Reducing Postal Survey Nonresponse Bias by Sample Selection Incorporating Noncontact Propensity

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Abstract

Noncontact, the failure of a postal survey sample member to receive a survey request, is a potential source of nonresponse bias that has largely been ignored. This is due to the difficulty of separating the components of nonresponse in postal surveys when nothing is heard from potential respondents. Yet, the need to understand postal nonresponse is increasing as more studies move to mixed mode designs incorporating a postal element, and technological, resource and societal changes increase the attractiveness of self-administered surveys. Thus, this research sought to estimate the level of noncontact in postal surveys, to identify the direction and magnitude of bias due to it, and to investigate targeted in-field mechanisms for reducing this bias. A series of empirical studies involving New Zealand postal surveys fielded between 2001 and 2006 were undertaken to meet these aims.

Noncontact was found to relate to survey-independent demographic variables (e.g., age, household composition). Furthermore, its incidence was estimated to be as much as 400% higher than indicated by 'gone, no address' (GNA) returns, although an envelope message tested as part of the research was able to increase levels of GNA reporting significantly. Thus, noncontact was established as a nontrivial source of nonresponse in the surveys examined.

As far as bias is concerned, noncontacts had a different profile compared to refusers and ineligibiles, and were estimated to account for up to 40% of net nonresponse error for some of the variables in the surveys examined. Accordingly, there appears to be a clear opportunity for methods targeted at reducing noncontact bias to improve final survey estimates for a range of items.

A number of potential methods for reducing noncontact bias were explored, but only one had both a compelling theoretical foundation and potential for wide applicability; the noncontact propensity sampling (NPS) scheme. In a resampling simulation study a prototype of the scheme, which increases the selection probabilities for sample units with a higher predicted propensity for noncontact, consistently improved the demographic profile of valid postal survey returns compared to a simple random

sample (SRS). Furthermore, the scheme reduced nonresponse bias by an average of 28% as measured against a range of frame variables (e.g., age, gender) and 17% as measured against survey variables for which census parameters were known (e.g., religiosity, household size, qualifications, income and marital status).

Although the prototype NPS procedure increased the standard deviation of simulated point estimates for a given sample size (1,500 in this research), the effect was small; an average of 4% for frame variables and 2% for survey variables. Furthermore, the scheme had almost no impact on reported cooperation rates and is likely to be cost effective compared to other potential targeted in-field mechanisms, particularly in situations where researchers regularly survey a specific population.

Pairing the scheme with three common post-survey adjustment methods (frame or census age/sex cell weighing, and response wave extrapolation) did not lead to consistently better estimates than an unweighted SRS. But this was largely due to the shortcomings of these methods because in many cases combining them with either sampling scheme (SRS or NPS) actually degraded estimates. This reinforces the idea that researchers should expend effort minimising bias during the field period rather than relying on post-survey weighting to deal with the issue.

Finally, since the NPS scheme aims to reduce error due to noncontact but is not expected to affect error due to other components (e.g., refusal, ineligibility), it presents an opportunity for researchers to begin decomposing the various facets of postal survey nonresponse bias, an important precursor to the development of other targeted bias reduction interventions. Thus, as a methodological tool, the NPS scheme may serve a dual role as both a bias reduction and decomposition mechanism.

In addition to their implications for postal survey research, the methods developed and insights into noncontact established in this research are likely to have applications in other domains. In particular, they will inform activities such as research into online survey nonresponse, organisational database management cost reduction and list procurement.

1. Summary, Applications and Future Directions

1.1. Introduction

Nonresponse is of increasing concern to survey methodologists, who are facing general declines in response to survey requests. Indeed, the situation is such that the editors of a recent compilation of nonresponse research proposed that two key challenges facing methodologists at this juncture in history involve "*determining the circumstances under which nonresponse damages inference to the target population"* and identifying "*methods to alter the estimation process in the face of nonresponse to improve the quality of sample statistics"* (Groves et al., 2002, p. xiii).

In response to these challenges, practitioners and academics have begun to investigate the contribution to total survey bias of individual nonresponse components (e.g., refusal, noncontact, ineligibility). Furthermore, there has been a movement toward responsive survey designs that allocate increasingly limited survey resources to targeted interventions aimed at improving response or mitigating biasing effects at a component level. For example, a survey may include callbacks, incentives, refusal conversion techniques and mixed-mode contact strategies.

Although much has been done to better understand the causes and effects of nonresponse in telephone and face-to-face modes, relatively little is known about the components of postal survey nonresponse. In part, this is because it is difficult to separate out nonresponse components in that mode. Nevertheless, there is good reason to expect that the components contribute differentially to bias, just as they do in other modes. Indeed, as more postal surveys are deployed either as stand-alone vehicles or as part of mixed mode designs, researchers will require a better understanding of postal survey nonresponse components if they are to minimise overall survey bias and maximise effective use of survey resources.

This research therefore sought to examine the nature and extent of noncontact in the postal mode, to better understand its contribution to survey bias, and to explore the development of in-field interventions targeted at any bias associated with it.

The three overarching objectives of the research were to:

1. *Empirically estimate the levels of total noncontact present in the surveys examined and identify key correlates of both noncontact incidence and reporting*;
2. *Identify the direction and magnitude of postal survey bias introduced by noncontact and compare it to error introduced by other nonresponse components*;
3. *Investigate targeted in-field mechanisms for reducing postal survey bias introduced by noncontact.*

To achieve these objectives, a series of empirical studies was undertaken involving general population postal surveys fielded in New Zealand between 2001 and 2006. In addition to identifying a number of key features of the noncontact phenomenon, the research developed procedures for uncovering, estimating and adjusting for noncontact nonresponse that are directly applicable to postal survey practice.

1.2. Key Findings and Implications

1.2.1. Noncontact is Underreported and Systematic in Nature

Conceptually, postal noncontact was considered to be a survey-independent phenomenon related to individual propensity for movement, frame update processes, and household or individual propensities for notifying frame-keepers of changes. Furthermore, the level of noncontact reported to researchers was expected to relate to household propensity to return misaddressed mail and the attributes of the survey invitation.

A study embedded in a general population survey of 2,400 people confirmed many of these expectations. It did so by exploiting a unique frame update situation to identify addresses that were likely to be inaccurate at the time the survey was fielded and comparing these with 'gone, no address' (GNA) returns to the survey invitation. Independent frame information was also used to develop profiles of sample units more likely to change addresses and third parties more likely to report noncontact. Finally, the study tested the efficacy of a 'please return' message on the survey invitation envelope, aimed at increasing noncontact reporting rates.

Frame address inaccuracies were found to correlate with age, employment status and household composition. For instance, those who were young, living in multi-surname households, or who were students or beneficiaries were more likely to have changed address details. Furthermore, noncontact reporting related to household characteristics, such that those households more likely to contain movers were also less likely to report noncontact when it occurred.

Using a procedure developed as part of the study to estimate levels of unreported noncontact, it was found that follow-up mailings and envelope messages both significantly increased reporting by third parties. Moreover, results suggest that estimated total noncontact was as much as 400% higher than the reported level in a single-contact unmessaged study (2.8% vs. an estimated 12%). Indeed, even with three contacts and an envelope message, total noncontact was estimated to be 30% higher than reported (9.6% vs. an estimated 13%).

These findings have significant implications for survey practice. Specifically, noncontact appears to be drastically underestimated in standard postal surveys using frames such as an electoral roll. The cooperation rates reported for many postal studies are therefore likely to be understated. Moreover, the results also suggest noncontact is a much larger component of total postal survey nonresponse than typically acknowledged. Given widespread concern about declining survey response, this is important to know. Efforts aimed at understanding the reasons for declining response, identifying any associated bias, or developing tools to combat the problem, all require knowledge of the size and nature of nonresponse components. Both the envelope message technique and the notification rate estimation procedure developed as part of this study contribute to the development of that knowledge.

Finally, the interrelationships identified between mobility and noncontact, and household characteristics and reporting, present opportunities for targeted design interventions to be developed for this component of postal survey nonresponse. These might, for example, modify reporting propensities by the manipulation of survey features under the researcher's control (e.g., the survey invitation) or incorporate expected noncontact propensities into the survey design (e.g., at the sampling phase) to reduce the effect of this potential error source on estimates.

1.2.2. Noncontact Contributes to Net Survey Bias

Notwithstanding the findings regarding the underreporting and systematic nature of noncontact, noncontact does not necessarily contribute error to survey estimates. Moreover, if it does, it is possible that any error is either the same as, or entirely offset by, that contributed by other nonresponse components. Therefore, an empirical study was undertaken to identify the direction and level of postal survey noncontact bias and to compare it to error introduced by other nonresponse components.

The study, which examined a selection of general population surveys fielded between 2001 and 2006, established estimates of bias due to noncontacts, active refusals, ineligibles, and inactives (respondents from whom no response at all was received). Multiple techniques for estimating error were employed, including benchmarking against population parameters, comparisons on individual-level frame data, and analysis of valid responses over successive waves of contact.

Steady trends in bias were identified across the surveys. Specifically, survey estimates were consistent in their direction of deviation from known population data on age, gender, Maori ethnicity, marital status, qualifications, income and household composition. As noted in the prior study, and in recent research published by *Statistics New Zealand* (2007j), many of these variables are known to relate to movement and noncontact. Furthermore, the trends in deviations identified persisted across variables for which individual frame data were also available (e.g., age, gender, Maori descent). Since a frame-level analysis eliminates the possibility for identified deviations to be due to coverage or measurement, this suggests that the deviations on related survey-only variables are also at least in part due to nonresponse.

At the component level, sample units for which a refusal or ineligible response was recorded differed substantially from those listed as a noncontact or inactive, on average, over a range of frame variables. Moreover, although the different component biases cancelled each other out to some degree, net nonresponse bias remained and was attributable to the noncontact and inactive groups. Indeed, an

analysis of bias on the frame variables taking into account noncontact underreporting rates established in the prior study suggested that up to 40% of residual nonresponse bias after multiple follow-up contacts may be contributed by noncontact.

It was not possible to assess the degree of bias caused by noncontact on survey-only variables, because comparative population parameters were either unavailable or potentially confounded by coverage and measurement error. Furthermore, an attempt to assess bias magnitude by wave-of-response extrapolation proved too unreliable to generate any sound conclusions. Nevertheless, there were clear correlations between many of the frame variables for which nonresponse bias was known to exist, and a range of demographic and attitudinal survey-only items. Thus, it seems reasonable to conclude that noncontact bias affects a variety of variables.

Together, these findings point to a clear opportunity for methods targeted at reducing noncontact bias to improve final survey estimates for a range of items.

1.2.3. Practical Issues Limit the Options for Targeted In-Field Noncontact Interventions

In general, two approaches to bias reduction are proposed in the nonresponse literature; post-survey adjustment via techniques such as weighting or imputation, and in-field design interventions aimed at improving the distribution of responses. Although both are commonly employed, the success of post-survey approaches ultimately rests on the amount of data gathered during the field period and the validity of assumptions about the relationship between responders and nonresponders. Thus, where possible, researchers are advised to adopt the responsive design approach to fieldwork mentioned earlier, and to allocate resources to in-field interventions targeted at low-response groups.

With this in mind, an exploration of potential in-field mechanisms targeted at noncontact nonresponders was undertaken. A search of the literature for techniques that could be modified for such a purpose yielded four potential methods: finding and subsampling noncontacts, sampling movers from an independent source, substitution from within mover households, and sampling based on propensity to be a

noncontact. Of these, the first three were found to have significant limitations in the postal mode, at least in a New Zealand context. For instance, evidence from an attempt to find and survey noncontacts to one study suggests this approach is unlikely to succeed in obtaining data for many noncontacted individuals, within the budgetary constraints of many postal surveys. Moreover, it appeared that an independent list of movers available to New Zealand researchers would suffer from significant coverage issues, and thus, would be unsuitable for substitution purposes. Similarly, a small study that attempted substitution from within noncontact households did not deliver an adequate or representative set of replacements.

However, the fourth option, noncontact propensity sampling (NPS), was found to have both a compelling theoretical foundation and potential for wide practical applicability. The procedure is based on the rationale that, because noncontact is survey independent, sample units with similar propensities for noncontact should be substitutable with respect to survey items. Hence, noncontact bias may theoretically be eliminated by altering the survey sampling weights based on individual propensity for noncontact. That is, potential respondents may be sampled in proportion to their likelihood of noncontact, with the aim of achieving a contacted sample that is equivalent, on average, to a random sample taken from a frame with no contact inaccuracies.

The practicality of an NPS scheme relies on researchers' ability to predict noncontact together with a clear procedure for turning these predictions into sampling weights. In order to further explore these factors, a propensity modelling study was undertaken using data from the six surveys examined in earlier work. As anticipated, a number of demographic and household variables previously identified as correlates of movement and noncontact were consistently retained in logistic regression models built to predict reported noncontact. Furthermore, the models, which related to different base datasets and field periods, each performed similarly with respect to predictive power. In addition to establishing that noncontact may be predicted using common frame-based variables, the consistency in the performance of the models lent support to the idea that noncontact propensity is a survey-independent phenomenon.

A strata-based procedure was adopted as the most practical means of translating propensity scores into adjusted sampling weights for postal noncontact, for two reasons. First, results from the modelling indicated that the distribution of propensity scores would require it. This has also been the experience of other researchers employing propensity adjustment for nonresponse to internet surveys or undercoverage in telephone samples. Second, the fact that noncontact is often underreported means further adjustments to the sampling weights must be made to take this into account. In many situations a strata-based procedure will be the most conducive to such an adjustment.

There are some clear advantages to this approach compared to the other targeted mechanisms explored. Specifically, an NPS scheme:

- Is more cost-effective than procedures that require follow-up of noncontacts. In particular, organisations that undertake multiple surveys from the same frame could expend effort building a noncontact propensity model which they could then apply across multiple surveys;
- Is founded on unambiguous and defensible assumptions;
- Allows use of a single frame for sourcing all sample units, thereby eliminating the potential for coverage error to be compounded across sub-samples;
- Maintains a probability-based sampling procedure that can be specified and documented, and potentially used in combination with other probability procedures.

As such, of the potential methods identified, the NPS scheme comes closest to the ideal of an in-field design intervention that is "*practical, cheap, effective, and statistically efficient*" (Kish & Hess, 1959, p. 17).

1.2.4. An NPS Scheme can Reduce Noncontact Bias

Although the NPS scheme appeared to hold the greatest potential of the alternatives examined, the limits of predictive models, along with a strata-based weighting scheme and the need to adjust for underreporting, was likely to mean it could not totally eliminate noncontact bias. Thus, an empirical test of the scheme was undertaken to assess its likely practical effect on estimates.

Specifically, a simulation study was carried out using bootstrap resampling of results from three surveys fielded between 2003 and 2005. Two different NPS scheme implementations were tested (no adjustment for underreporting and stepped adjustment for underreporting). Furthermore, a parallel simulation for each survey employing an SRS scheme was conducted for comparison. Each simulation run involved 1,000 sample replicates of size 1,500, with summary measures calculated for a range of frame and survey variables for which independent data existed. In addition, three common post-survey weighting procedures (frame age/sex weighing, census age/sex weighting and wave extrapolation weighting) were applied as part of the simulation to examine the effect of the NPS scheme on the adjusted estimates they produce.

The results of the simulation suggest that the NPS scheme altered response distributions such that a higher proportion of the sample generates inactive or GNA outcomes, while a lower proportion generates valid or refusal outcomes. This effect was most pronounced for the stepped adjustment version of the NPS scheme thought to be most representative of a real-world implementation. Although it was expected, the obvious consequence is that standard cooperation rates for NPS samples will be lower than a comparative SRS. However, the effect on this important survey metric was relatively small and becomes trivial if an appropriate adjustment for unreported noncontact is made. Furthermore, what is ultimately important is whether or not the scheme results in better survey estimates.

In that regard, the NPS scheme did consistently produce a superior profile of valid responders than an SRS scheme when compared on independent frame data, with the stepped adjustment version generating the greatest reduction in nonresponse bias (an average 28% reduction in absolute error over the three simulated surveys). Furthermore, the NPS scheme produced survey item estimates closer to known census figures than the comparative SRS over a range of variables and survey periods. In particular, the scheme appeared to consistently improve estimates for age, religiosity, household size, qualifications, income, and marital status for two of the three simulated survey scenarios. However, the amount of bias reduction achieved was not as large as for the frame values; where it improved survey item estimates, the scheme led to an average 17% reduction in absolute error. The

scheme also performed worst in the 2005 survey simulations, as expected given the lower predictive power of the propensity model developed for that period.

With respect to variability, although on average the NPS procedure increased the standard deviation of simulated point estimates, the effect was relatively small. For frame variables, an average 4% increase was observed (e.g., a standard deviation of 10.0 would increase to 10.4). For the survey variables examined, the increase was 2% on average. This is a positive result considering the scheme returns fewer valid responses than an SRS for a given initial sample size (1,500 in this case).

The scheme did not lead to substantive improvements in estimates when paired with frame age/sex weighing, census age/sex weighting or wave extrapolation weighting. But this result is more of a reflection of the shortcomings of these common post-survey weighting procedures than it is of the utility of the NPS scheme. Indeed, in many cases weighting or wave extrapolation combined with *either* sampling scheme (SRS or NPS) actually made the survey estimates worse.

Overall, the NPS shows promise as a targeted in-field mechanism for reducing noncontact bias in postal surveys and therefore warrants further developmental effort. It is likely to have the greatest impact where noncontact can be expected to be a nontrivial component of total nonresponse, where the sampling adjustment is based on a strong predictive model, and where the survey covers variables that are likely to covary with items known to relate to propensity for noncontact (including age, household composition, employment status and ethnicity).

Furthermore, given that the procedure reduces error due to noncontact but is not expected to affect error due to other nonresponse components (although it may alter the proportion contributing to net nonresponse bias), it will allow researchers to at least partially decompose the various facets of nonresponse bias. In turn, this is likely to contribute to the development of in-field procedures targeted at reducing bias due to these other sources. As more studies move to mixed mode designs incorporating self-administration by post, such development work is expected to become the focus of increased attention.

1.3. Potential Applications

The insights and procedures relating to noncontact contributed by this research have a range of potential practical applications. Three general domains to which the knowledge generated here could be applied are postal survey methodology, online survey methodology and organisational database management.

1.3.1. Postal survey methodology

Knowledge of the correlates of noncontact, methods for improving reporting or estimating the level of reporting, and procedures for reducing its associated bias will be useful across countries and disciplines of research. For example, depending on access restrictions, researchers in countries with voter or population registers such as Australia, Finland, Norway and the United Kingdom may be able to closely follow the process outlined here to develop country-specific estimates of noncontact and reporting rates, and models of noncontact propensity. These could then be applied to a variety of postal surveys in those locations. Indeed, even in countries without such frames, or for organisations without access to them, it is likely that minor variations on the approach presented here (e.g., using internal lists or other publically available frames) may be applied to gather more information about noncontact than is currently available. Certainly, the findings regarding envelope message effects on reporting rates and procedures for estimating total noncontact should be generally applicable to a wide variety of postal survey situations.

Organisations undertaking panel or longitudinal research would probably gain the most benefit from the implementation of an NPS scheme, since they will have ready access to prior response data and use a consistent frame over time. Moreover, the cost of developing a model could be amortised across surveys. Nevertheless, since noncontact is a survey independent phenomenon, there is also the potential for industry-level development of guidelines relating to noncontact reporting rates and key predictors of noncontact for commonly employed frames. If these were to be developed, individual researchers could make use of them at relatively little cost in their own one-shot studies.

1.3.2. Online survey methodology

Although the results of the empirical studies presented here cannot be directly applied to an online context, the self-administered and individualised nature of many online surveys means there are parallels between the online and postal modes. Furthermore, the relatively recent advent of online media means there are many aspects of methodology that require further investigation in this mode. One such aspect relates to the receipt of, and response to, email invitations. It is likely that several of the issues addressed in this project will also be faced by researchers examining nonresponse to online questionnaires (e.g., understanding reporting of noncontact, estimating total noncontact levels, identifying bias and developing targeted in-field interventions).

There are, of course, clear differences in an online setting because a certain amount of noncontact reporting is automatic (i.e., email bounce-back). Yet, there is still a decomposition problem with respect to inactive nonresponse due to abandoned email accounts that still accept messages, messages that are received but caught up in spam filters, or passive refusal by those who see the invitation. Thus, the general approach to identifying and mitigating the effects of noncontact developed here will be useful to researchers in that field of inquiry. For instance, technical methods exist for identifying when an email message is opened in certain situations. These might be employed to establish estimates of passive refusal versus unreported noncontact that could assist with cooperation calculation and help develop a better understanding of online survey nonresponse.

It is also worth noting that some researchers are employing postal invitations in online studies to overcome coverage problems with email frames (if these are available at all). In such cases, many of the findings and procedures presented here may be directly applicable.

1.3.3. Organisational database management

Postal survey noncontact represents a special case of a much broader issue – mail nonreceipt caused by individual physical contact information inaccuracies due to population movement. This affects a range of activities, including corporate

communications with customers, governmental notifications or requests to citizens and organisational messages to members or subscribers. In all of these endeavours the costs associated with noncontact may be reduced by targeted list maintenance activities focusing on those records most likely to change. Many of the procedures developed for this project should be helpful in this regard. For example, organisations undertaking ongoing data cleaning exercises could routinely incorporate a prominent envelope message on their communications to better identify invalid addresses.

Furthermore, initial individual data capture requirements might include data known to be predictive of noncontact propensity (e.g., household composition, employment status). Models built on such data would have a range of uses, including predicting likelihood of membership churn for geographically focused services or selecting nonrespondent individuals for follow-up by more expensive alternative contact methods.

Turning to external lists, organisations may also find use for the results regarding noncontact reporting rates in their data purchase decisions. For instance, many publicly available lists have 'per record' costs based on a number of factors, one of which is the contact rate for the list. Given these rates are very likely to *overestimate* the true contact rate, organisations could use knowledge of noncontact underreporting correlates to better assess the comparative costs of alternatives.

1.4. Limitations and Directions for Future Research

While effort was made in the research to achieve robust results by examining multiple methods and datasets, there were inevitably limits to the scope of investigation that could be undertaken. Thus, there are a number of aspects of the research presented in this thesis that would benefit from replication and extension.

Specifically, all of the datasets employed relate to general population surveys of individuals undertaken in New Zealand and sponsored by *Massey University*. Hence, it is possible that some results may vary in different countries and for different sponsorship organisations. For instance, the dynamics of population movement,

frame maintenance and postal service efficiency could alter the correlates of noncontact incidence and reporting rates in different settings. Furthermore, surveys sponsored by different organisations may not achieve the same levels of response to survey requests or envelope prompts. Additional research is therefore required to assess the effect of changes in these factors.

Similarly, the bias analysis in this research focused on simple linear statistics (e.g., means and proportions) and was based on data obtained from surveys with simple sampling designs (i.e., where stratification was employed in base surveys, the estimated design effects were generally close to 1). As such, it is unknown how bias in nonlinear statistics, or for linear statistics in surveys with more complex base designs, would be affected by noncontact nonresponse or the NPS schemes explored here.

There was also limited examination undertaken of potential noncontact reporting rate influencers. It is possible that future research may lead to significant improvements in reporting cues. For instance, there are likely to be interactions between the existence of an envelope message and other attributes of the invitation package (e.g., logos, envelope size, bulk of package, etc.) that alter the achieved reporting rate. Furthermore, variations in message wording may lead to improved response. With regard to this, additional research incorporating diffusion of responsibility theory may bear fruit.

Further research on, and improvements in, noncontact reporting rate stimuli are also likely to have a flow-on effect for the continued development of total noncontact estimation procedures. Such development will be important because estimates of underreporting are a critical input for targeted in-field interventions such as an NPS scheme. Although it was not examined further in this research because of sample size limitations, an ideal progression of development would lead to household-level models of reporting propensity. Since these could be incorporated at an individual level along with survey response data, they may lead to improvements in the prediction of noncontact propensity that would, in turn, improve the bias-reducing effects of an NPS scheme.

Other areas that could be explored with the aim of improving NPS scheme performance include frame data augmentation (e.g., small area census data may provide additional predictive variables that would realistically be available to a variety of researchers), the incorporation of frame snapshot age into estimates of noncontact propensity, and the development of propensity models using techniques other than logistic regression (e.g., discriminant analysis, Bayesian classification or neural networks). To the extent that exploration of these approaches leads to models with greater predictive power, gains in noncontact bias reduction should also be achieved.

An alternative approach to predicting noncontact, not explored here, may be to move away from the use of prior survey response data entirely. For example, it may be possible to develop models of movement using publicly available data, which could then be applied to survey frames as a proxy for expected noncontact. In New Zealand, this might be achieved by the use of limited individual-level census record sets such as the *Confidentialised Unit Record Files* (Statistics New Zealand, 2007a), which include a range of demographic variables and a length of residence indicator. However, although such an approach would circumvent the problem of noncontact underreporting, it could potentially introduce issues relating to discrepancies between the model development data and variables available on the survey frame.

Moving beyond the specific issues and approaches that were the focus of this research, there are a number of related areas that could build on the findings presented here. For example, knowledge of the bias contributions of the various nonresponse components is likely to be useful in the development of post-survey adjustment procedures that account for differences; the second approach to postal survey bias reduction recommended by Mayer and Pratt.

> *"Inasmuch as the biases tend to be offsetting for certain characteristics, the researcher who has carefully segmented nonresponse by source could minimize total nonresponse bias by (1) controlling the relative sizes of offsetting nonresponse segments, or by (2) applying differential weights based on the relative sizes of these segments."* (Mayer & Pratt, 1966, p. 644)

Such post-adjustment measures might specifically include items in the questionnaire (e.g., a question on length of residence or recency of movement) to facilitate differential weighting for noncontact. Certainly, the poor performance of the common post-survey weighting procedures examined as part of the nonresponse error and NPS simulation studies suggests work examining the bias-reducing efficacy of alternative methods is needed.

Another area potentially worth exploration is the effect of moving from individual to household level selection for postal surveys. For instance, many of the techniques employed by telephone researchers to generate pseudo-random samples of the population might be applicable to a postal setting. If so, the problem of noncontact may be avoided completely. However, other significant issues are likely to arise from this approach that could outweigh any benefits gained, such as a reduction in cooperation, distortions in sample representativeness and problems in determining selection weights.

Finally, coverage is another source of postal survey error that might be addressed via the sampling adjustment technique explored in this research. Certainly, researchers have employed post-survey propensity weighting in the telephone mode in an attempt to reduce coverage bias (e.g., Duncan & Stasny, 2001). Furthermore, it seems reasonable that at least some of the noncoverage in frames such as the electoral roll would be due to population movement (e.g., when a noncontact return is used to remove a record from the frame). Thus, there are likely to be a number of parallels between noncontact and noncoverage in the postal mode that mean advances in targeting and reducing the bias in one can be applied in some form to the other.