Title: THE TRANSITION FROM GOOD TO POOR HEALTH: AN ECONOMETRIC STUDY OF THE OLDER POPULATION

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Abstract: This is a study of the influence of socioeconomic factors on the state of health of older Canadians. Three years of panel data from the Survey of Labour and Income Dynamics are used to model the transition probabilities between good and poor health. Care is taken to avoid the problem of endogeneity of income in modelling its effects, and to adjust reported income to free it from its strong association with age at the time of the survey. Of particular note are the significant effects found for income, in spite of universal public health care coverage. Significant effects are found also for age, education, and other variables.

JEL Classification: I12 (Health Production: Nutrition, Mortality, Morbidity, Substance Abuse and Addiction, Disability, and Economic Behaviour)

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1. INTRODUCTION

It is well known that morbidity and mortality rates increase with age at older ages, reflecting the on-going general deterioration of health. It is well known too that health outcomes differ systematically with socioeconomic status (SES), however measured. Thus it is found that those with higher incomes and higher status occupations tend to live longer, and in better health; their so-called *health gradients* are flatter. However, why that should be so is not clear. Do people enjoy better health and longer lives because they are in higher SES groups, or is the reverse true: are they in higher SES groups because of a predisposition to good health?

We are concerned here with the influence of SES on health status. Our principal focus is the effect of income but to assess that properly we must concern ourselves also with the effects of other factors, including personal attributes such as age, education, and marital status. We are fortunate in having access, for our purposes, to the Survey of Labour and Income Dynamics (SLID) master file which Statistics Canada has made available recently to the research community through the Research Data Centres established at a number of Canadian universities.

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The SLID file makes it possible to follow the same individuals through time, and to know when changes in their (self-reported) health status occurred. Also, we have found it possible to link the SLID records with information from other sources about the characteristics of the areas in which the individuals live, and thus to explore the possible role of some "environmental" variables.

Health status for an individual is self-reported in SLID. (We refer to it that way although in some cases the reporting is by another member of the individual's family.) Not only is self-reported health status widely used in studies of this kind (see, for example, Benzeval and Judge, 2001, Bound, 1991), but also it appears to be a good predictor of subsequent health care utilization and mortality. (See, for example, McCallum et al., 1994, Idler and Benyamini, 1997, Bierman et al., 1999, and Badley et al., 2000. Badley et al. provide extensive references.) This is so in spite of the fact that there appears to be much inaccuracy in the self reporting of specific health conditions (Baker et al., 2001, Raina et al., 2002).

2. DOES INCOME MATTER?

In what follows we define more carefully the income concept that is relevant for our analysis, but for the moment let us think of income simply as representing resources available to meet one's health or other needs. An obvious question is why higher income should be associated with better health in a society such as the Canadian one in which there is universal access to a publicly funded health care system. One can think of reasons, of course. For one, the Canadian system covers "essential services", but not all services; by a broad definition it covered about 70 percent of total health expenditure in the late 1990s (Canadian Institute for Health Information, 2001). For another, income may affect spending on food, and that in turn may have implications for nutrition. However, the question of *why* income should matter is put to one side in this paper; the question addressed is rather *whether* in fact it does matter. Our purpose is thus to assess the relationship running from income to subsequent health outcomes in the older population. The importance of longitudinal data in this regard is evident: the evolving health status of individuals with differing characteristics can be observed over a number of years as their circumstances change, and inferences drawn about the role of income.

There is a large international literature concerned with the income-health connection, and it has been ably reviewed by Smith (1999), Benzeval and Judge (2001), Evans (2002), and Deaton (2002, 2003). Smith (1999) emphasises the difficulty of assessing the direction of causation and cautiously notes, in his concluding remarks (p. 165), that "... economic resources also appear to impact health outcomes ... [and] innovative methods that help isolate economic and health shocks would be informative on this vexing issue of causality". Evans (2002, p. 77) states that "[t]he association between income inequality and health inequality ... is now pretty well established ... but the causality is less clear ...". Earlier (p. 15) Evans observes that "the much broader literature on the determinants of health indicates that, at least among citizens of wealthy societies, any relationship between individual income level and health status has to arise from the effects of the social context in which people at different levels find themselves". Of related interest is the idea developed by Wilkinson (1996) that income inequality, like air pollution, is itself a health hazard. That notion has been convincingly disputed by Deaton who argues that "it is not true that income inequality itself is a major determinant of population health ... [I]t is low incomes that are important, not inequality, and there is no evidence that making the rich richer ... is hazardous to the health of the poor ..." (Deaton, 2003, p. 151).

The Canadian literature on this topic is quite limited, reflecting the absence of suitable data, at least until recently. One study, that of Badley, Wang, Cott, and Gignac (2000), used two years of longitudinal data (1994 and 1996) from the National Population Health Survey for the purpose of assessing the relationship between self-reported health, on the one hand, and chronic health conditions and a variety of factors, on the other. While respondent income was not of central interest in that study, a variable indicating whether income was 'low' or 'not low' was included in the analysis, and 'low' income in 1994 was found to have a statistically significant and negative association with self-reported health in 1996. So far as we are aware, that is the only study that has used Canadian longitudinal survey data to assess health outcomes in relation to income.

Another study, that of Wolfson, Rowe, Gentleman, and Tomiak (1993), used administrative records from the Canada Pension Plan in a longitudinal analysis of male mortality after age 65. The findings are striking: "higher earnings ... in late middle age (age 45 to 64) are associated with significantly lower mortality at older ages (65 to 74)". Furthermore, the differences are substantial. For example, the proportion surviving from age 65 to 70 was 0.862 among those in the first earnings quintile and 0.906 among those in the fifth quintile. The proportions surviving to age 74 differed by even more (0.740 for the first quintile, 0.807 for the fifth). Beyond that, the authors find differences by marital status (those who are married tend to live longer), retirement age (those who retire later tend to live longer, although the difference diminishes with retirement age), and whether there was an increasing trend in income before retirement (a positive trend was found to be associated with reduced mortality). The analysis draws on a very large data set (close to 550,000 observations), which is almost exhaustive of the relevant population and has highly reliable information relating to career income and age of death.[1] However, there is no direct information relating to health status (the main focus of our work) and there are no indicators of socioeconomic characteristics other than marital status and income.

We note too another recent Canadian study, one that relies on cross-sectional rather than longitudinal records. Tremblay, Ross, and Berthelot (2002) worked with observations based on more than 118,000 respondents in the 2000/01 Canadian Community Health Survey. The individual responses in that survey were combined with community level data drawn from census and other sources, and the relationships between a variety of individual and community-level variables and self-perceived health explored. The authors concluded that lower levels of education and household income are associated with worse health, as are smoking, obesity, and lack of frequent exercise. However, after taking those factors into account, the characteristics of the regions in which people lived – whether they were remote, prosperous, or disadvantaged, and the variation in the number of hospital beds and physicians per capita – accounted for, at most, only a very small share of the reported differences in health status.

3. THE INCOME/WEALTH NEXUS: BIDIRECTIONAL EFFECTS

Any attempt to use survey data to investigate the effects of income on the health status of individuals must confront the fact that there may be – indeed, almost certainly will be – statistical effects in the other direction as well. In Deaton's (2003, p. 120) view, the "most difficult issue of all is sorting out the dual causality between income and health". While the availability of resources may affect a person's ability to maintain good health, the person's state of health may in turn affect his/her ability to hold a job and earn income. Even for someone of retirement age the existence or level of an employment-based pension may reflect previous earning ability, and possibly therefore previous state of health – and previous state of health may well be correlated with reported current state, again setting up a health-to-income link. An observed statistical correlation or regression relationship between income and health status may therefore be hard to interpret: Does it reflect the effect of income on health, of health on income, or both?

If the goal (as here) is to model and assess the effect of income on health status then the effect in the other direction implies that income is an endogenous variable in the model. A standard procedure in an econometric context is to seek one or more other variables that can be used as instruments for model estimation purposes. The requirements for a suitable variable to serve as an instrument in this case is that it be correlated (preferable highly correlated) with income, uncorrelated with the error term in the equation used to model the effects on health, and not itself an explanatory variable in the model. Level of education might be thought of as a possible choice since it is obviously highly correlated with income but education is also a candidate for explaining variations in health status among individuals, and so is disqualified if one wants to identify the separate effects of income and education. In fact, it is difficult to think of a suitable instrumental variable for the purpose, and certainly impossible to find one in the data set with which we are working.

The endogeneity of income in a health-on-income regression model is a troublesome problem for anyone using one-time survey data for model estimation. It is troublesome too if the data are multi-period panel data (as with SLID) if one attempts to estimate a model in which the dependent variable is the reported state of health in each successive period. However, there is a way around the problem if one can recast the model in terms of change in health state, rather than health state itself, and that is the approach that we take in this study. We restrict our analysis to a subsample of the SLID sample, the restrictions being that individuals must be 50 years of age or older and in good health in the initial year of the sequence of panel observations. We then model (for men and women separately) the change or constancy of health state in the subsequent years for which panel observations are available as a function of the initial-year income level (adjusted, as described below) and the individual's age, education and other variables, also defined as of the initial year. The idea is that a person's propensity to stay healthy or to move into a poor health state may be related to his/her income (or rather household income, in our model) and other state variables. By excluding from the subsample persons in poor health in the initial year we avoid having to deal with the possibility that the incomes of those people were affected adversely by their health state; all of the individuals in the subsample were reported initially to be in good health[2]. The definitions of good and poor health and the formal structure of the model are dealt with below.

4. THE SLID SURVEY DATA SET

SLID, a national household survey, is primarily concerned with the labour force and income characteristics of respondents. However, questions have been asked also about a variety of other characteristics, including health. The survey follows a panel of about 15,000 households, including about 35,000 adults, for a period of six years. Household members who were present when the household was first interviewed are followed for the entire six year period, even if they move, and changes in household composition are noted. Those who join the household at a later time are counted as members of the household but not followed.

Each household is interviewed twice in each year; labour topics are covered in January, income topics in May. In both cases the questions relate to the previous calendar year. Importantly for our purposes, respondents can opt to have Statistics Canada access their income tax files directly to obtain income information, and thereby avoid the income interview. In 1996, for example, 77 percent of the sample that we have worked with had income information derived from tax files. The quality of the income data is thus improved, and that is one of the strengths of SLID.

The first panel was interviewed in 1994 (when it was asked about income and labour activity in the reference year 1993) and followed each year until 1999 (when it was asked about activity in 1998). The second panel started three years later, in 1997, and a third panel three years after that. Hence for the three years 1997, 1998, and 1999, two panels overlapped (were "active"), and by the end of 1999 about 30,000 households (representing 70,000 adults) had been in the survey for a full three-year period. (In what follows, we adopt Statistics Canada practice and refer to each survey by its reference year rather than the year in which interviews were conducted.)

The questions about health were not asked in the first three years of SLID; hence the first health information is for 1996. At the time of our study useful information was available for respondents in the first panel for 1996, 1997, and 1998 (thereby providing two year-to-year transitions in health status), and for those in the second panel it was available for the four years 1996 through 1999 (thereby providing three transitions). Using both panels roughly doubles the sample size but means that it is not possible to take advantage of the four-year time period for the second panel. We chose the larger sample option (using both panels for three years) but experimented also with the second panel for the four-year period to confirm that the results obtained in that case were essentially similar to those for the three-year period.

After restricting the sample to individuals 50 years of age and older[3] in 1996 who were present in the longitudinal sample in all three years[4], and who were in ‘good health’ (as defined in the next section) in 1996, we were left with 5,812 males and 6,818 females.[5] Summary descriptive statistics relating to the sample are provided in Appendix Tables A1 and A2.

5. INTERPRETING THE SURVEY HEALTH STATUS RESPONSES

The SLID questions pertaining to self-reported health are the following: “Compared to other people your age, how would you describe your state of health? Would you say it is excellent, very good, good, fair, or poor?” We have combined the responses into a binary form: *good health* is defined for our purposes to include health states reported as “excellent”, “very good”, and “good”; *poor health* is defined to include “fair” and “poor” health. In addition, we have used information from the survey to classify respondents who became institutionalized or died to the “poor health” category[6]. Changes in health status over the three-year period could be defined in a variety of ways. We decided to work with a variable which we refer to as *continued good health*, with value one if the respondent remained in good health in both 1997 and 1998, zero otherwise.

The health status question is sometimes answered by proxy, as are all questions, and SLID includes a flag to indicate whether the questionnaire is answered in that way. In our sample, 44 percent of respondents consistently self-reported, 17 percent were consistently reported by proxy, and the remaining 39 percent were a mixture. We found no obvious differences between the health status of respondents who consistently self-reported and those whose health status was consistently reported by proxy: about 80 percent experienced continued good health in both cases. However, the proportion fell to about 74 percent for those who self-reported in some years and were reported by proxy in others. The difference no doubt reflects two confounding effects: a change in who reports might influence the reporting of health status and a change in health status might affect who reports. Our decision was to use all responses, both proxy and self-reported.

6. PERIOD vs. LIFETIME INCOME

One would expect that if there is an effect of income on health it would be more in the nature of a cumulative effect rather than one based on annual income in any given year; at least income in earlier periods of a person's life might bear on his/her current health status, if indeed there is an income effect. Some sort of wealth measure would be a more appropriate variable than income to represent the influence of household resources on health, in that it would come closer to reflecting an individual's previous income history at the time of the survey. But wealth is not reported in SLID, only annual income, and so we have had to make do with that. To come closer to a wealth type of measure, though, we introduced a procedure to standardize household income across individuals of different ages in our older population subsample to obtain what can be thought of as an indicator of lifetime income. What we do is to establish a regression relationship between the household income of an individual, as dependent variable, and the individual's age and other characteristics, and use that relationship to estimate what income would have been when the individual was in the age group 50-54, as distinguished from his/her age group at the time of the survey. In that way the incomes of all individuals in our subsample – individuals 50 and over and in good health in the initial year of the survey period – are placed on a comparable basis at an age well prior to normal retirement age; to the extent that income is generated by employment, the constructed measure may be thought of as reflecting household earning power at a prime time in a person's working life. This is not a perfect solution to the problem of not having a proper wealth variable or an income history to work with but we think it preferable to using unadjusted annual income. Annual income will vary with age, of course, especially as between individuals of working age and those of retirement age. By adjusting the income variable to a standard age for all individuals we thus hope to get a clearer picture of the pure effect of income on health, separate from the effect of age.

The details of the income standardization procedure are as follows. Let Y_{i0} be the annual family income for individual i in survey year 0, expressed as a ratio to the Statistics Canada "low income cut-off" (LICO); the income variable is thus defined relative to a low income level that is often interpreted (although not by Statistics Canada) as a "poverty line" for a family with similar characteristics[7]. Also, let A_{i0} be the age group to which the individual belongs in that year and let Z_i be a vector of variables representing other observed characteristics of the individual. The relationship used for making the adjustment is then of the form

(1) $\ln Y_{i0} = f(A_{i0}, Z_i) + \varepsilon_i$

where f stands for "function of" and ε_i is an error term that can be thought of as representing the effects on relative income of unobservable individual characteristics. In practice f is treated as a linear regression function and estimated in a straightforward way by least squares.

Nine age groups are identified and represented in the equation by dummy variables (5-year groups from 50-54 to 85-89, plus 90 and over). The remaining explanatory variables, represented by Z_i, include the LICO variable and dummy variables for province of residence (10), education category (4), marital status (5), period of immigration or nonimmigrant status (4), and rural/urban category (4). (One dummy variable is dropped from each set in estimation to avoid a well known singularity problem.) Separate equations were estimated for males and females, and are shown in Appendix Table A3.

Equation (1) having been obtained, the age-standardized relative income variable for individual i is then calculated as

(2) $\ln \overline{Y}_i = f(A_i = \overline{A}, Z_i) + \varepsilon_i$

where $\overline{A}$ stands for 50-54, the age group chosen for standardization. Note that by including ε_i the effects of unobservable characteristics are maintained: if the individual's relative household income is above or below the conditional mean in year 0, as calculated from the regression function, it is assumed to have been similarly above or below in the year in which the individual was 50-54. The adjustment is thus a pure age adjustment. It is intended to answer the following question: Given the characteristics and reported household income of an individual at the time of the survey, what is the best estimate of what that individual's relative family household would have been when he/she was 50-54?

The final step is to sort the standardized relative incomes into quartile groups. A set of dummy variables is thus defined, R_{ij} (j = 1,2,3,4), representing the quartile group in which an individual is located, based on his/her relative household income:

(3) $R_{ij} = Q_j(\overline{Y}_i)$

where Q_j is an operator that determines whether the individual is in quartile group j. R_{ij} is 1 if individual i is in quartile j, 0 otherwise.

7. OTHER INDIVIDUAL CHARACTERISTICS

In addition to the relative income variable, the health change models reported in this study include variables representing an individual's age category, education level, and possible change in marital status. Age category and education level, like the relative income variable, are defined as of 1996, and appear as binary dummy variables. There are nine age categories (50-54, 55-59, ..., 85-89, and 90+, with 50-54 as the reference group for regression purposes) and four education levels (less than grade 11; grade 11 to high school diploma, the reference group; some post-secondary, and university bachelor's degree or higher). Marital status is the only variable defined in terms of change from 1996 (rather than state in 1996): "became non-married" is a binary variable that indicates whether or not a survey respondent changed to non-married status during the survey period 1996-1998 because of separation, divorce, or death of a spouse.

8. ENVIRONMENTAL CHARACTERISTICS

We think of environmental characteristics as features of an area (larger or smaller) in which a respondent resides that may affect his/her health status. As with the individual level characteristics, we define the area characteristics as binary dummy variables. The rural/urban variable indicates whether a respondent resides in a rural area (value 1) or an urban area (value 0). Province is represented by 10 dummy variables, with Ontario chosen as reference category (and thus omitted).

We include also a number of variables representing other area characteristics: average family income, incidence of poverty (defined as the percentage of economic families below the low income cut off), population density, proportion of population aged 15 and older with university degrees, and the proportion who are immigrants. These variables are defined at the enumeration area (EA) level except for incidence of poverty, which can be calculated only at the census sub-division (CSD) level. A database for 1996 EAs and CSDs in Canada was created from 1996 census data and dummy variables derived to indicate whether a given area was above or below the Canadian median[8]. This database of area characteristics was then merged with our SLID subsample to provide area characteristic dummy variables for each respondent.

9. MODELLING THE GOOD-TO-POOR HEALTH TRANSITION

The models that we use to assess the health effects of income and other variables focus on individuals of age 50 or more who are reported to be in what we define as good health in the initial year for which SLID provides health status data, and on their maintenance or loss of good health in subsequent years. More specifically, letting H denote health state, G good health, and P poor health, we model the probability of transition from $H = G$ to $H = G$ and (by subtraction from 1) the probability of transition from $H = G$ to $H = P$. The model, in general form, is

(4) Prob $(H_{it} = G, t > 0 | H_{i0} = G) \;=\; f(R_{ij}, A_{i0}, E_i, X_i) + \eta_i$

where the symbols not defined previously are E_i, the education level of individual i, X_i, a vector of all explanatory variables other than the income, age and education variables, and η_i, an individual-specific error term representing all effects on health transitions not captured elsewhere in the model.

We report, in Tables 1 and 2, four estimated probit models for each of males and females, being variants of the model just described and differing only with respect to the inclusion or exclusion of particular explanatory variables. (To avoid constraining the functional form, all variables are expressed as dummy variables.) Model 1 is the most basic one of the four; it includes as explanatory variables only relative income quartile group, age group, education category, the rural/urban variable, and the "became non-married" variable. Model 2 is the same except that it includes also variables representing province of residence. Model 3 drops the province variables but adds five other environmental characteristics variables. Model 4 includes all of the variables in the preceding three. The estimated incremental effects of the explanatory variables on the probability of remaining in good health in each of the models – the ΔP columns – are shown in the tables, along with the associated p-values (the probabilities of obtaining the estimated probit coefficients under the null hypothesis that the variables in fact have no effects). Also, p-values for groups of variables (and for some of the individual ones, repeated) are provided in Table 3, based on the all-inclusive Model 4[9].

10. ASSESSMENT OF THE MODELS

The first point to note in Tables 1 and 2 is that in all cases the models account for about 8 percent of the variation of the health transition probabilities, based on the values of the pseudo-R squared statistic.(The pseudo-R squared statistic is defined as in Judge et al., 1985, p. 767.) At face value then, some 92 percent of the variation is left to be accounted for by unobservable individual characteristics – individual genetic differences, chance exposure to communicable diseases, accidents, etc. The 8/92 percent split does not seem surprising to us.

A second point to note is that all of the incremental probabilities associated with the explanatory variables in Model 1 are quite stable when other variables are added, as in the succeeding models. Of particular interest in this regard is the stability of the income quartile probabilities but the stability associated with the age, education, and other variables is noteworthy too. We have done a considerable amount of experimentation with alternative sets of explanatory variables, including those shown in the tables but others as well, and the fact that the estimated probabilities are robust in the face of different model specifications enhances considerably their credibility.

A third point, which also enhances the credibility of the estimates, is that the incremental probabilities for income quartiles, age groups, and education categories behave in a generally monotonic fashion: those for income quartiles rise from lowest to highest quartile; those for education rise also from lowest category to highest; and while there are some minor reversals, those for age generally decline from youngest to oldest group, as one would expect. The patterns for these three groups of variables are shown in Figures 1, 3, and 4 [10].

The coefficients of the province-of-residence variables introduced in Model 2 do not differ from zero as a group, and in many cases individually, at any level of statistical significance that would suggest rejecting the null hypothesis of no effects (although there are exceptions among the individual coefficients) and there seems to be little consistency in the estimates as between the models for males and females. The probabilities associated with the area variables in Models 3 and 4 are somewhat of a mixed bag too. Based on the p-values, and testing at the 5 percent level, the results suggest for males some effect of population density on the probability of remaining in good health but the same is not true for females. On the other hand, area education level and proportion of recent immigrants in the population seem to have some effect for females but not for males. How much credence should be given to these area variables, and how one might interpret the apparent effects if one believed them, are not clear to us[11]. What is clear though is that the incremental probabilities associated with the relative income quartile, age group, and education category variables are little affected by whether or not the area variables are included. Given that our interest in this paper is largely in the effects of income on health transitions, if we had to choose a single model we would choose Model 1, the most parsimonious of the four.

11. WHAT DO THE MODELS TELL US?

Perhaps the most obvious (but least surprising) point is that age matters. Figure 1 illustrates just how strong the effect is. While the figure shows the estimated effects based on Model 1, the estimates are almost identical for the other models. As compared to the youngest age group, 50-54, the probability of remaining in good health generally declines with age. Furthermore, the effect is similar for men and women, although at each age women are somewhat less likely than men to move from good to poor health. The direction of the age effect is as expected, but the estimated magnitudes of the effect are of interest, as are the male-female differentials.

To assess whether a change in marital status affects health we consider the effects of the "became non-married" variable. In most cases the loss of a spouse for an older person would be through death, but the loss could occur also through separation or divorce. The estimated effect on the transition probability is negative for both men and women, as one might expect. However, for women the effect is very small, and in any case not statistically significant; see Tables 1 and 2 and Figure 2. On the other hand, for men it is both statistically significant and quantitatively important. Indeed, as Figure 2 illustrates, for men who experience such a change in marital status the probability of remaining in good health over a two-year period is reduced by 0.115 (from 0.856, the base case, to 0.741); for women the reduction is only 0.006. These estimates are consistent with the casual observation that women generally have better personal support systems than men, and hence are able to deal better with such a change. We emphasise that for men the effect of this change in marital status is large, exceeding (as we see below) the effect of education or income.

What about education? The estimated transition probabilities, as plotted in Figure 3, indicate that the effect is quite substantial: the probability of staying in good health is about 0.09 greater for a male in the highest education category (university degree) than for someone in the lowest (less than grade 11 completed). For females the difference is 0.14. These results are generally consistent with the international evidence that higher socioeconomic status is associated with a better health outcome. We return to this matter below.

The effect of relative income is a primary focus of this paper. The differences across the relative household income quartiles, as plotted in Figure 4, are substantial. Both men and women in the highest quartile are about 0.07 more likely to remain in good health than are those in the lowest. It is to be emphasised that this is the difference associated with income alone, after taking account of the effects of education and age, and other influences. It is to be emphasised also that the income measure here is not current income (which one might expect to have less of a bearing on health status) but rather an approximate indicator of relative “lifetime income”. Hence the interpretation is that a higher lifetime standard of living is associated with a higher probability of maintaining better health in later life[12].

Higher income individuals are likely also to be in the higher education categories, and we can ask about the combined effect on health status. Based on the Model 1 estimates, we infer that a male in both the highest income and highest education groups is 0.15 more likely than one in the corresponding lowest groups to remain in good health, and a female 0.18 more likely. Based on the survey data that we are using, the combined effects of (lifetime) relative income and education are perhaps our best measure of the influence of socioeconomic status on health.

It is clear that the differences are substantial, but less clear how these results are to be interpreted. What is the link between income and health? Could it be differential exposure to risk factors? We know that individuals lower on the SES scale are also exposed to higher risks associated with their lifestyles (smoking practices, dietary habits) and their work (greater likelihood of accidents or unhealthy environments on the job). However, based on other studies (e.g., Marmot et al., 1978, Evans, 2002), it seems likely that differences in individual risk factors such as smoking, blood pressure, and blood lipid levels (none of which are observed in the SLID data set) would explain only a small fraction of the health differences across income/education groups. As Evans (2002, p. 35) observes, “they are not irrelevant, but ... the individual attributes account for peanuts. The elephants lurk in the background of the social environment.” But what is that “social environment”?

One possible explanation is that higher income and education are both associated with better life skills: the higher your income/education, the better able you are to cope with adversity and stress, and thereby avoid many health problems or, when required, deal with them more effectively. That interpretation would be consistent with recent work by Goldman and Smith (2002), in which they find strong evidence of better self-management of illness among those with more education (the two illnesses considered were diabetes and HIV) and conclude that "self-maintenance is an important reason for the steep SES gradient in health outcomes" (p. 10,929).[13] Another possibility is that in Canada low income people are less likely to visit their doctors even though the visits themselves would be covered by the public insurance system; the patients' concern rather would be supplementary expenses not covered by the insurance system.

12. SUMMING UP

A prime focus of this paper has been the question of how income affects health among the older population. We have addressed that question using Canadian data, and hence within the context of the national health care system that has been in operation in Canada for more than three decades. One might expect that such a system would remove income as a barrier to access, and hence eliminate health inequalities associated with income inequalities. However, our analysis indicates otherwise: we find that people age 50 and older, and in initial good health, are more likely to report continued good health the younger they are, the more education they have, and the higher their incomes. In arriving at this result we have gone to some lengths to control for the bidirectional effects of income (income endogeneity) and to develop a measure that reflects lifetime income, not just current income level. On that basis, and after taking into account age, education, and such other characteristics as can be considered with our data base, we are still left with the conclusion that income matters, for both men and women.

In section 2 we stated that our concern is with *whether* income matters, not with *why*. However, given the evidence that it does matter it is natural to wonder why. One possibility, of course, is that higher income means greater command over resources, including access to adequate nutrition. It could also affect access to health services, even with a universal health care system, if some important elements of care (e.g., prescription drugs, access to health care professionals such as physiotherapists) or the private costs of accessing the system (e.g., transportation) are not covered[14]. It could happen also if the system is "too downstream" – that is, if it is concerned with health-related behaviour and health care delivery and drugs – when the underlying "causes of causes" of disease and death are more "upstream" in the "social and economic structure of society ... " (Deaton, 2002, p. 14; examples might include low income and discrimination). Another possibility is that income acts not only or even primarily as an indicator of command over resources but rather as a marker for social status or position within an occupational hierarchy, and that those with higher income experience less chronic stress because they have greater freedom to make decisions, a possibility that is discussed in Evans (2002) and Deaton (2003), for example. We are not able to explore such hypotheses with data available to us, but they do suggest possible directions for further research.

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ENDNOTES

1. The data consist of all males in the administrative files of the Canada Pension Plan who reached age 65 in the period September 1, 1979, to September 30, 1988.

2. We recognize that this is not a perfect solution. Some respondents may have had a history of poor health, and consequent low income, even though they happened to be in good health at the time of the survey. To the extent that it is the history of poor health that is the proximate cause of the later decline in health, some identification problem remains.

3. As an aside, we note that age 50 is obviously arbitrary. In response to a concern raised by a referee all equations reported below were re-estimated to include all respondents aged 40 and older. We found that the results were little affected: the coefficients of the age dummies for those in the age groups 40-44 and 45-49 did not differ significantly from the coefficients of the omitted age 50-54 dummy (i.e., from zero) and other coefficients changed very little.

4. Individuals can be 'lost' from the panel because they were known to have moved out of the 10 provinces (the survey covers only the provinces, not the territories), they moved and could not be traced, they became institutionalized, or they died. The SLID file notes the reason and we retained the records for those who were institutionalized or died, as noted below.

5. This total allows also for a few observations that were dropped because variables required by the study were not reported.

6. While SLID does not collect information on health status in years in which a respondent is a resident of an institution, the file does indicate that the respondent was institutionalized. That category includes residents of both nursing homes and penal institutions; the few individuals in our sample of the older population who were institutionalized would be almost all in nursing homes.

7. The Statistics Canada calculation of LICO values is done annually to take account of family size and differences in the cost of living among rural and urban areas of different population size. A value so calculated is assigned to each economic family in the SLID sample and reported in the file, along with the survey data collected. See Statistics Canada (various years).

8. For example, if an enumeration area's population density was higher than the Canadian median, calculated across all enumeration areas, then that area's density dummy variable would be equal to 1.

9. The standard errors have been calculated by a bootstrap procedure using 1000 bootstrap weights for each observation as supplied by Statistics Canada, the agency that conducted the survey. The use of this procedure is encouraged by Statistics Canada. The weights are

designed to account for the multistage sampling nature of the survey. See Yeo, Mantel, and Liu (1999, 2001) and Pierard, Buckley, and Chowhan (forthcoming).

10. Because of the experimentation involved in getting to these final tables we were concerned about the statistical tests presented. For that reason we re-estimated Models 1 and 4 for a different two-year time period, 1997 to 1999. Doing so meant that we lost about half of our observations because they could be drawn only from the second SLID panel. The observations differed not only in the years studied but also in who are in good health in the initial year and their levels of income. The results were reassuring: the magnitudes of the coefficients and of the incremental probabilities, and the corresponding p-values, were very close to those reported here. The patterns of the coefficients and probabilities (monotonicity across relative income groups, for example) were also similar.

11. A referee asked why some sort of hierarchical method was not used. A practical problem is the difficulty in using the survey bootstrap weights and hence taking account of the complex survey design while simultaneously taking account of the hierarchical nature of the data. However, to address the concern that was raised we estimated an unweighted hierarchical random effects model, allowing errors in individual responses to be correlated within enumeration areas. We also re-estimated our model without random effects, and without weighting, to provide a proper comparison. The comparison indicated that introducing within-area random effects made virtually no difference to the estimation results. (Indeed, the results were almost the same when the unweighted model, with or without random effects, was compared with the weighted original model.)

12. Deaton (2002, p17) reports estimates based on the US National Longitudinal Mortality Study for the population aged 25-59 that indicate a large and durable protective effect of income on subsequent mortality. After controlling for education, he found that doubling income reduces the probability of mortality by about one quarter for the first five years and by somewhat less for the subsequent five.

13. It is again worth recalling that in trying to isolate the effect of income on health we have analysed the health trajectory only of those who were in good health in the first of the sequence of three surveys. In that way we have tried to minimize any effects that health might have on income. However, we recognize that there may be individuals who were reported as in good health in 1996 but who have moved in and out of good health over their lifetimes, and have lower incomes in consequence; such individuals may be more likely to move into poor health again.

14. Williamson and Fast (1998a, 1998b) report finding that many respondents on social assistance (all of whom were poor) reported failing to see a doctor when they needed to either because they thought the doctor would prescribe medication that they could not afford (the most common reported concern) or because they could not afford the transportation cost. Also, many respondents reported not filling prescriptions that had been written for them because they could not afford to do so.

Figure 1. Age Effects, Model 1

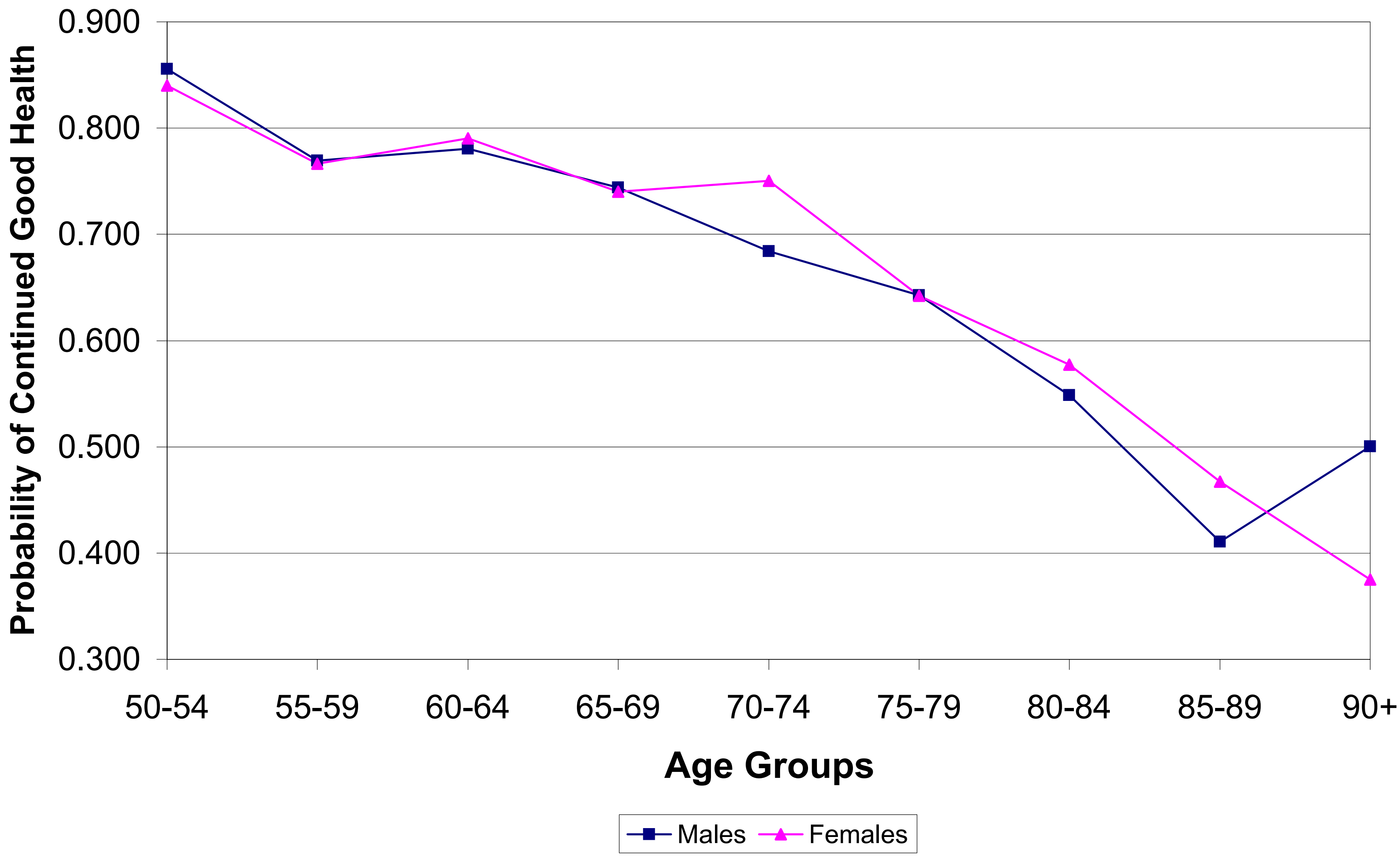
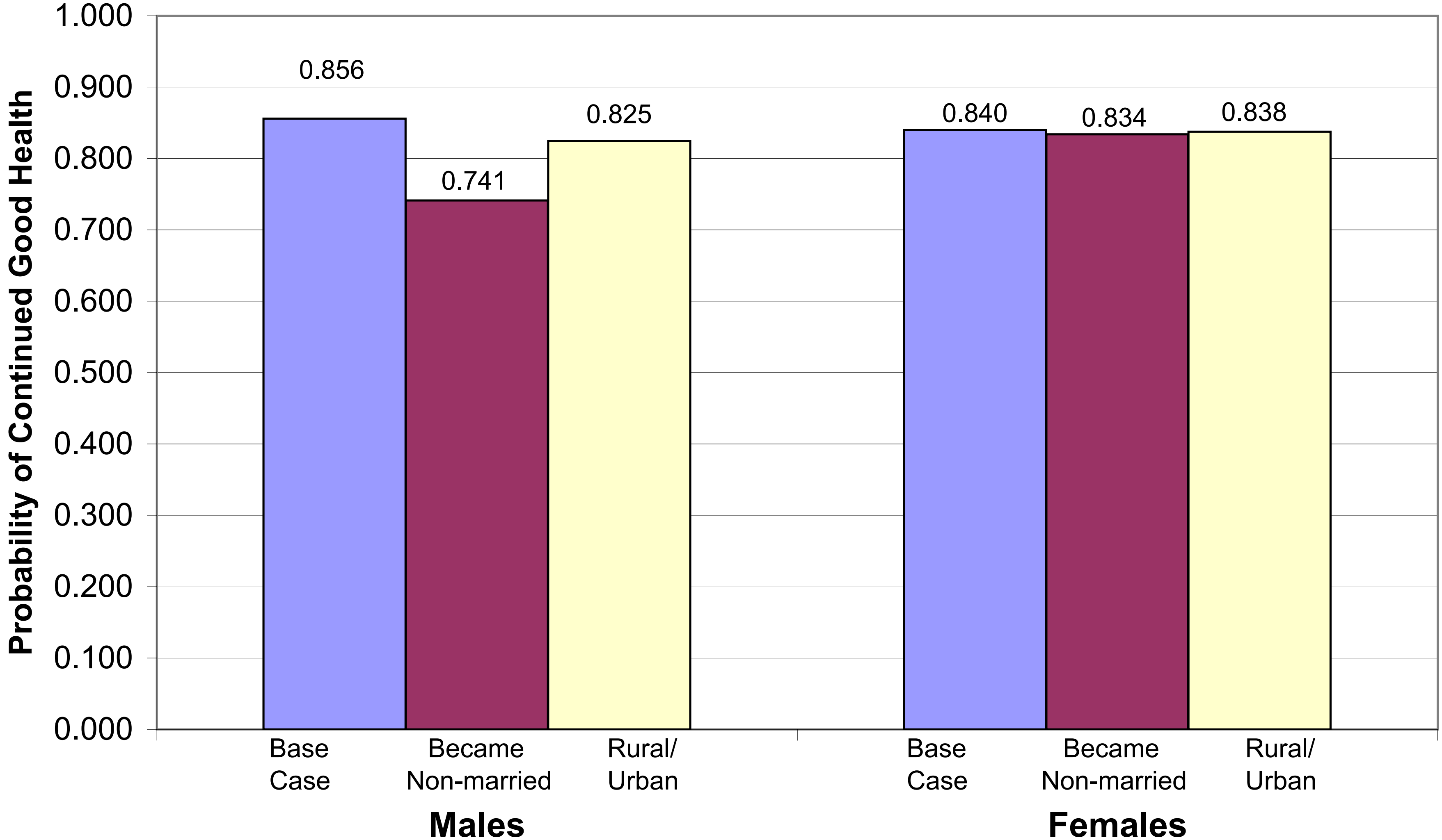


Figure 2. Marital Status Change and Rural/Urban Effects, Model 1



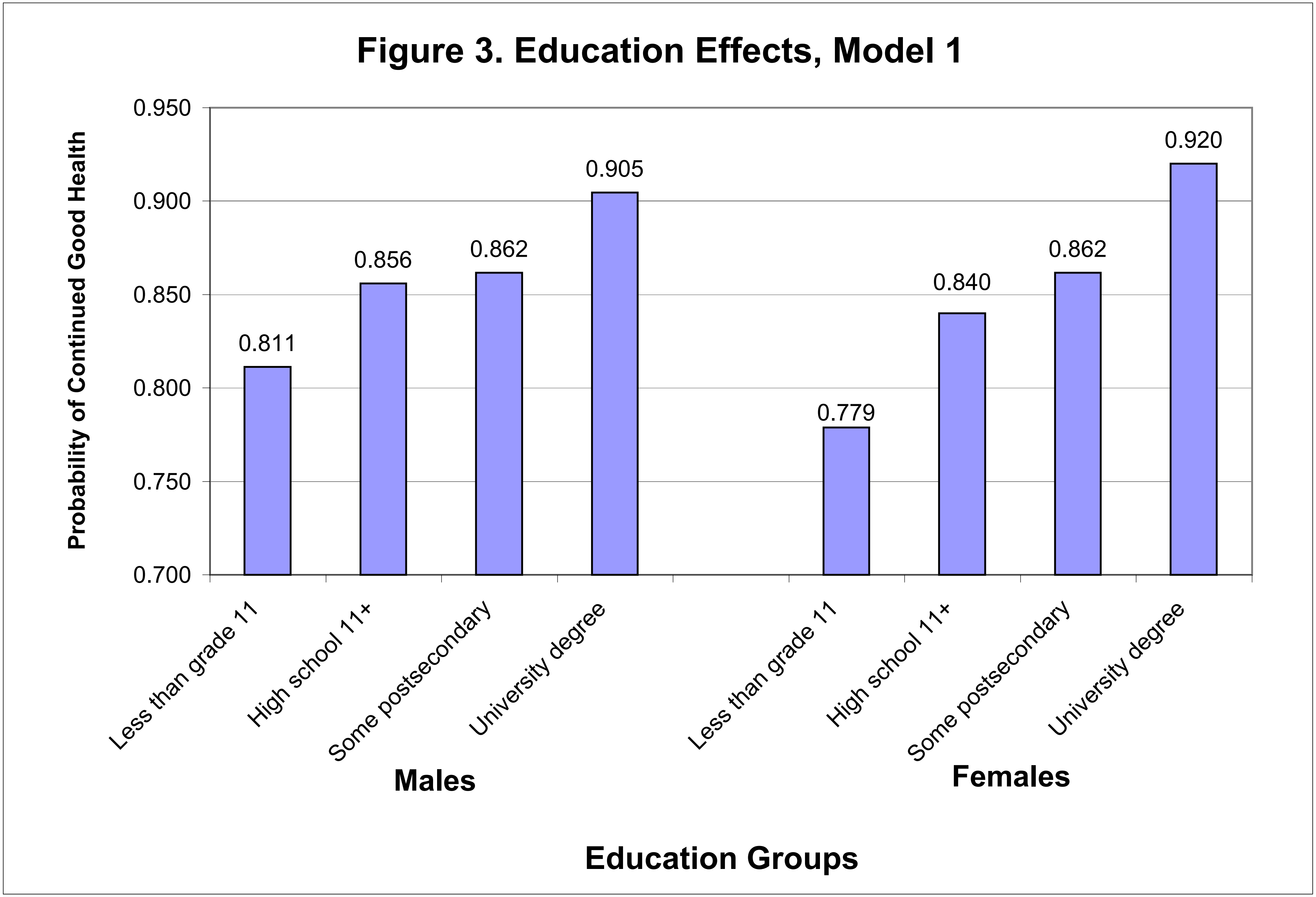


Figure 3. Education Effects, Model 1
Probability of Continued Good Health
0.950
0.900
0.850
0.800
0.750
0.700
0.811
0.856
0.862
0.905
0.779
0.840
0.862
0.920
Less than grade 11
High school 11+
Some postsecondary
University degree
Less than grade 11
High school 11+
Some postsecondary
University degree
Males
Females
Education Groups

Figure 4. Relative Income Effects, Model 1

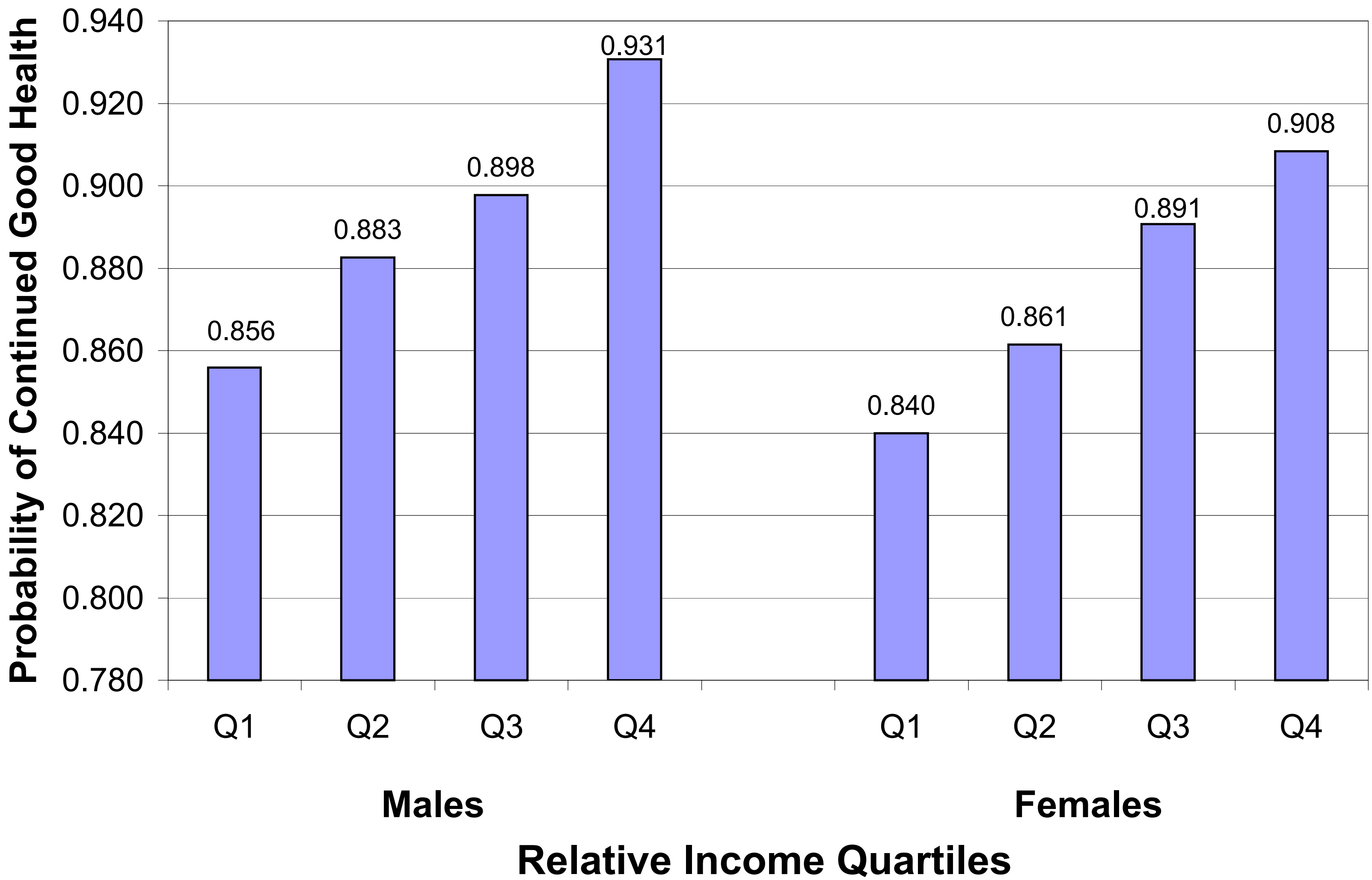


Table 1. Probit Regression Models of Health Transition Probabilities: Males

Independent	Model 1		Model 2		Model 3		Model 4	
Variable	**ΔP**	***p-value***	**ΔP**	***p-value***	**ΔP**	***p-value***	**ΔP**	***p-value***
Individual characteristics								
Income quartile: 1	–	–	–	–	–	–	–	–
2	0.0268	*0.090*	0.0290	*0.083*	0.0282	*0.085*	0.0302	*0.077*
3	0.0420	*0.006*	0.0447	*0.006*	0.0435	*0.006*	0.0457	*0.006*
4	0.0749	*0.000*	0.0794	*0.000*	0.0775	*0.000*	0.0811	*0.000*
Age group: 50-54	–	–	–	–	–	–	–	–
55-59	-0.0864	*0.000*	-0.0887	*0.000*	-0.0911	*0.000*	-0.0925	*0.000*
60-64	-0.0752	*0.002*	-0.0781	*0.002*	-0.0794	*0.002*	-0.0815	*0.002*
65-69	-0.1116	*0.000*	-0.1169	*0.000*	-0.1173	*0.000*	-0.1210	*0.000*
70-74	-0.1717	*0.000*	-0.1763	*0.000*	-0.1810	*0.000*	-0.1834	*0.000*
75-79	-0.2133	*0.000*	-0.2234	*0.000*	-0.2228	*0.000*	-0.2298	*0.000*
80-84	-0.3074	*0.000*	-0.3161	*0.000*	-0.3202	*0.000*	-0.3257	*0.000*
85-89	-0.4453	*0.000*	-0.4560	*0.000*	-0.4512	*0.000*	-0.4591	*0.000*
90+	-0.3556	*0.006*	-0.3679	*0.006*	-0.3753	*0.005*	-0.3824	*0.005*
Edn: Less than grade 11	-0.0446	*0.027*	-0.0436	*0.041*	-0.0430	*0.044*	-0.0422	*0.056*
High school 11+	–	–	–	–	–	–	–	–
Some postsecondary	0.0060	*0.759*	0.0061	*0.766*	0.0069	*0.733*	0.0066	*0.754*
University degree	0.0488	*0.027*	0.0512	*0.030*	0.0506	*0.034*	0.0517	*0.039*
Became non-married	-0.1148	*0.038*	-0.1197	*0.041*	-0.1202	*0.038*	-0.1237	*0.041*
Environmental characteristics								
Rural/urban	-0.0311	*0.078*	-0.0354	*0.064*	-0.0352	*0.104*	-0.0369	*0.104*
Province: NF			0.0490	*0.021*			0.0447	*0.076*
PEI			-0.0065	*0.840*			-0.0057	*0.867*
NS			-0.0122	*0.645*			-0.0163	*0.587*
NB			0.0356	*0.095*			0.0304	*0.218*
QC			-0.0022	*0.913*			-0.0011	*0.963*
ON			–	–			–	–
MB			0.0290	*0.230*			0.0275	*0.299*
SK			0.0229	*0.361*			0.0219	*0.077*
AB			0.0115	*0.604*			0.0098	*0.082*
BC			0.0403	*0.061*			0.0395	*0.534*
Area: Income					-0.0187	*0.246*	-0.0180	*0.299*
Poverty					-0.0315	*0.064*	-0.0321	*0.077*
Density					0.0298	*0.040*	0.0270	*0.082*
Education					0.0079	*0.624*	0.0103	*0.534*
Immigration					0.0163	*0.250*	0.0119	*0.509*
No. of observations	5812		5812		5812		5812	
Pseudo R^2	0.0753		0.0779		0.0782		0.0803	

Note: ΔP is the estimated change in the probability of continuing in good health due to the discrete change from 0 to 1 in the value of a dummy variable. A p-value corresponds to a two-tailed test of the null hypothesis that the underlying coefficient is zero, calculated using all 1000 bootstrap weights provided with the Statistics Canada data. Variables are defined in the text.

Table 2. Probit Regression Models of Health Transition Probabilities: Females

Independent	Model 1		Model 2		Model 3		Model 4	
Variable	ΔP	*p-value*	ΔP	*p-value*	ΔP	*p-value*	ΔP	*p-value*
Individual characteristics								
Income quartile: 1	–	–	–	–	–	–	–	–
2	0.0215	*0.223*	0.0251	*0.189*	0.0194	*0.248*	0.0219	*0.227*
3	0.0508	*0.003*	0.0578	*0.002*	0.0465	*0.004*	0.0513	*0.003*
4	0.0685	*0.000*	0.0784	*0.000*	0.0625	*0.000*	0.0693	*0.000*
Age group: 50-54	–	–	–	–	–	–	–	–
55-59	-0.0734	*0.003*	-0.0776	*0.003*	-0.0717	*0.003*	-0.0753	*0.003*
60-64	-0.0495	*0.057*	-0.0536	*0.054*	-0.0467	*0.060*	-0.0502	*0.056*
65-69	-0.0998	*0.000*	-0.1062	*0.000*	-0.0961	*0.000*	-0.1020	*0.000*
70-74	-0.0895	*0.001*	-0.0928	*0.001*	-0.0864	*0.001*	-0.0896	*0.001*
75-79	-0.1978	*0.000*	-0.2087	*0.000*	-0.1916	*0.000*	-0.2025	*0.000*
80-84	-0.2627	*0.000*	-0.2766	*0.000*	-0.2548	*0.000*	-0.2680	*0.000*
85-89	-0.3729	*0.000*	-0.3829	*0.000*	-0.3656	*0.000*	-0.3756	*0.000*
90+	-0.4647	*0.000*	-0.4764	*0.000*	-0.4640	*0.000*	-0.4761	*0.000*
Edn: Less than grade 11	-0.0610	*0.002*	-0.0651	*0.002*	-0.0571	*0.002*	-0.0583	*0.004*
High school 11+	–	–	–	–	–	–	–	–
Some postsecondary	0.0218	*0.192*	0.0222	*0.222*	0.0191	*0.233*	0.0194	*0.259*
University degree	0.0802	*0.003*	0.0877	*0.003*	0.0734	*0.005*	0.0791	*0.005*
Became non-married	-0.0062	*0.864*	-0.0070	*0.859*	-0.0049	*0.886*	-0.0053	*0.885*
Environmental characteristics								
Rural/urban	-0.0023	*0.881*	-0.0089	*0.616*	0.0077	*0.657*	0.0076	*0.693*
Province: NF			0.0552	*0.040*			0.0431	*0.131*
PEI			0.0691	*0.007*			0.0500	*0.071*
NS			0.0351	*0.152*			0.0194	*0.468*
NB			0.0040	*0.860*			-0.0135	*0.592*
QC			0.0197	*0.300*			0.0100	*0.621*
ON			–	–			–	–
MB			0.0298	*0.166*			0.0237	*0.270*
SK			0.0454	*0.046*			0.0314	*0.197*
AB			0.0418	*0.084*			0.0372	*0.111*
BC			0.0332	*0.120*			0.0348	*0.083*
Area: Income					-0.0179	*0.228*	-0.0173	*0.289*
Poverty					0.0118	*0.406*	0.0137	*0.382*
Density					-0.0152	*0.322*	-0.0193	*0.244*
Education					0.0263	*0.052*	0.0291	*0.048*
Immigration					-0.0291	*0.046*	-0.0314	*0.093*
No. of observations	6818		6818		6818		6818	
Pseudo R^2	0.0772		0.0792		0.0808		0.0827	

Note: See note to Table 1.

Table 3. p-values for Hypothesis Tests Based on Model 4

	Males	Females
Income categories	≤0.001	0.001
Age categories	≤0.001	≤0.001
Education categories	≤0.001	≤0.001
Became non-married	0.014	0.891
Environmental characteristics (all)	0.119	0.017
Rural/urban	0.104	0.693
Province	0.317	0.129
Area characteristics	0.205	0.032

Note: All tests use the null hypothesis that the coefficient or coefficients involved are equal to zero, calculated using all 1000 bootstrap weights provided with the Statistics Canada survey data.

APPENDIX TABLES

Table A1. Weighted Samples Frequencies for Population 50 and Over: Health Status

Sex	Health Status	1996	1997	1998
Male	Excellent	24.55	23.31	20.57
	Very good	39.75	35.00	35.74
	Good	35.69	28.66	28.64
	Fair	–	9.21	9.57
	Poor	–	2.59	2.71
	Institutionalized	–	0.25	0.42
	Deceased	–	0.97	2.36
	Total	100.00	100.00	100.00
Female	Excellent	20.39	17.27	16.71
	Very good	40.16	36.46	37.09
	Good	39.45	32.25	30.67
	Fair	–	10.38	9.95
	Poor	–	2.45	2.82
	Institutionalized	–	0.29	0.78
	Deceased	–	0.90	1.98
	Total	100.00	100.00	100.00

Table A2. Weighted Sample Frequencies for Population 50 and Over: Other Variables

Variable	Percentage of sample	
	Male	Female
Continuing good health	78.7	77.6
Age group: 50-54	25.9	22.0
55-59	19.0	16.5
60-64	15.5	14.0
65-69	15.2	14.4
70-74	11.5	14.5
75-79	6.7	9.6
80-84	4.1	5.8
85-89	1.4	2.5
90+	0.7	0.8
Education: Less than grade 11	36.7	38.7
High school 11+	17.0	21.9
Some postsecondary	32.1	32.0
University degree	14.2	7.4
Became non-married	2.0	3.1
Rural/urban	12.4	11.3
Province: NF	1.9	1.9
PEI	0.5	0.5
NS	3.0	3.1
NB	2.7	2.6
QC	27.0	27.6
ON	36.7	36.9
MB	3.5	3.6
SK	3.0	3.2
AB	8.2	7.7
BC	13.6	13.1
Area: Income	37.8	38.2
Poverty	22.4	19.5
Density	37.0	34.0
Education	56.4	54.9
Immigration	52.3	54.2

Note: Income variables used in the study are in the form of quartile groups and are thus not shown in this table.

Table A3. OLS Regressions for ln(Y)

Independent Variable	Males		Females	
	Coefficient	*p-value*	Coefficient	*p-value*
Constant	0.5948	*0.388*	-4.4747	*0.000*
Age group: 50-54	–	–	–	–
55-59	-0.0821	*0.044*	-0.1147	*0.004*
60-64	-0.1924	*0.000*	-0.1874	*0.000*
65-69	-0.2005	*0.000*	-0.0950	*0.012*
70-74	-0.2509	*0.000*	-0.1126	*0.004*
75-79	-0.2860	*0.000*	-0.1555	*0.000*
80-84	-0.4037	*0.000*	-0.1965	*0.000*
85-89	-0.4186	*0.006*	-0.2461	*0.000*
90+	-0.0753	*0.681*	-0.2192	*0.016*
Edn: Less than grade 11	-0.1961	*0.000*	-0.2568	*0.000*
High school 11+	–	–	–	–
Some postsecondary	0.0149	*0.648*	0.0749	*0.010*
University degree	0.3780	*0.000*	0.2838	*0.000*
Marital Status: Single	-0.5223	*0.000*	-0.2970	*0.000*
Married	–	–	–	–
Separated	-0.3545	*0.000*	-0.6567	*0.000*
Divorced	-0.2770	*0.001*	-0.4989	*0.000*
Widowed	-0.0783	*0.157*	-0.2807	*0.000*
Immigration: Non-immigrant	–	–	–	–
0-10 yrs. ago	-0.2901	*0.221*	-0.4719	*0.008*
11-14 yrs. ago	-0.5267	*0.000*	-0.4474	*0.002*
15+ yrs. ago	-0.0603	*0.045*	-0.0831	*0.023*
Location: CMA	–	–	–	–
CA	0.0317	*0.314*	0.1026	*0.000*
Other urban	0.0598	*0.065*	0.1578	*0.000*
Rural	0.1013	*0.016*	0.2947	*0.000*
Province: NF	-0.3172	*0.000*	-0.3371	*0.000*
PEI	-0.1923	*0.000*	-0.1641	*0.000*
NS	-0.1849	*0.000*	-0.2275	*0.000*
NB	-0.1826	*0.000*	-0.2252	*0.000*
QC	-0.2715	*0.000*	-0.2636	*0.000*
ON	–	–	–	–
MB	-0.2332	*0.000*	-0.2235	*0.000*
SK	-0.1333	*0.009*	-0.0900	*0.030*
AB	-0.1857	*0.000*	-0.1835	*0.000*
BC	-0.0970	*0.038*	-0.0958	*0.007*
ln(LICO)	0.0545	*0.421*	0.5547	*0.000*
No. of observations	5804		6807	
R^2	0.2189		0.2783	

Note: A p-value corresponds to a two-tailed test of the null hypothesis that the coefficient is zero, calculated using all 1000 bootstrap weights provided with the Statistics Canada survey data. Variables are defined in the text.