \sum_{i \in NR} w_i \times |Y_i - Y_{i\{R\}}| \times [(1 - \mathcal{I}_i\{NC\}) - F_i(\mathcal{I}_i\{C\} - \mathcal{I}_i\{NC\})]$$
$$= \sum_{i \in NR} w_i \times |Y_i - Y_{i\{R\}}| \times (1 - \mathcal{I}_i\{NC\}) - \sum_{i \in NR} w_i \times |Y_i - Y_{i\{R\}}| \times F_i \times (\mathcal{I}_i\{C\} - \mathcal{I}_i\{NC\})$$
(3)

Obtaining (2) from (3) is taking a conservative approach, as it no longer takes into account the possibility that non-response biases from different units may cancel out. Minimising (3) is equivalent to maximising:

$$\sum_{i \in NR} w_i \times |Y_i - Y_{i\{R\}}| \times F_i \times (\mathcal{I}_i\{C\} - \mathcal{I}_i\{NC\}) \tag{4}$$

subject to the same constraint of $\sum F_i$ [m or $\sum K_i F_i$ [K as the first term of (3) is independent of the IFU process. From (4) we can define a unit level score function, denoted by S_i as:

$$S_i = w_i \times |Y_i - Y_{i\{R\}}| \times (\mathcal{I}_i\{C\} - \mathcal{I}_i\{NC\}) \tag{5}$$

Thus to solve the problem we need to maximise:

$$B = \sum_{i \in NR} S_i F_i$$

This expression can be regarded as a benefit function (B) that we wish to maximise, in order to obtain the maximum benefit from performing IFU. This concept reflects that by maximising B through the use of IFU we minimise the non-response bias in the survey estimate.

The parameters $\mathcal{I}_i\{C\}$ and $\mathcal{I}_i\{NC\}$ of S_i are random variables, hence we need to take the expected value of S_i, which yields:

$$E_{\xi, \mathcal{I}\{C\}, \mathcal{I}\{NC\}}\{S_i \mid C, NC, y_i \text{ and } i \in R\} = w_i \times |Y_i - Y_{i\{R\}}| \times [\ p_i\{C\} - p_i\{NC\}] \tag{6}$$

In practice, the components of S_i would have to be estimated, hence we consider:

$$E_{\zeta, I\{C\}, I\{NC\}}\{S_i | C, NC, x_i, y_i \text{ and } i \in R\} = w_i \times |\hat{y}_i - y_{i\{R\}}| \times [\hat{p}_i\{C\} - \hat{p}_i\{NC\}] \tag{7}$$

We denote this quantity in (7) as $\hat{S}_i$ and consequently our estimated benefit function that we wish to maximise as:

$$\hat{B} = \sum_{i \in NR} \hat{S}_i F_i$$

Maximising $\hat{B}$ subject to $\sum F_i$ [m leads to choosing the m units with the largest values of $\hat{S}_i$.
Maximising $\hat{B}$ subject to $\sum K_i F_i$ [K leads to a 0-1 integer programming problem (not easy to solve).

4. ISSUES TO CONSIDER IN THE PRACTICAL APPLICATION OF THE FRAMEWORK

4.1. Initial score function

In (7) above we have defined the following estimated unit level score function:

$$\hat{S}_i = w_i \times |\hat{y}_i - y_{i\{R\}}| \times [\hat{p}_i\{C\} - \hat{p}_i\{NC\}],$$

which we want to determine for every unit in the sample which is a non respondent prior to IFU. This raises a number of issues in regards to applying this theory in practice.

4.2. Multiple variables

In the majority of surveys, more than one data item is collected, and the unit of measurement for different data items collected will often be different e.g. for a survey collecting, say, employment and gross wages and salaries. We would like to assess the benefit of IFU on each data item to derive an overall score for a non responding unit. This would require some form of scaling to ensure scores for each variable are comparable, and then combining the scores for each variable in some way to form an overall score for the unit.

4.3. Controlling for different levels of estimates

It is unlikely that the users of survey output are only interested in estimates at one aggregate level, e.g. for a variety of ABS surveys, users may be equally interested in Australian level estimates and Industry or State level estimates. If the scoring function in (7) was applied to all units, it is likely that the units with the highest weights (e.g. those in the most populous States or Industries) will attract the largest scores (assumed with all other things being equal). Prioritising IFU on this basis may therefore bring the greatest benefit to estimates at the aggregate level and the largest sub populations, but this could be at the expense of the resultant quality of estimates for smaller sub populations, which could be of equal importance to users. Therefore some scaling of scores to take account of this issue may also be necessary.

4.4. Maximising benefit subject to fixed costs

In developing the framework it was mentioned that maximising $\sum F_i S_i$ subject to $\sum K_i F_i$ [K leads to a 0-1 integer programming problem that is difficult to solve. In practice, estimating the K_i for individual units would be difficult, as separate units may require a substantially different amount of IFU effort to elicit a response, and this is unlikely to be constant across survey cycles for the same unit. It may be possible to estimate an average K_i (say **k**) over all units, however if this was used the inequality: $\sum K_i F_i$ [K would break down to $\sum F_i$ [K / **k** which is equivalent to $\sum F_i$ [m. Hence the focus in the practical application of the framework will be to choose the m units with the highest S_i scores, after some form of scaling has been performed to address the issues raised in 4.2. and 4.3..

4.5. Probabilities of response

A key component of the scoring function is $[\hat{p}_i\{C\} - \hat{p}_i\{NC\}]$. The $\hat{p}_i\{C\}$ depends on the nature of the IFU contact. As we are attempting to ensure that all units regarded as important by our scoring function should be followed up until a response is achieved (which may even involve visiting the respondent), then unless a business refuses to be part of the survey a response is most likely to be obtained. Experience with ABS surveys is that only a small proportion of businesses will refuse to be involved in the survey, under which case the ABS then has the power to make the survey their legal obligation. Consequently it would be reasonable to use a value of $\hat{p}_i\{C\} = 1$ in our model. The $\hat{p}_i\{NC\}$ depends on when IFU is performed. The longer this is after the specified due date for the originally mailed out form the more likely it is that this value will tend to 0. Consequently assuming a value of $\hat{p}_i\{NC\} = 0$ is also reasonable for our model. These assumptions simplify our scoring function to the expression below, which will be used in the practical application of the framework presented in this paper.

$$\hat{S}_i = w_i \times \left|\hat{y}_i - y_{i\{R\}}\right| \tag{8}$$

The score function in (8) can be interpreted as the expected absolute imputation bias of not receiving a response for the i^{th} unit which is minimised over the set of non respondents by achieving a response through IFU from the m units with the largest $\hat{S}_i$ scores.

5. APPLICATION OF THE PRIORITY IFU FRAMEWORK TO THE AUSTRALIAN SURVEY OF EMPLOYMENT AND EARNINGS

5.1. The Australian Survey of Employment and Earnings

The Australian Survey of Employment and Earnings (SEE) is a quarterly sample survey collecting data from approximately 13,500 businesses in Australia across all industries excluding Agriculture, Forestry and Fishing. The data items collected are total employment (split by full time / part time) for the pay date closest to the middle of the quarter and gross quarterly earnings (consisting of gross wages and salaries, severance termination and redundancy payments, and directors fees) paid to all employees of the business in the quarter. The proportion of businesses new to the SEE sample each quarter is approximately 8%.

Estimates are first produced in the SEE approximately five and a half weeks after the reference quarter to feed into the preliminary National Accounts release. Final estimates for publication purposes are then produced approximately 12 weeks after the reference quarter. The key estimates produced from the SEE are total employment (TE) and gross quarterly earnings (GQE) at a variety of estimation levels, the finest being at the State (8 States) by Industry (16 Industries) level. The following collection strategy is currently in use for the SEE:

1) Due date for the form is the second Thursday of the month following the reference quarter, at which time approximately 35 - 40% of businesses have responded. Mail reminders are sent to outstanding businesses the day after the form due date.

2) Phone IFU action commences for businesses outstanding three weeks after the reference quarter, at which time approximately 55 - 60% of businesses have responded. All outstanding businesses are contacted at least once within a two and a half week period.

3) Preliminary estimation is performed at five and a half weeks after the reference quarter, at which time approximately 80% of businesses have responded.

4) Phone IFU action continues for all units, with the aim of achieving 100% response prior to close off for final estimation at 12 weeks after the reference quarter, in general approximately 99% of businesses respond each quarter.

It has been estimated that roughly the same amount of resources are expended on phone IFU in the SEE to achieve a response rate of 90% and to get the response rate from 90% to 99%. Consequently the application of a priority IFU technique to SEE could result in large efficiency gains.

5.2. Method used for applying the priority IFU framework to the SEE

5.2.1. The model adopted for scoring a unit

We need to make use of auxiliary information (i.e. the $\mathbf{x_i}$) to determine a relevant value for $\hat{y}_i$ from the scoring function in equation (8), which is reproduced below.

$$\hat{S}_i = w_i \times \left|\hat{y}_i - y_{i\{R\}}\right|$$

Also in deriving equation (2) from equation (1) in section 3.2. it was assumed that $y_{i\{R\}}$ was unlikely to change much as a result of performing IFU (i.e. $y_{i\{R\}}$ is assumed not to vary much with the survey response rate), or more importantly that any change in a unit's imputed value as a result of IFU is likely to be small relative to the value of $\left(\hat{y}_i - y_{i\{R\}}\right)$ prior to performing IFU.

In applying the framework of this model to the SEE the reliance on this assumption is removed, as we estimate the actual $(\hat{y}_i - y_{i\{R\}})$ from the previous quarter's survey data file (SDF). That is, our imputation model ζ is independent of the set of respondents R at any stage of the current survey cycle. This is achieved by using the knowledge of what unit i reported for the data item y last quarter as our value of $\hat{y}_i$, and what the impute of data item y for unit i would have been last quarter if it had not responded as our value of $y_{i\{R\}}$. The assumption we are introducing however is that the expected absolute imputation bias (i.e. the quantity $(\hat{y}_i - y_{i\{R\}})$) for a business is relatively constant from one quarter to the next.

Different imputation strategies are used in the SEE for units in sampled strata and completely enumerated (CE) strata (i.e. all units in the strata are selected). The above calculation cannot be made for businesses that were non-respondents in the previous quarter. In this case the relevant data from 2 quarters ago is used. If a business has been a non-respondent for the past two quarters, or is new to the sample, then a default score is given to ensure the business receives IFU (this is explained in greater detail in section 5.2.2.).

5.2.2. Scaling for different variables and levels of estimation

Users of the SEE are most interested in estimates of total employment (TE) and gross quarterly earnings (GQE) at the State (8 groups) by industry (16 groups) level and relevant aggregates of these. Therefore scores for priority IFU need to be scaled to account for the different magnitudes of the main data items and different levels of estimates required as discussed in 4.2. and 4.3.. The procedures below describe how this was done for the SEE in our case study. The basic idea was to derive a simple integer score for each unit between 0 and 10 which is then easy for survey processing staff to interpret.

1) Group together industries dominated by a particular sector (i.e. public vs private) and / or having similar total employment. This enabled the 16 industry groups to be reduced to 7, requiring priority IFU to be controlled for 8 (for the 8 States) x 7 = 56 separate groups.

2) Using historical SDF's, calculate the values of $\hat{S}_i$ by the method described in 5.2.1. for all units in each historical SDF where possible (i.e. all units except for chronic non respondents or units new to the survey for the particular quarters' SDF).

3) At the 56 State by industry group levels, determine deciles for the distribution of $\hat{S}_i$ values for the particular quarters SDF for each variable and then median smooth these decile values over the quarters analysed.

4) To determine the scaled IFU score for an outstanding unit in a future quarter, calculate the unit's $\hat{S}_i$ value for both TE and GQE, and determine which decile (where deciles are numbered from 0 - 9) it belongs to for its particular State by broad industry grouping based on the smoothed decile values obtained by the process described in point 3 above. Take the maximum decile (i.e. the maximum between TE and GQE) the units $\hat{S}_i$ belongs to as the units priority IFU score e.g. if an outstanding unit's $\hat{S}_i$ value for TE fell in the 20 – 30th percentile, but for GQE fell in the 30 – 40th percentile, then the unit's priority IFU score would be 3. The maximum priority IFU score for a unit is therefore 9. We denote this scaled $\hat{S}_i$ score as Z_i to indicate the final scaled IFU score for unit i.

5) For the purpose of this analysis, outstanding units who were new to the survey for the particular quarter or had been a non respondent for the previous two quarters were given a default priority IFU score of 10, and thus can be separately identified.

The decision to group a unit's $\hat{S}_i$ scores for TE and GQE into deciles was arbitrary. However it is a simple method to scale different variables and produce a meaningful discrete score that can be used to effectively distinguish between those units for which receiving a response is important and other units for which obtaining a response through IFU is less important.

5.2.3. Determining cutoff priority IFU scores

The framework refers to the optimal solution as choosing the m units with the highest Z_i scores to be subject to IFU, where m is based on some knowledge of the unit cost for IFU and the total resources available to undertake IFU in the particular survey. In applying the theory to the SEE we have taken a slightly different approach, where we are interested in a cutoff Z_i score for which the benefit in obtaining a response through performing IFU for units below this score is marginal in relation to the expected impact on the survey estimates relative to the sampling error of the estimate. It is expected that choosing this cutoff score will equate to a relatively stable value of m each quarter, or equivalently a stable number of units that will not receive IFU.

5.3. Results from applying the priority IFU framework to the SEE for a test quarter

5.3.1. Description of data files used and resulting scores

Data from the SEE for all four quarters of 1998 and the first quarter of 1999 were used to determine the appropriate median smoothed deciles by the procedure outlined in 5.2.2. From performing this process it was found that the absolute error of imputation for a unit was reasonably consistent from quarter to quarter, which supported the assumption required for this scoring technique to be effective as discussed in section 5.2.1.. With the median smoothed deciles calculated, it was possible to score outstanding units for the second quarter of 1999, referred to as 2/99. Scoring for units in the 2/99 survey was performed for all units outstanding at preliminary estimation time, which equated to approximately 17.5% of the survey sample. Note that this analysis has been performed retrospectively, and appropriate files did not exist to allow scoring at the commencement of IFU or at any other time in the survey cycle. The following table lists the distribution of resulting scores.

Table 1: Scores set for outstanding units at preliminary estimation in 2/99

Scores	Number of units assigned this score	Final response rate (%) if units less than this score are not received after preliminary estimation
0	66	100
1	63	99.5
2	98	98.9
3	108	98.1
4	122	97.2
5	177	96.2
6	191	94.8
7	250	93.2
8	288	91.1
9	385	88.7
10	364	85.6
All	2112	82.5

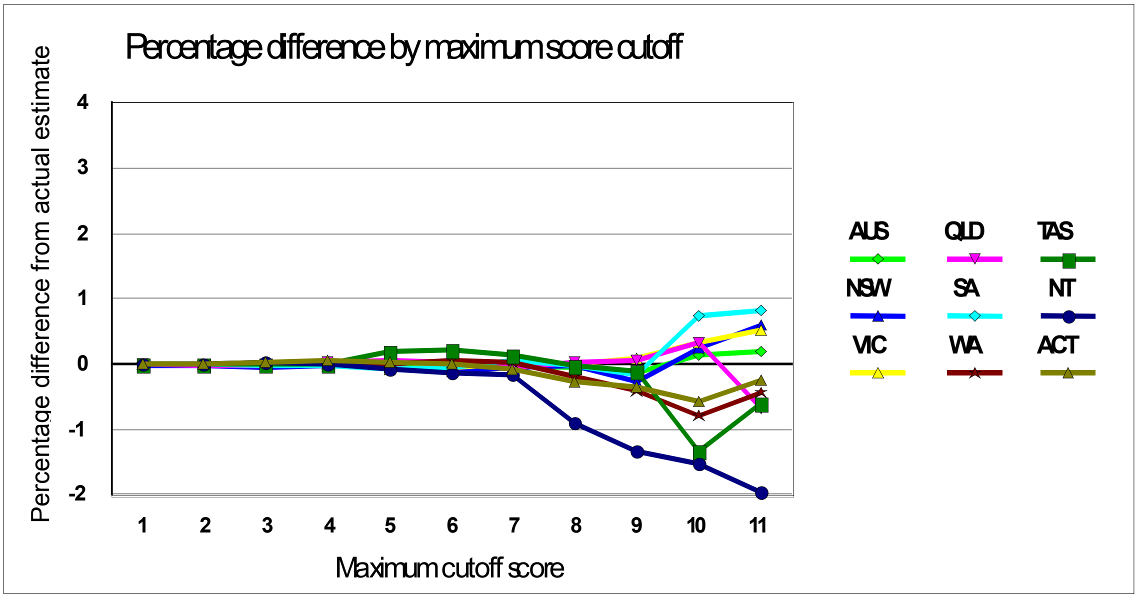
It is interesting to note that the distribution of scores across outstanding units is not even, and increases with the score value. This indicates that non-response is not random. Historical analysis of data from the SEE shows that large units, which contribute significantly to estimates, tend to be later respondents.

5.3.2. Assessment of the impact on estimates

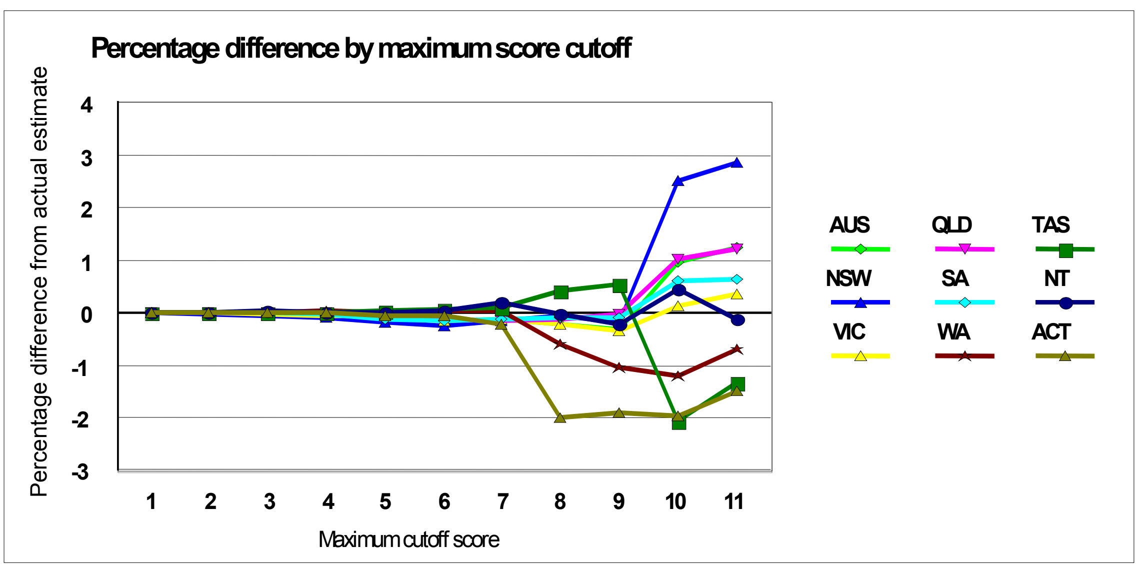
The final SEE estimation file for 2/99 contained responses from approximately 99% of units. All units, which failed to respond prior to final estimation, have been excluded from this analysis, and were also excluded from table 1 above. Consequently the 100% in table 1 actually refers to all units which had responded by the final estimation close off time.

The stated purpose of the priority IFU technique was to choose a cutoff Z_i value for which the benefit in obtaining a response through performing IFU for units below this score is marginal in relation to the expected impact on the survey estimates relative to the sampling error of the estimate. With knowledge of each units final reported values, we can assess the impact on estimates of not having performed IFU for units with a Z_i below a range of cut-off values, by re-running final estimation with imputes substituted for units whose Z_i value was below the cutoff level. This of course assumes that the unit would not have responded if IFU had not been performed. The graphs below present these results for both TE and GQE at the State and Australian levels.

Graph 1: Percentage difference from actual TE estimate for each maximum score cutoff



Graph 2: Percentage difference from actual GQE estimate for each maximum score cutoff



The graphs show that the estimates converge to the actual final estimate quite rapidly after responses have been obtained for the highest scoring units, with the estimate of GQE showing somewhat more variability than the estimate of TE. A logical choice for the cutoff score based on the above graphs would be a value of 7, which equates to a survey response rate of 93.2%. Table 2 shows the expected deviance from the final estimate this would cause compared to the survey relative standard errors for the State level estimates.

Table 2: Impact on estimates of using a cutoff score of seven compared to survey standard errors

Variable	**Total Employment**		**Gross Quarterly Earnings**	
State	% absolute deviance from final estimate	Relative standard error of estimate (%)	% absolute deviance from final estimate	Relative standard error of estimate (%)
New South Wales	0.07 %	2.2 %	0.17 %	2.4 %
Victoria	0.01 %	2.2 %	0.13 %	2.7 %
Queensland	0.04 %	2.5 %	0.13 %	2.7 %
South Australia	0.04 %	2.7 %	0.12 %	2.9 %
Western Australia	0.04 %	3.4 %	0.04 %	2.7 %
Tasmania	0.00 %	3.4 %	0.43 %	2.8 %
Northern Territory	0.14 %	4.2 %	0.20 %	5.8 %
Aust Capt Territory	0.07 %	3.1 %	0.23 %	3.7 %
Australia	**0.02 %**	**1.1 %**	**0.13 %**	**1.3%**

The table shows that the impact of not obtaining a response for units with a Z_i value of less than 7 has had negligible impact on the survey estimates relative to the survey's standard errors, and as such any inferences being made on the survey data would not have been affected had this priority IFU policy been employed for the 2/99 quarter.

Testing of this priority IFU strategy on more than one quarters worth of data is necessary to ensure that the choice of an appropriate cutoff score is robust and can expect to yield consistent results over time. To assess this, data from the SEE for the third quarter of 1999 was also analysed in the same manner as described in this paper and yielded very similar results.

5.4. Restrictions of this analysis and related issues

5.4.1. Scoring for IFU at an earlier stage of the processing cycle

The method of scoring described in this paper relies completely on historical data thus a units Z_i value is known prior to the form being dispatched. This is advantageous, as it is therefore possible to prioritise IFU at a very early stage in the survey cycle. For the purpose of this paper the model was applied to the SEE to ascertain whether total IFU costs could be cut without noticeably affecting the quality of the survey estimates. By retrospectively deciding which units would continue to receive IFU after preliminary estimation occurred, it appears we could have drastically cut the large IFU costs associated with obtaining a response from the final 10% of outstanding units (which as stated previously equates to approximately half of the total IFU cost for the survey), without noticeably affecting the quality of the estimates produced. In applying this framework in general, different survey areas may wish to cease IFU action for units with a score below the cutoff much earlier in the survey cycle depending on their objectives for applying the framework. The ultimate aim is to ensure the most strategic use of the survey resources available for the IFU process.

5.4.2 Simplification of the framework by use of assumptions

Several assumptions have been made in this paper to simplify the mathematical framework developed for ease of practical application. The results of the case study indicate that the simplified model should work well in practice, however further gains could be possible by revisiting some of the simplifications. For example the role of the $[\hat{p}_i\{C\} - \hat{p}_i\{NC\}]$ in (8) suggests we should collect and analyse individual businesses response histories. Effectively estimating these quantities should lead to more effective application of the framework.

5.4.3. Scoring at higher aggregate levels or controlling estimate quality at a lower level

In this example we applied the scoring function at the State by broad industry level but decided on the cutoff score based on the impact on estimates at the State level. Deciding on a cutoff score from considering the potential impact on all state by broad industry estimates would be cumbersome, and the fact that the actual scores were determined at this level is enough to exert some control on the impact of the process on estimates at this level. If we were not interested in exerting some control over the impact on State by industry estimates by performing priority IFU we would have applied the scoring function at a higher level e.g. just at the state level. This may have resulted in a higher cutoff score being chosen (i.e. requiring less IFU to be performed) to achieve the same expected level of accuracy as the scoring function would be directly aimed at this level.

5.4.4 Collection strategy for new units to the survey and long term non respondents

In this example we gave all new units to the survey and those which had not responded for the previous two quarters a default priority IFU score of 10. For application of the priority IFU framework to be successful it is important that special attention is paid to these two groups of units. New units to the survey should undergo some form of induction process aimed at maximising the likelihood of response prior to IFU being undertaken (this is the practice used in the SEE). Units, which have not responded for the last two quarters, should be identified prior to dispatch and be given special attention to ensure their early response. This may involve having to negotiate with the provider as there may well be good reasons why they have not responded in the past (e.g. lack of data availability, not understanding the survey requirements etc). If specific procedures to address long term non respondents are not developed there is a danger that the number of units with default scores will increase over time and thus the savings in processing costs from applying the priority IFU framework would be eroded.

6. CONCLUSION

This paper has developed a mathematical framework to minimise the non-response bias in survey estimates from performing IFU for a fixed number of initial non-respondents to a sample survey. In considering the issues involved in the practical application of this framework, simplifications to the mathematical model based on a number of assumptions and approximations have been required. Testing of this priority IFU model in the Australian Survey of Employment and Earnings has shown that substantial reductions in survey IFU costs are likely to be possible without noticeably affecting the quality of estimates produced from the survey. Consequently the application of this technique to establishment surveys in general is likely to enable efficiencies in the survey process to be realised.

References

Carlton, S (1998). A framework for prioritising IFU. Unpublished report, Methodology Division, ABS.

Granquist, L. and Kovar J.G (1997). Editing of Survey Data: How Much is Enough? in Survey Measurement and Process Quality. New York. Wiley, 415-435.

Latouche, M. and Berthelot, J.M (1992). Use of a Score Function to Prioritize and Limit Recontacts in Editing Business Surveys. Journal of Official Statistics, 8, 389 - 400.

Lawrence, D. and McDavitt, C. (1994). Significance editing in the Australian Survey of Average Weekly Earnings. Journal of Official Statistics, 10, 437 - 447.