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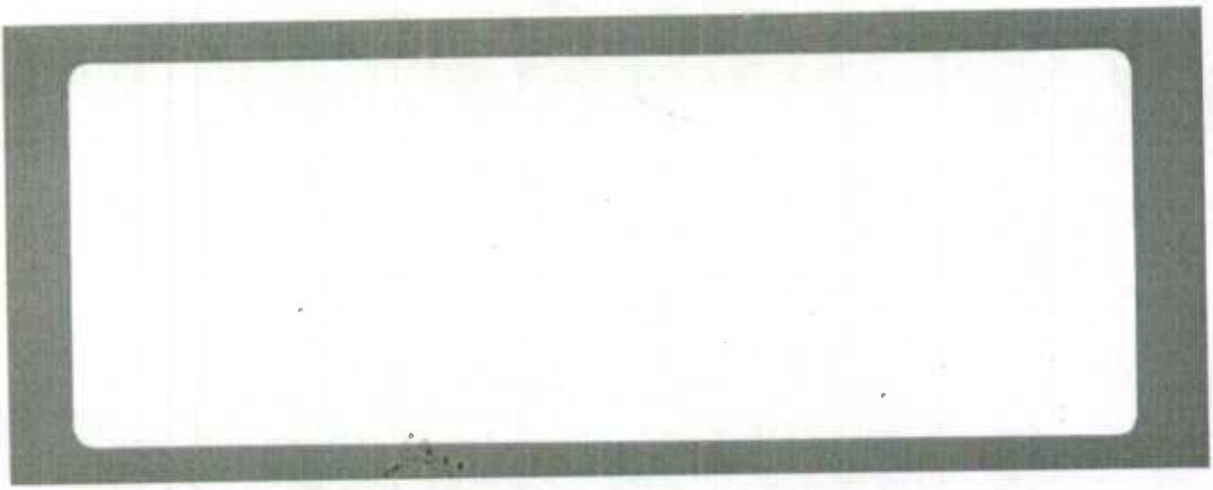

Methodology Branch

Household Survey
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WORKING PAPER
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SLIPPAGE IN THE LFS

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November 2001

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Executive Summary

Slippage is a measure of Labour Force Survey (LFS) coverage error and is defined as the percent difference between the Census population projections and the LFS population counts. In general, slippage is positive, thus the LFS consistently misses people who should be enumerated. Slippage is of special concern currently because it has been increasing for years and is now consistently around 10%. Slippage differs by region, reaching as high as 15% in certain provinces.

To study slippage, a two-part study was undertaken. The first stage was a historical review of the projects that have studied slippage in the past as well as the operational changes that have been implemented over time. The second stage was an analysis of various factors and their impact on the slippage rate.

Slippage has been under study for over 30 years. Previous studies have examined the quality of listing, roster coverage, manuals, field procedures and Census projections. In addition, analytical studies have attempted to explain slippage in terms of other variables. Many of the previous studies came to similar conclusions. For example, the relationship between vacant dwellings and slippage is important because misclassifying occupied dwellings as vacant increased slippage rates. Strong relationships exist between nonresponse, household size and slippage. The 20-24 age group presents special difficulties, but there is no evidence that this is caused specifically by students. Also, the accuracy of post-Censal estimates at small geographic levels have been called into question.

Over time, there have been many operational changes that may contribute to the increasing slippage rate. Many of these changes have resulted from technological changes such as the increased use of telephone interviewing, the move to computer-assisted interviewing and the subsequent changes to that system. With each change, some of the emphasis is removed from interviewing and listing skills to be placed on mastering the newest technology. While quality programs, such as interviewer observation, training and reinterview, are needed to maintain the quality of listing and interviewing, these programs have gradually been reduced or cut due to budgetary constraints. Previous studies have recommended emphasizing group training. In addition, previous recommendations include both the regular and random application of quality control procedures. The periodic LFS redesigns are able to improve the slippage rate for a short period of time, but it soon begins its upward trend.

Analysis of the relationship of the slippage rate with respect to other variables reveals a strong negative correlation between slippage and household size. This may be a result of the decreasing household size in society since, if on average, the same number of people are missed per household, they will have a larger impact on the slippage rate if the household size is smaller. Slippage is negatively correlated with the rate of personal interviewing, increasing as the rate of personal interviewing decreases. Slippage is highly correlated with the vacancy rate justifying the ongoing use of vacancy checks. Since slippage has been increasing over time and the interviewer workload has also been increasing overtime, it is not surprising that there is a positive correlation between the two.

As well, changes in the demographic profile of Canadians seem to influence slippage. Despite the high, and steadily increasing, slippage rates among 20-29 year olds, their overall contribution to the slippage rate has remained relatively constant over the study period, whereas the contribution of the 40-54 year olds has doubled between 1976 and 2000 due to their increasing proportion of the population.

Sommaire

Le glissement, qui est une mesure de l'erreur de couverture de l'Enquête sur la population active (EPA), est défini comme étant l'écart en pourcentage entre les projections de population du recensement et les chiffres de population fondés sur l'EPA. En général, le glissement est positif, ce qui signifie que, durant l'EPA, des personnes qui devraient être recensées sont manquées systématiquement. Le glissement est devenu particulièrement préoccupant ces jours-ci, parce qu'il a augmenté pendant des années et qu'il est maintenant régulièrement de l'ordre de 10 %. Il varie selon la région et atteint jusqu'à 15 % dans certaines provinces.

Une étude en deux volets a été entreprise pour étudier le glissement. Le premier volet est un historique des projets antérieurs portant sur le glissement et des changements opérationnels mis en œuvre au cours du temps. Le deuxième est une analyse de l'effet de divers facteurs sur le taux de glissement.

L'étude du glissement se poursuit depuis plus de 30 ans. Les travaux antérieurs visaient à examiner la qualité des listes et de leur couverture, les manuels, les procédures sur le terrain et les projections du recensement. En outre, des études analytiques avaient pour objet d'expliquer le glissement en fonction d'autres variables. Nombre de ces études passées ont abouti aux mêmes conclusions. Par exemple, le lien entre les logements vacants et le glissement est important, puisque le classement erroné de logements occupés dans la catégorie des logements vacants augmente le taux de glissement. Il existe en outre une forte association entre la non-réponse, la taille du ménage et le glissement. Le groupe des 20 à 24 ans pose des problèmes particuliers, mais rien ne permet de conclure que ces problèmes soient causés spécifiquement par les étudiants. Enfin, l'exactitude des estimations postcensitaires à de petits niveaux géographiques a été mise en doute.

Au fil du temps, de nombreux changements opérationnels pourraient avoir contribué à l'augmentation du taux de glissement. Nombre de ceux-ci résultaient de changements technologiques, comme le recours accru à l'interview téléphonique, l'adoption de l'interview assistée par ordinateur et les modifications apportées subséquemment à ce système. Lors de chaque changement, on a accordé un peu moins d'attention aux compétences nécessaires pour réaliser les interviews et établir les listes, et un peu plus à la maîtrise de la technologie la plus récente. Alors que des programmes d'assurance de la qualité, tels que l'observation de l'intervieweur, la formation et la réinterview, sont nécessaires pour maintenir la qualité des listes et des interviews, les contraintes budgétaires ont obligé à les réduire ou à les supprimer. Des études antérieures ont recommandé que l'on accorde plus d'importance à la formation en groupe. Il a également été recommandé de procéder à l'application régulière ainsi qu'aléatoire de procédures de contrôle de la qualité. Les remaniements périodiques de l'EPA permettent d'améliorer le taux de glissement pour une brève période, mais la tendance à la hausse reprend rapidement le dessus.

L'analyse des liens entre le taux de glissement et d'autres variables montre qu'il existe une forte corrélation négative entre le glissement et la taille du ménage. Ce lien pourrait résulter de la diminution de la taille des ménages observée dans la société, puisque, si l'on continue de manquer, en moyenne, le même nombre de personnes par ménage, l'effet sur le taux de glissement sera plus important si la taille du ménage est plus faible. Le glissement est corrélé négativement au taux d'interviews sur place, sa valeur augmentant lorsque le taux d'interviews sur place diminue. Le glissement est fortement corrélé au taux de vacance, ce qui justifie la vérification continue des logements vacants. Puisque le glissement a augmenté au fil du temps et que la charge de travail des interviews a aussi augmenté, il n'est pas étonnant qu'il existe une corrélation positive entre ces deux variables.

En outre, les changements du profil démographique du Canada semblent avoir un effet sur le glissement. Bien que ce dernier soit élevé, et encore à la hausse, chez les 20 à 29 ans, la contribution de ce groupe au taux global de glissement est demeurée relativement constante pendant la période à l'étude, alors que celle du groupe des 40 à 54 ans a doublé de 1976 à 2000 à cause de leur proportion croissante dans la population.

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1. INTRODUCTION

Objective

The purpose of this document is two fold. The first is to gather existing knowledge and experience with slippage in one location. The second is to document recent analysis of various factors and their impact upon slippage.

1.1 What is slippage?

Slippage is a measure of survey coverage error. It is defined as the percent difference between the Census population projections and the LFS population counts. A negative slippage rate indicates that the LFS has a problem of overcoverage, while positive slippage indicates the LFS has an undercoverage problem. In general, slippage is positive, thus the LFS consistently misses people who should be enumerated.

Slippage occurs when dwellings or persons within households that should have been covered by the survey are missed. Dwellings may be missed because some areas are difficult to map, because they are erroneously classified as vacant, or because several dwellings may be classified as one (multiples). Persons are sometimes missed in listed dwellings because the concept of "usual place of residence" is misunderstood or incorrectly applied, or because information was withheld.

There are other factors that can influence slippage. Census population projections can introduce error into the slippage rate if the projections do not accurately represent the true growth. Weaknesses in the sample design can impact the slippage. This is one of the reasons that the LFS is redesigned every ten years.

1.2 Why is slippage a problem?

Slippage is a problem if the characteristics of missed dwellings and persons are different from those that are enumerated (which is very likely). As such, slippage can introduce bias into the estimates. Also, because the realized sample size is lower than the planned sample size in certain groups, slippage can increase the variance of estimates.

1.3 Background

Due to the potential problems associated, slippage has been a concern for a very long time. Slippage is of special concern currently because it has been increasing for years and has recently been higher than 10%. Slippage differs by region, reaching as high as 15% in certain provinces. In comparison, in the United States, the slippage rate is between 7% and 9% and, while it is increasing, it is doing so quite slowly. Why does our slippage rate show this increasing trend?

1.4 Study plan

Two questions that need to be addressed are: "Why is slippage increasing?" and "What can we do to stop the increase and, if possible, decrease it?" To study slippage, a two-part study was undertaken. The first stage was a historical review of the projects that have studied and tried to control slippage in the LFS as well as the operational changes that have been implemented over time. The second stage was an analysis of various factors and their impact on the slippage rate.

2. HISTORICAL REVIEW

2.1 Historical Studies

2.1.1 Types of studies

Many studies have examined the slippage issue in the past. They can be grouped into several broad categories: listing checks, vacancy checks, studies into roster coverage, examination of manuals and procedures, evaluation of Census projections and analytical studies.

Listing checks attempt to discover, understand and control mistakes in listing which could lead to slippage. They can be conducted on an ongoing basis as a form of quality control or on an ad hoc basis as a form of quality check. Ongoing listing checks ensure that interviewers receive prompt feedback if they are making errors and that listing quality is maintained. Ad hoc listing checks were conducted in 1968 (Mason *et al*), 1981 (Sida), 1987 (Switzer), 1996 (Page), 1999 (Prairie Region) in order to understand unusually high or low slippage rates in certain regions. Listing checks are also generally conducted as part of each survey redesign to ensure the listing of the new clusters is of high quality (Joncas 1985), (Dufour 1995).

Vacancy and slippage are connected as occupied dwellings classified as vacant results in an underestimation of the number of households. To detect the erroneous classification of vacants, vacancy checks can be performed. A vacancy check is a visual check of dwellings which were listed as vacant in the previous interview cycle. Vacancy checks are performed as a part of interviewer observation and are sometimes carried out on an ad hoc basis, for example in 1981 (Sida), 1987 (Switzer), 1993 (Wysocki), 1996 (Page), 1999 (Prairie Region).

Even when a household is correctly identified, persons within it may be missed and therefore contribute to slippage. Several methods have been used to study this phenomenon. Results from reinterview and ad hoc roster checks can be compared to the original interview roster to determine whether persons were missed or added by mistake (Mason *et al* 1968), (Earwaker 1981). Analytic methods can also be used to evaluate household composition (Switzer 1987), (Gardner *et al*, 1998). The effect of the questionnaire has on the likelihood of missing persons was also studied (Bench *et al* 1994).

The interviewer's manual and procedures have also been evaluated to determine their impact on slippage in terms of the adequacy of the concepts and the quality control practices (Switzer 1987), (Wysocki 1993).

Since Census projections have a large impact on the LFS slippage rate, the Census counts have been evaluated in that context (Switzer 1987), (Clark *et al* 1993).

Sometimes analytical tools have been used to study the quality of the sample, for example by identifying certain regions that are causing the slippage to rise or by examining the variance associated with the slippage estimates (Newton 1977), (Sida 1981), (Switzer 1987), (Beebakbee 1993), (Ray *et al* 2000).

2.1.2 Previous studies

Below is a chronological list of some of the studies into LFS slippage that have been conducted.

(1) In 1968, a large study was conducted into the slippage rate in Saskatchewan (because it had increased to 7.0%). A field check of sample coverage was conducted on a subsample of the

September sample involving a check on the completeness of cluster lists and an interview check on the completeness of coverage within sampled listings. The study concluded that missed dwellings and persons were responsible for 3.9 of the 7.0 percentage points in September slippage (and 5.4 of the 8.8 in August) (Mason *et al* 1968).

(2) Reinterview data from September 1979 were evaluated as a supervisory tool. It was found that the listing check done during reinterview was an important tool to monitor listing maintenance by interviewers. Seniors frequently used reinterview as a method for indentifying concepts or procedures that need to be emphasized during group training sessions. Also, since the interviewers did not know in advance that their work would be checked, reinterview thus gave a more accurate measure of interviewer quality than the observation program (Ghangurde *et al* 1979).

(3) After increasing between January and September 1980, the slippage rate in PEI steadily decreased until June 1981. A study examined reasons for the decrease. The study found that some high yield clusters rotated in, replacing low yield clusters. In addition, the vacancy rate decreased after a vacancy check was done as part of a reinterview program. The vacancy rate decreased from 14.7% to 12.1%. It is not clear whether this decrease is due to greater diligence on the part of interviewers, reflective of an actual decrease in vacancy rates, or perhaps a result of the above mentioned clusters having very low vacancy rates, though a combination of factors typically accounts for any change in vacancy rates over a short term in a small geographic area (Sida 1981).

(4) A 1981 study quoted results by A. Gower on reinterview data. The Gower study found that LFS nonrespondent households were generally smaller than respondent households. In fact, a comparison of reinterview responses for nonresponding households (August to November 1977) concluded that nonresponding households (to the original LFS) were 15% smaller than the average size for all reinterview households. This means that weighting created a positive bias in the average household size (estimated at being 0.7%). The study also concluded that the within household undercoverage rate was twice as high as the dwelling undercoverage rate (Earwaker 1981).

(5) Also in 1981, the vacancy rates for the apartment frame and the non-apartment frame were compared. It was found that the vacancy rate for the apartment frame (9%) was well above the rate for the non-apartment frame (5%), especially the B (occupied by persons not to be interviewed) and V (vacant) codes (Sida 1981).

(6) Due to increasing slippage at the Canada level in 1983, changes in the slippage rate were analyzed and the relationships to other variables were studied. The study concluded that the increase in slippage was largely accounted for by a decrease in the estimated number of households (undercoverage of households in cluster lists) (Ghangurde 1984)

(7) As part of the redesign, a cluster listing check was conducted to measure and evaluate the quality of cluster listing for the new clusters introduced between October 1984 and March 1985. The results found that the average coverage level for clusters for Canada was 98.5% (Joncas 1985).

(8) In 1986 and 1987 a large scale slippage study was conducted involving analytical studies, listing checks, vacancy checks and examination of the interviewer procedures and Census estimates. The first component of the study examined final and sub-weighted estimates in areas with high slippage. Several operational studies were conducted: a special listing check program was undertaken in large city fringe areas between October 1986 and March 1987, a vacancy check program was undertaken

in July 1987 for one quarter of all assignments (this resulted in a 7.4% conversion from vacants rate to households) and a rural listing check was done in July 1987. The post-Censal estimates were examined at various geographic levels and interviewer procedures and the interviewer's manual was examined in detail. The studies resulted in many changes to concepts and procedures, many of which were aimed at harmonization with Census concepts (see Section 2.2.1) (Switzer 1987).

(9) In 1993, vacancy checks were conducted monthly. The check consisted of a visual check of selected dwellings (selected by the senior - nonrandom) coded vacant in the previous month. An analysis was done of data from the vacancy check to assess the extent of vacant misclassification. It was found that 2.7% of the dwellings checked had been incorrectly coded as vacant (on average over the months checked) and of these, 81% were converted to a response when checked. As a part of the same study, the relationships between vacancy, nonresponse and slippage rates at the national level were examined. A relatively strong inverse linear relationship was found between nonresponse and slippage (since nonresponding households have smaller household sizes than responding households) (Wysocki 1993).

(10) In 1993, a complete evaluation of all programs related to data collection quality (including interviewer observation, the validation program and reinterview) was undertaken. Many recommendations resulted from the study (see Section 2.1.4) (Wysocki 1993).

(11) In 1993, an evaluation of the error associated with post-Censal estimates was done. The error in the post-Censal estimates of the LFS target population was estimated to be between -0.4% (underestimation) and 1.0% (overestimation). This implies a measure of error in the slippage rate. It was also noted that following the decision in January 1993 to adjust population estimates to account for Census coverage error LFS estimates would be adjusted accordingly. The authors concluded that "Slippage will increase as a consequence of this change particularly for those individuals like young males who are undercovered the most by the Census" (Clark *et al* 1993).

(12) In 1993, a large increase was observed in the slippage in Alberta. As a result, an investigation was undertaken into the provincial slippage by age/sex group and geographic levels. The study concluded that increases in Edmonton and Calgary explained much of the increase in the slippage rate. Also, a decrease in the average household size was associated with the increase in the slippage (Beebakbee 1993).

(13) In November (Manitoba) and December (Saskatchewan and Alberta) 1996, a vacancy check of ALL dwellings coded as vacant in the previous month was conducted in the prairies. A listing quality check was conducted at the same time. In the three provinces, 86% of the vacant dwellings were confirmed vacant while 6% were occupied and 8% could not be confirmed. As a result of the cluster check, 45 of the clusters had changes made with an average of 2.9 changes, additions and deletions per checked cluster. " The exercise in itself was probably long overdue and, at least to us, illustrates the importance of ongoing quality assurance checks" (Page 1997).

(14) After 1991 Census, the LFS Data Quality Unit conducted a micromatch between LFS and Census data to study the quality of LFS data. The relative quality of LFS data was measured by comparing LFS data from May 1991 to the same data from the Census. A key observation was that nonrespondent households in the LFS tend to be smaller than respondents. A similar observation shows that of 1393 matched dwellings coded vacant in the LFS, 813 were listed as occupied in the Census. Of 753 vacants in the Census, 173 were occupied in the LFS. This indicated that LFS

vacancy rates were higher than the true vacancy rate, and this contributed to slippage. (Allard et al 1998).

(15) When analyzing LFS slippage rates by age, two groups stand out: the 20-24 and 25-29 year-olds, with rates between 17% and 18%. One commonly held belief is that students are the cause for these high slippage rates because of their high mobility and confusion about where they should by listed. A report completed in 1998 examined the issue of students and the slippage rate. The LFS estimates were compared to another source of education data - the Internal Bank of Education Statistics (IBES) in order to determine if LFS has an undercoverage problem for students. Furthermore, the slippage rates for students and nonstudents were compared while controlling for various other characteristics. When comparing slippage rates between students and nonstudents while controlling for other variables, student status was not significant, e.g., the group with the highest slippage rate was for single men living alone, followed by married respondents without children, both male and female. High slippage rate respondents were found to live in low-rise apartments, in urban areas, and in large cities. Unfortunately, due to the differences in the definitions between the LFS and the IBES, no conclusions could be drawn (Gardner *et al* 1998).

(16) In August 1999, a field validation was conducted by the Edmonton RO to:
- ensure that a complete interview was properly conducted in a representative sample of households in each assignment
- verify that the Vacant code has been properly applied in each assignment
- conduct a cluster check on one rotation in the assignment

Results from the interview check, vacancy check, or cluster check that did not match the information initially reported by the interviewer were designated an anomalies.

Results were quite good for the first objective. For interviewers in the prairies provinces, more than 80% had between zero and four anomalous results for households that had just rotated out, and most of the others fell between five and nine. These results indicate that interviewers are generally doing a good job. An exception is one interviewer who had 138 anomalies. In addition, the rates in Northern Alberta were also somewhat unusual - the percentage of interviewers with anomalies is much higher, and of those who have more than four, there is an almost even split between 5-9 and 10-14 anomalies. The higher rates are partly due to interviews conducted in remote areas, which generate anomalies as they are still typically conducted by paper.

Results were also positive for the vacancy check. Only three dwellings coded vacant in July were found to have been occupied. In one instance the interviewer received incorrect information from a contact, and in the other two instances "the verification steps followed by the interviewer during July were not as thorough as they might have been."

For the cluster check, there were strong regional differences. Only 1.0% of original listing lines in Saskatchewan were affected. In this instance, the percentage was calculated by summing the number additions, deletions and lines requiring change, and dividing that figure by the original number of listing lines. For Northern Alberta, this value was 1.6% and for Manitoba it was 3.0%. The highest figure was in Southern Alberta, where the figure was 10.5%. It is not known if this rate was connected to the interviewer with 138 anomalies. For all areas, there were more dwellings added than deleted. In fact, based on this cluster check, the dwelling undercoverage in the prairie region

was about 1.5%. The slippage in the Edmonton R.O. in July 1999 was 4.6%, so this would indicate that about 1/3rd of the slippage was due to missed dwellings (Prairie Region 1999).

(17) A cluster check was conducted in British Columbia to measure the listing quality. The cluster check was conducted in selected clusters in three ERs (910, 920, and 930) in B.C. These ERs were chosen because they contribute the largest portion of the provincial slippage rate in B.C. The selected clusters originally had 23 741 dwellings. The cluster check found 303 dwellings that were not originally listed and 33 listed dwellings that should not have been included, for a net increase of 270 dwellings. This is an increase in the number of dwellings of 1.14%, which would decrease the measured slippage in the area.

2.1.3 Conclusions

Many of the historical studies came to similar conclusions about slippage. Their major conclusions are listed below:

(1) **Quality Control Programs**
Verification checks result in improved coverage.
Reinterview programs give a more accurate measure of interviewer quality than does the observation program and are an important supervisory tool.
Alert field work and verification checks can produce substantial reductions in slippage.

(2) **Vacants**
The miscoding of dwellings as vacant is a significant factor influencing slippage rates.
The vacancy rate for the apartment frame is well above the rate for the nonapartment frame.
The number of incorrect vacants is correlated with the month in survey, i.e. the number of incorrect vacants in a rotation group generally increases during the 6 months that the group is in sample (interviewers may assume the status is the same as the previous month).

(3) **Relationships with other variables**
A relatively strong inverse linear relationship exists between nonresponse and slippage.
Nonrespondent households are generally smaller than respondent households and a relationship can be seen between average household size and the slippage rate.

(4) **20-24 age group**
Slippage in the 20-24 age group presents special difficulties.
Student status is not an influencing factor.
Slippage is concentrated in urban areas and low rise apartments.

(5) **Census projections**
The accuracy of post-Censal estimates at the small geographic levels (e.g. ER) is in question.

(6) **Household versus person level slippage**
Missed persons within listed dwellings is a more important factor in slippage than missed dwellings.

2.1.4 Recommendations

Once again, many of the studies presented similar recommendations, including:

(1) **Group training**
Group training for interviewers to review LFS standards and procedures, household membership rules, listing procedures, how to verify vacants, multiples.

(2) **Newsletters**
Regular follow-up articles in newsletters.

(3) **Regular and random application of quality control procedures**
Reinterview program should be reinstated including a check of complete clusters and the senior should not see the results of the initial interview.
Greater coordination and automation (probability-based sample) in the process of selecting interviewers for observation including coordination with validation programs.
Special and follow-up observation including checks of vacants and clusters by senior and PM.
Widespread vacancy checks and continued spot checking of the vacancy check forms to confirm vacant code applied properly.
Increased validations in random assignments.

2.2 Operational Changes

2.2.1 Operational changes over time

Operational changes, particularly those involving quality control procedures, can have a large impact on slippage. Operational changes can be grouped into four categories: survey design, questionnaire, quality assurance and field procedures.

2.2.1.1 Survey design

(1) There was a mini-redesign of SRU strata in areas of heavy growth in 1977. Strata were relisted and remapped manually. This caused a significant decrease in slippage, as can be seen in Figure 1.

(2) Redesigns are conducted after each decennial Census in order to update and improve the sample design. A sample redesign was carried out in 1984. No impact can be seen on the graph of slippage versus time (Figure 1) but this may be because, at the same time, the reinterview program was modified so that it no longer included a field validation component (Section 2.2.1.3).

(3) In January 1993, it was decided to adjust population estimates to account for Census coverage error. As the error typically results from missing people, the estimates are revised upwards. The post-Censal estimates used by LFS were adjusted accordingly. This was expected to increase slippage particularly for individuals who are undercovered most by the Census, e.g. young males.

(4) A major sample redesign was done in the mid 90s. Large changes were made to the sample, the method for the nonresponse adjustment was changed and a new questionnaire was phased in late in 1996. This redesign resulted in an initial decrease in the slippage rate. However, the slippage started increasing shortly after implementation. One reason may be that a decreased volume of listing

maintenance was noticed since the introduction of the new sample (1994). "There is a drop off in the quantity of monthly list updated since the introduction of (CAI) computer assisted interviewing. Fewer dwellings are being added, fewer clusters are involved in list maintenance and the average number of dwellings added per cluster has dropped even when you restrict the calculation to those clusters involved in updates" (Lindeyer 1994). Also, the number of interviewer selected dwellings has decreased over time, particularly recently. In fact, prior to implementation of the new sample in October 1994, the average monthly volume of temporary dockets was 320. Since then, the number has decreased (maybe in part due to a decrease in housing markets). There are two ways a dwelling can become an interviewer selected dwelling: it was either missed during the initial listing, or it is a dwelling that has been built in the time between the listing and the interviewing.

2.2.1.2 Questionnaire

(1) A new questionnaire was phased in between September 1996 and January 1997. An interdivisional working group (in consultation with interviewers) examined the household membership questions with an eye to redesigning the questions to minimize the within household undercoverage. The recommended questions simplified the first question (for simple living arrangements) but went into much more detail for the more ambiguous cases. It was felt that the implementation of these questions would result in missing fewer household members. However, there was criticism that more questions were proposed. That may be why the questions that were adopted for the new questionnaire were a mixture of the two sets of questions (with some questions and examples dropped). In addition the working group had several suggestions on modernizing the household membership rules (Bench *et al* 1994).

2.2.1.3 Quality assurance

(1) Reinterview was implemented prior to 1976 in order to measure nonsampling error, verify listings and monitor interviewer performance. Reinterview consists of a cluster check and reinterview of a sample of dwellings and reconciliation of the data with that of the original interviewer. Prior to 1984, the reinterview was done in person resulting in additional information on listing. However, in May 1984 the reinterview program was changed to telephone interviewing. Due to this change, the listing check portion of the reinterview was no longer available. Subsequently, reconciliation with the original interviewer data was dropped in April 91. The program was scaled back, then cancelled due to budget concerns even though several studies concluded that it was useful as a management and supervisory tool (Ghangurde *et al* 1979), (Ghangurde 1983), (Cyr 1985).

(2) Interviewer observation consists of a listing check, observation of telephone and personal interviews and a vacancy check in order to provide feedback and training and identify potential problems. Interviewer observation used to be done once a year for every interviewer. However, in 1993/94, the frequency was reduced to once every two years.

2.2.1.4 Field procedures

(1) There was a dramatic increase in telephone interviewing in the mid 80s. This probably had a large impact on listing maintenance since it was no longer necessary for the interviewers to do a large volume of interviews in the field. This increase in telephone interviewing "may contribute to slippage since interviewers lose the opportunity to see individuals who may usually reside in the household" (Brainstorming, 1993).

(2) In 1987, several changes were made to the manual to eliminate gaps between LFS and Census household rules, to ensure consistency with the rules on the use of noninterview codes and to eliminate ambiguities in the noninterview instructions. Household membership rules were divided into a section on identification of persons not in the universe and another section dealing with persons who are not associated with one dwelling. Interviewers were instructed to include Canadian residents with a second residence outside Canada (regardless of the dwelling occupied during survey week). Persons with two dwellings in Canada were now counted at the one they occupied for the greater part of the year. The distinction between T (temporarily absent) and V (vacant) codes was clarified. Seasonal dwellings were now listed and the S code (seasonal dwelling) was dropped. The definition of a collective was made consistent with Census. Finally, instructions relating to the B code (dwelling occupied by persons not to be interviewed) were clarified (Switzer 1987). The effect of these changes and instructions was a decrease of approximately two percentage points in the slippage rate between July 1987 and December 1987, as can be seen in Figure 1.

(3) Group interviewer training used to be done twice a year (five days for seniors, three days for interviewers). However, in 1992/93 the frequency was reduced to one group training session per year (three days for seniors, two days for interviewers).

(4) Computer-assisted interviewing was implemented in November 1993. This resulted in a vast number of changes to field and head office procedures.

(5) The interviewer workload has increased over time with the addition of more and more supplementary surveys and larger clusters. In addition, demands increase or stay constant with decreasing budgets. In fact, in 94/95 seniors were given a small assignment of cases for the first time.

(6) A new CAI application was phased in from September to November 1999. There were significant technical problems during the phase in, resulting in markedly higher nonresponse. In November 1999, the first month of full implementation, the total nonresponse was 13% including nonresponse due to technical problems of 6.6%. These problems have decreased over time. Preliminary analysis shows that interview times significantly increased under the new system, because of the increased requirements of the new application. The interview times eventually improved to previous levels, both as a result of increased interviewer familiarity and more powerful laptops.

(7) Centralized CATI was implemented in 2000. The first rotation group was brought into centralized CATI in June 2000, with full implementation reached in September 2000. Initial results show that nonresponse from centralized CATI is higher than under the previous system. There is some concern that with fewer interviewers in the field, less new growth will be discovered.

2.2.2 Conclusions

It seems that quality control procedures are one of the first activities to be reduced or eliminated when budgets are tight. However, the decision to cut quality control procedures has most likely had a detrimental effect on the slippage.

2.2.3 Recommendations

In the short term, use ad hoc studies to examine the slippage issue in areas with high slippage. In the long term, reinstitute quality control procedures on interviewer activities.

3. ANALYSIS

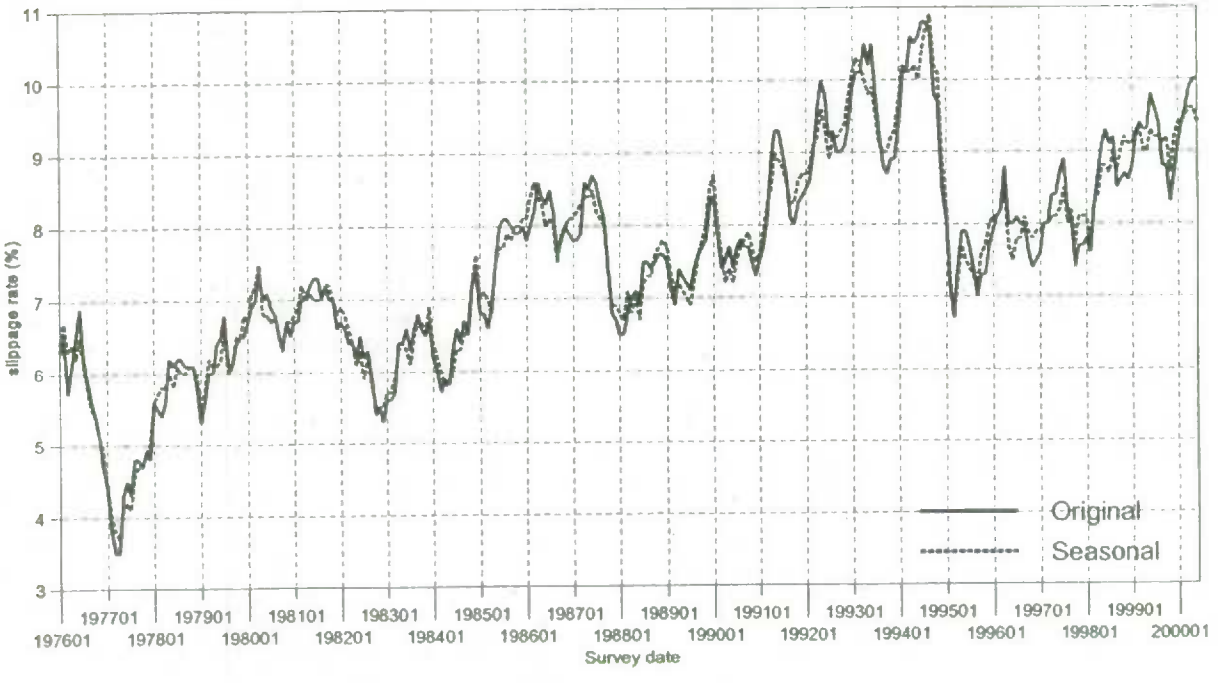
This analysis covers the time period from January 1976 to June 2000. Issues covered are changes in demographics over time, the relationships between slippage and other key variables measured in the LFS, such as nonresponse and vacancy, and the effects of operational changes. In addition, issues related to the design and weighting of the LFS and census projections are covered.

3.1 Slippage rate

Figure 1 presents the slippage rate for Canada since January 1976. The slippage rate is based calculated using population estimate time series adjusted using 1996 census projections. The series is characterized by a steadily increasing trend interrupted by several sudden sharp drops. The drops occur between June 1976 and March 1977, June 1987 to February 1988, and July 1994 to March 1995.

Figure 1.

CANADA - Slippage Rate



The drops can all be attributed to operational effects.

- The large drop in 1977 can be attributed to an SRU update in that year, i.e., there was a mini-redesign of SRU strata in areas of heavy growth. Strata were relisted and remapped manually.

- "The large reduction in slippage in 1987 and into early 1988 was the result of several changes to the Interviewers Manual in April 1987. The flavour of the revisions was to "include a dwelling when in doubt." This meant, for example, that all dwellings suspected by the interviewer to be seasonal were to be listed."

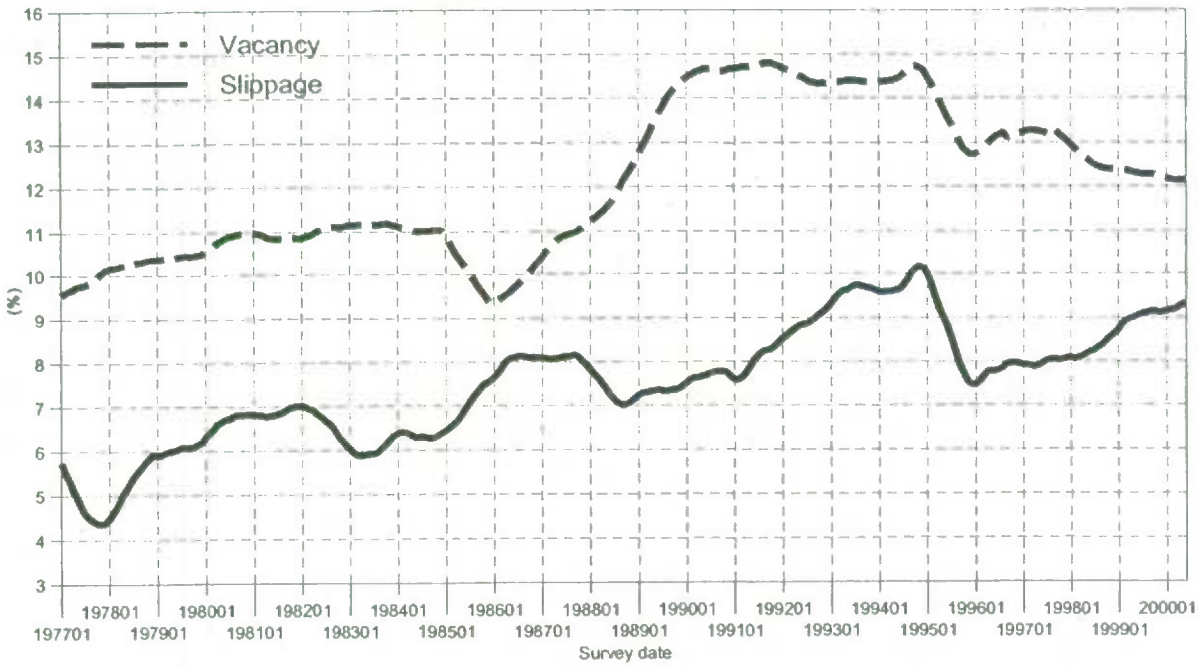
- Slippage reached its highest level of the study period in July 1994 at 11.9%. This is just before the phase in of the new sample from October 1994 to March 1995, and the subsequent drop in slippage over this period reflects the expected impact of the new sample design.

3.2 Vacancy and slippage

The following graph compares 12 month moving averages of slippage and the vacancy rate. The vacancy rate below reflects four categories of dwellings; unoccupied but inhabitable dwellings, dwellings under construction, demolished dwellings, and dwellings occupied by people not to be interviewed, such as diplomats, or households occupied only by full time members of the military. The two variables exhibit some unusual behaviour. Both show general upward trends, and, as is discussed in section 3.12, are strongly correlated. The graph does show that there is not a perfect correlation between the two.

Figure 2A.

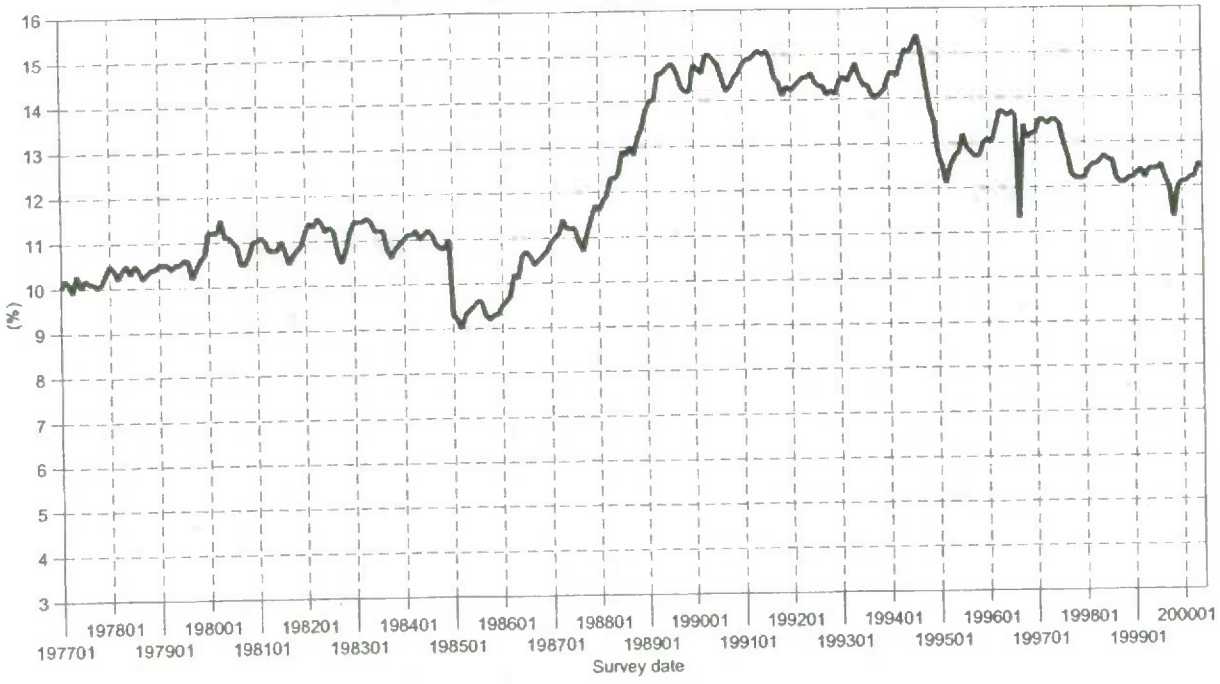
Slippage Rate vs. Vacancy, 12 MMA



The raw data for the vacancy rate is available in figure 2B. We would like to confirm that the LFS vacancy rate is accurate. Vacancy checks, for the most part, indicate that although some dwellings coded vacants were actually occupied, the error rate is not very high. The opposite problem, dwellings with reported occupants that are actually vacant, will only be an issue where interviewers practise "kitchen tabling" and can assumed to be virtually nonexistent. Hence, our concern is whether the vacancy rate is correct or overstated.

Figure 2B.

Vacancy, Original, Trend and Seasonally Adjusted



To determine whether LFS vacancy rates are comparable to those of other sources, we examined data from other large household surveys that use area frames. This limits us to the Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS). Surveys such as the General Social Survey use random digit dialling (RDD), so vacancy rates are not applicable. Many other surveys use the LFS frame or are done as a supplementary survey to the LFS, so vacancy rate comparisons should result in very similar values.

The CCHS is a new survey using a combination of an area frame survey and RDD. The first two months of data collection were September and October 2000. For the LFS, the vacancy rates at the national level were about 2.5% lower than those for the CCHS. At the provincial level, differences between vacancy rates ranged from 5% lower in the LFS than the CCHS in Québec, to 1% higher in the LFS in British Columbia. The NPHS has not conducted a cross sectional survey in some time. In 1994, the NPHS survey data showed a vacancy rate of 14.66%, while the average vacancy rate for the LFS for 1994 was 14.85%. Vacancy rates for the LFS are about equal or lower than those in other area frame household surveys.

We looked for estimates of vacancy rates from external sources. The only data we found was from the Canadian Mortgage and Housing Corporation (CMHC), and these rates only cover apartments in selected CMAs. This data is unfortunately not directly comparable, as CMHC publications provide vacancy rates for apartments in buildings with more than six units while the LFS apartment frame covers buildings with 30 or more units. Indeed, examining data from the same month from the two sources yields very different results. For October 1999, the CMHC vacancy rate for "privately initiated rental apartment structures of six units and over" in Toronto is 0.8%. For dwellings that are part of the apartment frame (5+ stories, 30+ units) in the CMA of Toronto, the vacancy rate is 3.9% based on the October 1999 LFS data. For Ottawa-Hull, CMHC reports 1.2%, while the LFS reports 6.9% for the combined Ottawa-Hull CMA. Having determined

that the rates are not directly comparable, it is still a worthwhile exercise to do some comparisons. The difference between the frames is that the CMHC includes smaller buildings. It does not seem clear that the addition of smaller buildings to a frame should drive the vacancy rate down significantly, as this would require that smaller buildings have near zero vacancy rates.

The vacancy rate as defined for LFS quality studies includes vacant dwellings, dwellings under construction, demolished dwellings, and dwellings occupied by persons not to be interviewed. The CMHC presumably calculates the "typical" definition of a vacancy rate, that is, an unoccupied inhabitable dwelling. The following table shows the normal and narrow LFS vacancy definitions as well as the CMHC vacancy rate.

CMA	LFS Vacancy Rate	Typical LFS Vacancy Rate	CMHC Vacancy Rate
Halifax	8.9	3.3	3.6
Quebec City	10.9	10.9	3.4
Montreal	7.1	4.4	3.3
Ottawa/Hull	6.9	1.9	1.2
Toronto	3.9	2.7	0.8
Hamilton	7.3	6.5	1.7
St. Catharines-Niagara	6.0	4.0	3.0
London	19.2	5.3	3.2
Windsor	12.0	10.7	2.3
KW	4.0	3.0	0.9
Winnipeg	4.9	3.9	2.8
Saskatoon	4.6	4.6	0.9
Calgary	6.0	1.5	2.8
Edmonton	3.3	1.1	2.2
Vancouver	12.1	5.1	2.7
Victoria	18.2	15.2	3.6
Oshawa	9.0	9.0	1.7

As previously noted, there are differences between the narrow LFS rate and the CMHC rate. Also of interest is the difference in the LFS vacancy and the narrow LFS vacancy chart. In CMAs where the difference is more than five percentage points (Halifax, Ottawa/Hull, London and Vancouver), further study revealed that those vacant dwellings that did not meet "typical" criteria, virtually all were dwellings occupied by people not to be interviewed, with the lone exception being a demolished dwelling in Vancouver. These results are derived from a very small sample, consisting of a combined total of 78 dwellings in those four CMAs.

At the national level, 13% of vacant dwellings (918 dwellings, or about 1.5% of the sample in October 1999) are occupied by people not to be interviewed. Although weights are not available for these dwellings, they are distributed across Canada, so by using the average household weight of approximately 200, we obtain approximately 180 000 dwellings, or 450 000 people. This number seems high, as, of people in private dwellings, we primarily exclude members of the military and diplomatic personnel.

Further examination of these dwellings revealed that a number of them are occupied by students, and though they are properly excluded by current usual-place-of-residence rules, it may be worth revisiting these rules.

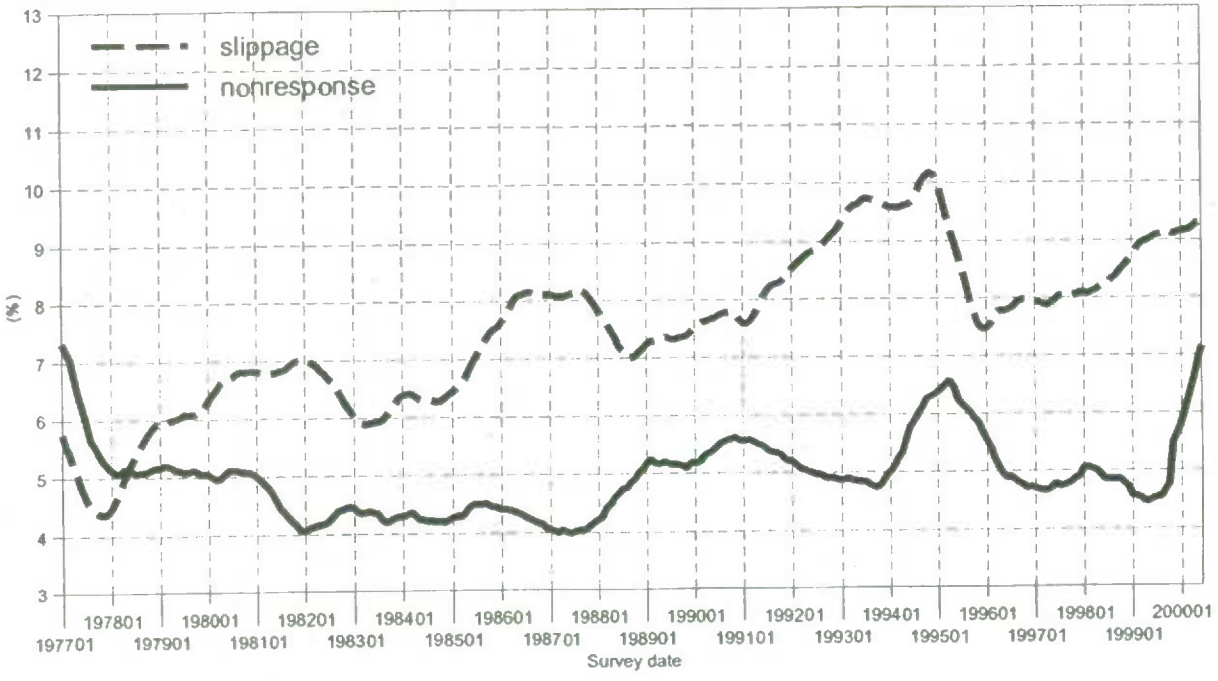
Also noted was that the 918 such dwellings found in October 1999 appears to be higher than average, and that 600 to 800 is the typical range. Nonetheless, even at the low end of the range, this potentially represents 300 000 people.

3.3 Nonresponse and slippage

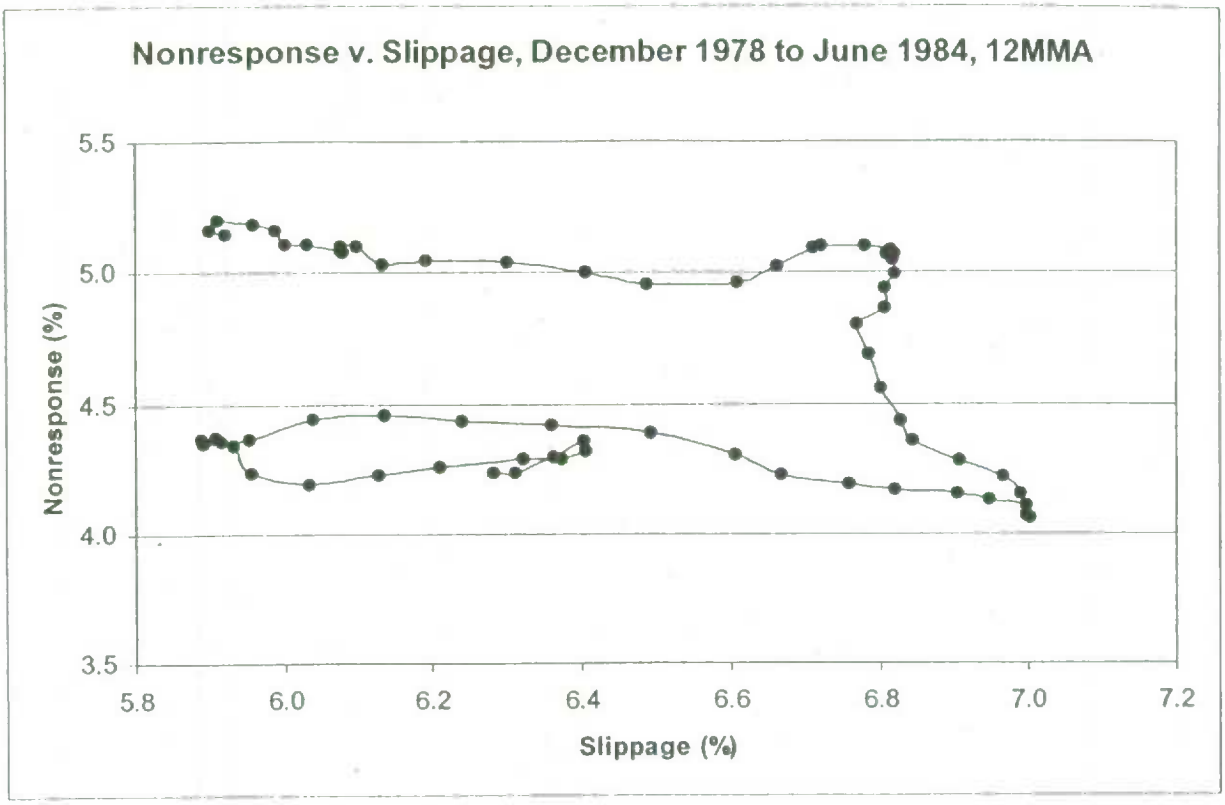
It has been shown several times that the household size is smaller for nonresponding households (Gower 1979, Allard *et al* 1998). This is likely because the smaller the household, the less likely it is that there is someone at home for the interviewer to contact. As has been pointed out to the authors, smaller households will have fewer or no children, and hence the adult members will have more opportunities to leave the house, causing higher nonresponse. Thus, if nonresponse rate increases, the average household size of respondents also typically also increases. Since the weight of respondents is adjusted for nonresponse, a higher nonresponse rate will decrease slippage because the actual number of persons in the LFS sample is overestimated. This effect is noticeable, although hard to see without removing the seasonality intrinsic to nonresponse. When 12 month moving averages are used (Figure 3A), the slippage rate shows an inverse relationship to the nonresponse rate.

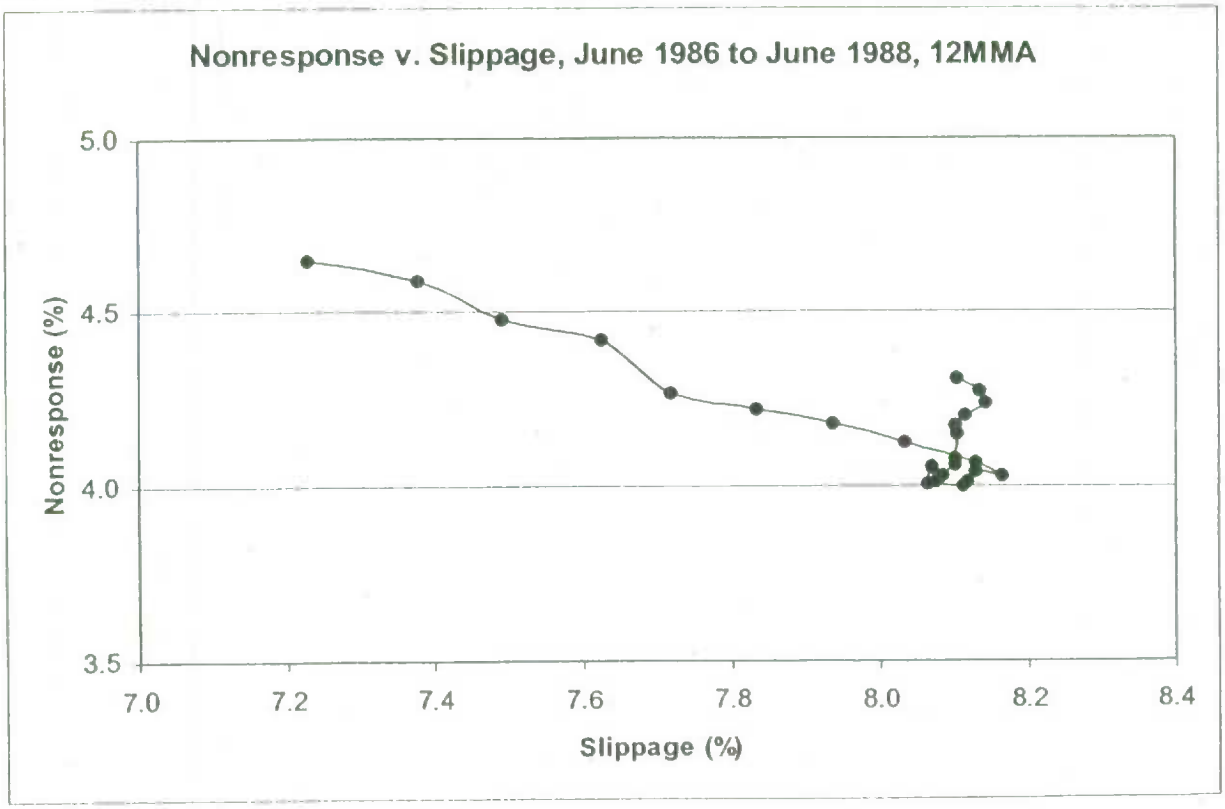
Figure 3A.

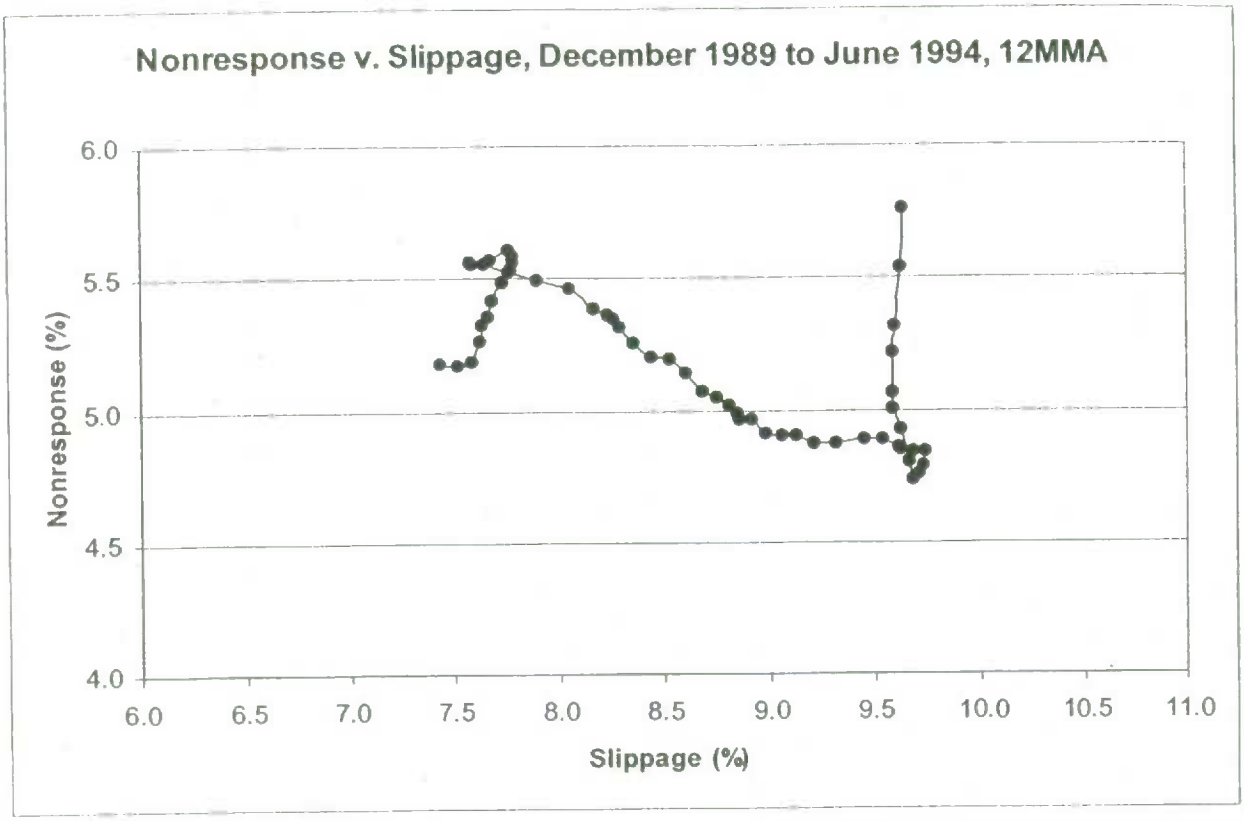
Slippage Rate vs. Nonresponse Rate, 12 MMA



A graph plotting these two variables yields a series of generally negatively sloped lines, with jumps between series generally occurring at major changes in the survey. For readability, this graph has been broken into four pieces over the next two pages, using the two redesigns in 1984/85 and 1994/95 and implementation of the changes to the interviewer manual in 1988 as break points. The most recent graph also features a sharp positively sloped line to end the series. The phase in of new data collection systems and phase-ins contributed to an increase in nonresponse, and in future years will likely be used as a break point. However, for a report up to the present, we felt it better to include this data.


Nonresponse v. Slippage, December 1978 to June 1984, 12MMA
Nonresponse (%)
5.5
5.0
4.5
4.0
3.5
5.8
6.0
6.2
6.4
6.6
6.8
7.0
7.2
Slippage (%)


Nonresponse v. Slippage, June 1986 to June 1988, 12MMA
Nonresponse (%)
5.0
4.5
4.0
3.5
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
Slippage (%)


Nonresponse v. Slippage, December 1989 to June 1994, 12MMA
Nonresponse (%)
6.0
5.5
5.0
4.5
4.0
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
10.5
11.0
Slippage (%)

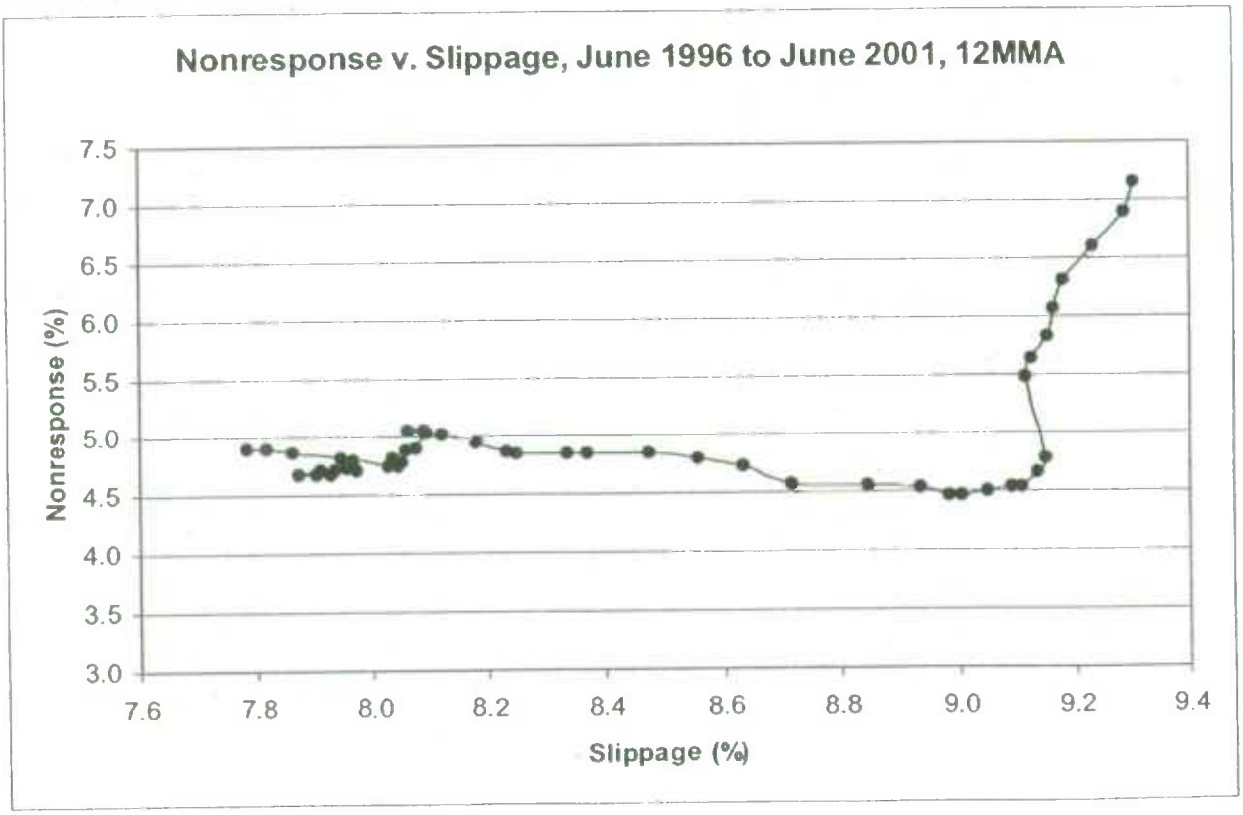
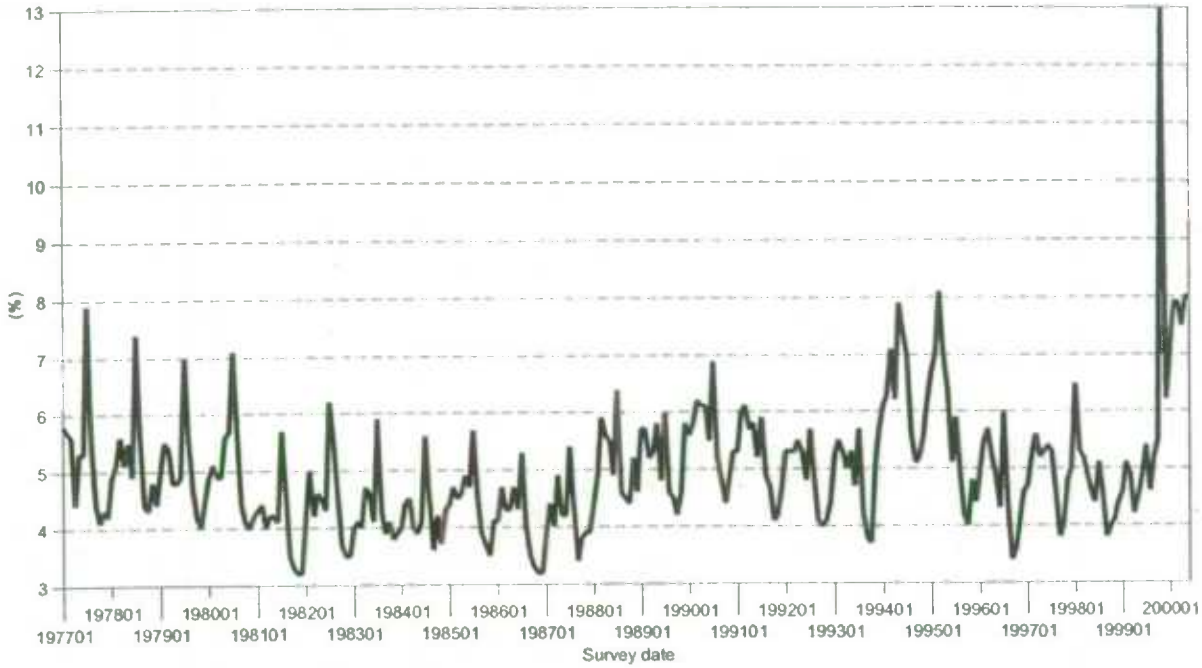

Nonresponse v. Slippage, June 1996 to June 2001, 12MMA
Nonresponse (%)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4
Slippage (%)

Figure 3B.

Nonresponse Rate



An important result about the relationship of nonresponse and slippage concerning subgroups smaller than nonresponse adjustment level groups was developed by Gambino (2000). It states that "The slippage for Group G is overstated if and only if the nonresponse rate in G is higher than the overall nonresponse rate." Nonresponse adjustment is done at a certain level. For smaller groups, such as age/sex crossings, we calculate slippage, but the results are biased if the nonresponse in these groups does not match the nonresponse rate in the adjustment level group.

3.4 Household size over time

The average household sizeof LFS respondents has been steadily decreasing since 1976. This trend is not in doubt, it has been confirmed with auxiliary data from the Census and from the CANSIM database. For unweighted data, the average household size (including children) has fallen from 3.24 to 2.53. The final weighted household sizes have slightly smaller values, falling from 3.08 to 2.51. As was previously mentioned, there is a negative correlation between household size and likelihood of nonresponse, so it might be expected that falling household size would lead to increasing nonresponse. However, if one examines the nonresponse rate in Figure 3B prior to September 1999, there is no evidence of long term changes in the nonresponse rate.

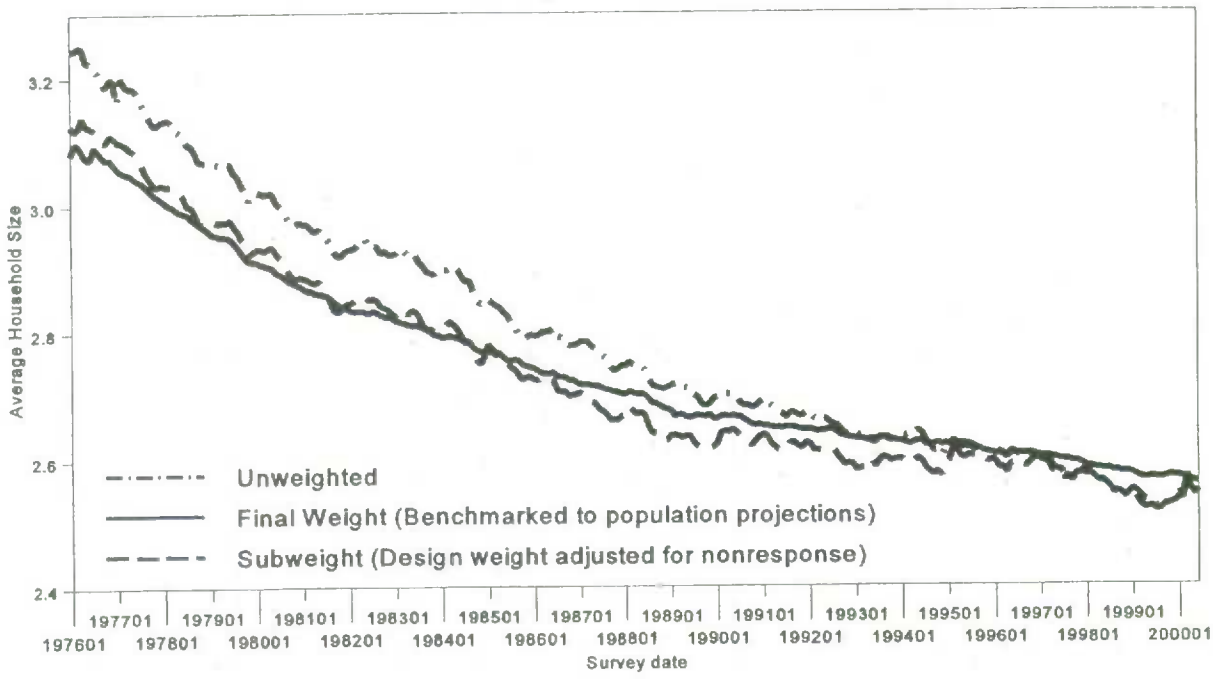
It is difficult to quantify what effect a decrease in household size would have on the slippage rate. One component contributing to the slippage is the difference in size between respondent and nonrespondent households. The small number of studies investigating this have shown that nonrespondent households are smaller than respondent households. A reinterview study between 1977 and 1979 showed that nonrespondent households were on average 15% smaller than respondent households (Ghangurde *et al* 1979). A micromatch between LFS records and the 1991 census showed average respondent household size to be 2.6 persons, and average nonrespondent household size to be 2.1 persons, or about 19% smaller (Allard *et al* 1998). The

conclusion to be reached is that nonresponse lowers the slippage rate, as it leads to overestimation of the number of people living in sampled households. The two studies show that there is not a significant difference between the evolution of size of respondent and nonrespondent households over time, as both seem to be getting smaller at the same time.

Therefore, an analysis that includes the relationships among the three series shown in Figure 4 is more worthwhile.

Figure 4.

Average Household Size



There is a seeming paradox in the Figure 4 as for most months prior to January 1985 the average household size is smaller using finalweights than using subweights, leading to the expectation that this represents fewer people and, therefore, negative slippage. This is not true, as Figure 1 shows that slippage has been positive throughout the study period. The average finalweight is still higher than the average subweight, but the distribution of final weights is more skewed to smaller households prior to 1985.

The differences between the unweighted and both of the weighted series have decreased with time. This is mostly a reflection of changes in both society and the sample design. There is a larger difference early in the series as household sizes in the smaller provinces tended to be significantly larger than those in larger provinces. Since smaller provinces had higher sampling rates, the unweighted sizes were significantly larger than the weighted sizes. Over time, the household size has been decreasing in all provinces, but has been decreasing faster in the smaller provinces. As a result, higher sampling rates in the small provinces are having less of an effect on the unweighted results.

The decrease in household size can have definite results on slippage, even if all else remains the same. Since the difference between the final weight and the subweight is not changing very much, we are missing, on average, the same fraction of a person per household. Yet, as the households are getting smaller, this fraction

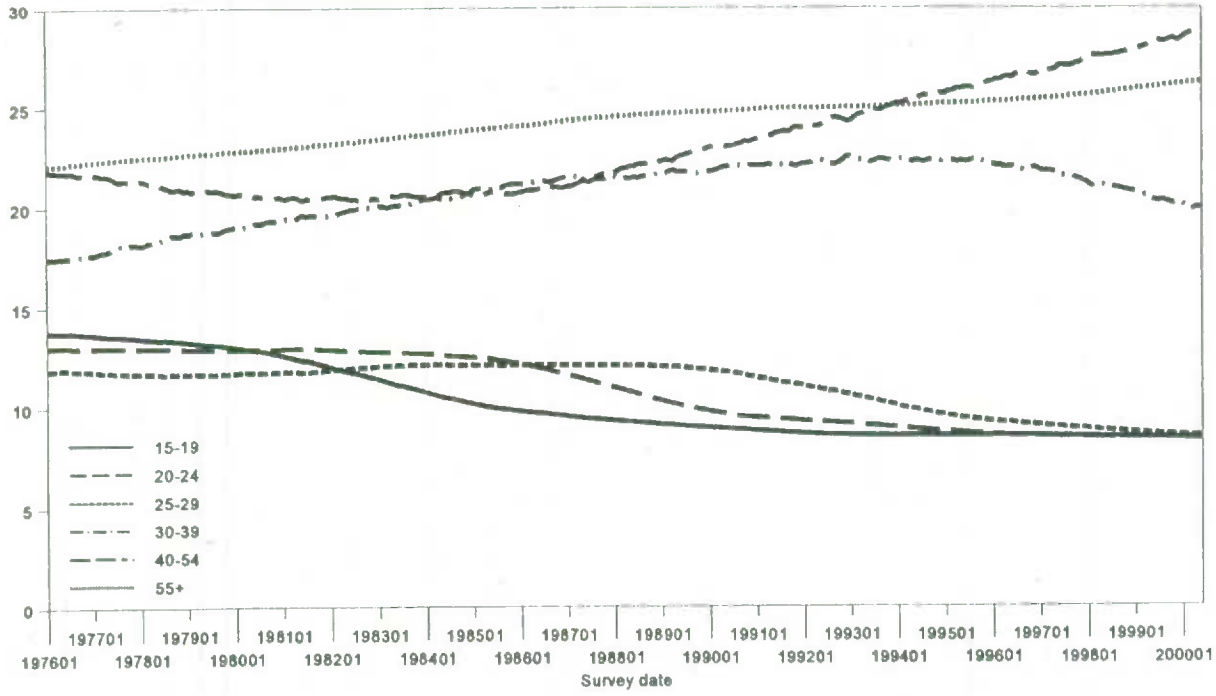
of a person makes up a larger and larger percentage of the average household. Therefore, there is a connection between decreasing household size and the slippage rate.

3.5 Demographic Change

Since 1976, there have been changes in the demographics of Canadian society. Due to increased life spans and decreased birth rates, the population is getting older. Figure 5 shows the LFS age groups as percentages of the population. Although there are slight differences in the actual percentages, the patterns are the same for males and females. It should be noted that the three age groups under 30 have not only decreased as proportions, they have actually decreased in absolute size between 1976 and 2000.

Figure 5.

Age groups as a percentage of population, 1996 post-censal estimates



Since slippage varies by age group, changes in the makeup of society affect the slippage rate. Of course, slippage rates by age have also changed over time, so it is worthwhile to look at the contribution of each age/sex group to the slippage rate over time to see which groups have the largest impact. Graphs for all groups follow for both actual slippage rate by group as well as contribution to the overall slippage rate.

For 15-19 and 20-24 olds, the contribution to slippage has decreased over time. For 25-29 year old males, the contribution has been fairly constant over time. For 25-29 year old females, the contribution has increased slightly due to a major increase in slippage rates for that group (from below 5% prior to 1978 to an average of more than 15% in 2000). The increase in slippage among females under 30 is likely due to increasing presence in the labour force and a corresponding increase in young females living in smaller households, which are most often missed. For males and females, the 30-39 and 40-54 groups show definite increases in both actual rates and percentage of the total since 1976. Males 30-39 have gone from about 10% of the total to a present average of 15%, while for females the rate has gone from below 5% percent to just

under 10% in 2000. Numbers for the 40-54 group are similar. For the 55+ age group although both the actual population in this age group and the slippage rate have increased, the contribution has not changed significantly.

To summarize, changing demographics have a notable influence on the slippage rate. While the slippage rate among those under 30 is increasing, the contribution to the overall slippage rate is decreasing. The decreasing proportion of younger people in society means that more and more of the slippage is due to people over 30 years of age. This trend is likely to continue for some time, with the aging of the population. Efforts to decrease the slippage among the older age groups would be of more use in decreasing the overall slippage rate than would focusing efforts on younger people. However, this ignores the bias caused by the higher slippage rates among the younger age groups.

Figure 6A.

Slippage rate of 15-19 year olds by sex

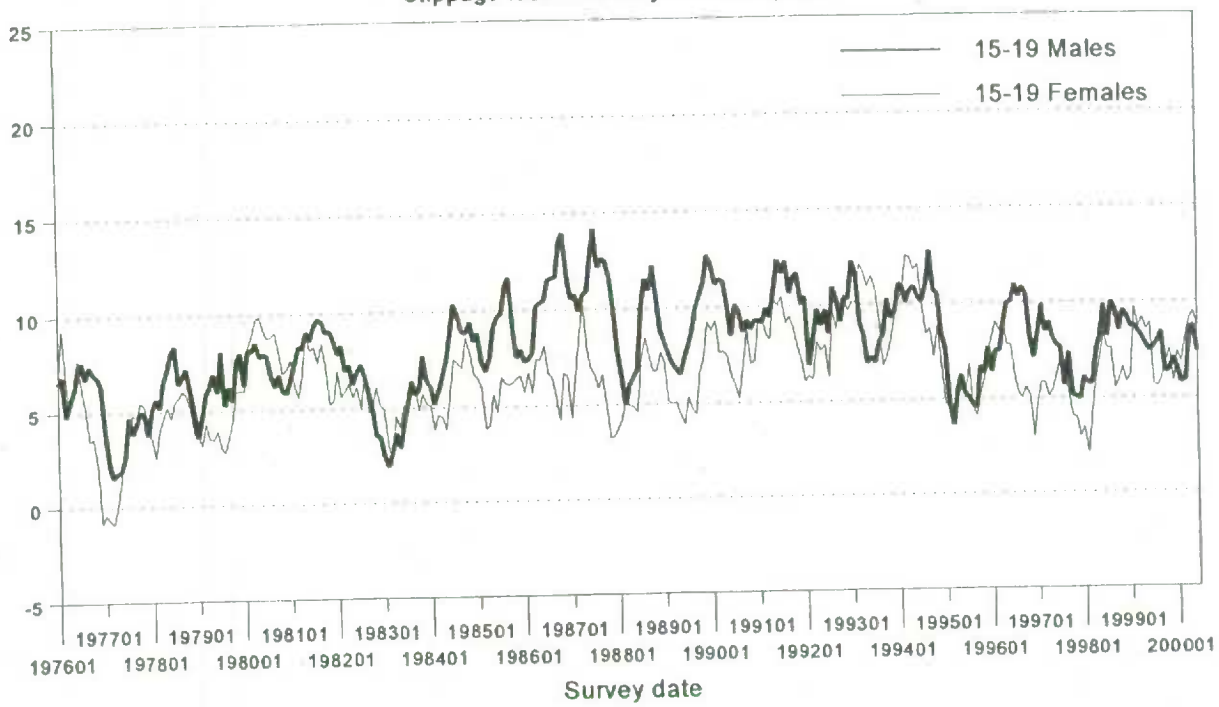


Figure 6B.

Percentage contribution to overall slippage rate of 15-19 year olds by sex

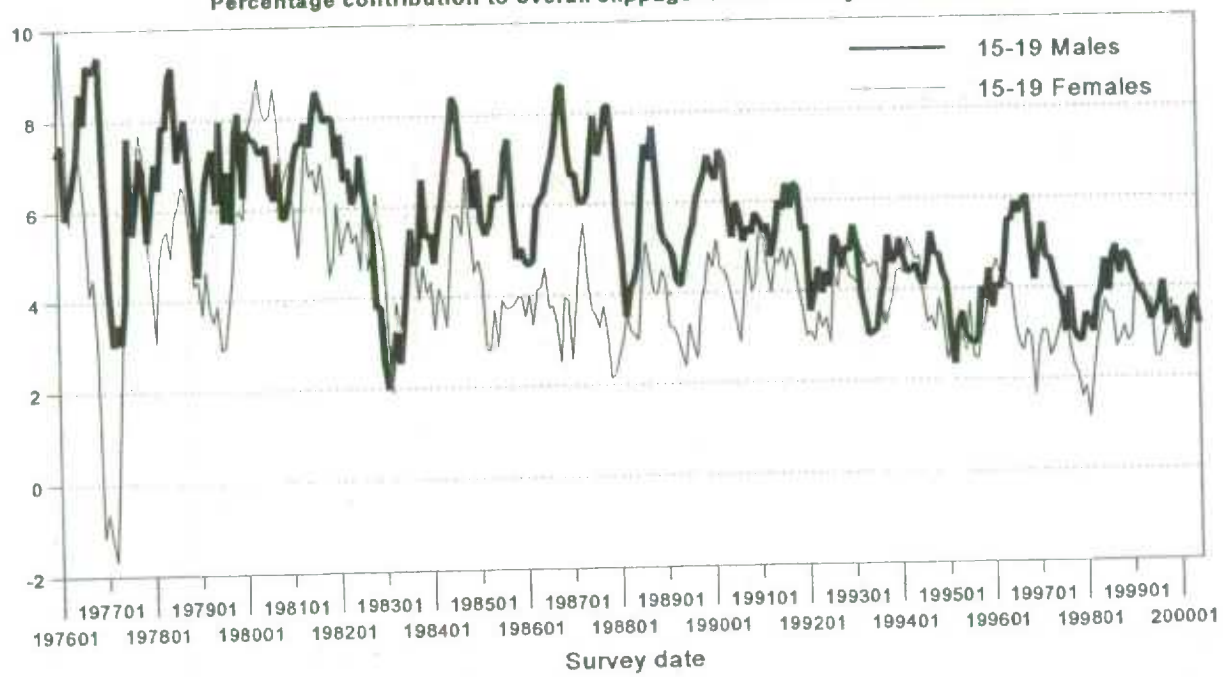


Figure 6C.

Slippage rate of 20-24 year olds by sex

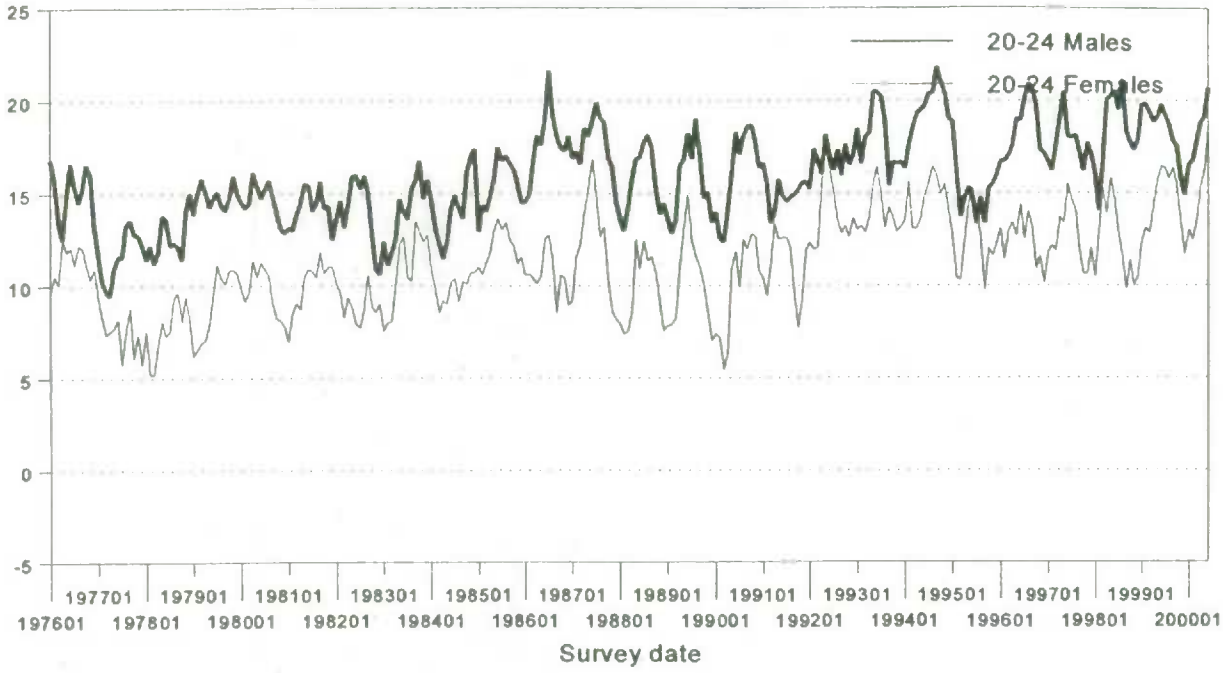


Figure 6D.

Percentage contribution to overall slippage rate of 20-24 year olds by sex

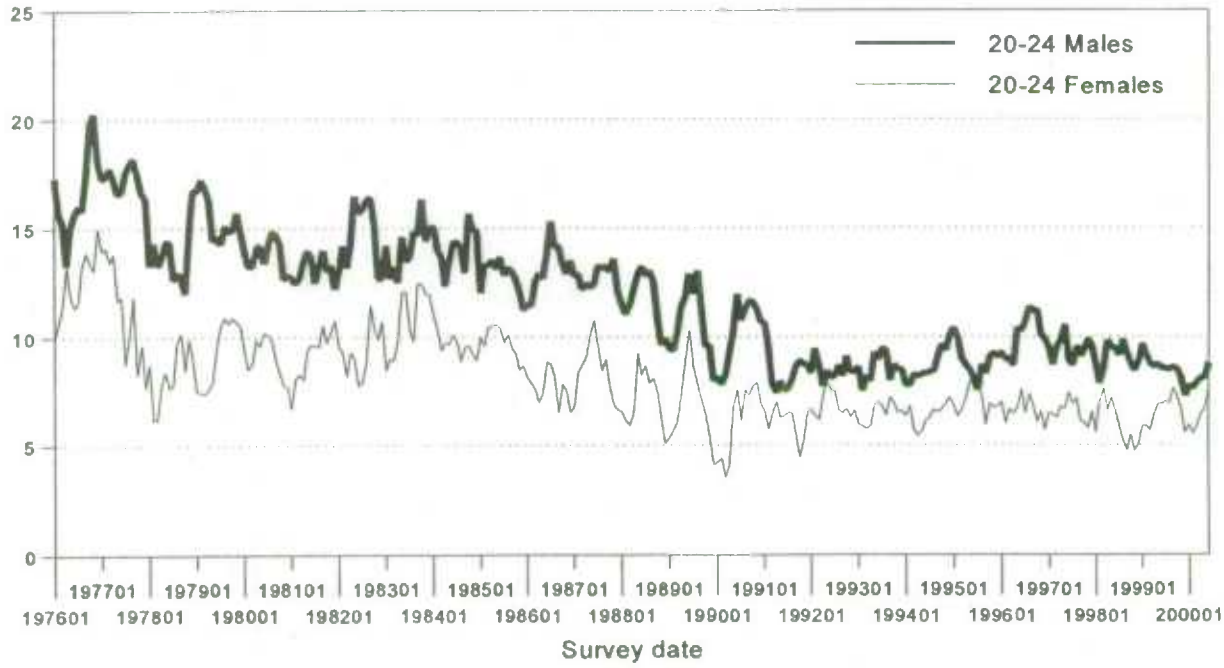


Figure 6E.

Slippage rate of 25-29 year olds by sex

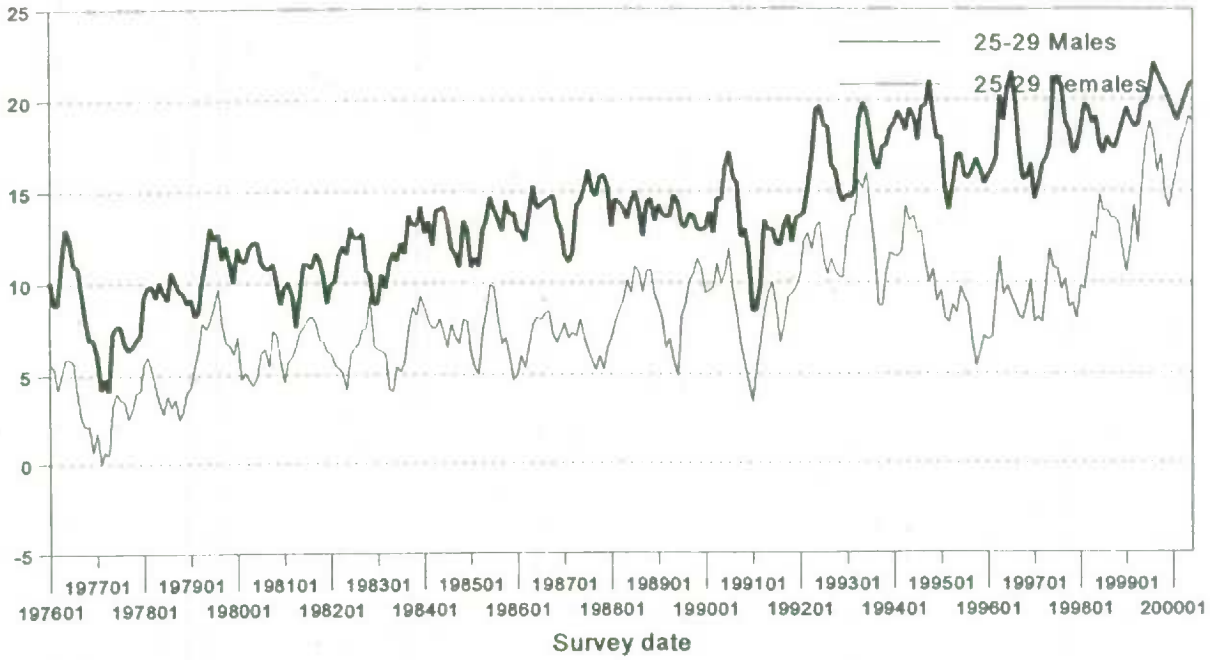


Figure 6F.

Percentage contribution to overall slippage rate of 25-29 year olds by sex

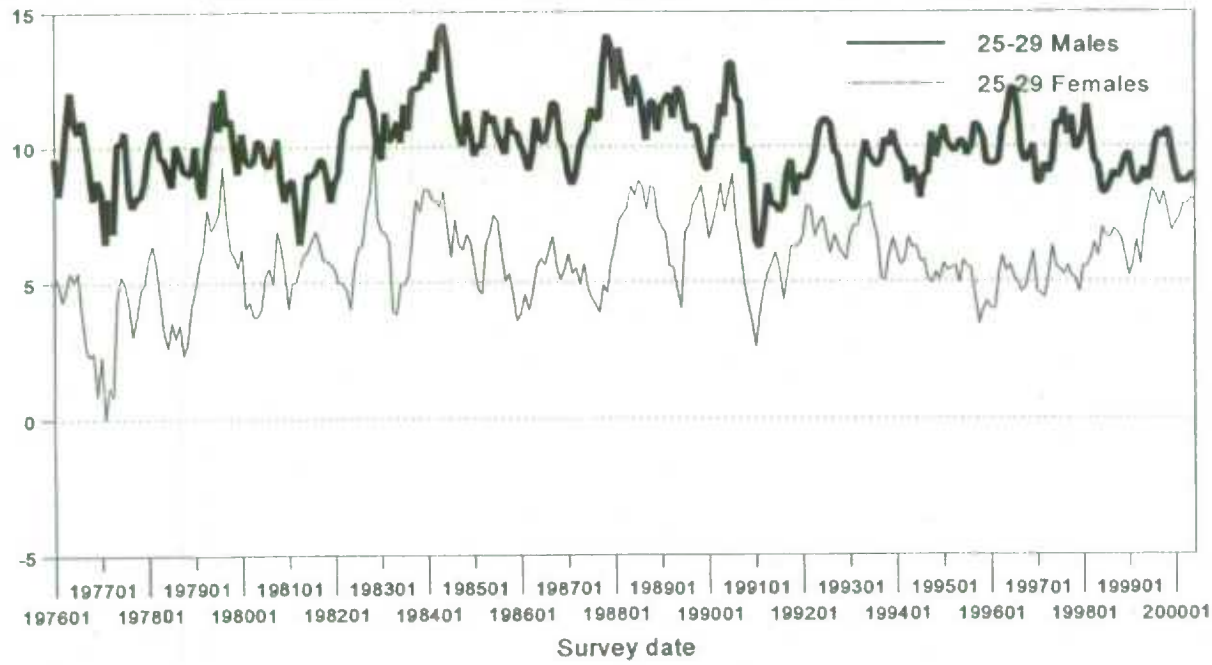


Figure 6G.

Slippage rate of 30-39 year olds by sex

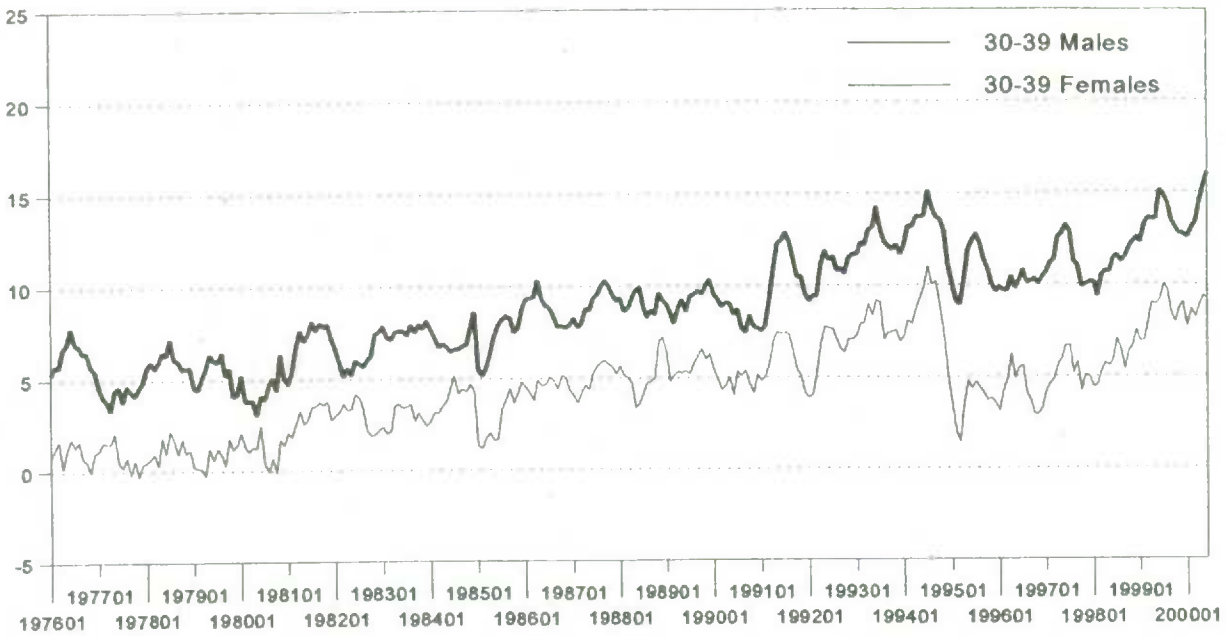


Figure 6H.

Percentage contribution to overall slippage rate of 30-39 year olds by sex

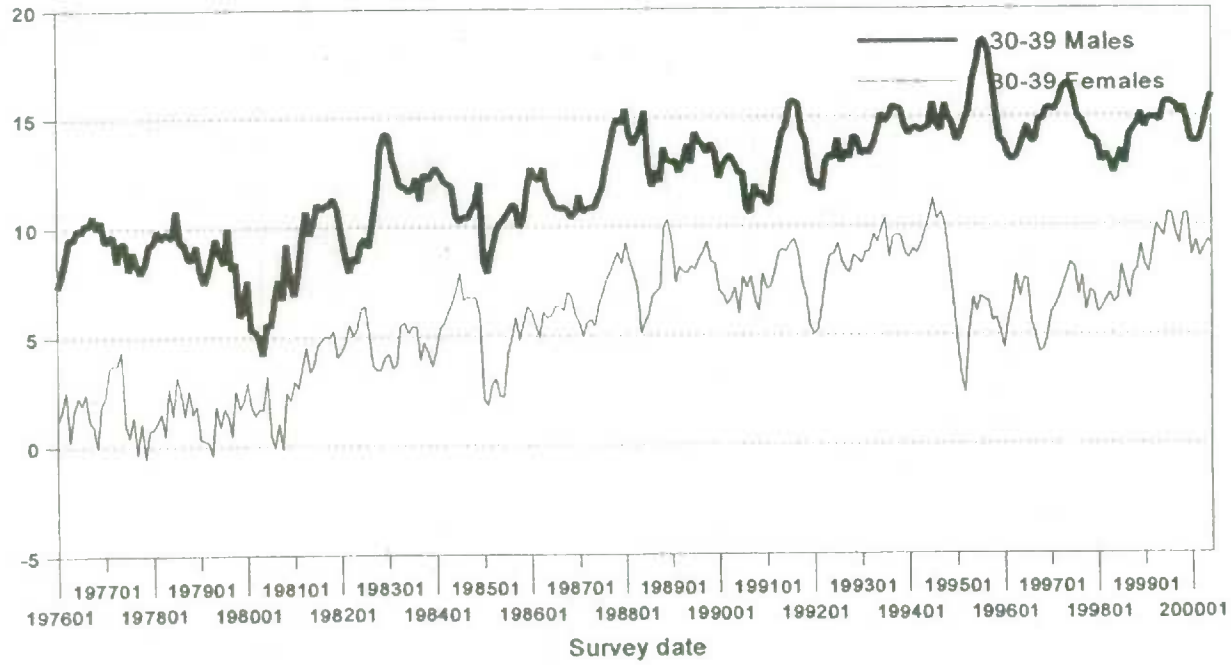


Figure 6I.

Slippage rate of 40-54 year olds by sex

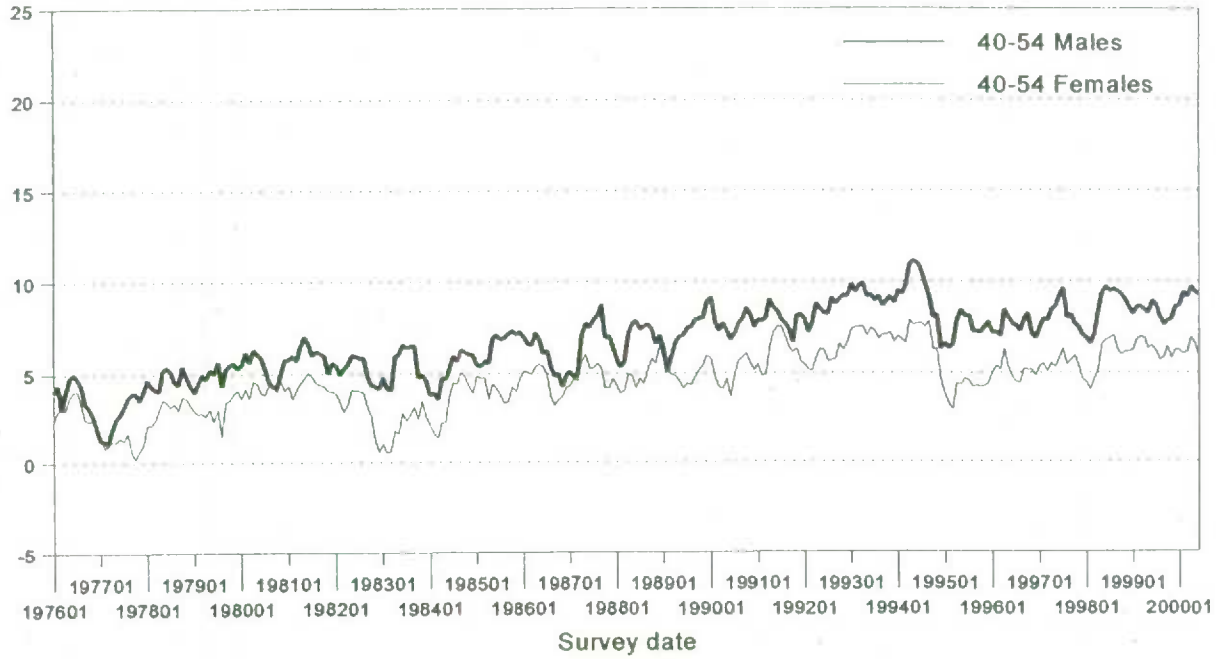


Figure 6J.

Percentage contribution to overall slippage rate of 40-54 year olds by sex

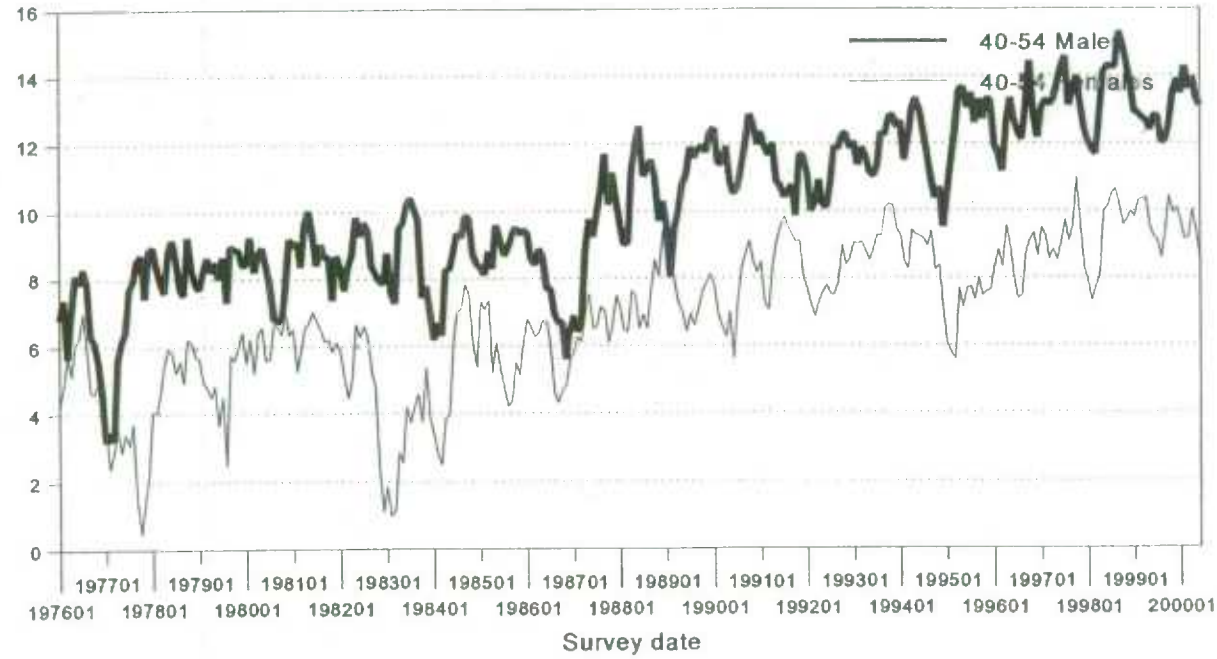


Figure 6K.

Slippage rate of 55+ year olds by sex

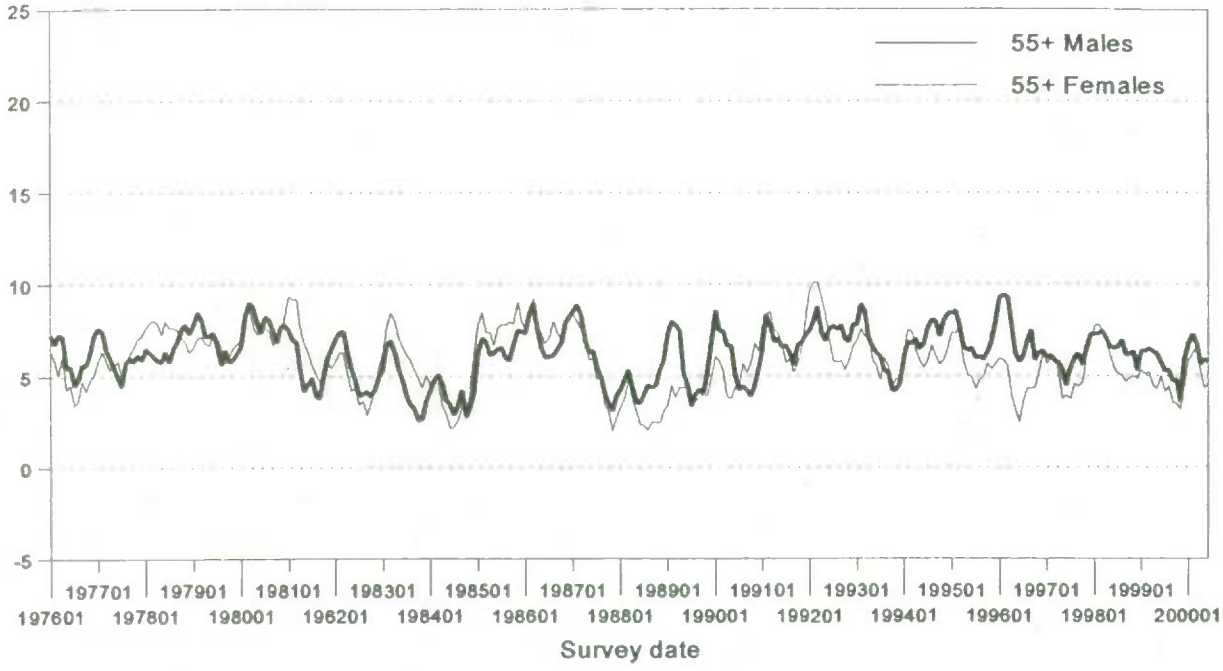
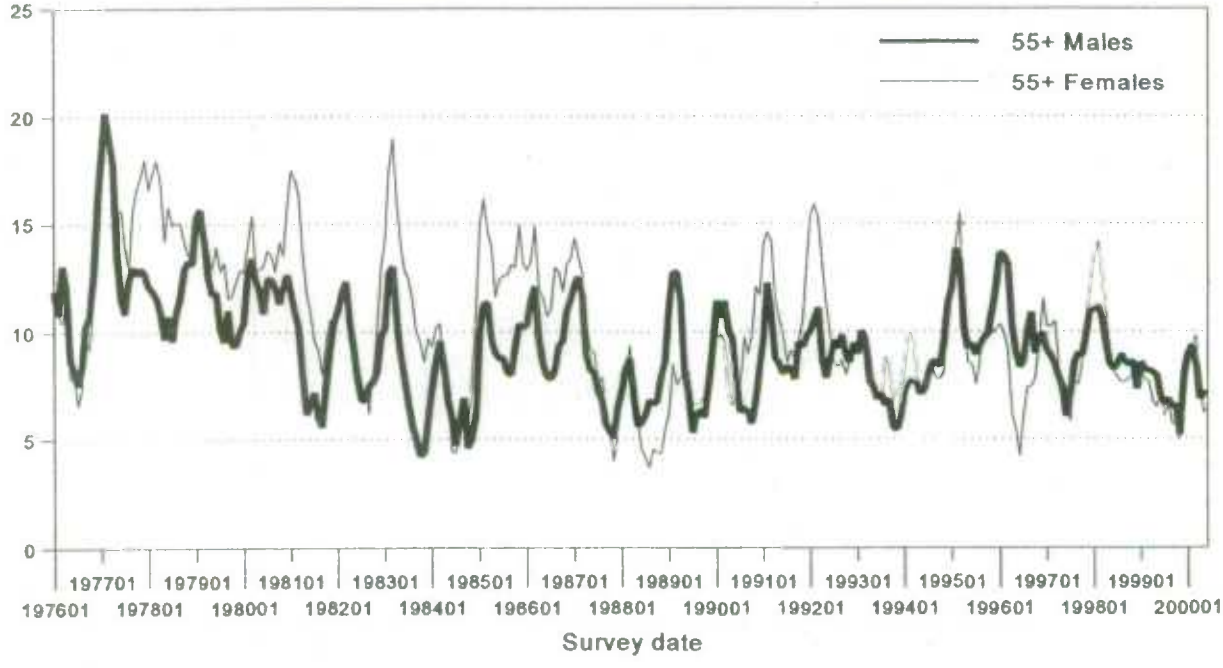


Figure 6L.

Percentage contribution to overall slippage rate of 55+ year olds by sex

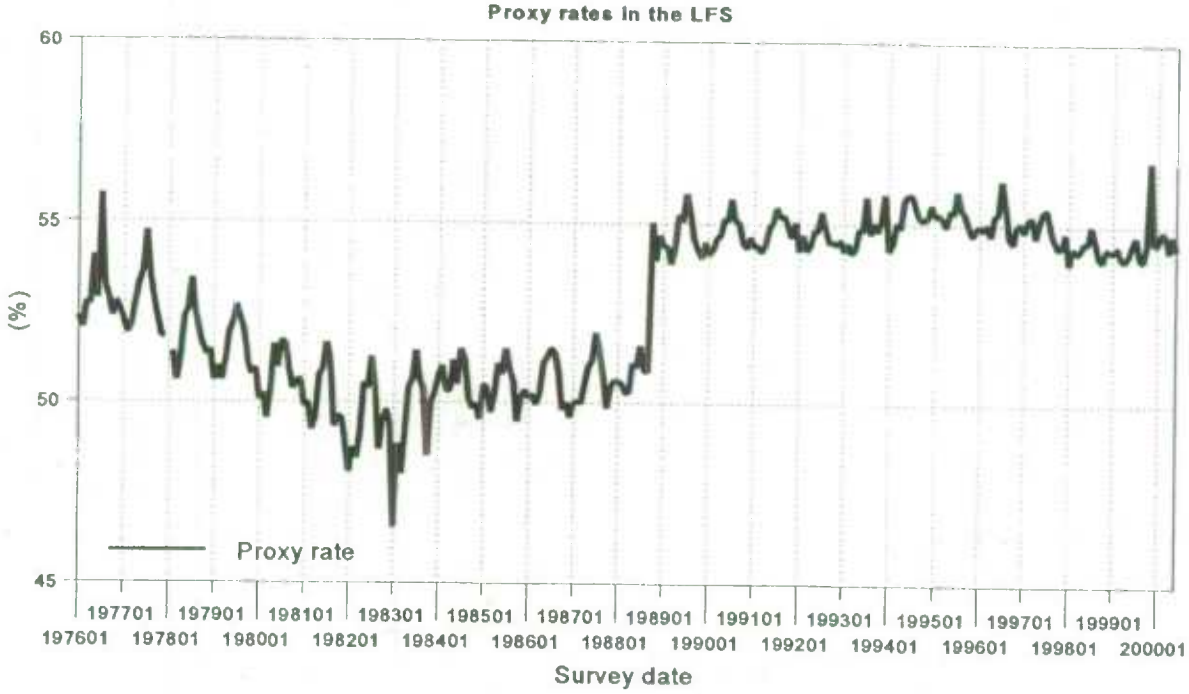


3.6 Proxy rates

The most noticeable behaviour in the proxy rate series is the sudden increase in late 1988. The major change contributing to this increase is that, in households where all residents are 70 years and older and out of the labour force, no contact is made after the birth interview. All 'responses' for the next five months are considered to be proxies. This change was implemented in late 1988. In addition, dwellings imputed by carry forward are considered to be proxy responses, but it is not known when this was implemented. Another factor may be changes that were implemented as a result of a study into coverage (Switzer 1987). Changes were made to interviewer procedures to harmonize with Census concepts, e.g., inclusion of Canadian residents with a second residence outside Canada, seasonal dwellings were listed etc. These changes may have resulted in the inclusion of additional households and persons, many of which would have been interviewed by proxy. This is consistent with a decrease in the slippage rate around the same time.

Figure 7.

Proxy rates in the LFS

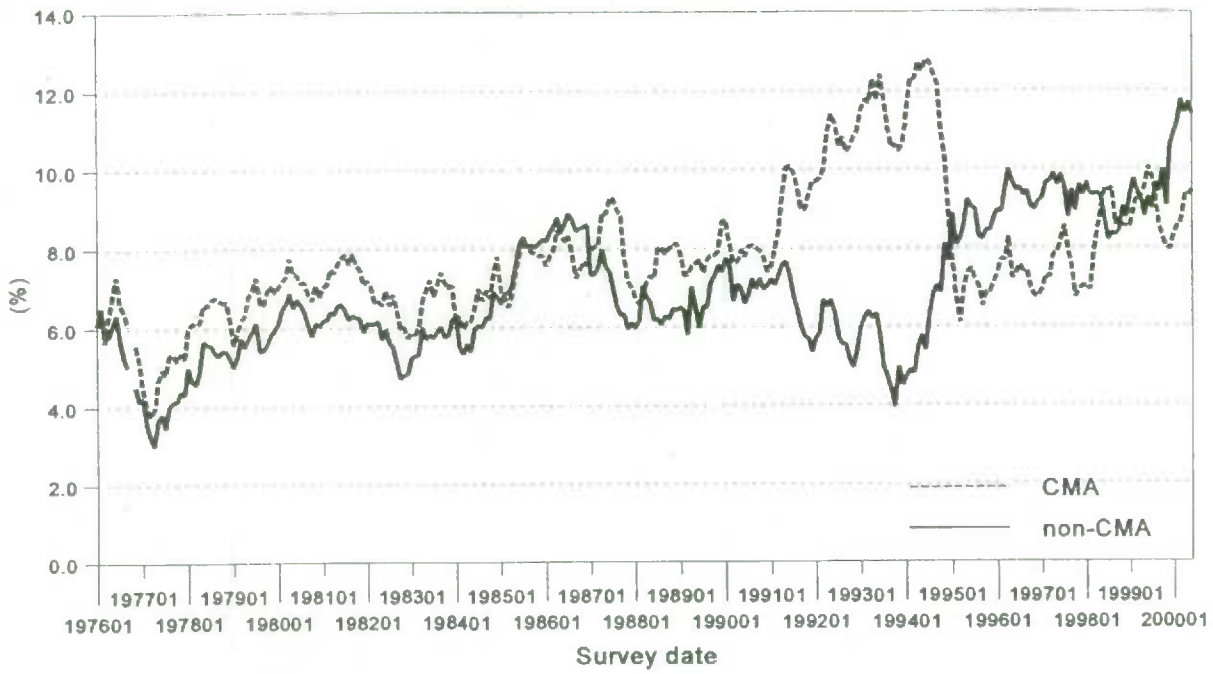


3.7 Slippage by urban/rural

Slippage rates split into urban and rural components are also of interest. However, since weights are not benchmarked to urban/rural counts, calculating slippage based on these values is not very meaningful. In lieu of a strictly urban rural analysis, the best approximation is the Census Metropolitan Area (CMA) variable. Values are benchmarked for CMAs, Urban Centres (UC) and non-CMA areas. The following graph shows CMA (including UCs) and non-CMA slippage rates.

Figure 8.

Slippage rates by CMA/non CMA



Between 1976 and 1991, the two slippage rates are fairly similar. The rates in the CMAs are higher by, on average, about three-quarters of a percentage point during this time. Beginning in 1991 the rates begin to diverge quite drastically - the slippage rate for non-CMA areas falls, while the slippage rates in the CMAs begin to increase dramatically. The use of CMA population projections for poststratification began in 1987. During the period from 1991 to 1994, the subweights within CMAs did not increase, while the projections went from 15 million to 15.8 million. This leads to the increase in CMA slippage. From the graph, it appears the CMA projections were overstated, resulting in higher slippage in the CMAs. As the CMA and nonCMA population form a mutually exclusive covering of the LFS population, an overstatement in one implies understatement in the other. The overstatements were evidently reduced when 1991 Census projections were adopted in late 1994 as part of the redesign, as the two series converge again. The slippage rates for non-CMA areas generally remain higher than the slippage in CMA areas, a converse of the original pattern. It is not known why this is so.

3.8 Temporary Dockets

A temporary docket is a dwelling listed by the interviewer that did not appear on their original cluster list. There are two types of temporary dockets: growth and multiples. A multiple is a listing that appeared to the lister to be one dwelling but which actually contains multiple sets of living quarters. Growth refers to dwellings which have been built (or finished) between the time that dwellings were listed and the time they come into sample, or alternately, dwellings that were missed during initial listing. Both types of temporary dockets can affect slippage.

Multiples are treated differently than regular dwellings. If a unit is a multiple, all dwellings must be interviewed. The weighting is also handled somewhat differently. In areas of high growth, random

households are dropped from the sample (to contain both the sample size and cost). Since this changes the probability of inclusion, a stabilization weight is created, which is multiplied by the design weight to reflect the true weight of households within the stabilization area. Temporary dockets are never assigned a stabilization weight, i.e they have the default weight of one. They do not have the greater weight as they did not have a chance to be dropped in the first place. For multiples, the dwellings had a chance to be dropped from the sample, on an all or nothing basis, and undoubtably some listings which are actually dropped would have been multiples. The current approach is to give one dwelling within the multiple the stabilization weight and give the remaining dwellings a stabilization weight of one. The choice of which dwelling actually gets the stabilization weight $\neq 1$ appears to be arbitrary.

If all dwellings in a multiple were to receive the stabilization weight, there would be a minor decrease in slippage. For July 1999, a month chosen as there was preexisting data from another small study, the effect would be approximately 0.06 of a percentage point: the rate would drop from 10.24 to 10.18. Whether to apply the stabilization weight to all of the dwellings within a multiple is a still being debated. While the LFS does not do so, SHS (formerly FAMEX), which uses the LFS sample design does use the stabilization weight for all dwellings within a multiple.

Properly recorded new growth is not believed to be a source of slippage - new houses or subdivisions which are properly listed and sampled should not contribute to the slippage rate. Growth which is built but not discovered does contribute to the slippage rate. It is believed that growth is currently being undercovered. Figure 11 shows a general declining trend in growth in terms of dwellings per month since 1989. Since new houses in a cluster may be completed before listing begins, and are therefore not considered growth, it is difficult to say for certain how close a relationship there should be between new housing starts and new growth in the LFS. Higher growth may simply indicate that houses are being built faster, so new dwellings are more likely to appear between listing and interviewing. Conversely, lower new growth may mean longer building times, so there is less likelihood of a home appearing between listing and interviewing. As with all aspects of this study, auxiliary information was sought. While we sought an indication of construction of dwellings of all types, the best we could locate was annual construction of single detached homes. This series is presented in figure 9. There is no obvious link between the data in figure 9 and the data in figure 11.

There is a small positive correlation between multiples and the slippage rate - the more multiples in a given month, the higher the slippage rate is likely to be. Multiple dwellings represent errors in initial listing. If we consider a given area, in samples not containing the multiple, estimates would likely be low. Samples containing dwellings that are multiples may overestimate (as each found dwelling represents an additional number of dwellings), and subsequent samples in the same area would have weights that account for the additional dwellings on the listing file.

There is a negative correlation between new growth and the slippage rate. The more new growth is discovered and sampled in a given month, the lower the slippage rate is likely to be that month.

Figure 9.

Single detached homes, 1978-1998

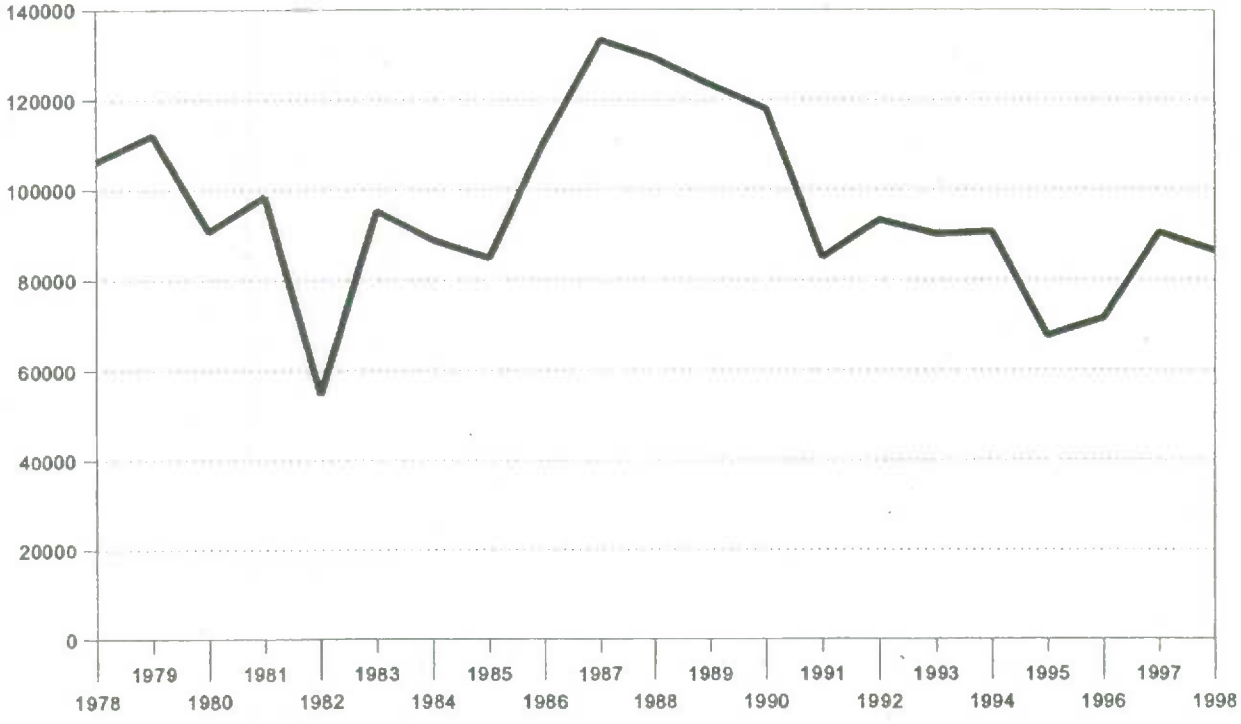


Figure 10.

Multiple dwellings per month

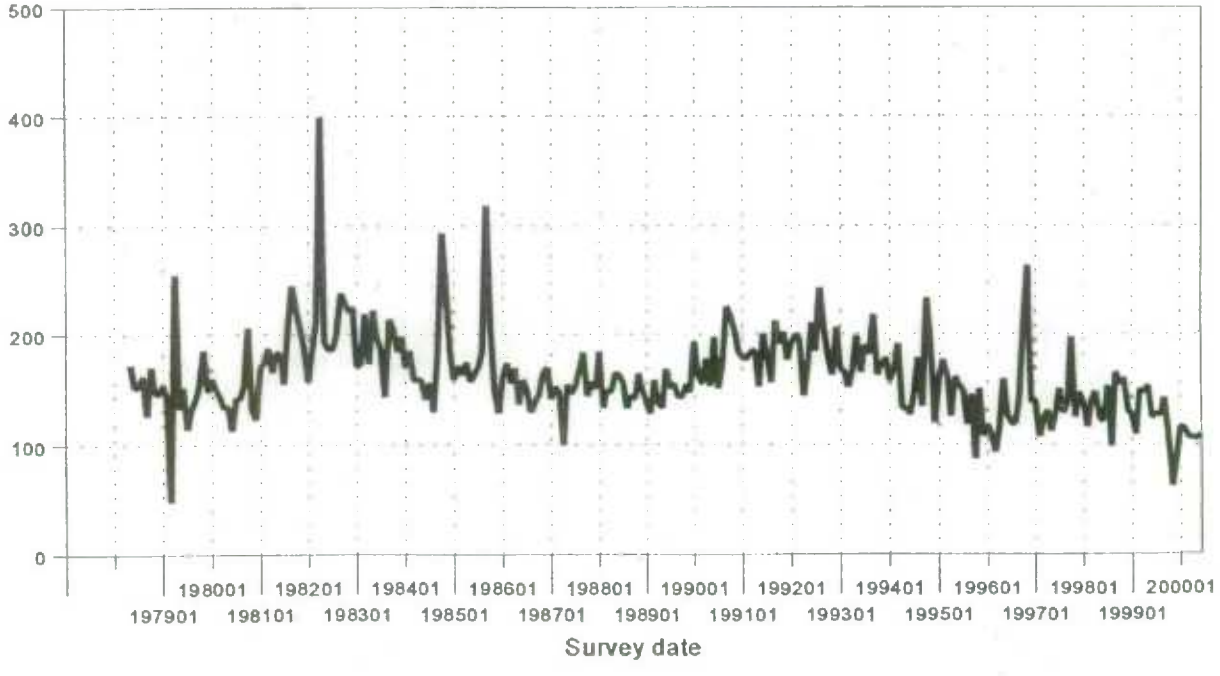
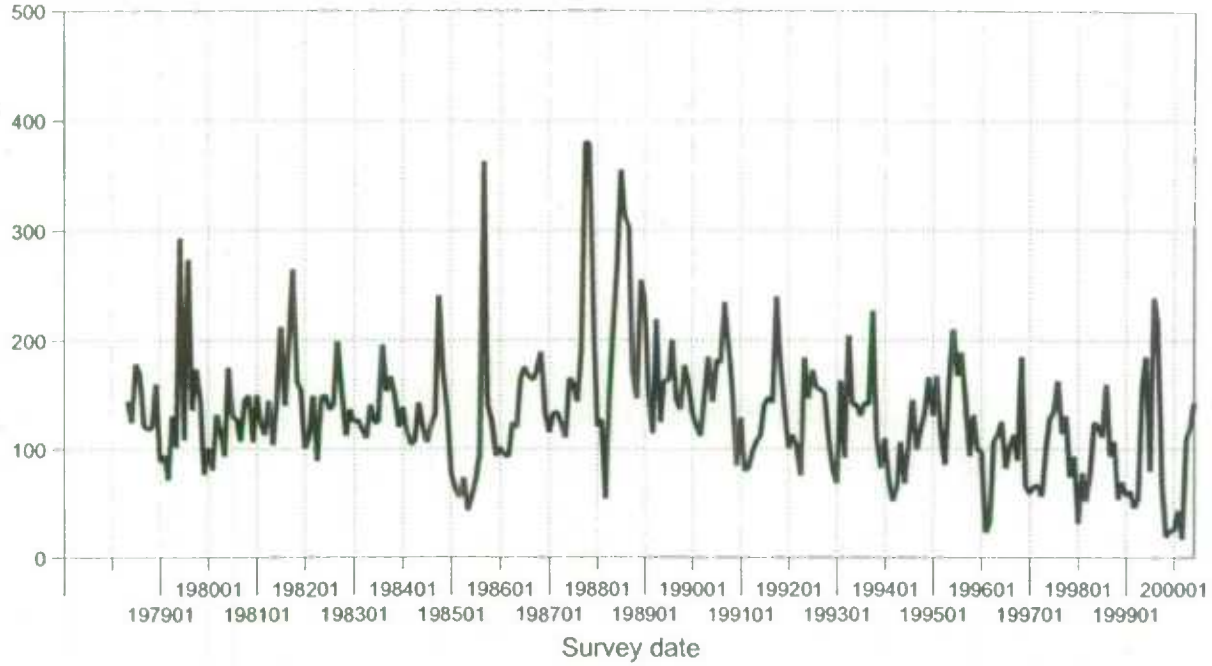


Figure 11.

New growth in dwellings per month



3.9 Interviewer workload

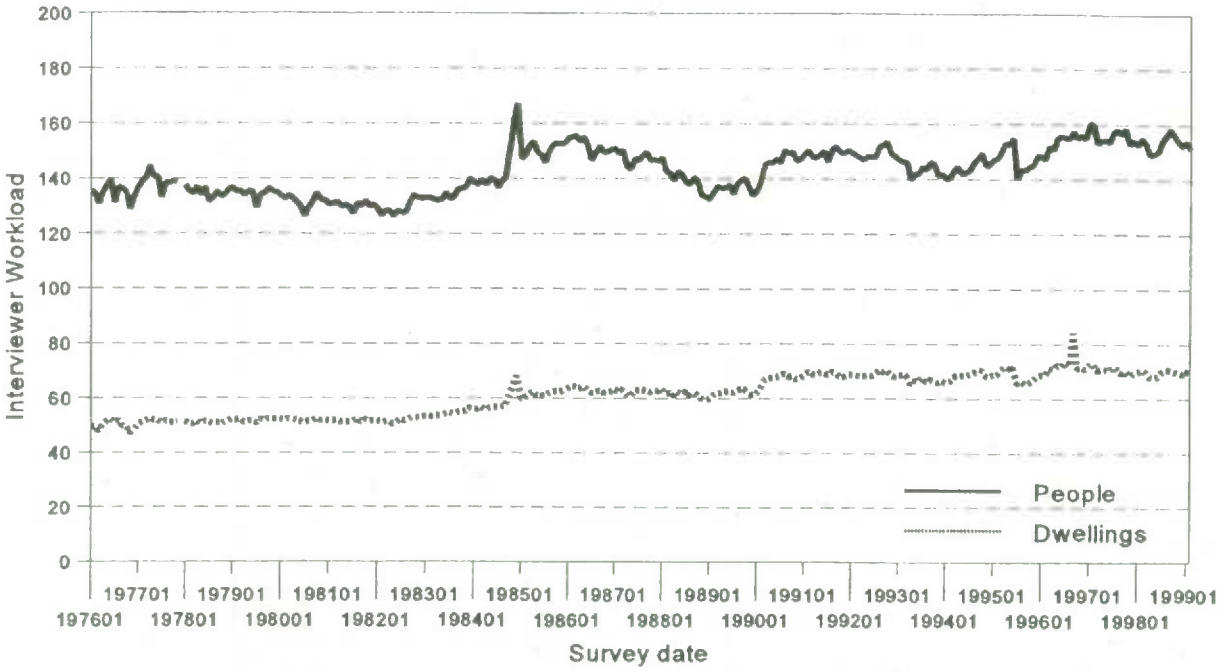
Average interviewer workload of dwellings has been increasing constantly since 1976. In terms of persons the workload has been less consistent but still shows an increasing trend. All else being equal, increasing workload would likely have a deleterious effect on slippage, as dwellings or persons would be more likely to be missed as interviewers would spend less time on each case.

However, increasing use of technology, both the use of telephone interviews (early 1980's), and the use of laptop computers (early 1990's), has made the interviewer more productive, particularly as much less time is spent travelling between cases. However, the increasing use of telephone interviews means the interviewer spends less time in the field, and is therefore less likely to discover new dwellings.

One last concern regarding interviewer workload is the increasing number of supplements. There have been an increasing number of supplements to the LFS during the study period, and this has increased interviewer workloads more than just the increase in dwellings would indicate.

Figure 12.

Interviewer workloads, Canada

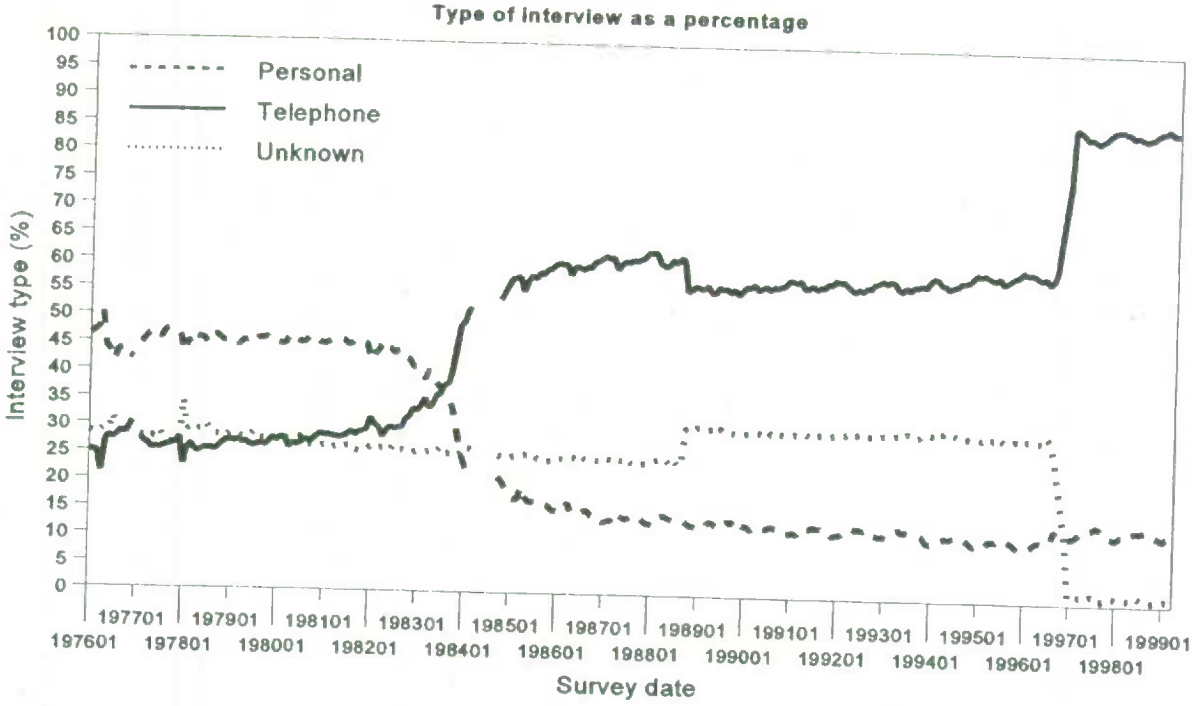


3.10 Personal interview rate

The rate of personal interviewing has been decreasing over time (Figure 13), particularly in the mid 80's. Consequently, the rate of telephone interviews has been increasing over time. The odd shape of the telephone line is caused by the "unknown" code, which was a valid code until the introduction of the most recent questionnaire in 1997.

Figure 13.

Type of interview as a percentage



3.11 Urban rate

After the 1985 redesign, the percentage of urban households increased from about 50% of the sample to about 75%. As the design includes stabilization of the sample size in high growth clusters, over time there is no significant increases in the sample size for either urban or rural allocation. Therefore, these rates stay fairly constant aside from redesigns. The only means for a change would be a decrease in one of the two types. Since rural households have a lower nonresponse rate, a switch to a higher proportion of urban dwellings could affect slippage simply by increasing the nonresponse rate, as outlined in section 3.3.

3.12 Multivariate tests

Several tests were done in order to detect relationships between variables. For these tests, slippage was treated as the dependent variable and the other variables (vacancy rate, nonresponse rate, proxy rate, rate of telephone interviewing, average household size, average interviewer workloads for both dwellings and persons and temporary dockets) were treated as independent variables.

Tests were done both over the whole series (January 1976 to January 1999) and over smaller time frames that fell between major changes to the LFS. In general, tests done over smaller time frames did not reveal significant results. Some months were excluded from the analysis as there was no data available for some of the series.

The analysis began with an examination of correlations. These were done on raw unadjusted numbers from 1976 to June 2001.

Correlations between Slippage and Other Variables (January 1976- January 1999)	
	Pearson Correlation Coefficient
Average household size	-0.77
Personal Interview Rate	-0.75
Vacancy rate	0.67
Interviewer workload, dwellings	0.66
Urban sample percentage	0.64
Proxy rate	0.57
New growth	-0.32
Temporary dockets	-0.23
Nonresponse rate	0.08

Slippage is highly correlated with average household size. Since average household size has been steadily declining and slippage has been (more or less) steadily increasing, this is expected. However, average household size is not a variable we can control, nor does this necessarily mean there is a *causal* link between the two variables. Slippage is also highly correlated to the rate of personal interviewing. Specifically, slippage has increased as the rate of personal interviewing decreases. This does raise some concerns about the switch to centralized CATI. As expected, slippage is highly correlated with the vacancy rate. This justifies the ongoing use of vacancy checks. As expected, there is a negative correlation, although a small one, between slippage and the number of temporary dockets, specifically new growth. Ideally, the more temporary dockets there are, the more accurately the sample represents the given areas. Since slippage has been increasing over time and the interviewer workload has also been increasing overtime, it is not surprising that there is a positive correlation between the two. The very low correlation between slippage and nonresponse seems to contradict the data presented in section 3.3, but remember that these correlations use the entire series, and both slippage and nonresponse are highly affected by changes in the survey. Using purely the data presented in the nonresponse vs. slippage graphs in that section, the following data is obtained. It should be noted that unlike the graphs, we did remove data past August 1999 from the last set, as the changes phased in between September 1999 and August 2000 do represent a significant change in the survey.

Time Period	Correlation of Slippage and Nonresponse
December 1978 - June 1984	-0.20
June 1986 - June 1988	-0.87
December 1989 - June 1994	-0.70
June 1996 - August 1999	-0.65

Several multivariate approaches were used to examine the data. First, we used a stepwise regression, modelling slippage on the variables noted in the correlation table above. Unsurprisingly, the dominant variable in the regression was the household weight, and though other variables were added in, they contributed little extra to the precision of the model. The actual results, using the stepwise routine are as follows:

Summary of Forward Selection Procedure for Dependent Variable SLIPPAGE

Step	Variable Entered	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	HH_UNWGT	1	0.5889	0.5889	37.5162	378.1906	0.0001
2	NR_RATE	2	0.0287	0.6177	18.5713	19.7741	0.0001
3	VAC_RATE	3	0.0076	0.6252	15.0612	5.2869	0.0223
4	URBRATE	4	0.0128	0.6380	7.7259	9.2388	0.0026
5	NEWGRWTH	5	0.0068	0.6448	4.7871	4.9619	0.0268
6	TEMPDOCK	6	0.0020	0.6468	5.3497	1.4466	0.2302

Following this approach, several multivariate analysis techniques were used to further examine the relationships between variables.

A brief analysis of principal components performed upon our key quality indicator variables did not show that any variable strongly dominates data quality. Most contributed fairly equally, with household weight and slippage having opposite signs. The only exception was nonresponse, which was not a significant portion of the first principal component, but was the most significant factor of the second principal component.

Using principal components for data quality variables does not provide any strong results about the data.

Instead, it was decided to return to regression, which is the best tool when our ultimate goal is to explain one variable in terms of others. In addition to our other quality measures, it seems obvious that certain changes to the LFS over time should be incorporated into the analysis. We created an indicator variable for the most recent redesigns in 1984 and 1994. We also created an indicator variable to reflect the change in procedures regarding seasonal dwellings made in 1987. As a note, the redesigns were phased in over a six-month span. We chose the 4th month as the difference between the old and new designs, as an alternative to adding in more variables for the phase in period.

Also, given the strong seasonality of slippage data, we added a variable for monthly data. We considered using seasonally adjusted data, but there is some evidence of changing seasonality over the history of the slippage series and use of the seasonally adjusted series would not provide any extra benefits.

One problem with using regression for the data is that there is a high degree of correlation between subsequent terms in the series. This is due largely to fact that in the LFS samples in consecutive months have a 5/6th sample overlap. Consequently, the factors driving a certain value for the slippage rate in one month will likely result in a similar value in the next month. In addition, slippage is strongly seasonal. As a result, when running a regression, we obtain a high degree of autocorrelation in successive error terms and a very low Durbin-Watson score. This seems indicative of longer term trends that are not accounted for by the model.

Thus, for this attempt at creating a model to explain slippage, we will model slippage purely as a function of time based dummy variables. We will use a dummy variable for each of the redesigns (RDSGN1 and RDSGN2), one for the changes implemented in 1988 (called SEASONAL as one of the larger changes was the consistent inclusion of all seasonal dwellings), and dummy variables for each month. February has the lowest average slippage, so this was the variable we left out of the model. This model considers the period from January 1980 to June 2000.

For the month effect, the month we omit is February, chosen as it has the lowest average slippage rate. Experimentation using different months as the one omitted did not reveal any significant changes in the model. The preliminary examination using just the redesign, seasonal dwelling classification and month effect parameters as follows yielded the following results.

Root MSE	0.85385	R-square	0.4920
Dep Mean	7.79185	Adj R-sq	0.4610
C.V.	10.95827		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	6.342432	0.16779266	37.799	0.0001
RDSGN1	1	0.933901	0.24558654	3.803	0.0002
RDSGN2	1	1.367793	0.19120937	7.153	0.0001
SEASONAL	1	0.569537	0.18053956	3.155	0.0018
JAN	1	-0.046493	0.23995886	-0.194	0.8466
MAR	1	-0.002992	0.23995886	-0.012	0.9901
APR	1	0.420496	0.23995886	1.752	0.0811
MAY	1	0.438288	0.23995886	1.827	0.0692
JUN	1	0.540809	0.23995886	2.254	0.0252
JUL	1	0.458622	0.23995886	1.911	0.0573
AUG	1	0.328034	0.23995886	1.367	0.1731
SEP	1	0.156054	0.24444286	0.638	0.5239
OCT	1	-0.028905	0.23995886	-0.120	0.9042
DEC	1	0.005526	0.23995886	0.023	0.9817

The R-square value of 0.4920 indicates that about half the variability in the model can be explained by these variables. The monthly values do not seem to contribute much to the model; only for June would we reject the null hypothesis of no impact (a parameter value of 0) with 95% confidence, though the values are obviously clustered. April through August are close to significance, September through March are not.

An examination of the graph shows that aside from seasonality and breaks at major changes in the survey, another trend is an increase from the point of the redesigns. After further examination of different models, also considering a variable for length of time since the last redesign, our best model for explanation uses just four variables. The redesign and seasonal dwelling variables are still in the model, and with the addition of a variable for length of time since the last redesign, we have a model that explains about 68% of our variability.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	4	208.77195	52.19299	118.890	0.0001
Error	223	97.89772	0.43900		
C Total	227	306.66967			

Root MSE	0.66257	R-square	0.6808
Dep Mean	7.79615	Adj R-sq	0.6750
C.V.	8.49872		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	4.038276	0.21663083	18.641	0.0001
RDSGN1	1	4.414750	0.33473711	13.189	0.0001
RDSGN2	1	3.441224	0.22171042	15.521	0.0001
MSLR	1	0.027550	0.00219921	12.527	0.0001
SEASONAL	1	-1.093036	0.19215275	-5.688	0.0001

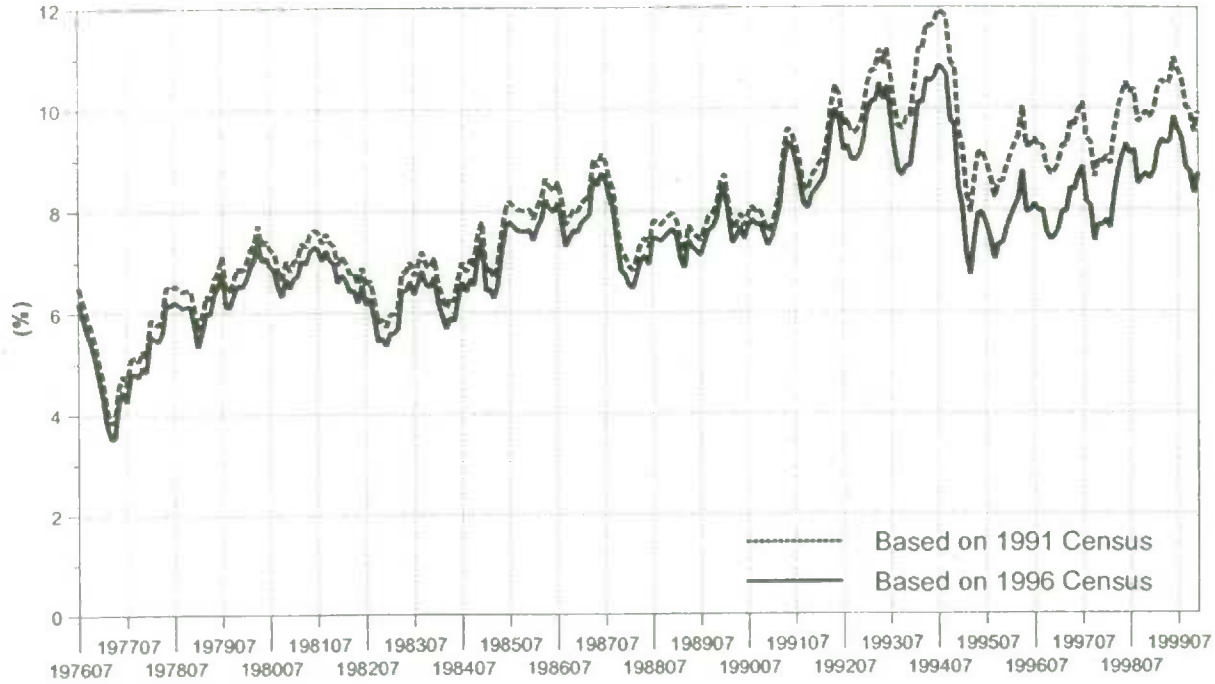
This is both simpler and yields better results than our previous model. This model simply verifies some facts that are obvious from the graph. For example, the inclusion of all seasonal dwellings provides a definite improvement in slippage rates. The current design yields a lower slippage rate than the previous one. Also, slippage rates increase as we get away from the implementation date of a sample design. This may simply mean that over time, the margin of error on census estimates increase while the margin of error on LFS population estimates remains constant.

3.13 Post-censal populations projections

Slippage is measured as the difference between census projections and LFS estimates. Generally, when analyzing slippage, the assumption is made that the census projections are correct and discrepancies are indicative of problems in the LFS. However, as can be expected, there are problems with both surveys. The LFS has recently changed from 1991 to 1996 Census projections. This resulted in lower slippage rates at the national level and in every province except B.C.

Figure 14.

Slippage in Canada: Effect of recent Census revisions



As the graph shows, prior to 1991 the average decrease in slippage was 0.34%. After 1991, the average decrease in slippage was just over 1.0%.

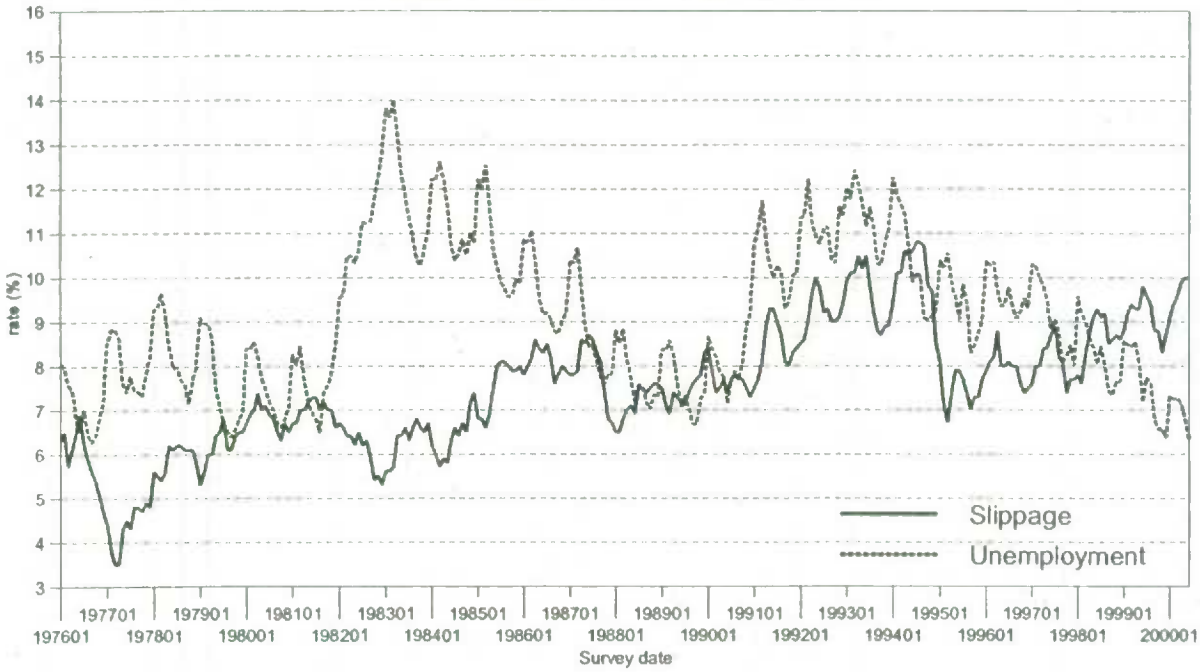
Also of interest are the census' own studies of coverage problems. The net undercoverage in the 1996 Census is 2.45%(±0.10%) at the Canada level. Studies show that slippage is typically highest in British Columbia, and Census undercoverage is also highest in British Columbia, at 3.68%(±0.25%). This also applies to age groups: males 20-24 and 25-29 have the highest slippage rates in the LFS and have net undercoverage in the Census of 7.14%(±0.39%) and 7.08%(±0.40%) respectively.

3.14 Unemployment Rate

Beyond the fact that slippage and unemployment are both seasonal, there is no strong relationship between the two. The two variables are not strongly correlated. It does not appear that the unemployment rate influences to slippage. It is possible that other economic measurements may show a link to slippage, but such comparisons will have the same problem as the strong correlation between slippage and average household size, namely that as many long term economic trends (size of the labour force, GDP, consumer price index) show general upward trends, it will be difficult to say whether there is a causal link between the two or whether this is simply a coincidence.

Figure 15.

CANADA - Slippage Rate vs. Unemployment



3.15 Provincial Factors

There are ongoing differences in provincial slippage rates. Slippage rates by province are available in the appendix. Slippage rates are typically lowest in Quebec and the prairie provinces, particularly Manitoba. They are highest in British Columbia. Slippage rates are more variable in the smaller provinces. It is not known why slippage rates have been consistently higher in British Columbia, or, indeed, why they are lower in Manitoba and Quebec. Explanations for periods of elevated localized slippage in British Columbia are available. For example, at one time census projections for some of the northern ERs did not reflect that some mines had closed, and the associated mining towns had lost much of their population. Hence, the sample reflected the true population in this instance.

However, census projections cannot be used to explain away all slippage. British Columbia is also the province with the clearest increasing trend, and the slippage rate there does not appear to have been affected by the new sample introduced at the end of 1995, whereas every other province showed a noticeable drop.

3.16 Slippage In the U.S.

It may be of interest to measure how the slippage rate changed over time for surveys in other countries. The graph below compares average annual slippage rates in Canada and the United States. In 1989, the slippage rates were virtually identical at 7.7%. Since then, the rate in the United States has stayed relatively stable, fluctuating between 7% and 9%, while the average annual rate in Canada has been as high as 11.2%, and, in general has shown much sharper inclines and declines. It is difficult to speculate why these rates might diverge. As the sample designs for the respective labour surveys and the undercoverage adjustments for the respective censuses are different, comparisons are difficult.

Figure 16.

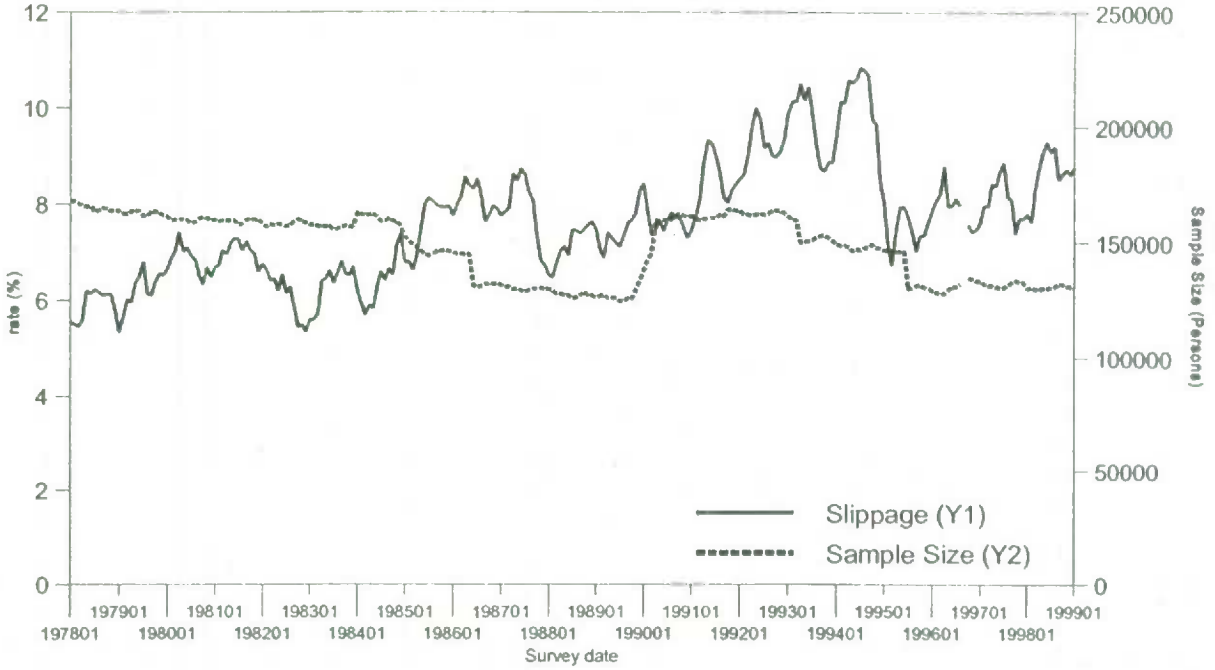
Slippage Rate: U.S. vs Canada

3.17 Effect of the Sample Size

There does not appear to be much of a relationship between the sample size and the slippage rate. The correlation between the two variables is -0.020, effectively zero. This is not a surprising result, as increases or decreases in the sample size are balanced by corresponding changes in the design weights, having minimal effect unless the sample size change is due to a sample redesign. As the sample size certainly has no impact on census projections, slippage, being a function of the design weights and census projections will not be affected by a change in the sample size.

Figure 17.

Slippage vs Sample Size (in persons)



3.18 Conclusions

There are several factors that appear to be related to the increasing slippage rate.

In general, it appears that slippage and nonresponse behave inversely. In the long term, the vacancy rate is closely related to slippage. Over short time spans, slippage and vacancy rates may be directly or inversely correlated. Misclassified vacants by definition contribute to slippage, but in the absence of quality control programs it is not known whether this is a serious problem.

It is difficult to measure the change in interviewer workload during the study period - interviewers are surveying more households, and asking more questions as the LFS questionnaire has increased in length over time, and there are more supplements. It is not known how much the use of computers or telephones has compensated for this increase in workload, but higher workloads could contribute to more missed individuals and dwellings.

Multivariate analyses of the causes of slippage reveal several interesting facts. The best explanatory variable for slippage is household size. There is a strong negative correlation between slippage and household size. There may be a causal effect, as, if on average the same number of people are missed per household, then they will have a larger impact on the slippage rate if the household size is smaller.

The inclusion of seasonal dwellings had a strong impact on the slippage rate, decreasing our observed slippage by more than a percentage point. The sample appears to degrade over time, as the slippage rate is positively correlated with the length of time since the last redesign.

3.19 Recommendations

There are a number of items that can be considered for further study

(1) Ad hoc studies should always be conducted in problem areas.

(2) Census projections should be further evaluated.

(3) As a redesign is scheduled to be phased in in 2004, this would be an opportune time to examine the LFS sample design

(4) It may be worth reexamining the rules for dwellings occupied by people not to be interviewed, as we appear to be missing a significant number of individuals with this code.

(5) We have not come up with a satisfactory answer explaining the large difference in slippage rates between provinces. A study why slippage rates in provinces with low rates are lower than elsewhere may lead to conclusions useful in lowering the slippage rate.

Quality control procedures have been shown to provide a beneficial effect on slippage. Thus, it would be worthwhile to:

(1) Have regular, frequent and systematic cluster, vacancy and roster checks.

(2) Enhance the communications between ROs

(3) Establish Best Practices regarding slippage

4. REFERENCES

Allard, B, I. Lévesque and J. Dufour (1998), *Evaluating Labour Force Survey Data Using the 1991 Census of Population*

Beebakbee, R. (1993), *Investigation of the increase in Alberta slippage, November 1992 to August 1993*

Bennett, K. (1983), *Telephone Interviewing for the Re-Interview Program*

Bench, J., C. Clark, G. Diotte, J. Dufour, R. Généreux, P. Rappak, M. Wysocki (1994), *LFS Questionnaire Redesign Household Membership Questions*

Brainstorming session on Slippage - Feb 15, 93

Clark, C., J. Dufour and R. Kaushal (1995), *Slippage Initiatives*

Clark, C., B. Kennedy, M. Wysocki (1993), *Coverage error in the Canadian Labour Force Survey*

Cyr, A. (1985), Memo to E. Ross dated January 23

Dufour, J. (1994), *Programme de vérification du listage des grappes de l'EPA*

Earwaker, S. (1981), *Slippage Estimates and Coverage Analysis*

Gambino, J., M.P. Singh, J. Dufour, B. Kennedy and J. Lindeyer (1998), *Methodology of the Canadian Labour Force Survey*

Gambino, J. (2000), *The Effect of Nonresponse Adjustment on Slippage Calculations*

Gardner, E. and C. Walker (1998), *Excerpt from The Effect of Student Status on the Labour Force Survey Slippage Rate*

Ghangurde, P. (1983), *Re-interview Program as a Management Tool*

Ghangurde, P., *Slippage in 1983 LF Surveys*, 1984

Ghangurde, P and A. Gower (1979), *Reinterviews as a Supervisory Tool in the Field*

Joncas, M. (1985), *Cluster Listing Check Program for the Redesigned LFS Sample*

Lemaître, G. (1986), *Aspects of the LFS Interviewer's Manual Pertaining to Coverage*

Lindeyer, J. (1994), *List Maintenance History*, memo dated June 20

Mason,K., E. McLeod, P. Timmons (1968), *Labour Force Survey Coverage Project - Saskatchewan*

Newton, F. (1977), *Estimated Slippage Rates for Subprovincial Areas*

Page, J. (1997), *Saskatchewan and Alberta Vacancy/Cluster check*

Prairie Region LFS Field Validation - August 1999

RO managers (1988), *Frequency of Cluster Checks*, memos to HO

Sida, R. (1981), *Apartment Frame Vacancy Rates* (memos dated December 7 and December 16)

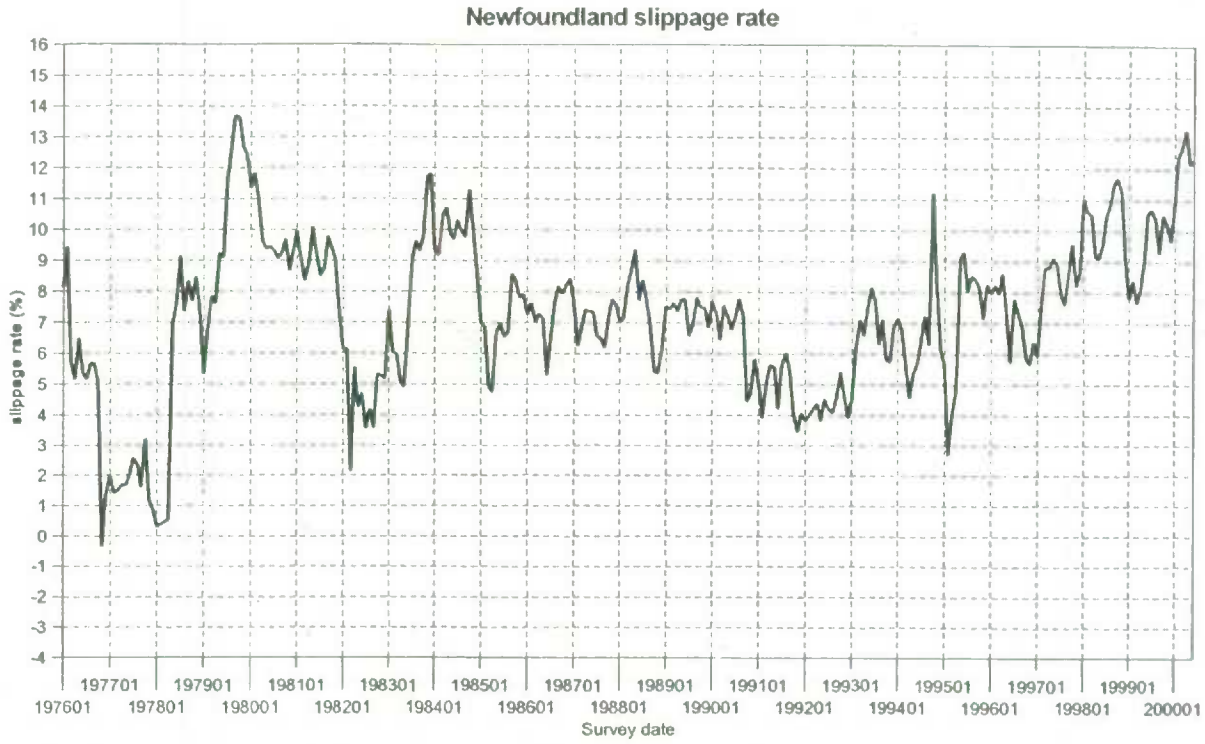
Sida, R. (1981), *Slippage Rate in PEI - 1981*

Switzer, K. (1987), *Reducing and Monitoring Slippage*

Wysocki, M. (1993), *Misclassification of Vacants*

Wysocki, M. (1993), *Evaluation of Current Programs Related to Data Collection Quality*

Appendix


Newfoundland slippage rate
slippage rate (%)
16
15
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-1
-2
-3
-4
197701
197901
198101
198301
198501
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199801
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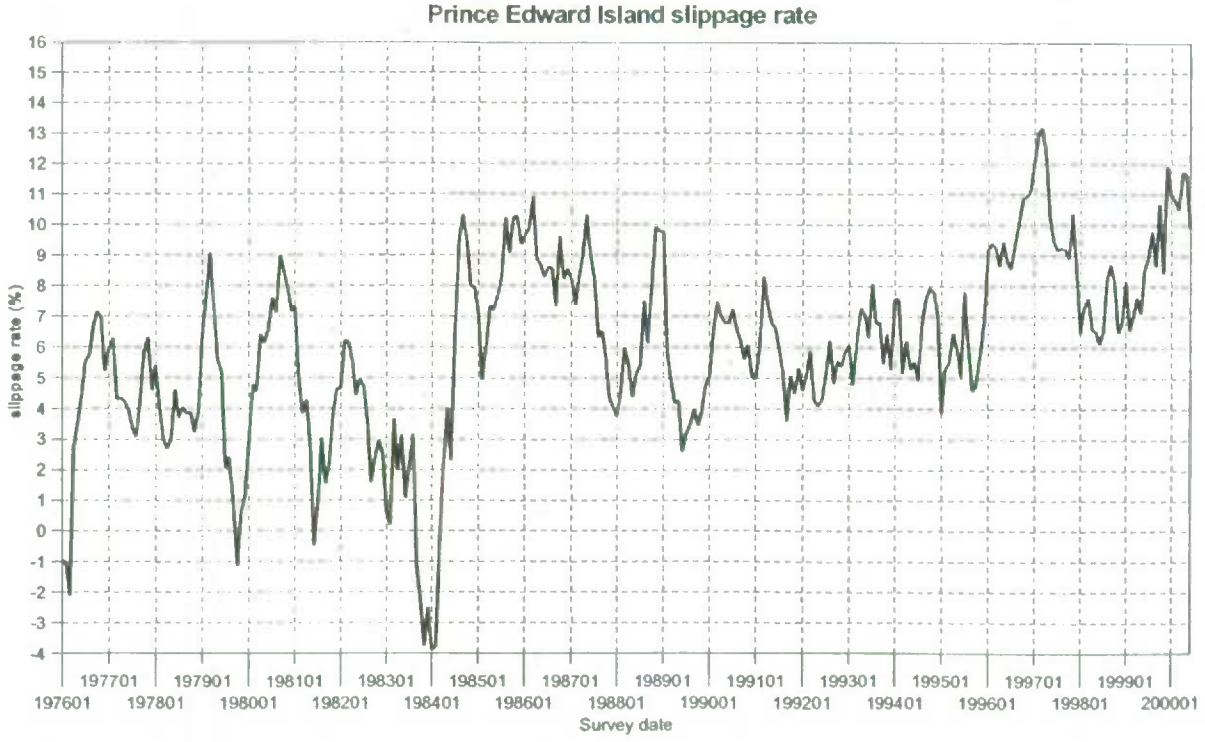
Survey date


Prince Edward Island slippage rate
slippage rate (%)
16
15
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12
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3
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-1
-2
-3
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197701
197901
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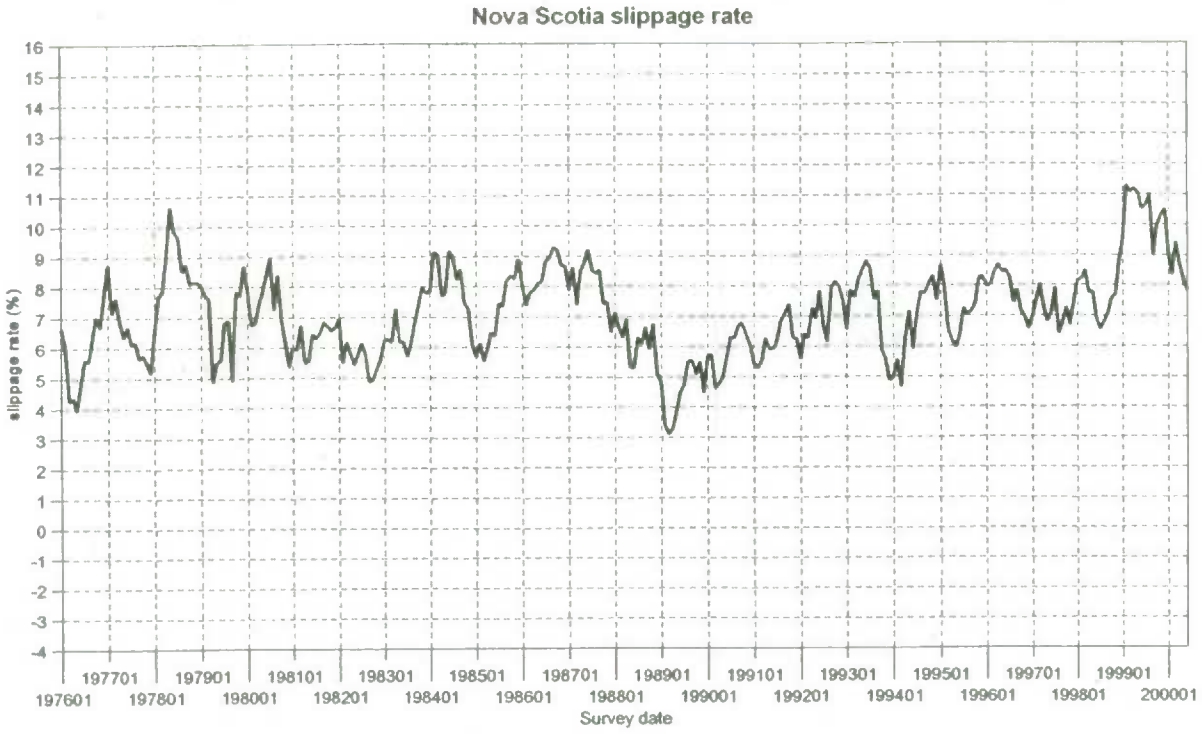
199601
199801
200001
Survey date


Nova Scotia slippage rate
slippage rate (%)
16
15
14
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12
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3
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1
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-1
-2
-3
-4
197601
197701
197801
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198001
198101
198201
198301
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198601
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199101
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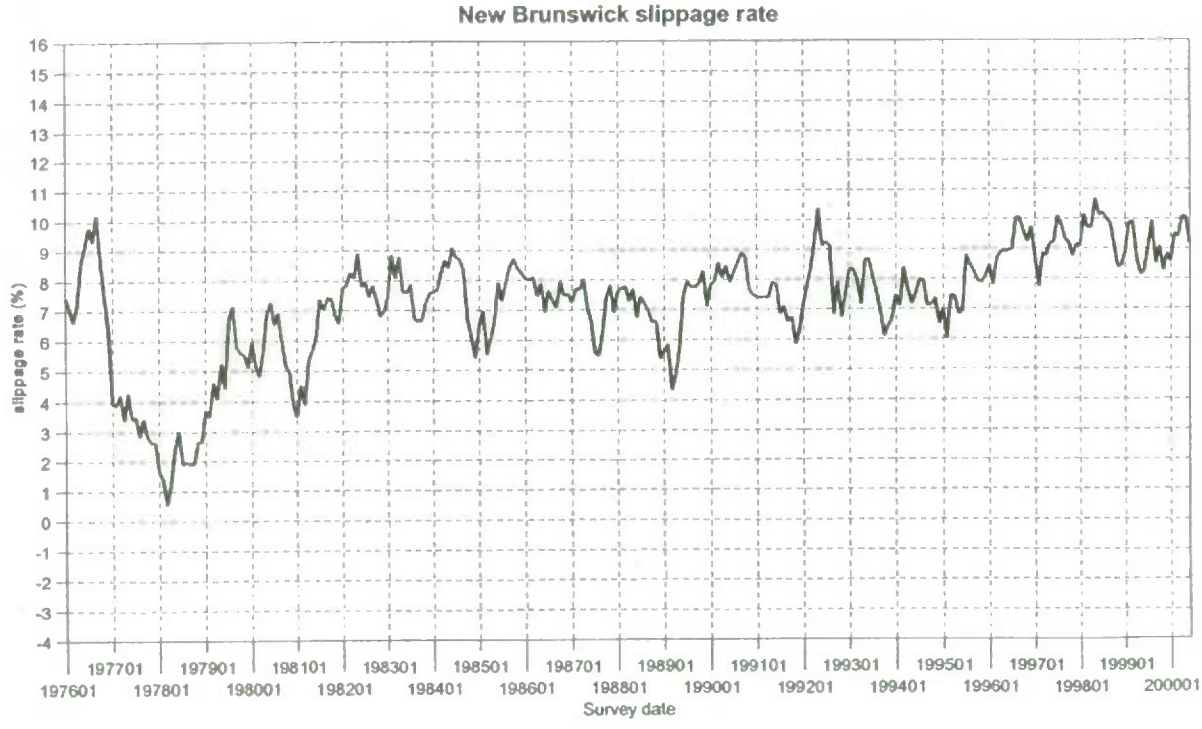
199301
199401
199501
199601
199701
199801
199901
200001
Survey date


New Brunswick slippage rate
slippage rate (%)
16
15
14
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12
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-1
-2
-3
-4
197601
197701
197801
197901
198001
198101
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198301
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199501
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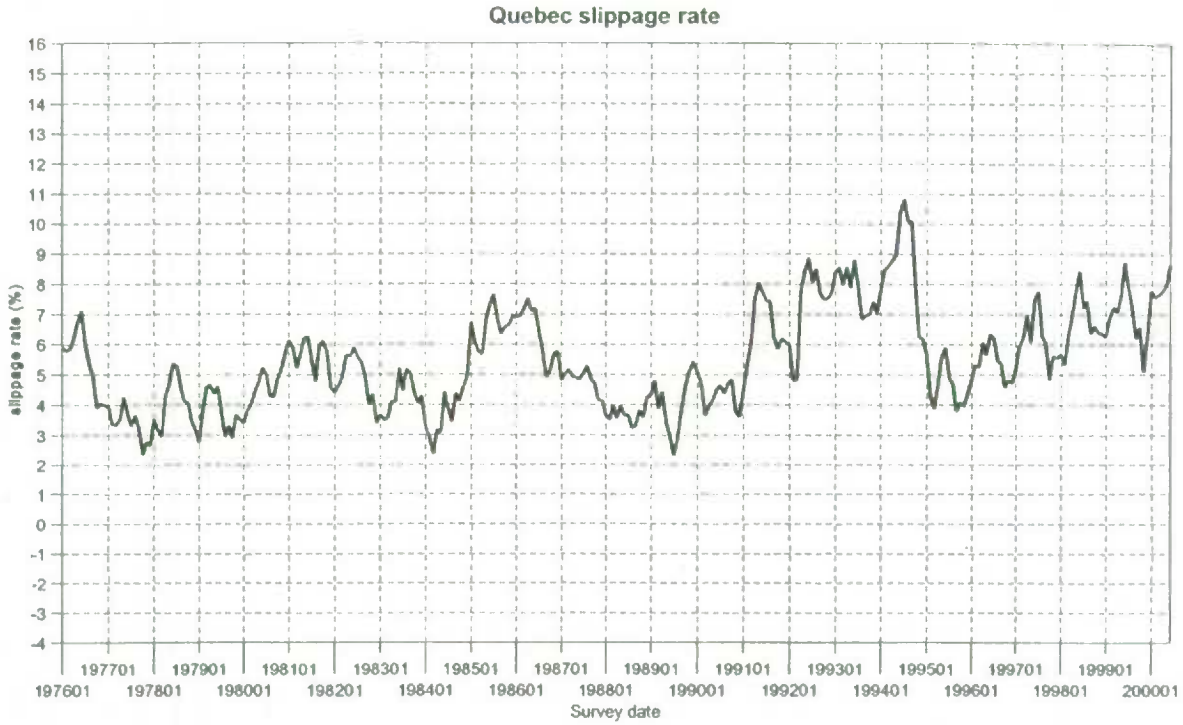
199801
199901
200001
Survey date


Quebec slippage rate
slippage rate (%)
16
15
14
13
12
11
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9
8
7
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-1
-2
-3
-4
197701
197901
198101
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198501
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198601
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199001
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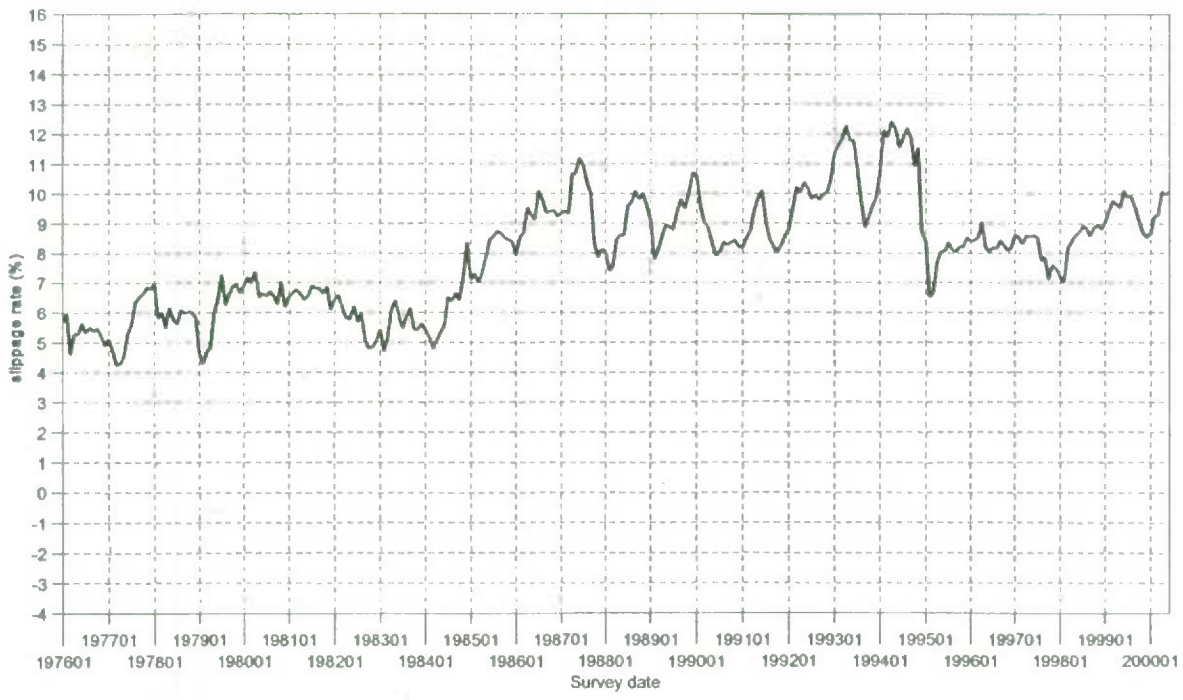
199601
199801
200001
Survey date


Ontario slippage rate
slippage rate (%)
16
15
14
13
12
11
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-1
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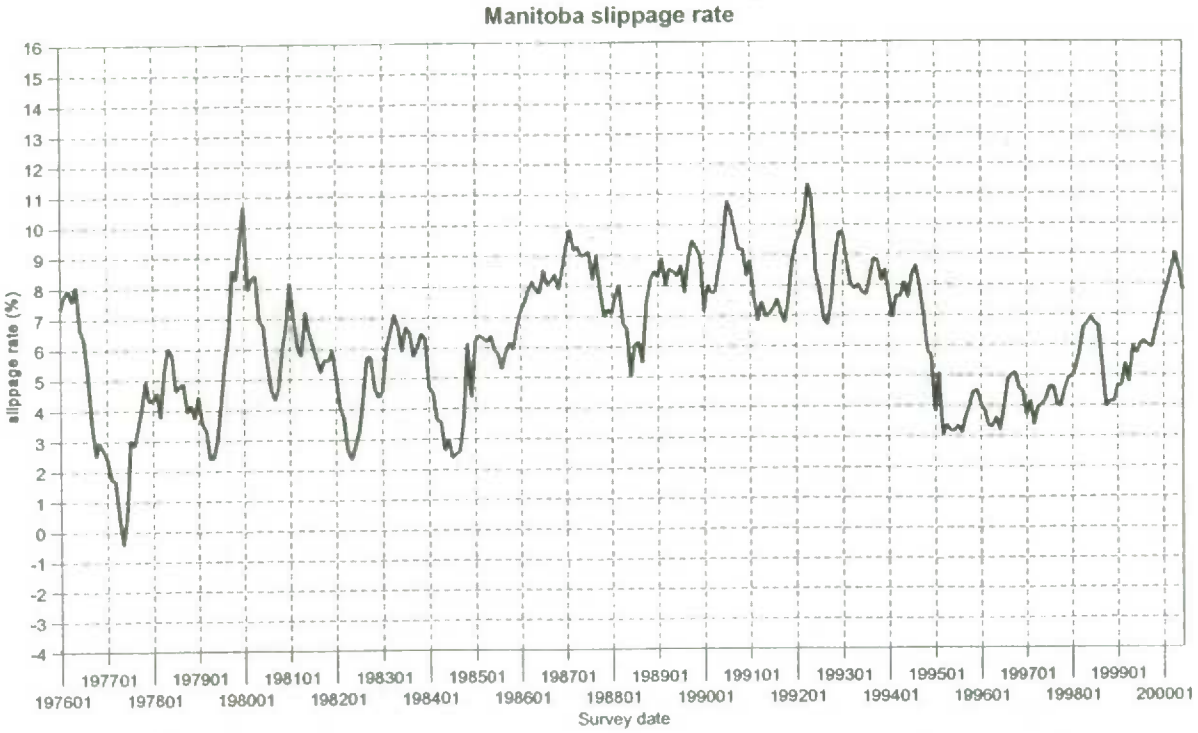
199801
200001
Survey date


Manitoba slippage rate
slippage rate (%)
16
15
14
13
12
11
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3
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-1
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197601
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199701
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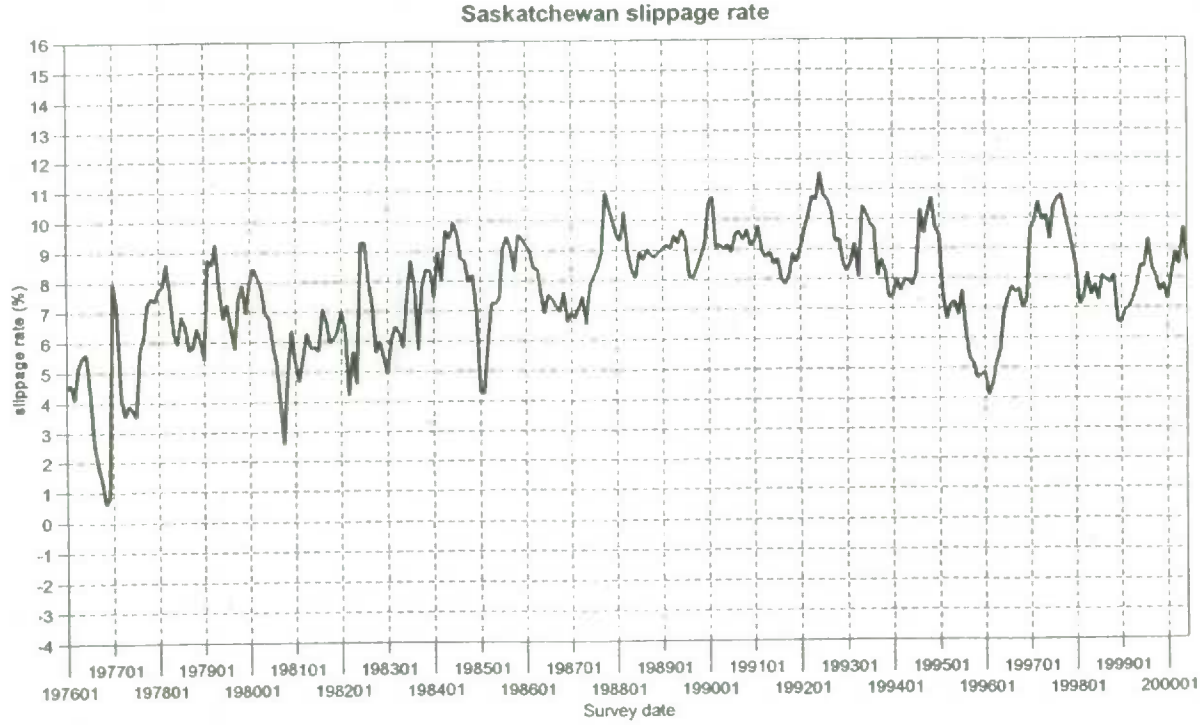
199901
200001
Survey date


Saskatchewan slippage rate
slippage rate (%)
16
15
14
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-1
-2
-3
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197601
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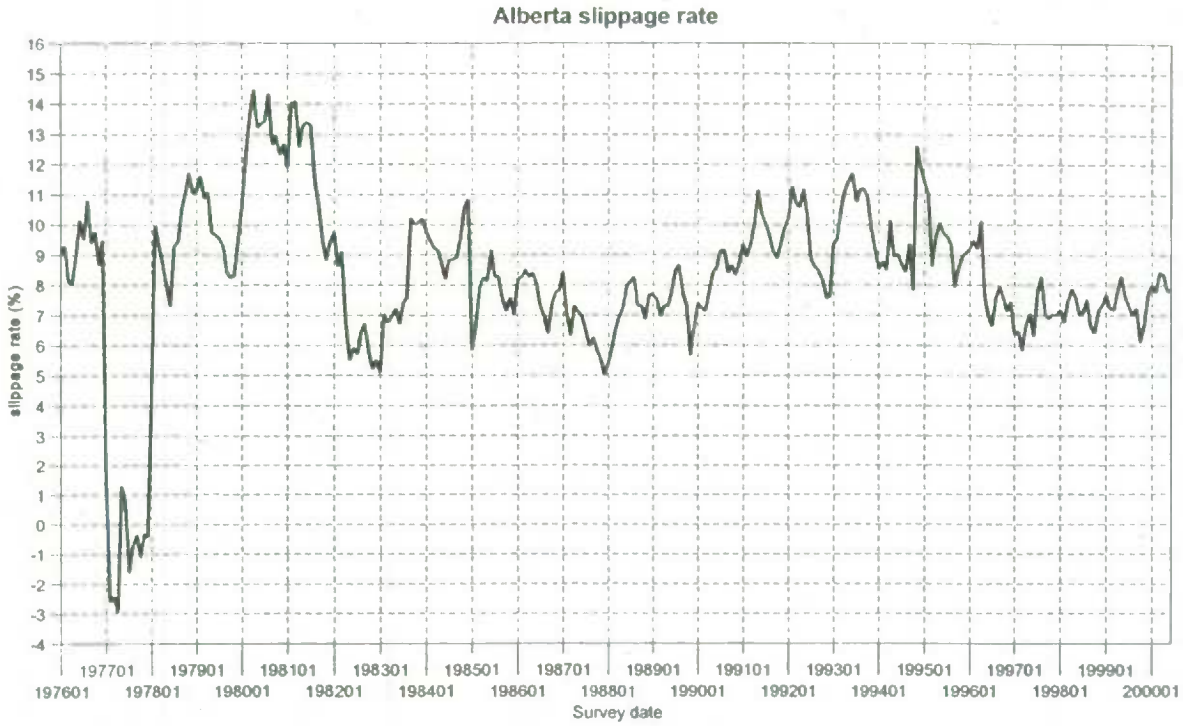
199701
199801
199901
200001
Survey date


Alberta slippage rate
slippage rate (%)
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15
14
13
12
11
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8
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4
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-1
-2
-3
-4
197601
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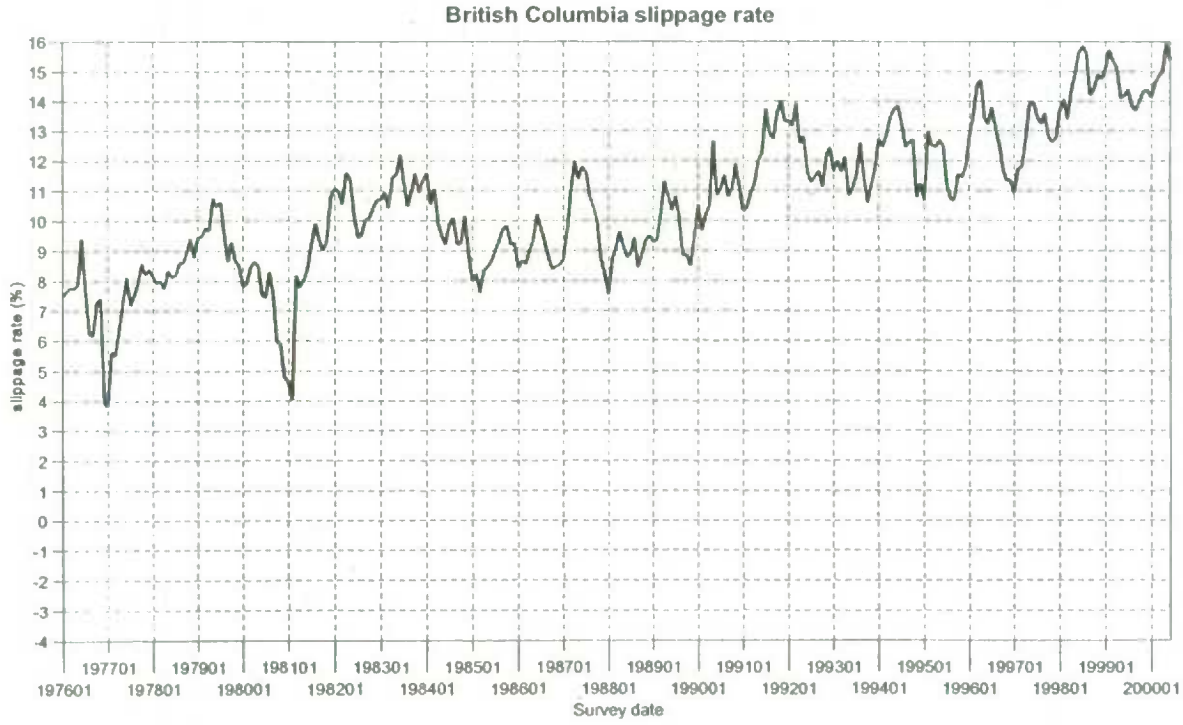
Survey date


British Columbia slippage rate
slippage rate (%)
16
15
14
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-2
-3
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197601
197701
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199901
200001
Survey date