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CAREER EARNINGS AND DEATH:
A Longitudinal Analysis of Older Canadian Men

by

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Career Earnings and Death:

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ABSTRACT

There is widespread interest in disparities in health status across income groups and other classifications of socio-economic status. In Canada, as in many other countries, there is considerable evidence showing such disparities. This study reports an analysis of male mortality at ages 65 to 74 in relation to socio-economic characteristics, specifically employment and self-employment earnings histories during the 10 to 20 years prior to age 65, marital status, disability, and age at retirement. The analysis is based on administrative data from the Canada Pension Plan covering more than 500,000 individuals. Significant mortality gradients are found throughout the earnings spectrum. These gradients are also clearly evident in a multivariate context. The results illustrate the major potential of administrative data for research. Substantively, the results cast doubt on the primacy of causal explanations such as "reverse causality" and "health selection," and raise important questions regarding pension and health policy.

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Introduction

This paper reports new longitudinal evidence of a strong positive association between mid-to-late career earnings of Canadian men and their subsequent survival after age 65. These results corroborate widespread international evidence that individuals who are economically or socially better off also live longer and are healthier. This contrasts with other evidence that, in Canada at least, broad-based public health insurance has succeeded in providing generally equal access to medical care irrespective of income (Broyles et al., 1983; Manga, Broyles, and Angus, 1987). The juxtaposition of these two lines of evidence is potentially disturbing. Why do socio-economic status gradients in health persist in a society with apparently equal access to medical care? Have we overvalued medical care as compared to other determinants of population health -- for example as discussed by McKeown (1984); or have we overstated the extent of equal access to medical care? These questions are particularly important in light of the large volume of resources consumed by medical care services.

Given the seriousness of the questions raised, evidence on socio-economic gradients in health status has been subject to intensive review and criticism, particularly in the U.K. (e.g., the "Black Report," Townsend and Davidson, 1988, and the extensive review in West, 1991). The debate over the Black Report has highlighted two major concerns -- the quality and reliability of the evidence of socio-economic gradients, and the causal interpretation of any gradients. The basic question relating to causality is whether lower income, or lower social status more generally, leads (via a series of more proximate variables) to poorer health, or the reverse.

This paper reports further evidence relating socio-economic and health status. More precisely, we present a longitudinal analysis of post-age-65 male mortality in relation to employment income over the previous ten to twenty years. The major questions addressed by the analysis are the extent and shape of the relationship between earnings and mortality, the importance of other variables such as marital status, and whether any light can be shed on competing causal hypotheses. The analysis is based on public pension plan administrative data, so the data are of exceptionally high quality, though limited in breadth. With a cohort size of over 500,000, the statistical reliability of the results is assured. The main conclusions of the analysis are clear -- higher earnings for males in late middle age (age 45 to 64) are associated with significantly lower mortality at older ages (65 to 74).

The plan of the paper is first to review briefly some of the studies that have examined mortality gradients in relation to socio-economic status variables. Then the series of results using the Canada Pension Plan data is developed starting with more straightforward bivariate relationships and then moving to a multivariate statistical analysis.

Background

A number of questions arise in considering associations between health and socio-economic status, particularly income or social class. One major question is the magnitude and shape of the relationship. Another much more difficult question concerns causal pathways. If higher income individuals live longer, is it because they are healthier to start, or does higher income itself predispose individuals to both better health and greater longevity? Or is the causal story far more complex? In principle, the only way to address these questions of causality is by a careful experiment which by its very nature would be both practically and ethically infeasible. Thus, only indirect and weaker methodologies are available. Much of the evidence is reviewed in D'Arcy (1989), Blaxter (1986), and West (1991). Following is a brief and very selective summary.

The Black Report (Townsend and Davidson, 1988) is one of the major studies in this area. It aroused a great deal of interest with its conclusion that disparities in mortality rates by social class were considerable, and that they were widening over time. One concern expressed about these results is the reliability of the occupation variable used to define a set of social classes and hence to measure socio-economic status (SES). Another concern is the grouped nature of the data; mortality rates were computed by age group, sex, and one of five social classes. No individual data were used so there could be considerable heterogeneity within each of these groups. Finally, the data are a sequence of cross-sectional snapshots of the British population. Thus, while correlations may be clearly evident, it is not possible to draw inferences about whether low social class leads to higher mortality, for example, or poor health leads to both, though the report argued for the former interpretation.

More detailed results for the U.K. have been derived from a longitudinal follow-up of one percent samples from both the 1971 and 1981 census (Fox, Goldblatt, and Jones, 1985; Goldblatt, 1989). These data do not suffer from the disadvantages just noted, other than problems regarding the use of "social class" defined in terms of occupation. These results also show significant and widening mortality differences.

The first major study in the U.S. to consider individual level correlations of mortality with income and other SES variables was Kitigawa and Hauser (1973). Their results were based on the 1960 census and matched death certificates for the four months immediately following the month of the census. As is characteristic of North American analyses, the focus was on income and educational attainment as the indicators of SES, rather than social class as in the U.K. Kitigawa and Hauser found higher incomes associated with lower mortality among the non-elderly, but not among those over age 65. A modest gradient with educational attainment was found for men age 65 to 74, however. Since income and education are correlated, this latter association may have been due to education acting as a proxy for income levels at earlier ages.

More broadly, these data are essentially a cross-sectional snapshot, so that the available current year income variable may be only an attenuated indicator of career or lifetime socio-economic status. Rogot et al. (1988) provide more recent and extensive results, based on a two year mortality follow-up for a representative sample of almost one million individuals. The data show clear mortality gradients among white males (the relevant group for comparison with the results presented below), both by income and by educational attainment within virtually all age ranges.

In Canada, the only broad-based population studies to date are based on grouped rather than individual data. Wigle and Mao (1980) used death certificates matched to average incomes of census tracts for the 1971 census. This analysis has been updated by Wilkins, Adams, and Brancker (1989) using 1986 census data. The two studies show clear gradients in mortality by SES indicators for the community, with an apparent decline in the magnitude of the gradient over the fifteen year period.

In addition to these broad national studies, many studies focus on more specific populations. Marmot (1986) shows a pronounced gradient in mortality over a ten year period by occupational grade in the U.K. civil service. In addition, a large number of variables such as family background, elements of blood chemistry, and other risk factors were ascertained at the beginning of the study. An important finding is that SES gradients remain even after controlling for risk factors such as smoking. Hirdes and Forbes (1989) report a strong association of mortality with income in a multivariate analysis from the 20 year Ontario Longitudinal Study of Aging. They also found that after controlling for smoking, the association of mortality with income remained significant, though the association with education did not.

The study most similar to this one in terms of data used is that of Duleep (1986, 1989), which uses a special sample of Social Security administrative data which has been exactly matched to death certificates in a six year follow-up period, and to a Census Bureau sample (the March Current Population Survey) giving data on other SES variables such as family income. From the Social Security data, Duleep thus has year-by-year employment earnings for the years prior to 1972, and year-by-year survival for the years 1973 to 1978. The analyses focus on a sample of about 10,000 white married males aged 35 to 65 (in 1972).

Controlling for education, Duleep (1986) finds a very large income effect on mortality at low levels of income, but that above average-income is not significantly associated with mortality, suggesting that the effect of income per se decreases with its level. Leaving education out of the estimation, however, Duleep (1989) found an income gradient throughout the income spectrum, with those earning more than about $40,000 (in 1988 dollars, her top income group) having lower mortality than those earning between $30,000 and $40,000. Income continued to have a strong effect on mortality even taking account of health problems preceding or concurrent with the measurement of income. She also found that earnings averaged over several years have a stronger effect than a single year's earnings, suggesting that studies based on only one year's earnings might understate the association of income and mortality.

Moore and Hayward (1990) corroborate this latter point with their longitudinal analysis of occupational associations with mortality among elderly men. They found that longest as well as most recent occupation are significantly associated with subsequent mortality, as was family income.

The Data

For this analysis, data have been drawn from the administrative records of the Canada Pension Plan (CPP). This is a public earnings-related pension covering (along with the identical Quebec Pension Plan, QPP) 100 percent of the Canadian paid labor force. The plans commenced in 1966. For their operation, employment earnings (both of employees and the self-employed) are subject to a payroll tax administered annually as part of the income tax system. In turn, everyone who has contributed for at least three years is eligible for a retirement pension (normally at age 65) and a lump sum death benefit. The retirement pension depends on year-by-year employment earnings between the ages of 18 and 65 according to a complicated formula.

Given this program structure, virtually everyone who has worked in Canada outside the province of Quebec and who attains age 65 will become a beneficiary of the CPP. The year and month of death are recorded on the administrative data file both for purposes of terminating retirement pension benefits and to pay the lump sum death benefit. Revenue Canada Taxation is the source of the employment income numbers while individuals are contributing to the CPP. The CPP file also contains earnings data from the QPP so there are no missing earnings data for CPP beneficiaries who spent parts of their working careers in the province of Quebec. Thus, both the date of death and the year-by-year earnings history variables are considered to be of high quality. The major limitation of these data is the small range of variables available. There is, for example, almost no information on health status and none on occupation.

The CPP beneficiary file that has been used contains over 5 million records. The analysis reported here is restricted to males who attained age 65 on or after September 1, 1979 (545,769 individuals). Males were selected as the starting point for the analysis because their earnings are assumed to be more indicative of their socio-economic status. The specific date was chosen for two reasons. First, the CPP/QPP had been in existence for over a decade, so the take-up rate for retirement pensions was virtually 100 percent. Second, this assured at least 13 years of year-by-year earnings history prior to attaining age 65 for all the observations used. Just over 10 percent

of this population (55,101) had died by September 30, 1988 -- nine years and one month later -- the cut-off point used when the data were extracted from the administrative file in the Spring of 1989.

The CPP population generally comprises the majority of the relevant population. For example, 87 percent of all males age 55 to 59 in 1986 are recorded in Revenue Canada's personal tax return files as having contributed to the CPP or QPP at some point in the last 20 years. (The CPP and QPP are sufficiently similar that the joint figures are highly indicative of the patterns for the CPP population alone.) Another 2 percent contributed but did not file tax returns. Most of those who were not CPP/QPP contributors had very low incomes.

Table 1 gives more details for all Canadian males age 55 to 59 based on data from personal income tax returns for 1986, and from the 1986 census. The estimated 549,000 male tax filers in this age range were divided into percentile groups as shown in the first column. The second column shows the maximum total income of the tax filers in each group. The third column shows the proportion that had ever contributed to the CPP/QPP. This proportion is over 95 percent except in the bottom fifth, and is 61.5 percent for the bottom 10 percent. This corresponds to the fact that many of those in the lowest income ranges are receiving income from sources other than their own earnings or self-employment -- for example from bond and bank interest, dividends, private pensions, welfare, and the incomes of other family members.

[Table 1 about here]

As well, 25,000 male tax filers in this age group reported negative self-employment income, losses which are not counted as earnings subject to contributions; but do offset income from other sources in determining total income. Many of these tax filers therefore appear to be in the lower total income ranges, though the ability to incur such losses is probably indicative of substantial wealth (e.g., collateral assets) rather than poverty. This is also evident in the fourth column which shows the percentage that earnings for CPP/QPP purposes are of total income. This exceeds 100 percent in the bottom decile, in part because positive employment income is being offset by negative self-employment income, and because of tax shelter and other losses. Otherwise, earnings which are taken into account in the CPP data generally amount to over 80 percent of total income.

The last column compares the tax filer data with the 1986 Census. The tax filer decile groups each contain about 55,000 individuals. The census data show almost twice as many individuals below the dollar cut-off for the bottom decile of tax filers. This is as expected because many very low income individuals do not need to file tax returns. Other than in the bottom decile, the figures from the census are very close to the tax data. (Note that the expected number in the 90-95 and 95-100% groups is about 27,500.)

Effects of Career Earnings

The CPP data provide mortality data for up to nine years after age 65, since those males who became 65 during September 1979 would be 74 by September 1988, the last month of data. Survival probabilities by month after exact age 65 to age 74 are shown in Figure 1, conditional on reaching age 65, for each quintile of "updated career average earnings."

[Figure 1 about here]

These earnings quintiles are based on employment income averaged over each individual's career from 1966 to the next-to-last year of positive earnings prior to attaining age 65 (i.e., trailing years of zero earnings and the last year of positive earnings where the individual most likely would have worked for only a fraction of the year have been excluded from the average). Each person's annual earnings were "updated" or re-scaled using the average industrial wage index

before the average was computed. Based on these averages, the population was sorted by updated career average earnings and divided into quintiles, and survival curves estimated for each group (using the product limit form of estimator which takes censoring into account).

The dashed line in Figure 1 shows overall male survival probabilities for Canada in 1985-87, centered on the 1986 census. These overall data show higher average mortality (i.e., lower survival probabilities, with the dashed line mostly between the survival curves for the first and second earnings quintiles). One explanation for this difference is that the CPP data exclude those with no employment income. Table 1 suggests they are primarily the poor living on government transfers rather than the very rich living exclusively on investment income. If the CPP data exclude a group with generally lower average incomes, then CPP beneficiaries should have higher survival rates than the general population. Another factor that could account for higher survival rates among CPP beneficiaries is the 1986 census undercount, estimated to be about three percent. This magnitude of undercount could depress male survival probabilities from age 65 to 75 by 0.4 percentage points. Finally, the CPP data generally exclude residents of Quebec which has about one-quarter of Canada's population. The Quebec survival rate for males age 65 to 75 was about four percentage points lower than the rest-of-Canada rates for 1981 and 1986 (68.3% and 70.2% for all Canada except Quebec versus 64.8% and 65.7% for Quebec in 1981 and 1986 respectively).

Substantively, Figure 1 shows a clear negative association of earnings prior to age 65 and mortality rates over the following nine years. The survival curves are rank order correlated with earnings quintiles over the entire period, and the distances between them gradually become wider.

In order to give an indication of the importance of these mortality gradients with career earnings, a simple comparison can be made with the results from cause-deleted life table analysis. Nagnur and Nagrodski (1987) estimate with 1981 all-Canada mortality rates that survival probabilities to age 75 for males who have already survived to age 65 would increase, for example, by about eight percentage points if cancer as a cause of death were eliminated (and mortality rates from all other causes of death were unchanged). The data underlying Figure 1 suggest an almost identical improvement in survival probabilities from age 65 to 75 if the CPP cohort had all experienced the mortality rates of the top quintile of average career earners rather than their observed mortality rates. In other words, the elimination of cancer would have roughly the same impact on mortality for this group as bringing the mortality experience of the bottom 80 percent up to the average of the top 20 percent. This is ironic given the much stronger connection in the public's mind between cancer and decreased life length, and the much larger research and medical care expenditures devoted to cancer than to explicating the connections between socio-economic status and mortality.

One major question in interpreting this gradient of mortality in relation to earnings is the role played by illness. One plausible hypothesis is that a chronic illness sets in which then leads both to lower earnings and to increased mortality. In the U.S. literature this tends to be referred to as "reverse causality" while in the U.K., where it has been the subject of much more debate, it is called the "health selection effect."

Table 2 casts doubt on this interpretation for at least a significant sub-population. The first two columns give the survival probabilities by quintile shown in Figure 1 at exact ages 70 and 74 (actually 73 plus 9 months). The other pair of columns (denoted "Males with Increasing Earnings") give the corresponding survival probabilities for a subset of CPP contributors -- the 103,741 observations who had a statistically significant (at the five percent level) positive rank correlation of earnings (between 1966 and the penultimate year the individual had positive earnings) with age, where earnings were first deflated by the average industrial wage. Except among the first two earnings quintiles, there is a clear and consistent increase in survival probabilities with earnings at both ages.

[Table 2 about here]

It is difficult to reconcile these data with the hypothesis that illness fully accounts for the gradient in mortality. It does not seem plausible that the individuals represented in the last two columns became ill in their forties and fifties, were thus predisposed to higher mortality after age 65, and yet that these illnesses were sufficiently asymptomatic or non-handicapping that they (1) survived to age 65, (2) continued to work, and (3) managed to increase their earnings year-by-year faster than the growth in the average wage index from their forties and fifties up to age 65. (We discuss this question further in the penultimate section below.)

Effects of Marriage and Retirement

Published statistics (e.g., Statistics Canada, 1980) have for a long time shown that married men have lower mortality than their single counterparts. Figure 2 shows the relationship of survival both to earnings and marital status using the CPP data. In contrast to Figure 1, survival probabilities are shown for a fixed age interval (from 65 to 70), but over a continuous range of pre-retirement earnings levels measured in dollars. Three curves are shown. The first is for the entire population (545,769 observations) and is surrounded by dashed lines giving 95 percent confidence intervals. (These confidence intervals are based on the assumption of homogeneity within each earnings group. Frequencies of death are assumed to be conditionally binomial. Since there is an apparently continuous gradient of mortality with earnings, the homogeneity assumption is an approximation, so that the displayed range of a confidence interval is really a lower bound.)

[Figure 2 about here]

The other two curves are for those who were married (at age 65 in most cases, otherwise married at the time of death; 411,115 observations, 27,004 deaths) and for those who were not married (80,829 observations, 8,802 deaths between ages 65 and 70). These two curves both exclude "disabled" individuals (those who have ever received a disability benefit from the CPP based on the very strict definition used; 49,610 observations, 7,062 deaths).

The vertical axis shows the proportions surviving over the five year period from exact age 65 to exact age 70, conditional on reaching age 65. As shown in Figure 1, data are available on deaths up to age 74 for a subset of the population. The age 65 to 70 interval was chosen because the coverage of the data is greater (fewer observations are right-censored) and it is a convenient interval for comparison with other studies.

The horizontal axis shows updated career average earnings in 1988 dollars. In order to compute five year mortality rates by earnings, the males in the population were first sorted in increasing order of their updated career average earnings, and then grouped based on percentiles. A total of 11 groups were defined by dividing the population at the 2nd, 5th, 10th, 20th, 40th, 60th, 80th, 90th, 95th, and 98th percentiles (i.e., more finely than the five quintile groups shown in Figure 1). The locations along the horizontal axis of the steps in the middle curve of Figure 2 for the entire study population (highlighted by little square dots) thus correspond to the average earnings cut-points for these percentiles.

The same 11 percentile groups were also constructed for each of the married and not married sub-populations (both excluding the disabled). As a result, the dollar levels for each percentile cut-point (corresponding to the steps in the curves) are at different locations along the horizontal axis in each of the three survival gradient curves. For example, the 98th percentile cut-points for the "married" and "not married" are at about $74,000 and $57,000 respectively, compared to about $70,000 for the overall study population. (This latter top 2 percent group of the entire population includes almost 11,000 observations. The dollar cut-points for the overall population by percentile are as follows: 2nd - $2,404, 5th - $5,137, 10th - $8,745, 20th - $14,494,

40th - $22,279, 60th - $27,991, 80th - $35,987, 90th - $44,049, 95th - $53,500, 98th - $70,069.) Five year survival rates were then computed for each earnings percentile and marital status group exactly as in Figure 1.

Aside from the lowest earnings groups (i.e., the bottom two or five percent in each population), there is a clear monotonic and statistically significant pattern -- higher income males experienced lower mortality all the way up to the top two percent of the population. Recall that these are not cross-sectional results. The earnings shown along the horizontal axis were received between the ages of 43 and 64 -- on average 10 to 20 years before the mortality experience being considered. The "blip" at the bottom of the earnings range likely reflects the fact that individuals with close to zero earnings over one to two decades of their lives probably depended on other sources of funds such as government transfers, investments, or the incomes of other family members, and thus may not have had disposable incomes as low as those recorded from earnings alone.

As expected, married males have lower mortality than their unmarried counterparts -- given that they are not "disabled." The mortality gradient with career earnings is again evident but is not as steep within each marital status group. The age 65 to 70 mortality rates for the top tenth of the overall population of career earners are about half those of the bottom tenth. In contrast, mortality rates of the top relative to the bottom tenths of married and not-married men are about three-quarters and two-thirds respectively. Thus, taking account of marital status reduces somewhat the magnitude of the univariate gradient in mortality as a function of earnings shown in Figure 2. (Another factor is the removal of the "disabled," who have lower earnings, from the two marital status sub-populations.)

Given the thirteen or more years of earnings data for each observation, an interesting question is the role of other attributes of these earnings streams, over and above the average that has been examined so far. One such attribute is the last year with non-zero earnings, which can be taken as a rough proxy for the year of retirement. (The actual date of retirement is not available.) Another is the "stability" in earnings prior to retirement. Figure 3 shows results for disaggregations of the population along these lines. (The "disabled" are again excluded.)

[Figure 3 about here]

An "early retirement" sub-population was identified as those whose last year of non-zero earnings was at age 61 or before (and there was no "disability," defined as any disability claim history -- 115,771 observations; 7,520 deaths). Those who were not "disabled" or "early retirements" were then divided into two groups -- those who had non-zero earnings in every year until retirement ("uninterrupted work history"; 279,023 observations; 20,910 deaths), and those with at least one year with zero earnings prior to their last year of earnings ("interrupted work history"; 97,150 observations; 7,376 deaths). Again, <u>each</u> of these three groups was further subdivided by updated career average earnings percentiles for their own group as in Figure 2.

Figure 3 shows no pronounced differences in mortality among late retirees between those with interrupted and with uninterrupted work histories. Both show some gradient with earnings. However, there is a sharper difference between early and late retirees. Early retirees generally have higher mortality, and a steeper gradient with earnings. The generally higher mortality of early retirees is in line with findings that early retirement is often associated with deteriorations in health status (Burtless, 1987). The latter phenomenon of a steeper gradient might be explained by greater heterogeneity among the early retiree population. Those at the lower end of the earnings spectrum could be workers laid off in their late 50s unable to find another job, or workers who had to quit work due to their deteriorating health (but were not so ill as to qualify for a disability benefit under the CPP nor to die prior to attaining age 65), or the deteriorating

health of a spouse. Those at the upper range of earnings, on the other hand, might have been so well off both financially and in terms of their health that they decided to retire early in order to enjoy themselves.

It is clear that higher earnings are associated with being married and with later retirement. Which way the causal pathways go is an open question. It could be that higher income leads to better chances of being married, rather than the reverse, and that higher earnings predispose to later retirement. To the extent this is true, the attenuated role of the earnings gradient once marital status and age at retirement are considered may understate the magnitude of earnings gradient.

Multivariate Analysis

The results so far support earlier findings (cited above) that a variety of factors are importantly associated with an individual's risk of mortality, including variables like the ones examined -- updated career average earnings, whether disability benefits have ever been claimed, marital status, and the age at which earnings ceased. Unfortunately, the CPP data do not contain any information on other individual attributes which have been found to be significantly correlated with mortality -- health status, education, occupation, and smoking, for example. Still, the CPP data are rich enough to support multivariate exploration. Moreover, the graphical results suggest that interactions among the variables available may be sufficiently complex to warrant explicit consideration of many possibilities.

Given the large number of observations, 26 independent regressions have been estimated, one for each of two marital states and 13 distinct ages at retirement. The regression specifications are linear models of the form $y_i = x\,b + s\,e_i$, where y_i is the natural logarithm of t_i, the time lived beyond age 65; x is a row vector of covariates; b is a column vector of unknown coefficients; and i indexes individuals. In least squares multiple regression, the error term e_i is from a standard Normal distribution, and s is a constant scale parameter. Here, as is commonly done for lifetime data, we assume instead that e_i is from a standard extreme value distribution. This is equivalent to a proportional hazards model with a Weibull density function (Kalbfleisch and Prentice, 1980).

The dependent variable uses the full data available up to age 74 -- the last age before all observations are right censored. The main covariate is average earnings from age 52 (the earliest year common to all the observations) to the last year before retirement. Note that this represents a change from the earlier graphical results where average earnings included all available years of earnings (for some observations extending back to age 43). Using earnings only from age 52 onward puts all the observations on a common footing. For example, the length of the post-65 follow-up period for each individual will not end (i.e., right censoring in September 1988) with a duration correlated with the inclusion of (generally lower) earnings at ages below age 52, thereby avoiding a possible confounding effect. Also, since separate regressions are estimated for each age at retirement, the period over which earnings are averaged is the same for each regression.

Two other covariates have been included in the regressions. One is the percentage of the years included in computing updated career average earnings where earnings were below $2,500. These percentages are intended to capture the non-monotonicity in the mortality gradient at very low incomes as is evident in Figures 2 and 3. The other covariate is the percentage of years where earnings appear to have been top-coded (i.e., truncated) at $9,999 (current dollars). This occurred from 1966 to 1971 and affects the age 52+ earnings histories of 46,936 persons and 88,111 person-years of earnings out of the total of 5,547,042 person-years included in the regressions -- i.e., about 1.6 percent of the person-years of earnings. In the most recent year of top-coding, 1971, when the effect of the nominal $9,999 upper limit would have been most pervasive, it appears that about 25 percent of contributors were affected.

An advantage of a proportional hazards model over a simple logistic model (e.g., as used by Duleep [1989]; Wigle, Mao, and Arraiz [1989]; and Marmot [1986])) is that it uses more than just the binary information as to whether or not the individual died during the period of observation. The proportional hazards model uses either the length of time he lived after age 65 (measured in years and months), if he died before the last date of observation (September 1988), or the fact that he survived past this date. The CPP data give up to 100 months of survival information for each individual, so it is clearly desirable to use this information.

To fit the model, the procedure LIFEREG from SAS (1985) was used. Because of their significantly different survival patterns, the model was fitted only to individuals who had never received a disability benefit. The validity of the Weibull regression model and the assumption of linearity with respect to average earnings were checked graphically and by analysis of residuals. The use of 26 distinct regressions avoids imposing an assumption of constant proportional hazards for marital status or age at retirement. The regression results are shown in Table 3.

[Table 3 about here]

Figure 4 illustrates these regression results by focussing on the effects of marital status and age at retirement. The histogram at the bottom shows the proportions of the population counted as retired at each single year of age by marital status. About half the population retired (i.e., their last year of positive earnings) in the year they attained age 65, and most of the population retiring at each age was married. The two solid lines show the average survival probabilities over the interval from age 65 to age 70 by year of retirement and marital status. These probabilities are computed from the regression fits assuming average earnings are $25,000. (The probabilities also assume that there were no years with top-coded earnings, and no years with very low earnings. As shown in Table 3, there is no systematic bias in the results associated with the variables for top-coding, or with very low earnings.) The dashed lines give approximate 95 percent confidence intervals (i.e., transformed confidence intervals for the log of life length).

[Figure 4 about here]

Consistent with earlier results, married males have significantly higher survival probabilities at all retirement ages. More interestingly, and in line with Figure 3, there appears to be a generally positive association between survival probability and age at retirement. However, the patterns are not entirely uniform or parallel for the two marital states. Thus, separate regressions (or equivalently full inclusion of all possible interaction terms) appear to have been warranted.

Figure 5 is identical to Figure 4 except that instead of showing confidence intervals, a second pair of curves is shown based on earnings of $50,000. The difference between the two solid lines thus shows the effects on survival probabilities of an increase in (updated career average pre-retirement) earnings from $25,000 to $50,000 for married men by age at retirement. The difference between the two dashed lines shows the corresponding effects for non-married men. Higher earnings always entail higher survival probabilities, but the magnitude of this earnings gradient tends to narrow for later retirement ages. The effect is similar but somewhat more variable among not married men.

[Figure 5 about here]

Finally, Figure 6 illustrates the implications of the regressions in terms of relative risks. Instead of showing only two earnings levels as in Figure 5, this graph shows the impacts for married men at various percentiles of the overall earnings distribution (i.e., for the distribution of career average earnings pooled for all retirement ages and both marital states). For the most numerous group, married men retiring at age 65 (the rightmost set of points in the graph, 208,572 observations), relative risks range from .86 for the 95th percentile to 1.10 for the 5th percentile, where the relative risk for median average earnings (equal to about $24,500) has been set to 1.00.

However moving to the left for earlier retirement ages, relative risks at median earnings rise to over 1.5. At the same time, the range of relative risks across earnings percentiles widens to over twice as high for the 5th compared to the 95th earnings percentile.

[Figure 6 about here]

Discussion

A number of significant results have been derived from both the graphical and multivariate regression analyses. One concerns the shape of the earnings gradient. This is explicit in Figures 2 and 3, and is implicit in the specification of the Weibull regressions (i.e., a linear relationship between log life length and average earnings) which fit the data well. The general implication is that an extra dollar of income is "beneficial" for longevity at all incomes, but it offers decreasing "protective effect" at higher incomes than at lower incomes. This is an intuitively plausible result. It is worth emphasizing that this is not consistent with a "threshold" relationship where poverty is associated with poorer health and longevity, but that above some low income level, income and health are independent. The positive association of longevity and earnings also extends up through the middle and upper classes.

Since average earnings is itself a function of earnings in all the years between age 52 and the year before retirement (inclusive), the implication is that an extra dollar of earnings in any of these years has the same "protective effect." Note that this proposition has not been tested by the regressions reported; it is implicit in the specification. However, it has been tested explicitly in other regressions not reported here. There are problems of multicolinearity of earnings at various ages. Nevertheless, the results clearly support a protective effect of income at each age, including an independent effect of earnings at age 52.

This may be surprising intuitively, though it accords with the notion that "permanent" rather than "transitory" earnings is the key variable. In turn, this suggests that there are long term effects of earnings on mortality, with lagged associations of as much as decades. It also suggests that not only cross-sectional analyses but also shorter term (e.g., 2 years) mortality follow-up studies using an annual income variable such as Rogot et al. (1988) may miss or understate important relationships.

The magnitude of the simple univariate earnings gradient shown by the middle curve in Figure 2 is reduced and becomes variable when account is taken of other factors in a multivariate analysis. When those claiming CPP disability benefits are excluded, the variations in mortality with respect to marital status and age at retirement are of the same general order of magnitude as the gradients with earnings within various sub-groups. Still, all these variations are non-trivial. Expressed in terms of relative risks, the impacts on post age 65 mortality of variations in pre-retirement average earnings, marital status, and age at retirement are of the same order as the impact of smoking or high blood cholesterol levels on the risk of a heart attack (i.e., relative risks of 1.5 to 2.0; e.g., Wilson, Castelli, and Kannel, [1987]; Semenciw et al. [1988]).

The increase in mortality associated with earlier ages at retirement suggests that onset of illness may predispose an individual both to withdraw from work -- retire earlier than age 65, and to higher mortality after age 65. This notion of "reverse causality" or a "health selection effect" has been used to argue that gradients in mortality with respect to social class are artifactual, the result of poor health causing both lowered earnings (or social class) and higher mortality.

Health selection undoubtedly accounts for the positive association between earnings and survival for some fraction of the population studied here. However, the key question is what fraction. It is clearly not applicable to everyone, nor probably to a majority. This is suggested in

Figure 6, where mortality gradients in relation to earnings are evident not just overall, but also within each of the groups who retired at the same age; indeed, they are larger for earlier ages at retirement.

In order for some kind of health selection effect to be the dominant factor operating in accord with the statistical results shown in Figures 5 and 6, there must be a wide variety of diseases incident at the latest by age 45 to 50 that are non-fatal and non-seriously disabling up to age 65, and whose progression is independent of marital status and age at retirement, which jointly give rise to lower average levels of earnings between disease onset and retirement, and higher mortality over the nine year period after attaining age 65. Moreover, considering the results in Table 2, this group of diseases would have to operate such that between the period of onset and retirement, earnings were generally increasing year by year over the entire pre-retirement period relative to the average wage (not just in nominal or even in real terms) and at the same time the diseases would have to have induced higher post age 65 mortality rates and lower pre age 65 average earnings.

Further evidence on this last point is provided by an additional regression, also reported in Table 3. It is exactly the same as the other regressions except that it focuses only on the largest retirement age-marital status group -- married males retiring at age 65 (over 200,000 observations), and it includes one additional variable -- the same rank correlation of pre-retirement relative earnings and age used to select the sub-population in Table 2. The coefficient for this term indicates a statistically significant and non-trivially positive association with post-retirement survival duration. Intuitively, this seems to suggest that when "things are getting better" economically, this has a beneficial effect on survival many years later, and vice versa. More importantly, however, the regression shows that controlling for such career earnings trends, there is still almost the same magnitude of "protective effect" from average earnings.

How do these results accord with basic disease patterns? The two major causes of mortality at ages over 45 are cancers and cardiovascular disease. Incident cases of diagnosed cancer are typically fatal within five years. However, smoking is a cumulative risk factor for lung cancer (the most important cancer for males) with at least a decade latency. Thus, a correlation of smoking with lower earnings levels at late career ages is entirely consistent with the observed associations -- individuals would survive asymptomatically to age 65 and many could indeed improve their earnings, but would then be at increased risk of early lung cancer after age 65.

Cardiovascular disease (CVD), on the other hand, is not immediately fatal in the majority of cases. Thus, many men could have CVD in their 50s and early 60s. In a fair number of these cases, a health selection effect could be expected to work -- incident CVD would be disabling (though not sufficiently disabling to give rise to a CPP disability claim), for example causing the individual to find lighter and less stressful work, often at lower pay. However, if this were the dominant story, it would be inconsistent with our statistical results. Alternatively, individuals with CVD incident in middle age might well be able to keep the disease under control, and thus manage not only to survive to age 65, but to do so with increasing relative earnings. However, Table 2 shows that in such cases, those who start higher up the socio-economic status ladder survive longer. Thus, something more must be going on than a simple story of health selection.

What is it about higher earnings that improves the survival prospects of such clinically ill individuals (assuming that some of the 104 thousand individuals in the rightmost two columns of Table 2 have CVD, as well as some of the 209 thousand married males retiring at age 65 in the additional regression in Table 3)? Unfortunately, the CPP data do not contain enough information to shed any light on this question. But the strong statistical associations are consistent with a range of mediating factors. For example, higher socio-economic status is likely associated with healthier lifestyles (e.g., less smoking, lower fat diet, better exercise). It may also be associated with better general resilience and ability to cope.

Thus, to recapitulate our findings with regard to the health selection effect hypothesis, we have

- excluded the seriously disabled;
- used average earnings, thereby minimizing the impacts of any acute health conditions;
- excluded earnings in the year of retirement; thereby excluding years likely to have been affected by any critical health events;
- disaggregated by, not just "controlled for," age at retirement and marital status;
- controlled for the effects of chronic degenerative health effects to the extent they limit earnings by including in the analysis individual level trends in earnings relative to average wages; and
- considered associations between earnings and mortality where the lags are quite long -- earnings between ages 52 and the early 60s, and mortality between age 65 and 74 conditional on surviving to age 65.

With all these considerations, a significant gradient in mortality as a function of earnings is apparent.

As noted in the beginning sections of the paper, the existence of mortality gradients with marital status and earnings (or related socio-economic status variables) is generally well known, though typically without the detail and tight confidence intervals presented here. Explanations, however, are much less certain. One important explanation -- health selection -- is evidently not plausible for large segments of the population studied here. Other results in this analysis such as (1) the positive association of post age 65 survival duration with increasing trends in pre-retirement earnings, (2) with retirement age, and (3) the widening gradient with earnings at earlier retirement ages, holding other things fixed, appear to be new. The first of these results has an intuitive appeal as just noted.

Intuition or explanations in the latter two cases are more problematic. The literature on retirement behavior suggests industry and occupation, level of earnings, health status, and expected levels of pension benefits as key determinants. Following Burtless (1987) for example, one possible explanation for the association with retirement age is that retirement customarily occurs earlier in occupations or industries that are most demanding in terms of adverse health effects (e.g., the "30 years and out" normal retirement in some industrial pension plans). However, the extent of early retirement in the CPP data (recall the histogram in Figure 4) appears quite low -- for example compared to the "normal" retirement ages in private pension plans, as well as the subsidized (in actuarial terms) "special early retirement" provisions and anecdotal evidence since the early 1980s of the use of "golden handshakes" and early retirement to assist in "downsizing" (Statistics Canada, 1989). The results of the analysis thus raise important questions about causal mechanisms. Conventional explanations cannot easily account for some of the results.

The results may also have important implications for public policy. In health policy, the existence of significant gradients raises questions about the efficacy of the current health insurance system. There are two broad possibilities. On the one hand, the health care system might not be offering equal access given need. Males with lower average earnings histories may be receiving poorer quality care, even though they visit health care providers with the same frequencies in relation to the prevalence of health problems (Broyles et al. 1983; Manga, Broyles, and Angus, 1987).

Alternatively, there may be aspects of lifestyle, work place, or home that vary systematically with earnings, that also predispose to higher mortality, and that are not affected by the services offered by the health care system. For example, low income workers may be exposed to higher levels of stress or workplace environmental toxins such that once they become ill, it is too late for the health care system to provide much in the way of cure. Either hypothesis raises serious though quite different concerns. Which one is most appropriate requires further research.

A second major area where these results are important to public policy is pensions. The results suggest that Canada's public pension system is not as progressive as many think. In lifetime income terms, if higher income individuals live longer, they collect pensions for a longer period. Thus, the earnings-related CPP which appears distributionally neutral because of its constant 25 percent replacement rate is actually regressive. For example, Leimer (1979), using the Kitigawa and Hauser (1973) differential mortality rates, concluded that the U.S. Social Security system was progressive in terms of expected lifetime internal rates of return. However, use of results such as ours showing important lagged effects of pre-retirement average career earnings on post-retirement mortality could easily reverse this conclusion.

(A 1989 unpublished analysis of U.S. Social Security beneficiaries examined mortality rates in the year after retirement stratified by the Primary Insurance Amount, which is based on a similar measure of updated career average earnings to that used in this study [Wade, 1992]. These rates show a similar association with earnings, and in some cases differ by as much as factor of two between higher and lower pre-retirement earning groups. It is interesting that these results have attracted virtually no follow on work, given their significant public policy implications.)

Gradients in post age 65 mortality by age at retirement also raise questions about the equity of current actuarial adjustment factors for the recently legislated early retirement benefits under the C/QPP. These actuarial factors are roughly "neutral" under the assumption that mortality rates do not depend on age at retirement. Thus, early retirees who, based on the results presented above, appear to face higher mortality prospects will receive smaller lifetime CPP/QPP benefits. (There are of course practical and moral hazard problems of linking retirement pensions to health status.)

In sum, this study has examined the relationship between pre-retirement earnings histories and mortality after age 65 for over half a million Canadian males. The data show a clear and significant gradient -- higher earnings as long as decades prior to age 65 are associated with lower mortality during the following nine years. As well, being married, not retiring early, not being disabled, and having relative (i.e., not just inflation adjusted) improvements in earnings during the latter decades of one's career are all significantly associated with higher survival probabilities.

On a methodological note, these kinds of results illustrate the as-yet largely unexploited power of administrative data for social science and medical research.

Finally, the causal pathways by which these socio-economic status variables may influence mortality are generally unknown. However, juxtaposing the gradient in mortality with the generally equal access to medical care services in Canada, without regard to financial position, raises fundamental questions about the most important directions for health research.

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Table 1:Distribution of Male Taxfilers Aged 55-59 in 1986 by Total Income

Total Income Percentile Group	Maximum Total Income	Percentage Ever Contributing to CPP/QPP	Percent of Total Income that is Earnings	Counts from 1986 Census in Same Total Income Ranges
0-10	6,032	61.5	128.5	100,370
10-20	12,165	89.7	56.4	53,345
20-30	17,942	95.8	66.1	60,850
30-40	22,594	96.6	73.2	54,855
40-50	27,060	98.6	79.2	60,440
50-60	31,376	99.0	83.1	56,210
60-70	36,278	99.0	86.1	51,175
70-80	42,606	99.3	87.5	50,795
80-90	54,598	98.8	87.3	52,865
90-95	70,228	99.4	85.8	26,615
95 +	--	99.1	82.3	27,375

Source: Special tabulations of 3% 1986 taxfiler sample and from 1986 Census.

Note:The table covers 549,488 tax filers. 7,904 tax returns of decedents, emigrants, and those claiming disability were excluded. Among these excluded returns, 5,614 had CPP/QPP contributions. The census data show a total of 594,895 males in this age range.

Table 2: Proportions Surviving by Earnings Quintile
(standard deviations in parentheses)

	All Males		Males with Increasing Earnings	
Earnings Quintile	to Age 70	to Age 74	to Age 70	to Age 74
1	0.862 (0.0013)	0.740 (0.0028)	0.887 (0.0028)	0.771 (0.0068)
2	0.871 (0.0013)	0.750 (0.0030)	0.883 (0.0029)	0.756 (0.0079)
3	0.881 (0.0013)	0.759 (0.0032)	0.895 (0.0029)	0.781 (0.0079)
4	0.889 (0.0013)	0.783 (0.0030)	0.901 (0.0029)	0.787 (0.0084)
5	0.906 (0.0012)	0.807 (0.0031)	0.914 (0.0028)	0.805 (0.0097)

Notes to Table 3

The following table contains the estimated coefficients for 27 Weibull regressions, with standard errors shown in parentheses beneath the coefficients. The first half of the table is for the not married male population; the second half is for married males.

Within each marital status group, there are 13 sets of regression results, one set for each age at retirement. In one case, married with retirement age 65, there is a second regression that contains one extra right hand side variable.

The left hand side variable in all cases is the log of life length after age 65 in years, measured to the nearest twelfth. The right hand side variables are as follows:

Const -- constant term

Earn -- average earnings in tens of thousands of dollars, where the average has been computed for each individual by first "updating" each year's earnings by multiplying it by the ratio of the average wage in 1988 to the average wage in the year of the earnings, and then averaging these "updated" figures; only earnings between age 52 and the year before the last year of non-zero earnings are included

Top -- fraction of all earnings years from age 52 to retirement that were top-coded

Low -- fraction of all earnings years from age 52 to retirement that were below $2,500

Tau -- rank correlation between age and earnings from age 52 to 64 (used in only one regression)

Also shown in the rightmost three columns are:

Scale -- estimated scale parameter for the extreme value distribution of errors

Deaths -- the number of persons in the regression where the individual died before the end of the period of observation, September 1988

Censored -- the number of individuals in the regression who were still alive at the end of the period of observation

Note that the number of observations in each regression is the sum of Deaths and Censored. All coefficients are significantly different from zero at the 5% level unless otherwise noted.

TABLE 3.a -- NOT MARRIED MALES

Regression Results by Age at Retirement

Age	Const	Earn	Top	Low	Scale	No. of Deaths	Number Censored
65	2.90440	0.00489*q*	0.10150*q*	0.33234	0.72586	5,061	26,718
	(0.02568)	(0.00810)	(0.22451)	(0.07342)	(0.00897)		
64	2.99524	0.08278	-1.31228	0.05734*q*	0.89087	1,512	10,568
	(0.06166)	(0.02295)	(0.52478)	(0.13360)	(0.01952)		
63	2.85259	0.12157	-1.13415	0.27225*n*	0.78360	789	8,925
	(0.07686)	(0.02826)	(0.57473)	(0.16371)	(0.02243)		
62	2.72166	0.12779	-0.96846*q*	-0.11642*q*	0.80232	673	4,698
	(0.08833)	(0.03451)	(0.59088)	(0.16820)	(0.02567)		
61	2.45090	0.15154	-0.03489*q*	0.21041*q*	0.79048	681	3,627
	(0.08269)	(0.03346)	(0.59000)	(0.16395)	(0.02518)		
60	2.69568	0.06887*n*	-0.59665*q*	0.07680*q*	0.83735	605	3,190
	(0.09372)	(0.03587)	(0.47917)	(0.17737)	(0.02853)		
59	2.55392	0.10399	-0.37460*q*	0.10940*q*	0.81768	474	2,230
	(0.09883)	(0.04337)	(0.59787)	(0.18324)	(0.03120)		
58	2.39547	0.20364	-0.49880*q*	0.35796*n*	0.88631	410	1,849
	(0.10929)	(0.05191)	(0.56387)	(0.19590)	(0.03694)		
57	2.39587	0.15963	-0.08590*q*	0.13195*q*	0.81564	345	1,539
	(0.11027)	(0.05485)	(0.77344)	(0.18122)	(0.03661)		
56	2.43017	0.09488*n*	0.65209*q*	0.52989	0.87821	299	1,286
	(0.11582)	(0.05512)	(0.65827)	(0.21761)	(0.04256)		
55	2.46218	0.16539	-0.58390*q*	0.38164*n*	0.88833	234	1,101
	(0.13254)	(0.06617)	(0.54961)	(0.22060)	(0.04877)		
54	2.50952	0.08724*q*	0.31101*q*	-0.02196*q*	0.90630	204	810
	(0.13722)	(0.07163)	(0.60058)	(0.16263)	(0.05246)		
53	2.77162	0.01582*q*	0.15024*q*	-0.14366*q*	0.96398	134	688
	(0.17571)	(0.07615)	(0.56726)	(0.20684)	(0.07000)		

n $p > 0.1$ (i.e. not significant)
q $0.1 \geq p > 0.05$ (i.e. questionable significance)

TABLE 3.b -- MARRIED MALES

Special Regression Including Age-Earnings Correlation

Age	Const	Earn	Top	Low	Scale	Tau
65	3.32337	0.03154	-0.00037*q*	0.19229	0.77991	0.07055
	(0.01518)	(0.0039)	(0.08995)	(0.04297)	(0.00483)	(0.01362)

Regression Results by Age at Retirement

Age	Const	Earn	Top	Low	Scale	No. of Deaths	Number Censored
65	3.31247	0.03527	-0.05910*q*	0.22369	0.78027	20,952	187,620
	(0.01503)	(0.00385)	(0.08944)	(0.04259)	(0.00483)		
64	3.48937	0.07334	-0.07547*q*	0.14335*q*	0.96559	4,974	56,825
	(0.03891)	(0.01118)	(0.24986)	(0.09151)	(0.01176)		
63	3.24130	0.09997	-0.52842	0.10265*q*	0.80071	2,339	49,890
	(0.04900)	(0.01408)	(0.25048)	(0.10743)	(0.01299)		
62	3.13113	0.10976	-0.69356	0.00055*q*	0.82092	1,736	24,170
	(0.06005)	(0.01797)	(0.25159)	(0.12206)	(0.01628)		
61	3.17650	0.06597	-0.10847*q*	-0.22602*n*	0.80305	1,462	16,754
	(0.06297)	(0.01763)	(0.23771)	(0.12547)	(0.01771)		
60	3.10184	0.10981	-0.31832*q*	0.23310*q*	0.86905	1,283	13,634
	(0.07037)	(0.02078)	(0.24659)	(0.15512)	(0.02068)		
59	3.15715	0.07214	0.06543*q*	-0.03179*q*	0.88101	732	7,008
	(0.08941)	(0.02534)	(0.31790)	(0.16942)	(0.02773)		
58	2.91643	0.15924	-0.23951*q*	0.16829*q*	0.87003	457	5,124
	(0.10057)	(0.03308)	(0.31344)	(0.17913)	(0.03142)		
57	3.19869	0.04761*q*	0.35924*q*	-0.29802*q*	0.87462	390	3,700
	(0.11784)	(0.03197)	(0.33986)	(0.19735)	(0.03747)		
56	2.71680	0.14939	-0.12294*q*	0.44377	0.85511	368	2,879
	(0.11118)	(0.03890)	(0.27263)	(0.21731)	(0.03760)		
55	2.77631	0.12688	0.09831*q*	0.33820*q*	0.81377	2276	2,258
	(0.11726)	(0.04220)	(0.27500)	(0.21984)	(0.04097)		
54	2.83806	0.17719	-0.02045*q*	-0.01221*q*	0.91712	197	1,348
	(0.14704)	(0.05989)	(0.33849)	(0.18593)	(0.05524)		
53	2.99709	0.07161*q*	0.58933*q*	0.19831*q*	0.94371	1149	1,104
	(0.16905)	(0.05037)	(0.37335)	(0.24169)	(0.06676)		

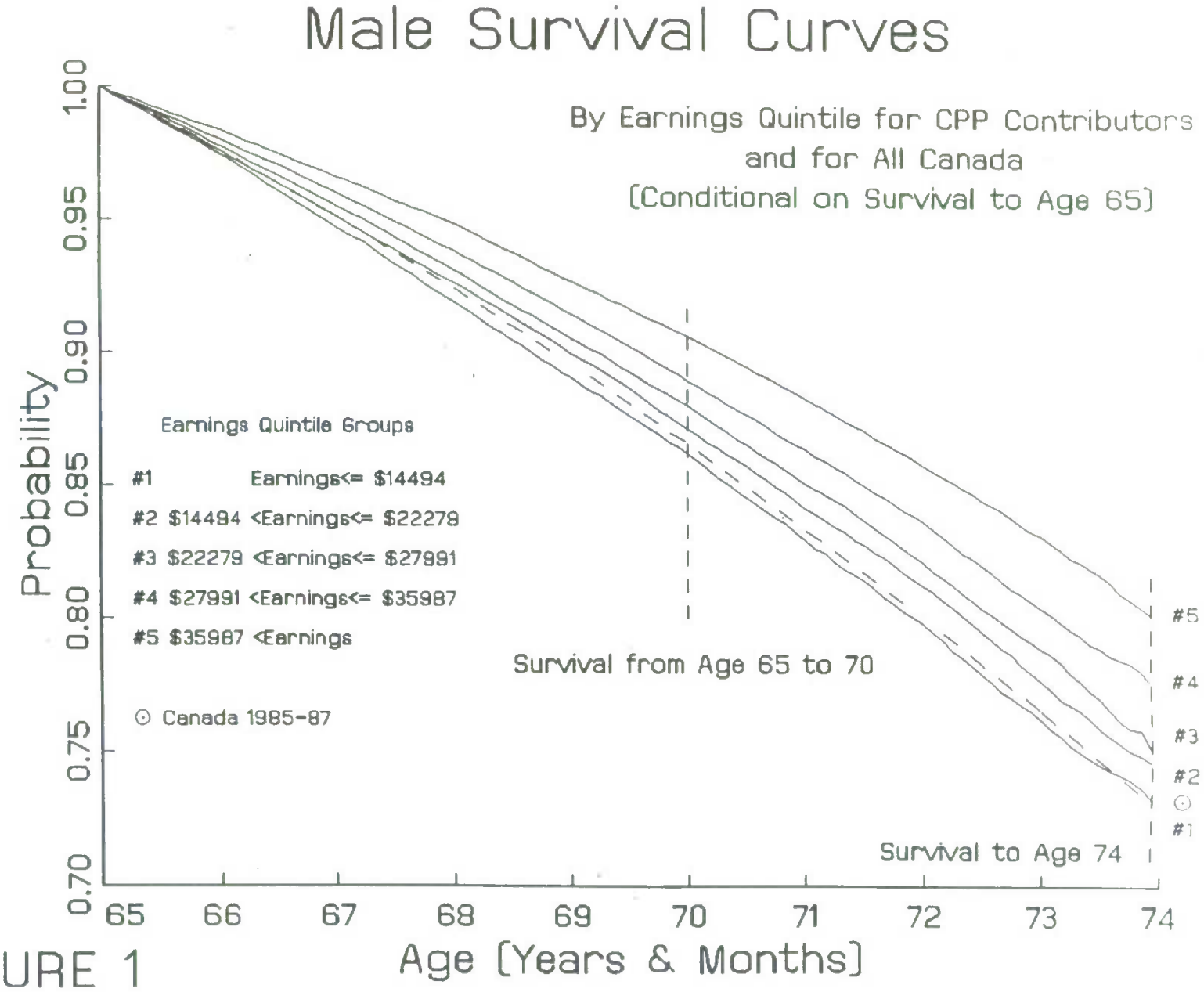
Male Survival Curves
By Earnings Quintile for CPP Contributors
and for All Canada
(Conditional on Survival to Age 65)
Probability
1.00
0.95
0.90
0.85
0.80
0.75
0.70
Earnings Quintile Groups
#1 Earnings<= $14494
#2 $14494 <Earnings<= $22279
#3 $22279 <Earnings<= $27991
#4 $27991 <Earnings<= $35987
#5 $35987 <Earnings
⊙ Canada 1985-87
Survival from Age 65 to 70
Survival to Age 74
#5
#4
#3
#2
⊙
#1
65
66
67
68
69
70
71
72
73
74
Age (Years & Months)

FIGURE 1

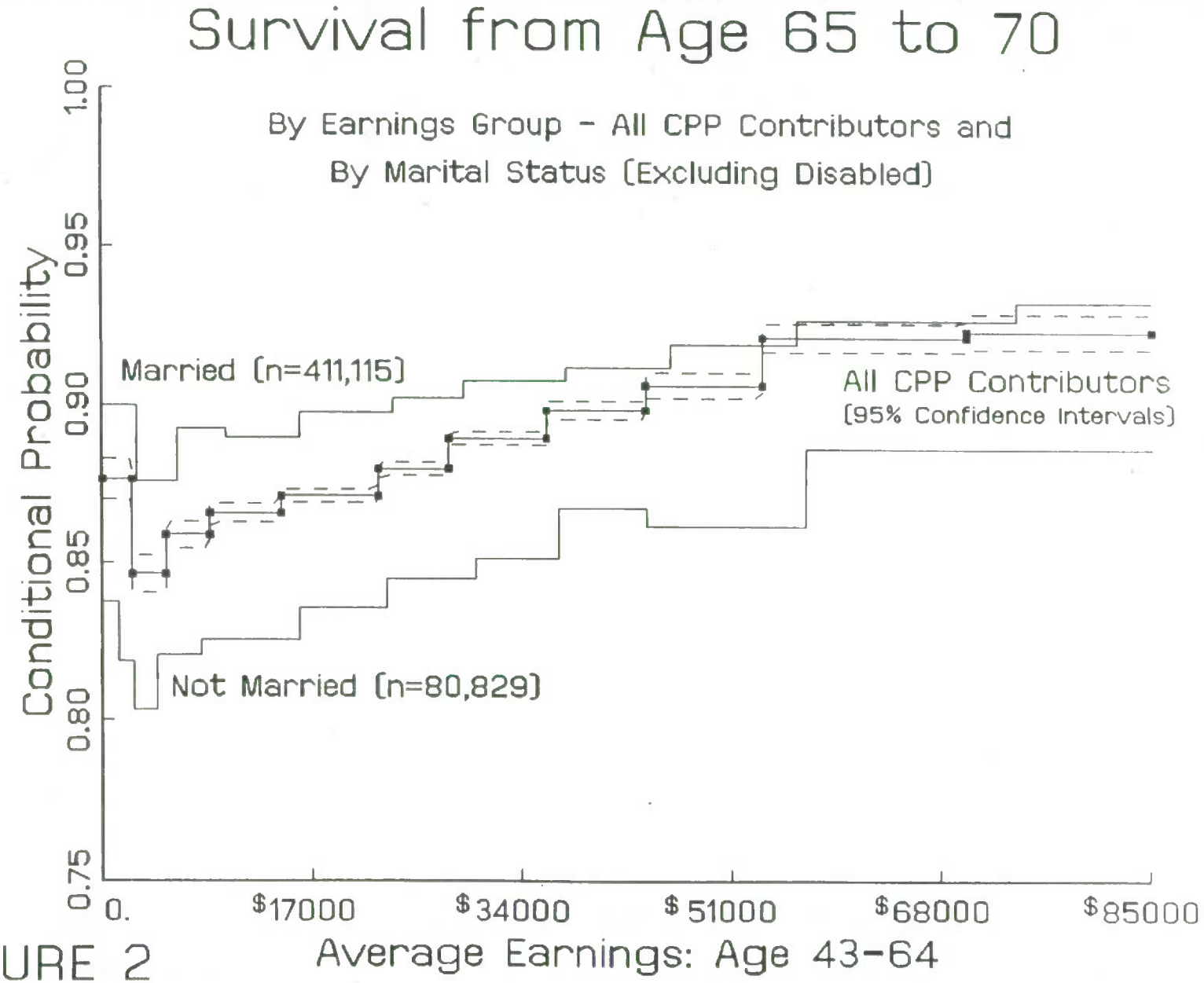
Survival from Age 65 to 70
By Earnings Group - All CPP Contributors and
By Marital Status (Excluding Disabled)
Conditional Probability
1.00
0.95
0.90
0.85
0.80
0.75
Married (n=411,115)
Not Married (n=80,829)
All CPP Contributors
(95% Confidence Intervals)
0.
$17000
$34000
$51000
$68000
$85000
Average Earnings: Age 43-64

FIGURE 2

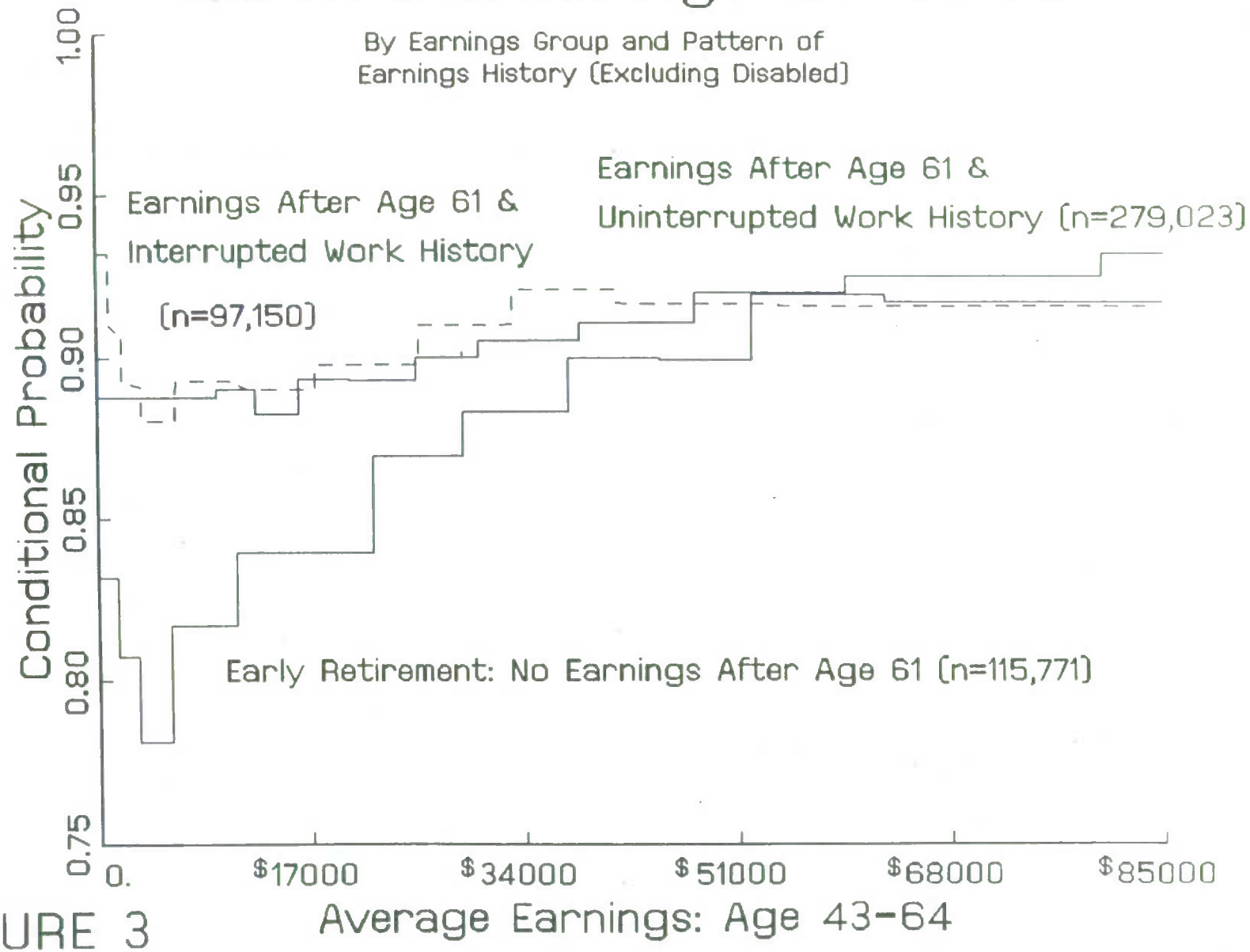
Survival from Age 65 to 70
By Earnings Group and Pattern of
Earnings History (Excluding Disabled)
Earnings After Age 61 &
Interrupted Work History
(n=97,150)
Earnings After Age 61 &
Uninterrupted Work History (n=279,023)
Early Retirement: No Earnings After Age 61 (n=115,771)
Conditional Probability
1.00
0.95
0.90
0.85
0.80
0.75
0.
$17000
$34000
$51000
$68000
$85000
Average Earnings: Age 43-64

FIGURE 3

Survival from Age 65 to 70

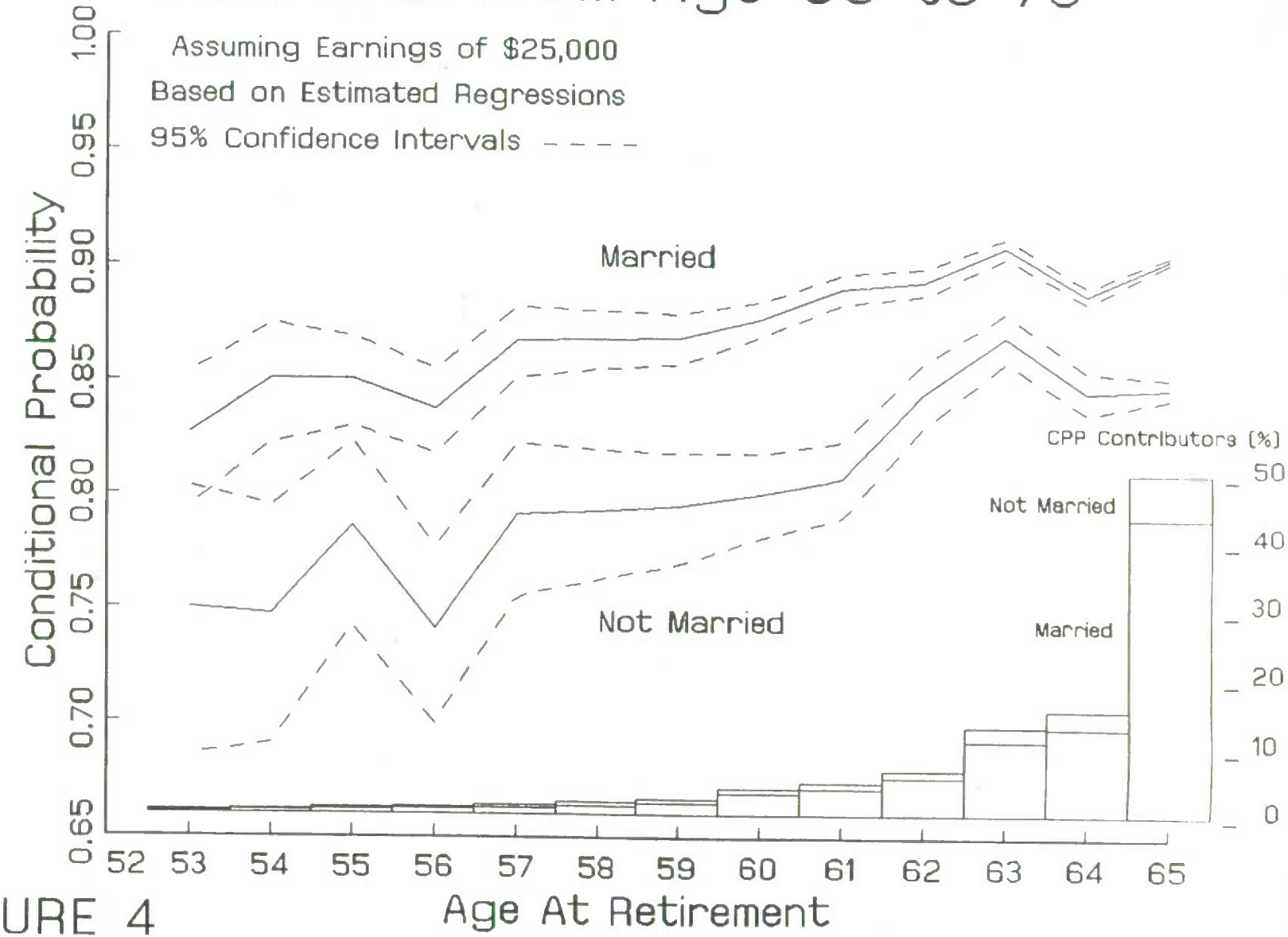

FIGURE 4

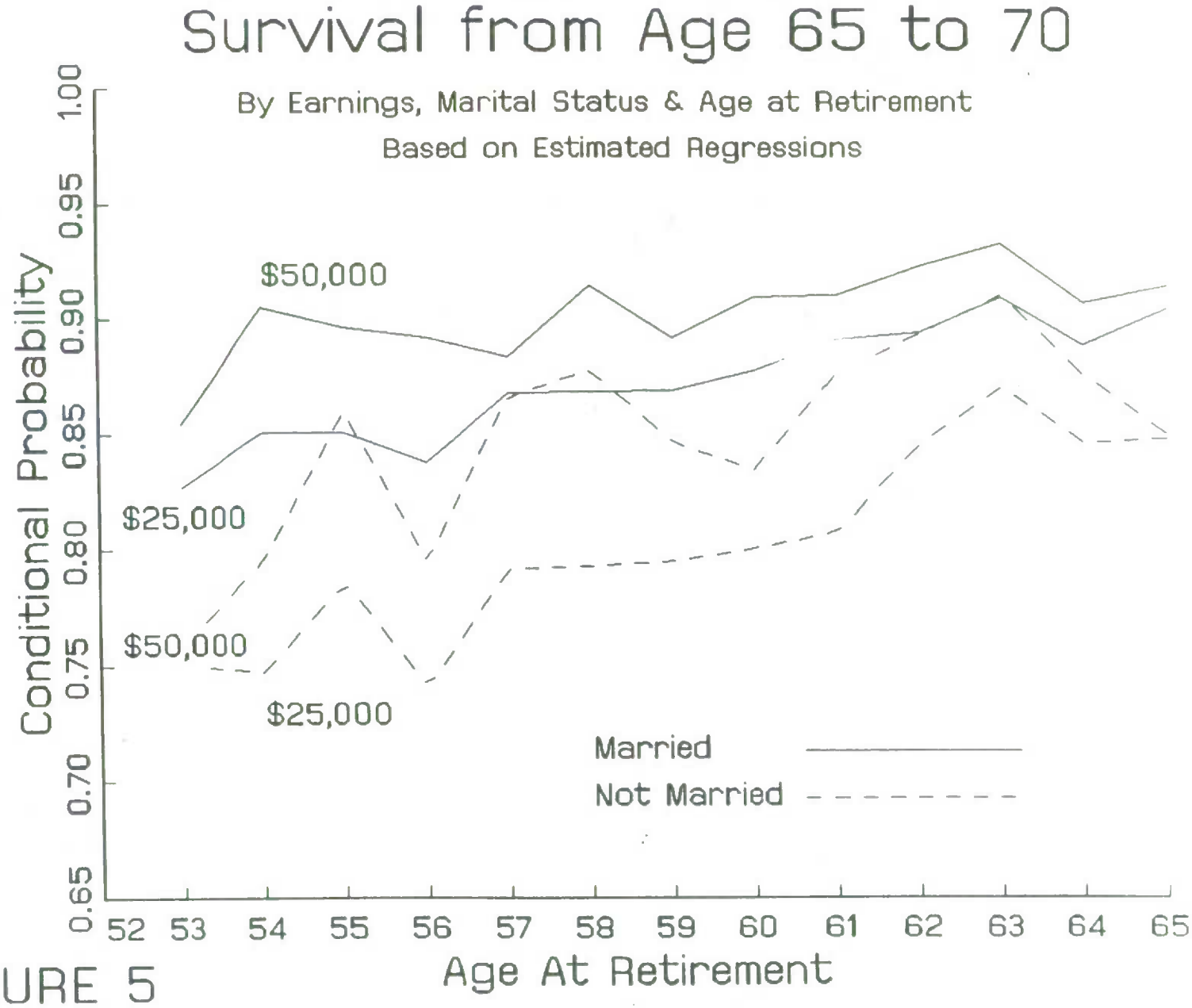
Survival from Age 65 to 70
By Earnings, Marital Status & Age at Retirement
Based on Estimated Regressions
Conditional Probability
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
$50,000
$25,000
$50,000
$25,000
Married
Not Married
52 53 54 55 56 57 58 59 60 61 62 63 64 65
Age At Retirement

FIGURE 5

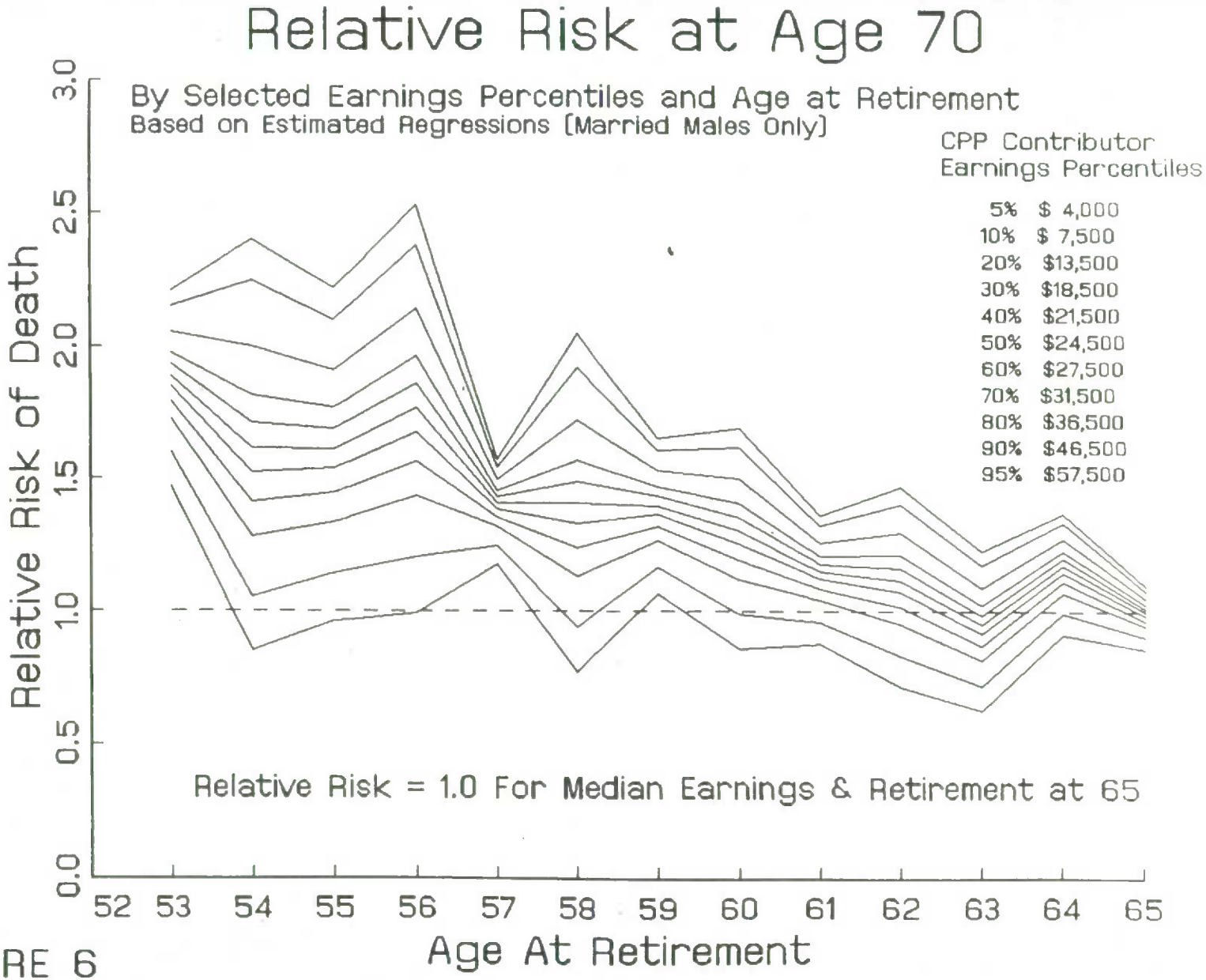
Relative Risk at Age 70
By Selected Earnings Percentiles and Age at Retirement
Based on Estimated Regressions (Married Males Only)
CPP Contributor
Earnings Percentiles
5% $ 4,000
10% $ 7,500
20% $13,500
30% $18,500
40% $21,500
50% $24,500
60% $27,500
70% $31,500
80% $36,500
90% $46,500
95% $57,500
Relative Risk = 1.0 For Median Earnings & Retirement at 65
Relative Risk of Death
0.0
0.5
1.0
1.5
2.0
2.5
3.0
52 53 54 55 56 57 58 59 60 61 62 63 64 65
Age At Retirement

FIGURE 6

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