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AGE-INCOME DYNAMICS OVER THE LIFE COURSE: COHORT TRANSITION PATTERNS IN RELATIVE INCOME BASED ON CANADIAN TAX RETURNS[1]

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ABSTRACT

This paper is concerned with patterns of cohort aging and income progression. We take a new approach to the characterization of relative income, explore the dynamics of age/income progression through the use of state transition matrices, consider alternative cohort definitions, and introduce an artificial cross-section cohort based on the transition matrices. Our applications make use of individual income records from the Statistics Canada Longitudinal Administrative Database. Relative income is defined by how an individual of a given age is positioned in the overall distribution of income in a given year. We derive the proportionate distribution of individuals in each decile group at each representative age, starting at 24, and the transition matrices then show the movements from the distribution at one age to the distribution five years later.

Keywords : age-income dynamics, cohort, relative income, state transition matrices

JEL Codes:

- C63 - Computational Techniques; Simulation Modeling
- C81 - Methodology for Collecting, Estimating, and Organizing Microeconomic Data
- D31 - Personal Income, Wealth, and Their Distributions

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1. INTRODUCTION

There are of course many other associations but income is obviously correlated with age. Young people enter the labour force, move through the working years, and then on toward retirement, phases that are recognized in life-cycle modeling (see, for example, Browning and Crossley, 2001). Some will move rapidly up the income ladder, some slowly, some not at all, and the elderly may see their incomes decline. Patterns of cohort aging and income progression are the subject of this paper. We take a new approach to the characterization of relative income, explore the dynamics of age/income progression through the use of state transition matrices, discuss and compare alternative cohort definitions, and introduce a new form of artificial cross-section cohort based on the transition matrices. Our applications make use of individual income records from the Statistics Canada Longitudinal Administrative Database.

Much of the available evidence in the literature about how incomes vary with age has been derived from cross-section surveys or administrative data. Some studies have focused on income at the individual level, others on income at the family or household level. To take a recent example, Mislinski (2018) draws on 51 years of cross-section data from the US *Current Population Survey* to show year-to-year movements in median real household incomes by age group over the period 1967-2017. The consistency in age patterns is striking: in every year median incomes increase from age group 15-24 through to 45-54, but at a decreasing rate, and decrease from age group 45-54 through to 65 and older at an increasing rate. Our findings, in a different context, are generally consistent with those results.

An advantage of cross-sectional age/income information is that it is readily available for analysis. A disadvantage is that cross-section age patterns observed in any given year may fall short of accurately representing cohort experience, the experience of an actual group of individuals who both age and move through time together. However, true cohort data are scarce; to follow the income progression of an actual cohort from labour force entry through to retirement would require access to longitudinal records or survey data compiled on a consistent basis over many decades. In the absence of such records measures based on time-series of cross-sections have often been employed.

One may of course be interested in a shorter segment of the life span. In a paper concerned with retirement patterns Denton, Finnie, and Spencer (2013) make use of data from annual Canadian Labour Force Survey samples to estimate age-specific retirement rates at ages 52 to 72 in two ways, first based on a pseudo-cohort for the period 1976 to 1996 (pseudo because the sample population is not the same in every year) and secondly based on cross-section data for the single year 1976. They then compare the two sets of results with longitudinal cohort measures based on income tax returns for 1976 – 1996.

A mixture of different approaches is possible. Wolfson and Rowe (2001) infer individual life paths by simulation using a combination of information from a variety of cross-section and longitudinal data sources. Their LifePaths model has been used to simulate individual life course trajectories over periods of many decades and, by aggregation, to derive economy- and population-wide projections.

Data bases that are longitudinal in individual records are most frequently administrative data bases and the information they contain is information required by the administrator. If they are made accessible for research the researcher must accept what is there and tailor his/her analysis accordingly. In an analysis of income based on tax records one may have age, sex, and geographic location as variables to work with but wish also for other variables – education, for example, but the tax records are silent on education. Thus to a considerable extent the types of research that can be done using longitudinal data are dictated by the administrative requirements that gave rise to the data. Subject to that consideration a given longitudinal data set may still permit the investigation of important issues. An example is Milligan and Schirle's (2018) study of the relationship between employment income (including self-employment) and mortality. The study draws on 50 years of individual-level administrative records from the Canada Pension Plan (CPP) and finds strong and persistent connections favouring life expectancy of high earners in comparison with low earners.

It must be emphasised that 50 years of high quality longitudinal data, as provided by the CPP data base, is rare. In the analysis that follows we rely on another longitudinal file drawn from individual income tax records, the Statistics Canada Longitudinal Administrative Database. LAD spans more than three decades and provides us with valuable information although, as discussed below, we are able to work with records from only two recent decades. As a partial list of other studies that draw on LAD we note that the following topics have been explored: the distribution of income and how it has changed over time (Beach and Finnie, 1998, 2004; Beach, Finnie and Gray, 2003, 2005, 2010; Murphy and Veall, 2016; Murphy, Veall, and Wolfson, 2015; Saez and Veall, 2005, 2007; Veall, 2012; Wolfson et al., 2016); intergenerational aspects of income (Corak, 2013; Corak, Lindquist, and Mazumder, 2014); the impact of marginal tax rates on income (Sillamaa and Veall, 2001); and geographic mobility (Finnie, 1999, 2006). Recent studies in the United States have also drawn on longitudinal income tax records. We mention in particular important recent work by Raj Chetty and co-authors that has made use of longitudinal income tax records linked to cross-sectional information drawn from the 2000 and 2010 Censuses and from American Community Surveys to focus on intergenerational mobility (Chetty et al., 2018a, 2018b). Jenderny (2016) analyses top income mobility using German income tax data.

2. THE LONGITUDINAL ADMINISTRATIVE DATABANK

Statistics Canada's Longitudinal Administrative Databank (LAD) is a large ongoing random sample drawn from the Canada Revenue Agency's T1 Family File (T1FF), which is itself a yearly cross-section file of all taxfilers and their families.[2] Selection for LAD is based on Social Insurance Numbers (SIN). Once selected for LAD, individuals remain in the sample and their subsequent information is picked up each year from the T1FF if they appear on the T1 tax form in that year[3]. Individuals selected into the sample are linked across years by unique LAD identification numbers derived from their SIN numbers to create individual longitudinal profiles. LAD is augmented each year with a sample of new taxfilers so that it consists of approximately 20 percent of all taxfilers in every year. The 20 percent

[2] This paragraph draws on Statistics Canada's (2017, p 13) original description.

[3] The LAD population includes a small number of relatives of taxfilers who did not file a T1 themselves but who had a SIN and received Canada Child Tax Benefits or a T4 statement of earnings, or were listed as dependants.

sample increased from 3,227,485 people in 1982 to 5,523,940 in 2015. That increase reflects growth in the Canadian population and also in the incidence of tax filing as a result of incentives to file provided by the introduction of the Federal Sales Tax Credit in 1986 and the Goods and Services Tax Credit in 1989.

Access to LAD is made available for research purposes under strict security provisions that ensure anonymity of individual taxfilers and confidentiality of their information. In addition to physical and electronic security of the data base itself Statistics Canada reviews all requests for release of tabular material to ensure that confidentiality cannot be breached. As a further safeguard it applies an algorithm to incorporate small random perturbations in the form of weights to the original data and requires that all calculated values intended for release be made using the weighted data. The perturbations (a term commonly used in this context) are sufficiently small that calculations of aggregates, averages, ratios, etc. are not affected in any significant way. We were able to do the calculations for this paper using both original and weighted data before seeking approval for release of the results based on the weighted data, and thus assure ourselves that there was in fact no significant distortion. (Security protection is in general a major consideration of governments in making available data based on individual records for research purposes; see Rinott et al. (2018) for recent discussion, methods, and references.)

3. CONSTRUCTING A FILTERED SAMPLE POPULATION OF TAXFILERS

We have adapted the LAD sample for our purposes by “filtering” it in a number of ways in order to allow consistent definitions and interpretations of individual income histories; individuals can thus be assigned to cohorts on a consistent basis suitable for our objectives. The complete LAD sample with which we have been working spans a period of 34 taxation years, from 1982 to 2015. Ideally (for our purposes) the taxfiler population from which LAD is drawn would cover the entire Canadian adult population but that of course is not the case. Not all adults are required to file tax returns in every year and the coverage ratio has varied over time. The ratio of taxfilers to the Canadian population 25 to 80 provides a rough measure of overall coverage in that respect[4]. For 1982 the ratio was less than 90 percent. By 1993, it had risen to more than 95 percent and it has remained relatively stable since then. In light of this coverage history we have chosen to restrict our use of the LAD data to the period 1993 – 2015. We excluded from our sample the few individuals whose gender was not reported consistently throughout the data period; also we included only those whose age (based on year of birth) was reported consistently for at least three consecutive years[5]. Our income definition requires three-year averaging of incomes over the current and previous two years (see below) and for that reason 1995 becomes the earliest starting year for any taxfiler cohort in our analysis. Also we restrict attention to those aged 24 and older. All those in that age range who filed tax returns in 1995 as well as in the previous two years are included, provided that they continued to file in each of the following 20 years,

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[4] The full LAD file includes some imputed individuals whose identity is known from returns that are filed but who did not themselves file income tax returns (e.g., the spouse of a taxfiler); imputed individuals are not counted as taxfilers and are excluded from our filtered sample.

[5] Checking for consistent reporting of year of birth starts with the latest three years (2013-2015) and extends backwards in time as far as necessary. Only xx percent were excluded because of inconsistent reporting in the latest three years.

or else died. Taxfilers turning 24 in the period 1996 - 2015 are added to the sample, year by year, again provided that they filed returns in the previous two years and continued to file in all subsequent ones, or else died. Thus, after 1995, the attainment of age 24 is the only way of entering the filtered sample, death is the only way of leaving. (That means that new immigrants to Canada are excluded unless they turned 24 during the data period and filed returns at ages 22, 23, and 24; all persons emigrating within the period 1995 - 2015 are excluded also.)

The sample so defined is a subset of the larger LAD sample. For 1995 the filtered sample includes 2.7 million individual taxfilers, 88 percent of the unfiltered LAD sample; for 2015 it is 3.8 million or 74 percent. (The drop is due mainly to the exclusion of immigrants who came to Canada after 1993 and were over the age of 22 at the time.) The filtered sample is the population with which we work in this paper and for convenience in terminology we refer to it as *the taxfiler population* or just *the population*, thus ignoring its sample origin unless the context demands otherwise.

Table 1 provides a summary comparison of death and survival rates for the filtered population of taxfilers, based on cohort calculations at 10-year age intervals, and a comparison with corresponding rates from Statistics Canada life tables for the Canadian population as a whole. (The taxfiler cohort noted in the table, labelled CSD and constructed from 2010 – 2015 cross-section data, is one of several defined below; the life tables are derived from mortality data for the period 2010 – 2012 and are commonly referred to as 2011 tables.) The death rates are somewhat lower and the survival rates higher for the filtered taxfiler population at all ages. (That there are differences should perhaps not be surprising in light of the restrictions imposed in defining the filtered population.) At age 64 the differences in survival rates are 3.0 years for males, 1.8 for females; at 84 they are 5.9 and 5.6.

4. INCOME MEASURES AND REFERENCE DISTRIBUTIONS

The individual records in LAD contain information on all types of income reported on tax returns. There are various forms of analysis that could be carried out with different types but for purposes of this paper we have chosen to focus entirely on after-tax income, as defined by the Income Statistics Division of Statistics Canada. (The measure of total income excludes capital gains and includes refundable tax credits and other non-taxable income; see Statistics Canada, 2017.) More particularly, we have chosen as our measure for an individual taxfiler the three-year average of after-tax income ending in the current year in order to reduce the effects of shorter-term fluctuations in examining patterns of cohort progression: the average over t, t-1, t-2 thus represents our income measure assigned to year t. All income comparisons in this paper are in terms of such three year averages.

Income is treated strictly in *relative* terms. The distribution for any cohort at any age is defined relative to an overall income distribution, a *reference distribution* as we shall call it. (One implication of this is that we avoid the issue of inflation adjustment of dollar levels.) We can then ask how the income distribution for a cohort of, say, age 24, or age 54, compares with the overall distribution, and how the cohort's distribution changes relative to the overall distribution as the cohort ages.

The overall distribution can be defined in terms of quantiles and the positions of individuals by their locations in particular quantile groups. We use deciles for our calculations: every individual in the taxfiler population is assigned to a reference decile group, based on the individual's three-year income average. (The reference distribution changes through time and the decile groups are thus specific to a particular year but for the moment we avoid a time subscript.) Now let S denote the set of all living members of the filtered taxfiler population (see below for the treatment of deaths). The members of S are distributed among 10 income decile groups D_j $(j = 1, \dots, 10)$. Let c_j $(j = 2, \dots, 10)$ denote the lower bound of group j and assume that individual i has income y_i. (Note that group 1, the lowest group, includes a small proportion of negative incomes, and so has no predetermined lower bound; at the other end group 10 has no upper bound.) The state of individual i is determined by the following assignment rules:

(1) $i \in S$

(2) $i \in D_1$ if $y_i < c_2$

(3) $i \in D_j$ $(j = 2, \dots, 9)$ if $c_j \leq y_i < c_{j+1}$

(4) $i \in D_{10}$ if $y_i \geq c_{10}$

Rules (2), (3), and (4) determine the income position of any member of the overall taxfiler population; they also determine the income position of any member of a *subgroup* of that population. For purposes of comparison the income boundaries are defined to be the same for any subgroup as for the overall population, and that is true in particular for age subgroups. The only change required in the assignment rules to position an individual member of a subgroup in terms of relative income is then to replace (1) with (1a):

(1a) $i \in S_x \subset S$

where S_x is the set of individuals of age x. This is the idea behind the definition of relative income distribution – the distribution of the members of an age group positioned relative to the overall distribution of all taxfilers at any given time, as represented by D1, … , D10.

Introducing a time subscript, consider now a particular cohort of initial age x in year t. The cohort is subject to mortality as it ages but the accumulation of deaths is kept track of and the size of the cohort, living plus dead, never changes in an accounting sense. If n_{xt} is the initial size of the cohort, $n_{xt} = l_{xt} + d_{xt} = n_{x+k,t+k}$ for all k, where l denotes survivors, d denotes accumulated deaths after the initial age. At any given time every member of the cohort must be in one of 11 possible states, 10 income decile groups plus the dead state. Recognizing that both the decile boundaries and the income of individual i are specific to the year of calculation we could simply attach t subscripts to all S, D, c, and y symbols in the assignment rules above to make the rules exactly consistent with practical application.

We have assumed implicitly that the reference income distribution is the distribution for both sexes combined. To substitute a sex-specific distribution in an analysis focussing on male or female taxpayers the both-sexes reference distribution would be replaced by the distribution for males only or for females only.

5. COHORT AGE/INCOME DYNAMICS

Assume a cohort of age x in year t. The n_{xt} members are distributed among the 11 possible states (income groups, dead) and expressed as proportions of the cohort total, thus defining an 11-element *status vector* v_{xt} (a row vector). We take a snapshot of that vector, so to speak, then another snapshot 5 years later, a third 5 years after that, and so on. For a "true" (age/time consistent – see below) cohort we would thus have a sequence of status vectors as the cohort ages: v_{xt}, $v_{x+5,t+5}$, $v_{x+10,t+10}$, etc. (The element representing dead in a status vector is 0 at the initial age of a cohort sequence, say $x = 24$. Thereafter it is an increasing positive element as the proportion in the dead state accumulates over age and time, in successive vectors.)

Now consider the process that links consecutive status vectors for a particular cohort. Define a set of 11 x 11 age-specific *state transition matrices* P that map each vector onto the next one in the cohort sequence. The rows of P represent current status, at x, t; the columns represent destination status, at $x + 5, t + 5$. The time and age intervals are the same for the cohort, 5 years, so again there is no loss in simplifying notation by suppressing the t subscript. Doing that, and noting that the elements of every row and every column must sum to 1, let P_x be such a matrix so that $v_{x+5} = v_x P_x$ and $v_{x+10} = v_{x+5} P_{x+5} = v_x P_x P_{x+5}$. All pairwise movements among income groups are permitted in the transition process (represented by positive elements in P) but dead is an absorbing state: the last element in the bottom row of every P matrix is 1 and all other elements in that row are 0. (Table 2, which we will examine in detail later, provides a sequence of selected matrices.)

Consider next a single individual of age x in decile group h (a one person cohort, if you like) and create a status vector v_x for that individual, with element h of the vector now set to 1 and all other elements to 0 ($v_x = (0, 0, 1, 0, \dots, 0)$, for example). The distribution among the 11 states at the next age, $x + 5$, would then be represented by $v_{x+5} = v_x P_x$, as above, and can be interpreted as a probability distribution for the individual at age $x + 5$, conditional on starting out in decile group h at age x. We can apply P_{x+5} to v_{x+5} to generate the corresponding probability distribution at $x + 10$, and so on.

A more general treatment for calculations of this kind is as follow. Consider two ages, $x = i$ and $x = j, j > i$ (by some multiple of 5), with status vectors v_i and v_j. Choose an initial income decile group for a hypothetical individual and set the corresponding element of v_i to 1 accordingly, all other elements to 0. Writing z= $(j - i)/5$ we then have

(5) $v_j = v_i \prod_{k=0}^{z-1} P_{i+5k}$ for some specification of the form $v_i = (0, .. ,0,1,0, .. ,0)$.

The elements of the status vector v_j are interpreted as the probabilities that the individual who started out at age i will be in income groups 1, 2, up to 10, or will be dead, by the time he/she reaches age j. Label the elements of the vector as $v_{j1}, \dots, v_{j10}, v_{j11}$. The elements sum to 1; the individual must be in one of the 11 states that they represent, v_{j11} being the dead state. If interest focuses on probabilities for a *survivor* at age j the probabilities over decile groups g, conditional on survival to j, can then be calculated from

(6) $s_{jg} = \frac{v_{jg}}{1-v_{j11}},\ g = 1, \dots, 10.$

6. ALTERNATIVE COHORT REPRESENTATIONS

We are restricted to 20 years (1995 to 2015) in tracking changes for actual cohorts in the filtered population. We take advantage of the 20-year span to follow some actual cohorts with different starting ages but in addition we can construct an artificial cohort based on cross-section data, allowing us to study income distributions and transition patterns over (approximately) the full adult life course. Possible types of cohorts are as follows, under four headings.

Cross-Section Actual (CSA) Cohort: A cross-section sequence is assembled using actual status vectors (v) for a particular year t, from age 24 to age 84: $v_{24t}, v_{29t} \dots, v_{84t}$. The sequence is then treated as if it represented a true historical cohort sequence.

Cross-Section Dynamic (CSD) Cohort: We find this definition to be a useful innovation. A cross-section sequence is calculated using transition matrices (P) for a particular 5-year period $t, t+5$, from age 24 to age 84; the matrices are applied to an initial age 24 status vector but status vectors for subsequent ages are calculated by sequential application of the transition matrices: $v_{24t}, \hat{v}_{29t}, \hat{v}_{34t}, \dots, \hat{v}_{84t}$ where $\hat{v}_{29t} = v_{24t}P_{24t}, \hat{v}_{34t} = \hat{v}_{29t}P_{29t}$, etc. CSD and CSA are both artificial cross-section cohort representations. However a CSD cohort has (implicitly) a constant composition represented by its initial status vector whereas a CSA cohort has a different composition (population of individuals) at every age.

Age-Time Consistent (ATC) Cohort: This is a true cohort – a given group of people who age and move through time together. That is its advantage. A disadvantage is the length of longitudinal time series required to observe such a cohort other than over a limited age span. Our data period restricts us to consistent ATC observations over no more than 20 years.

Pseudo Age-Time Consistent (PATC) Cohort: This cohort mimics an ATC cohort by using observations that follow an age-time path but the observations are not strictly for the same group of people and thus do not represent a true ATC cohort. They can be viewed simply as sequences of cross-section observations along a diagonal in an age/time cross-classification table. We mention the PATC option for completeness but it is of no interest here since diagonal entries in our filtered longitudinal data base constitute a proper ATC cohort.

7. PRESENTATION OF RESULTS

We have chosen five cohort representations for purposes of this paper. Our choice includes four ATC cohorts. As noted, those four have the advantage of representing actual cohort histories, with exactly the same population at each age (the dead included), but the disadvantage of covering only a specific 20-year age range in each case. In light of that, our fifth choice, and the one we make most use of, is a CSD cohort based on the 2010-2015 cross-section sequence of transition matrices, the initial input being the average of the age 24 status vectors for the two years 2010 and 2015. That cohort lacks the strict historical advantage of the ATC cohorts but covers the entire age range of interest, in a consistent manner, and we have focussed our attention largely on it. Although based on cross-section calculations (the P matrices) the initial population remains the same throughout the entire age progression, from youngest to oldest. We note (and verify later) that the CSD cohort exhibits income progression patterns (sequences of status vectors) quite similar to those of the ATC cohorts for comparable age ranges. We have also calculated CSD-type cohort status vectors for 1995-2000, 2000-2005, and 2005-2010 and those too show patterns similar to the 2010-2015 CSD cohort patterns. We conclude that the results we show in the tables below would be little affected by a different CSD choice. (We have referred to the use of *cohort* in the singular, but in several of the tables we show separate cohorts for men and women, constructed in the same way as for both sexes combined.)

All of the calculations underlying the tables have been carried out with income decile groups (D1, D2, …, D10) and 5-year age intervals. However for presentation purposes in some cases we combine the decile groups into quintile groups (Q1 = D1 + D2, …, Q5 = D9 + D10), allowing tabular results to be provided in a more compact form.

Note our symbols for the choice of reference income distribution in the tables: Ref B for both sexes combined; Ref M for males only, Ref F for females only. Note too that age in the tables is at December 31 of the year.

8. PATTERNS OF INCOME TRANSITION

Table 2 displays state transition matrices for the CSD cohort at selected ages, both sexes combined. Each matrix shows the proportionate transitions over a 5-year age interval. As displayed the matrices in the table are complete with the exception of those for initial ages 24 and 74 where confidentiality rules prohibited disclosure of some of the cells because of small sample sizes.

Except for dead, the absorbing state, there are movements into or out of every state at every age. Some of the movements would reflect common patterns associated with age, others would represent what might be called transient migration with respect to decile boundaries: individuals near the top or bottom of a decile group might require little alteration in circumstances for them to be reclassified to an adjacent group. Beyond that, some individuals might experience major changes in circumstances unrelated to common patterns of age progression or income group adjacency, and consequent shifts in distributional location that might be larger than expected. The framework represented by the transition matrices displays obvious patterns but is somewhat "noisy" (even though the income measure itself is averaged over a three-year period).

We facilitate the extraction of underlying age patterns within this framework by offering Tables 3 and 4. These tables identify, for each income group, the proportions moving up over five years to a higher group (symbolized by + in the tables) and the proportions not moving up (remaining in the same group or moving to a lower one, symbolized by 0/-). The tables represent an extension of coverage from Table 2: they include separate results for males and females calculated from sex-specific transition matrices. Table 3 is based entirely on Ref B; Table 4 employs Ref M for males, Ref F for females. (Note that the proportions in Tables 3 and 4, and all subsequent tables, apply to survivors - deaths are excluded in the calculations - whereas the transition matrices in Table 2 include the dead state.)

Looking first at Table 3, most 24-year-olds are in the lowest three income groups and the table shows roughly three quarters of the people in those groups going up the relative income ladder one group or more by the age of 29. The proportions moving up then decrease over the working-age range until retirement comes into play, at 64-69, and that is generally true of all income groups: advances in relative income status are most prevalent for people in their later twenties and the proportions fall off steadily thereafter. The broad patterns of income transition stand out clearly in Figure 1.

At the older end of the age spectrum (still in Table 3 and Figure 1), about three quarters of those 64-69 in D1 move to a higher income group over that interval, reflecting the effects of older-age transfer payments. The proportion so moving drops to about three fifths for D2 and then falls below 50 percent for higher groups, where transfers are less important. By 74-79 (when most people are fully retired) the proportions of individuals who increase their income status are very low except for those in the bottom decile group. The relatively high rates of transition out of that decile group are largely accounted for by those whose income at age 79 includes components previously associated with a spouse who died in the previous five-year period. (The main components are income from investments and survivor or other benefits including pension income.) Looking back to Table 2 we note that diagonal entries (no changes) are the largest entries for 74-79 age transitions in all cases; "fall back one decile group" entries are next largest for all groups except the bottom two.

These patterns are similar for men and women, broadly speaking. There are some notable differences though. Excluding D1, if the same reference distribution is used for both (Ref B in Table 3) the proportions moving up in the distribution are lower for women at all age intervals up to 54-59. For 64-69 they are again lower, up to decile group D4, but higher for D5 and above, and for the age interval 74-79 they are higher for all income groups. Thus increases in relative income status are less prevalent for women over the working ages but the pattern changes in the retirement range. Replacing Ref B with Ref M for men and Ref F for women alters the pattern somewhat but the proportions of women moving up in their distribution are still lower than the corresponding male proportions over the working ages. Where the effects of using different references for men and women are more in evidence is at older ages: the proportions increasing are now higher for women in all cases for age intervals 64-69 and 74-79.

9. INCOME STATUS OVER THE LIFE COURSE

We turn now from changes in income status to a consideration of the distributions that result from those changes, based as before on the CSD cohort definition. Tables 5 and 6 show relative distributions of income at 10-year age intervals, again for both sexes combined and for men and women separately. Again too we show the results in two ways, first based on the both-sexes reference distribution and then on sex-specific distributions. The distributions in these tables are by quintile groups (Q1, Q2, etc.) rather than decile groups, thus averaging out some of the "noise" in the decile-group movements. (The underlying calculations are still carried out with decile groups.) Figure 2 provides visual depiction of the distributions for Ref B. In addition to group proportions, Tables 5 and 6 show summary measures in the form of medians: think of all individuals of a given age in a given quintile group to be listed in order of income, lowest to highest; a median of 3.4, for example, shows the median individual in the income distribution to be located in Q4, four tenths of the way along the list of individuals in that group. (Medians are calculated using decile groups and then converted to quintile equivalents; see Appendix for details.)

Three quarters of all individuals of age 24 are in the lowest two quintiles: Q1 accounts for about 45 percent, Q2 for 30 percent. At age 34 the largest group is Q4 and at 44 and 54 it is Q5. At 64 the top three quintile groups are virtually tied, at around 20 percent each; at 74 the largest group is Q2 and at 84 it is again Q2, but now with a still higher share. This pretty much summarizes, broadly, the age/income story: relative income is low in the beginning, rises to its highest level in middle age, and then falls to low again (though not as low as at the beginning). There are more details to be extracted from the top panel of Table 5 of course: very large decreases in Q1 and Q2 going from age 24 to 34; an inverted u-shape path of Q5 going from age 24 to 84, including a precipitous drop from 35 percent at 44 and 54 to only 10 percent at 84; a more or less flat pattern (13-15 percent) shown by the lowest income group, Q1, in the 34-54 age range. But the overall low-high-low pattern is the dominant feature. The age path of the median tells a matching story, rising from 1.2 at 24 to 3.3-3.4 at ages 44-54, and then falling to 1.9 by age 84.

The differences in the distributions for men and women are noteworthy. Using Ref B, as in Table 5, shows the median to be lower for women than for men in every case although both series show the same general age pattern. However, as seen in Figure 2, the overall distributions at each age are quite different. Based on averages across the ages shown, men are 2.4 times more likely than women to have incomes in the top quintile group and women 1.7 times more likely than men to have incomes in the bottom quintile group. The differences are especially pronounced at ages 44 and 54, when more than 46 percent of men but only 25 percent of women are in the top group. Shifting to sex-specific reference distributions in Table 6 changes things rather significantly; the median patterns are now much more alike. Each has the low-high-low shape over the life course as before but the male/female differences are much smaller. The medians for men compared with men, women compared with women are very close. Reference distributions may differ but levels and patterns of change in relative income status are similar.

10. CSD/ATC COMPARISONS

All results presented up to this point have been based on the CSD cohort definition that we have chosen to focus on. To recapitulate, the CSD cohort is artificial but has the advantage of covering the whole life course, from 24 to 84, in a consistent manner; it combines a fixed initial input of 24-year-olds with a cross-section of 2010-2015 transition matrices. An ATC cohort, on the other hand, represents the actual movement of the survivors of a fixed group of people through age/time but only for a span of two decades. Distributions based on our four selected ATC cohorts are shown now in Table 7, each covering a different 20-year age interval but the same time interval, 1995-2015. We have labelled them ATC1, ATC2, ATC3, and ATC4. In addition we have constructed a fifth distribution by splicing together ATC1, ATC2, and ATC3 to form an artificial extension of ATC1 covering the full 24 to 84 age range; we label this one ATCX. The distributions in Table 7 can be compared with the CSD distributions in the top panel of

Table 5 or Table 6. They are much alike, although the ATC proportions are somewhat below the CSD projected values for the lower quintiles and somewhat above for the higher ones.

All distributions are relative, as has been emphasised: they represent the positioning of a distribution at a given age in a given year with respect to the overall distribution of income in that year. The positioning at a given age may vary from one year to another as a result of circumstances affecting that age group specifically. But it may vary also as a result of changes in the overall reference distribution. The observed relative income history of one cohort passing through age/time may differ from the history of another for that reason, quite apart from the characteristics of the cohorts themselves. One might look for similarity of patterns in comparing one cohort's experience with that of another but correspondence in detail need not be expected.

The results exhibited by the ATC cohorts in Table 7 are in general much the same as those in Tables 5 and 6. There are differences in individual quintile group proportions but the overall shapes of the distributions are much alike and the age patterns of medians are quite similar. ATC2 is twenty years removed from ATC1 but they overlap at age 44. Similarly, ATC4 overlaps with ATC2 at 54 and with ATC3 at 74; ATC4 also overlaps with ATC2 and ATC3 at 64. Direct comparisons among ATC cohorts are thus possible at particular ages and they further support the view that patterns are generally similar across cohorts, at least for the two sexes combined, as in Table 7.

11. MORE COHORT COMPARISONS OVER TIME

A wider-ranging presentation of cohort histories is provided in Table 8 to permit a larger set of comparisons of earlier and later cohorts within the 20-year period permitted by the data. The table is a cross-tabulation of years and ages showing median income status for each year/age cell; the years run from 1995 to 2015 at five-year intervals, the ages from 24 to 84, also at five year intervals. Each cell has a calculated status vector underlying it and a median calculated and displayed for that vector. Each cohort is identified in brackets by inserting the last two digits of the year in which it was age 24, its year of "birth" for our purposes. The calculations are made using decile groups, as in other tables, but for comparisons with earlier results the medians are shown in quintile form (2.3, for example, rather than the decile equivalent 4.6). Medians for both sexes combined and for males and females separately are shown in the three panels of the table, based in all cases on Ref B.

Altogether there are 17 ATC-type cohorts represented by diagonals or mini-diagonals in each panel of the table, each with a number of entries ranging from one to five. Table 8 shows the median income status histories of all 17. One might look for evidence of ascribable differences in three dimensions - over age, over time, and by cohort year of "birth" - but there is a well-known identification problem: changes in the three are not independent. Given any two of the three types of change the third is determined exactly. Cohort variations attributable separately to age, time, and year of birth would be defensible only if one could bring in additional information or credible assumptions to break the connection. (See Smith and Wakefield, 2016, and Schulhofer-Wohl, 2018, for recent discussion, related applications, and references to other literature.) That should be kept in mind in interpreting the table.

Looking across the rows (age comparisons) the general low-high-low pattern stands out among the medians in Table 8, as in the earlier distributional tables, but now in more age detail (five instead of ten-year intervals). From a low starting point at 24 the median invariably moves up over each five-year age interval, reaches a peak at 49, and then declines gradually as middle age gives way to the retirement years. This general pattern holds in every year for both sexes combined, for males, and for females. It can also be inferred from the fragmentary diagonal cohort age/time paths. Another result that stands out is the difference between the medians for men and women: there are sixty-five year/age cells for each sex in the table and the female median is lower than the male median in all sixty-five[6]. Again this result matches a result from earlier tables, but in more age and time detail. On the other hand, while female medians have been consistently lower than male medians the female medians have been rising over the 1995-2015 period, in particular for ages 34 to 64 and most prominently for younger groups in that age span: the median for women aged 34 was 2.0 in 1995, by 2015 it had risen to 2.6; the median for women aged 39 was 2.3 in 1995, by 2015 it had risen to 2.8. In the larger context of changes in medians calculated for all ages and both sexes those increases over 20 years can be viewed as of significant magnitude in comparison with other changes. The increases for ages older than 39 in the 34-64 span are smaller but generally consistent over the period.

12. SOME LIFETIME PROBABILITY CALCULATIONS

As described earlier, the relative income distribution at age $j > i$ of an individual who starts out at i in some specified decile group can be calculated by successive applications of P matrices. Table 9 shows results of this kind for an individual who starts out in one of four possible decile groups at 24 and survives to ages 44 and 64. The four initial decile groups are D1, D2, D3, and D4 but since we are reporting results as quintile distributions in the table we relabel these as Q1 (lower half), Q1 (upper half), Q2 (lower half), and Q2 (upper half). Probability distributions, expressed as percentages for consistency with earlier tables, are shown based on Ref B. To illustrate, a male who started out in the lower half of Q1 at 24 would have percentage probability 16.0 of being in Q1 at 44, probability 11.8 of being in Q2, and so on, and similarly for the age 64 distribution.

General interest is in how an initial position in the income distribution affects the probabilities of later positions. The first conclusion is that starting position does indeed matter. The probability of being in the lowest quintile at 44 declines consistently as the initial age 24 position moves to the right in the table: for a male the percentage probability of being in Q1 at age 44 is 16.0 if he started out in the lower half of Q1, 10.9 if he started out in the upper half, and 8.6 and then 6.6 if he started out in the lower or upper half of Q2. From an alternative perspective, a male in the lower half of Q1 at age 24 is twice as likely to be in Q5 rather than Q1 at age 44 while a similar male who was in the upper half of Q2 is seven times more likely. Similar patterns hold for the probabilities at age 64 for males. They hold too for females at both ages, although the probabilities for females are generally higher and somewhat less

[6] Of related interest, a recent analysis based on the 2016 Census of Population reports that the median total income of working women in the top 1 percent is lower than that of their male counterparts (Richards, 2019). The income information in that study is drawn from 2015 income tax returns which were linked to the one-in-four households that responded to the long-form census questionnaire.

sensitive to initial position. A reverse pattern holds at the high end of the income distribution: the probability of reaching Q5 by 44 or 64 increases monotonically with initial position for both males and females, although with much lower probabilities for females in all cases. In sum, (a) the probability of either remaining at the low end or reaching the high end of the income distribution in later years is clearly related to exactly where an individual starts out at the low end, and (b) the relationship holds for men and women but is stronger for men.

13. SUMMARY AND CONCLUSION

We have made use of sample data from Statistics Canada's Longitudinal Administrative Database to explore relationships between the ages and relative incomes of Canadian taxfilers. The LAD sample represents about 20 percent of all filers in any given year and includes records back to 1982. For reasons described in the paper we have chosen to work with data for 1995 to 2015 and to consider only individuals who filed in every year of that period, or who died, plus new young entrants at age 24. Our filtered sample population thus represents a large but specialized component of the overall Canadian adult population. It differs somewhat from that population in mortality rates and life expectancies, as we have shown. That should be kept in mind in interpreting and generalizing from our results.

What we believe may be an innovation is the way in which we define relative income. Our approach is to consider where an individual of a given age is positioned with regard to the overall distribution of income in a given year, the reference distribution as we call it. That is what we mean by the term *relative*. We define quantile boundaries (deciles or quintiles) for the reference distribution and observe the locations of individuals of different ages with respect to those boundaries. We then derive the proportionate distribution of individuals among the reference quantile groups at each representative age, starting at 24, and transition matrices that show the movements from the distribution at one age to the distribution five years later.

We have made use of an artificial cohort definition that we call cross-section dynamic which allows calculations over the entire adult life course based on the transition matrices, as well as a true cohort definition that can be implemented only for selected 20-year age/time spans, given our 1995-2015 data restriction. While the possibilities for full comparison are limited by differences in period, calculations based on the two definitions appear generally consistent, although differing in some details.

The transition matrices show movement among income decile groups at every age but patterns emerge. Increases in income status are most frequent in the late twenties and the proportions moving up the income ladder fall off generally thereafter. Concomitantly the relative income distribution that results from these changes shifts from a low median at age 24 to a peak at 44/54 and then declines sharply going into the retirement years. That is the pattern ignoring male/female differences. Looking at males and females separately, but with the same overall reference distribution, the general rising and then falling pattern of medians still holds for both but the medians are notably lower for women at all ages. If now the reference distribution is changed so that men at different ages are positioned according to the male distribution, and women similarly, the two sets of medians come closer together; there are differences between the distributions but the medians, as summary measures, are now much more alike at all ages. The pattern for women compared with women is similar to the pattern for men compared with men, based on the medians.

Viewing the data from a broader perspective, a table of medians for the entire filtered sample, cross-classified by age and year at 5-year intervals, contains 65 entries. Based on the both sexes reference distribution the median for women is less than the median for men in all 65. On the other hand, while still lower, the medians for women in the younger working age range generally increase over the 20-year period 1995-2015.

Putting aside details and differences between male and female distributions the overall age pattern of Canadian taxfilers can be characterized as low-to-high-to-low over six decades in the adult life of a cohort. One summary statement, based on the results from our Table 5: 2 percent are in the top quintile at age 24, 35 percent at 44, 21 percent at 64, and 10 percent at 84. The medians provide a similar statement.

Combining transition matrices in sequence allows the calculation of income probability distributions later in life, conditional on where an individual started out at 24. The calculations indicate that later achievement is quite sensitive to the starting point. The probability of a higher level of attainment at age 44 or 64 increases considerably as the starting point moves from the bottom half of the first quintile through to the top half of the second quintile.

The data set that we have used in this paper offers possibilities for extending the work that we have reported on here. We have chosen a particular definition of income but the personal tax records that are sampled in constructing LAD would allow other definitions and the exploration of age-related issues involving other types of income and associated variables. We present this paper as a first, self-contained report on an ongoing project.

APPENDIX: CALCULATION OF MEDIANS

There are N individuals distributed by population as $N_1, N_2, \dots, N_{10}$ among ten reference decile groups.

Imagine that the individuals are arranged in ascending order of income from 1 to N. (It is not necessary to actually arrange them that way, just imagine it to be the case.) The median position M is located at $(N+1)/2$ (a single individual if N is odd, a position between two individuals if N is even).

Write $S_k = \sum_{i=1}^{k} N_i$ for some $k < 10$ and make the following assumption:

$$S_k < M < S_k + N_{k+1}$$

This implies that the median position must lie in decile group $k+1$. Let α be its distance (in individual positions) along the ordering within that group. Then

$$M = S_k + \alpha N_{k+1} = (N+1)/2, \quad 0 < \alpha < 1$$

and $\alpha = ((N+1)/2 - S_k)/N_{k+1}$

The median in terms of decile groups is then reported as $m = k + \alpha$, or in terms of quintile groups

as $m = (k+\alpha)/2$.

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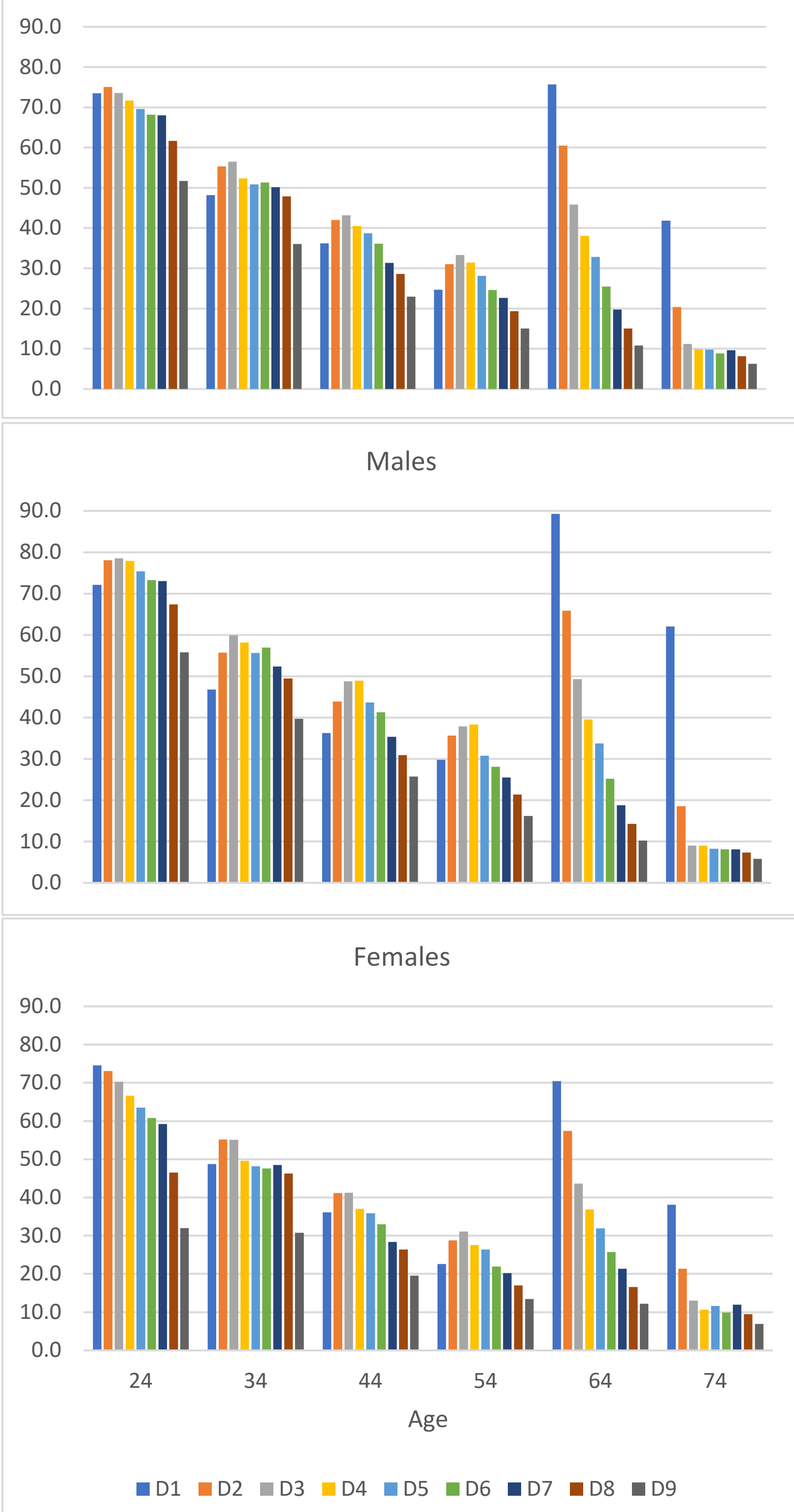

Fig 1: Percentages Moving Up Among Income Groups in the Next 5 Years, CSD Cohorts (Ref B), Both Sexes

Fig 2: Percentage Income Distributions, Quintile Groups, by Age CSD Cohorts (Ref B)

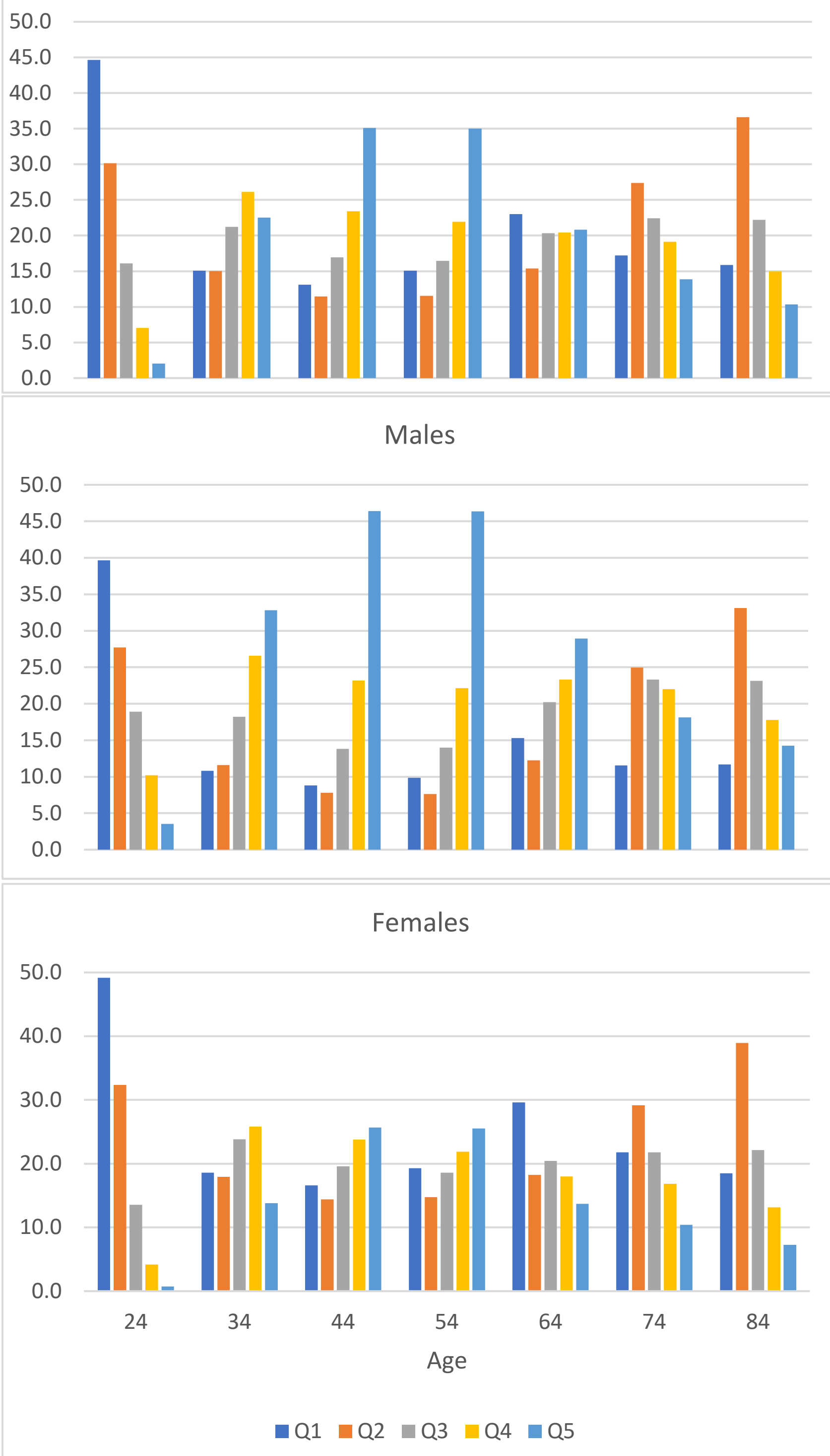

Table 1. Cohort Losses Due to Death and Proportions Surviving, Filtered LAD Sample Compared with Life Table Population

	Both sexes		Males		Females	
Age	10-year loss due to death	proportion surviving (from age 24)	10-year loss due to death	proportion surviving (from age 24)	10-year loss due to death	proportion surviving (from age 24)
	%	%	%	%	%	%
Filtered LAD population						
24	--	100.0	--	100.0	--	100.0
34	0.4	99.6	0.6	99.4	0.3	99.7
44	0.6	98.9	0.8	98.6	0.5	99.2
54	1.6	97.4	1.9	96.6	1.3	97.9
64	4.3	93.1	5.1	91.6	3.4	94.5
74	10.9	82.2	12.8	78.8	8.4	86.1
84	26.1	56.1	29.0	49.8	22.1	64.0
Life table population						
24	--	100.0	--	100.0	--	100.0
34	0.6	99.4	0.8	99.2	0.4	99.6
44	1.0	98.5	1.2	98.0	0.7	98.9
54	2.4	96.1	2.9	95.2	1.9	97.0
64	5.7	90.6	6.9	88.6	4.4	92.7
74	13.9	78.0	16.9	73.6	11.1	82.4
84	34.2	51.4	40.4	43.9	29.1	58.4

Note: Cohort calculations relate to the 2010/15 cohorts labelled CSD, as defined later in the text. Life table calculations are based on Statistics Canada tables for the three-year period 2010 - 2012 (commonly referred to as 2011 life tables). See Statistics Canada, Table 39-10-0007-01.

Table 2. Selected State Transition Matrices, CSD Cohort (Ref B)

State at age 24	State at age 29										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.264	0.160	0.113	0.110	0.095	0.075	0.072	0.058	0.038	0.012	0.003
D2	0.102	0.147	0.146	0.152	0.135	0.114	0.090	0.066	0.035	0.010	0.002
D3	0.059	0.083	0.122	0.173	0.171	0.130	0.119	0.078	0.050	0.014	0.002
D4	0.037	0.051	0.062	0.133	0.200	0.175	0.145	0.106	0.066	0.023	0.003
D5	0.026	0.030	0.036	0.071	0.141	0.201	0.202	0.153	0.100	0.038	0.002
D6	0.017	0.018	0.022	0.039	0.073	0.149	0.221	0.228	0.169	0.062	0.003
D7	0.009	0.012	0.013	0.025	0.036	0.074	0.150	0.286	0.269	0.123	
D8				0.019	0.019	0.039	0.070	0.215	0.362	0.254	
D9							0.049	0.084	0.304	0.516	
D10							0.031	0.052	0.137	0.746	
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

State at age 34	State at age 39										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.515	0.160	0.093	0.072	0.050	0.038	0.030	0.020	0.012	0.005	0.006
D2	0.200	0.244	0.181	0.134	0.096	0.055	0.040	0.024	0.014	0.006	0.007
D3	0.097	0.148	0.188	0.211	0.146	0.091	0.053	0.033	0.020	0.007	0.005
D4	0.061	0.078	0.111	0.226	0.227	0.141	0.079	0.045	0.022	0.009	0.002
D5	0.041	0.036	0.056	0.115	0.242	0.241	0.145	0.073	0.038	0.010	0.003
D6	0.023	0.022	0.028	0.052	0.108	0.253	0.276	0.151	0.062	0.023	0.001
D7	0.014	0.012	0.013	0.023	0.045	0.110	0.282	0.311	0.153	0.036	0.002
D8	0.009	0.008	0.007	0.012	0.021	0.036	0.091	0.338	0.389	0.089	0.001
D9	0.007	0.003	0.004	0.005	0.011	0.013	0.026	0.086	0.485	0.360	0.001
D10	0.006	0.001	0.002	0.002	0.004	0.007	0.012	0.029	0.105	0.829	0.002
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

State at age 44	State at age 49										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.630	0.144	0.067	0.050	0.037	0.020	0.014	0.012	0.008	0.005	0.012
D2	0.245	0.330	0.160	0.108	0.060	0.038	0.022	0.011	0.009	0.007	0.010
D3	0.123	0.178	0.261	0.205	0.107	0.051	0.030	0.020	0.009	0.005	0.010
D4	0.074	0.087	0.154	0.275	0.205	0.099	0.048	0.024	0.017	0.009	0.007
D5	0.036	0.050	0.067	0.159	0.297	0.213	0.098	0.045	0.020	0.009	0.006
D6	0.026	0.021	0.033	0.065	0.161	0.330	0.223	0.087	0.036	0.013	0.005
D7	0.017	0.010	0.017	0.033	0.063	0.159	0.385	0.220	0.070	0.022	0.005
D8	0.010	0.008	0.009	0.013	0.026	0.051	0.157	0.436	0.241	0.043	0.005
D9	0.009	0.004	0.005	0.007	0.009	0.015	0.031	0.135	0.552	0.228	0.005
D10	0.006	0.003	0.003	0.004	0.006	0.009	0.012	0.025	0.126	0.804	0.003
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table 2. (continued)

State at age 54	State at age 59										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.728	0.122	0.045	0.029	0.015	0.009	0.008	0.005	0.003	0.004	0.033
D2	0.294	0.372	0.157	0.070	0.031	0.018	0.010	0.004	0.005	0.004	0.035
D3	0.158	0.205	0.292	0.189	0.066	0.030	0.020	0.011	0.005	0.005	0.018
D4	0.098	0.105	0.157	0.313	0.168	0.070	0.037	0.019	0.008	0.006	0.019
D5	0.061	0.058	0.082	0.174	0.331	0.167	0.063	0.025	0.014	0.008	0.017
D6	0.041	0.034	0.055	0.091	0.182	0.340	0.158	0.054	0.020	0.010	0.014
D7	0.026	0.024	0.029	0.060	0.097	0.188	0.341	0.160	0.045	0.018	0.013
D8	0.023	0.015	0.017	0.038	0.066	0.093	0.175	0.366	0.155	0.036	0.014
D9	0.014	0.011	0.013	0.020	0.032	0.053	0.086	0.180	0.431	0.149	0.011
D10	0.013	0.006	0.006	0.010	0.014	0.022	0.037	0.066	0.156	0.659	0.010
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

State at age 64	State at age 69										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.229	0.450	0.160	0.047	0.023	0.013	0.009	0.005	0.003	0.004	0.057
D2	0.044	0.324	0.339	0.125	0.048	0.023	0.010	0.010	0.005	0.003	0.069
D3	0.029	0.186	0.303	0.246	0.104	0.042	0.022	0.014	0.006	0.003	0.045
D4	0.012	0.111	0.197	0.272	0.203	0.097	0.032	0.014	0.009	0.007	0.046
D5	0.007	0.065	0.120	0.183	0.267	0.179	0.083	0.031	0.012	0.008	0.044
D6	0.003	0.035	0.091	0.119	0.198	0.271	0.158	0.064	0.013	0.009	0.040
D7	0.003	0.019	0.054	0.083	0.123	0.222	0.268	0.142	0.035	0.013	0.037
D8	0.002	0.014	0.037	0.062	0.090	0.129	0.219	0.267	0.116	0.029	0.035
D9	0.003	0.006	0.021	0.037	0.053	0.108	0.138	0.224	0.275	0.105	0.030
D10	0.003	0.004	0.008	0.017	0.025	0.045	0.077	0.118	0.183	0.491	0.029
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

State at age 74	State at age 79										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Dead
D1	0.516	0.219	0.061	0.037	0.020	0.011	0.007			0.007	0.113
D2	0.045	0.640	0.129	0.024	0.009	0.005	0.003			0.002	0.139
D3	0.006	0.146	0.605	0.066	0.015	0.006	0.004	0.002	0.001	0.001	0.147
D4	0.005	0.036	0.258	0.478	0.054	0.013	0.009	0.006	0.002	0.002	0.138
D5	0.002	0.019	0.066	0.292	0.401	0.049	0.017	0.010	0.005	0.003	0.136
D6	0.002	0.009	0.031	0.072	0.306	0.386	0.055	0.015	0.005	0.003	0.116
D7		0.006	0.020	0.039	0.072	0.310	0.350	0.056	0.018	0.011	0.116
D8			0.014	0.020	0.042	0.061	0.290	0.396	0.050	0.023	0.101
D9			0.003	0.008	0.015	0.031	0.060	0.268	0.464	0.057	0.091
D10			0.008	0.008	0.012	0.016	0.029	0.056	0.196	0.580	0.088
Dead	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Table 3. Percentages Moving Up or Not Moving Up Among Income Groups in the Next 5 Years, Selected Ages, CSD Cohorts (Ref B)

	Income group	Age 24		Age 34		Age 44		Age 54		Age 64		Age 74	
		+	0/−	+	0/−	+	0/−	+	0/−	+	0/−	+	0/−
Both sexes	D1	73.5	26.5	48.2	51.8	36.2	63.8	24.7	75.3	75.7	24.3	41.8	58.2
	D2	75.0	25.0	55.3	44.7	42.0	58.0	31.0	69.0	60.5	39.5	20.4	79.6
	D3	73.6	26.4	56.5	43.5	43.2	56.8	33.3	66.7	45.8	54.2	11.2	88.8
	D4	71.7	28.3	52.3	47.7	40.5	59.5	31.4	68.6	38.0	62.0	9.9	90.1
	D5	69.6	30.4	50.8	49.2	38.7	61.3	28.1	71.9	32.9	67.1	9.8	90.2
	D6	68.1	31.9	51.3	48.7	36.1	63.9	24.6	75.4	25.4	74.6	8.8	91.2
	D7	68.0	32.0	50.1	49.9	31.3	68.7	22.6	77.4	19.7	80.3	9.6	90.4
	D8	61.6	38.4	47.8	52.2	28.6	71.4	19.4	80.6	15.1	84.9	8.1	91.9
	D9	51.7	48.3	36.0	64.0	22.9	77.1	15.0	85.0	10.8	89.2	6.2	93.8
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0
Males	D1	72.1	27.9	46.7	53.3	36.3	63.7	29.8	70.2	89.2	10.8	62.1	37.9
	D2	78.1	21.9	55.7	44.3	43.9	56.1	35.6	64.4	65.9	34.1	18.5	81.5
	D3	78.5	21.5	59.9	40.1	48.8	51.2	37.8	62.2	49.3	50.7	9.0	91.0
	D4	77.9	22.1	58.2	41.8	48.9	51.1	38.3	61.7	39.5	60.5	9.0	91.0
	D5	75.4	24.6	55.6	44.4	43.7	56.3	30.7	69.3	33.7	66.3	8.3	91.7
	D6	73.3	26.7	56.9	43.1	41.3	58.7	28.1	71.9	25.2	74.8	8.1	91.9
	D7	73.0	27.0	52.3	47.7	35.3	64.7	25.5	74.5	18.8	81.2	8.1	91.9
	D8	67.4	32.6	49.4	50.6	30.9	69.1	21.4	78.6	14.2	85.8	7.4	92.6
	D9	55.8	44.2	39.7	60.3	25.7	74.3	16.1	83.9	10.2	89.8	5.8	94.2
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0
Females	D1	74.5	25.5	48.7	51.3	36.1	63.9	22.6	77.4	70.4	29.6	38.1	61.9
	D2	73.1	26.9	55.2	44.8	41.2	58.8	28.8	71.2	57.4	42.6	21.4	78.6
	D3	70.3	29.7	55.1	44.9	41.2	58.8	31.1	68.9	43.6	56.4	13.1	86.9
	D4	66.6	33.4	49.6	50.4	37.1	62.9	27.6	72.4	36.9	63.1	10.7	89.3
	D5	63.5	36.5	48.2	51.8	35.9	64.1	26.4	73.6	31.9	68.1	11.6	88.4
	D6	60.8	39.2	47.6	52.4	33.0	67.0	22.0	78.0	25.7	74.3	9.9	90.1
	D7	59.3	40.7	48.5	51.5	28.4	71.6	20.2	79.8	21.3	78.7	12.0	88.0
	D8	46.5	53.5	46.3	53.7	26.4	73.6	17.0	83.0	16.6	83.4	9.5	90.5
	D9	32.0	68.0	30.8	69.2	19.6	80.4	13.4	86.6	12.2	87.8	6.9	93.1
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0

Note: Percentages apply to survivors; deaths are excluded in the calculations.

Table 4. Percentages Moving Up or Not Moving Up Among Income Groups in the Next 5 Years, Selected Ages, CSD Cohorts (Ref B for Both Sexes, Ref M for Males, Ref F for Females)

	Income group	Age											
		24		34		44		54		64		74	
		+	0/−	+	0/−	+	0/−	+	0/−	+	0/−	+	0/−
Both sexes	D1	73.5	26.5	48.2	51.8	36.2	63.8	24.7	75.3	75.7	24.3	41.8	58.2
	D2	75.0	25.0	55.3	44.7	42.0	58.0	31.0	69.0	60.5	39.5	20.4	79.6
	D3	73.6	26.4	56.5	43.5	43.2	56.8	33.3	66.7	45.8	54.2	11.2	88.8
	D4	71.7	28.3	52.3	47.7	40.5	59.5	31.4	68.6	38.0	62.0	9.9	90.1
	D5	69.6	30.4	50.8	49.2	38.7	61.3	28.1	71.9	32.9	67.1	9.8	90.2
	D6	68.1	31.9	51.3	48.7	36.1	63.9	24.6	75.4	25.4	74.6	8.8	91.2
	D7	68.0	32.0	50.1	49.9	31.3	68.7	22.6	77.4	19.7	80.3	9.6	90.4
	D8	61.6	38.4	47.8	52.2	28.6	71.4	19.4	80.6	15.1	84.9	8.1	91.9
	D9	51.7	48.3	36.0	64.0	22.9	77.1	15.0	85.0	10.8	89.2	6.2	93.8
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0
Males	D1	69.0	31.0	42.4	57.6	33.4	66.6	25.8	74.2	76.6	23.4	37.3	62.7
	D2	78.1	21.9	58.7	41.3	48.0	52.0	37.4	62.6	50.7	49.3	11.0	89.0
	D3	77.8	22.2	58.8	41.2	49.6	50.4	39.3	60.7	39.9	60.1	10.3	89.7
	D4	76.3	23.7	57.7	42.3	45.2	54.8	31.6	68.4	34.1	65.9	9.7	90.3
	D5	75.1	24.9	58.1	41.9	43.3	56.7	30.7	69.3	25.7	74.3	8.9	91.1
	D6	74.0	26.0	56.0	44.0	38.0	62.0	27.6	72.4	20.8	79.2	9.8	90.2
	D7	71.0	29.0	54.2	45.8	35.8	64.2	24.6	75.4	17.2	82.8	8.0	92.0
	D8	66.6	33.4	49.4	50.6	32.2	67.8	22.4	77.6	12.6	87.4	7.7	92.3
	D9	49.6	50.4	35.5	64.5	23.8	76.2	16.2	83.8	11.4	88.6	7.0	93.0
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0
Females	D1	77.2	22.8	50.6	49.4	40.0	60.0	25.1	74.9	78.7	21.3	41.9	58.1
	D2	75.5	24.5	53.6	46.4	40.2	59.8	27.9	72.1	69.0	31.0	32.0	68.0
	D3	73.0	27.0	56.9	43.1	43.1	56.9	32.4	67.6	51.9	48.1	15.7	84.3
	D4	68.7	31.3	53.2	46.8	38.6	61.4	30.1	69.9	40.7	59.3	11.3	88.7
	D5	65.5	34.5	49.0	51.0	36.1	63.9	26.7	73.3	35.8	64.2	10.7	89.3
	D6	63.2	36.8	46.8	53.2	33.3	66.7	24.7	75.3	30.0	70.0	11.2	88.8
	D7	57.9	42.1	45.5	54.5	30.2	69.8	20.3	79.7	24.1	75.9	8.6	91.4
	D8	56.2	43.8	45.3	54.7	24.9	75.1	16.5	83.5	18.7	81.3	9.3	90.7
	D9	39.4	60.6	36.4	63.6	20.7	79.3	12.9	87.1	12.3	87.7	7.9	92.1
	D10	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0	..	100.0

Note: See note to Table 3

Table 5. Percentage Income Distributions, Selected Ages, CSD Cohorts (Ref B)

	Income group	Age						
		24	34	44	54	64	74	84
Both sexes	Q1	44.6	15.1	13.1	15.1	23.0	17.2	15.9
	Q2	30.2	15.0	11.5	11.5	15.4	27.4	36.6
	Q3	16.1	21.2	16.9	16.5	20.3	22.4	22.2
	Q4	7.0	26.2	23.4	21.9	20.4	19.1	15.0
	Q5	2.1	22.5	35.1	35.0	20.8	13.8	10.3
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.2	2.9	3.4	3.3	2.6	2.2	1.9
Males	Q1	39.6	10.8	8.8	9.9	15.3	11.6	11.7
	Q2	27.7	11.6	7.8	7.6	12.3	25.0	33.1
	Q3	18.9	18.2	13.8	14.0	20.2	23.3	23.1
	Q4	10.2	26.6	23.2	22.2	23.3	22.0	17.8
	Q5	3.6	32.8	46.4	46.4	28.9	18.1	14.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.4	3.4	3.9	3.9	3.1	2.6	2.2
Females	Q1	49.2	18.6	16.6	19.3	29.6	21.8	18.5
	Q2	32.4	18.0	14.4	14.7	18.2	29.2	38.9
	Q3	13.6	23.8	19.6	18.6	20.5	21.8	22.1
	Q4	4.2	25.8	23.8	21.9	18.0	16.9	13.2
	Q5	0.7	13.8	25.7	25.5	13.7	10.4	7.3
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.0	2.6	3.0	2.9	2.1	2.0	1.8

Note: Percentage income distributions apply to survivors (and hence sum to 100.0).

Table 6. Percentage Income Distributions, Selected Ages, CSD Cohorts (Ref B for Both Sexes, Ref M for Males, Ref F for Females)

		Age						
	Income group	24	34	44	54	64	74	84
Both sexes	Q1	44.6	15.1	13.1	15.1	23.0	17.2	15.9
	Q2	30.2	15.0	11.5	11.5	15.4	27.4	36.6
	Q3	16.1	21.2	16.9	16.5	20.3	22.4	22.2
	Q4	7.0	26.2	23.4	21.9	20.4	19.1	15.0
	Q5	2.1	22.5	35.1	35.0	20.8	13.8	10.3
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.2	2.9	3.4	3.3	2.6	2.2	1.9
Males	Q1	51.2	13.8	10.6	11.3	17.8	20.6	22.8
	Q2	27.5	16.5	10.9	10.9	17.5	25.3	31.1
	Q3	13.4	20.9	16.8	16.4	21.3	22.9	21.0
	Q4	6.1	26.2	24.8	23.5	20.6	17.7	15.0
	Q5	1.7	22.6	36.9	37.9	22.8	13.4	10.1
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.0	2.9	3.5	3.5	2.7	2.2	1.9
Females	Q1	39.9	15.7	14.8	17.9	27.7	14.5	10.4
	Q2	30.8	13.8	10.8	11.7	15.2	29.8	40.1
	Q3	20.0	20.8	17.3	16.8	18.9	22.0	23.6
	Q4	7.5	26.3	23.1	21.5	20.2	19.0	15.7
	Q5	1.8	23.5	34.0	32.1	18.0	14.7	10.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	1.3	3.0	3.3	3.2	2.4	2.2	2.0

Note: See note to Table 5.

Table 7. Percentage Income Distributions, Selected Ages, ATC Cohorts (Ref B)

			Age						
Cohort	Period	Group	24	34	44	54	64	74	84
ATC1	1995-15	Q1	41.8	17.7	14.6	--	--	--	--
		Q2	31.2	16.0	12.7	--	--	--	--
		Q3	19.8	21.4	18.0	--	--	--	--
		Q4	6.2	24.5	23.4	--	--	--	--
		Q5	1.0	20.4	31.3	--	--	--	--
		Total	100.0	100.0	100.0	--	--	--	--
		Median	1.3	2.8	3.2	--	--	--	--
ATC2	1995-15	Q1	--	--	17.3	19.6	26.8	--	--
		Q2	--	--	12.5	12.5	16.5	--	--
		Q3	--	--	17.4	16.7	20.2	--	--
		Q4	--	--	22.3	21.0	18.9	--	--
		Q5	--	--	30.5	30.2	17.6	--	--
		Total	--	--	100.0	100.0	100.0	--	--
		Median	--	--	3.1	3.1	2.3	--	--
ATC3	1995-15	Q1	--	--	--	--	28.1	17.1	18.1
		Q2	--	--	--	--	19.2	34.9	40.8
		Q3	--	--	--	--	19.2	23.7	20.7
		Q4	--	--	--	--	18.1	15.3	12.4
		Q5	--	--	--	--	15.5	9.0	8.0
		Total	--	--	--	--	100.0	100.0	100.0
		Median	--	--	--	--	2.1	1.9	1.7
ATC4	1995-15	Q1	--	--	--	19.8	29.2	20.1	--
		Q2	--	--	--	12.7	17.9	30.5	--
		Q3	--	--	--	16.4	19.4	21.5	--
		Q4	--	--	--	20.0	18.5	16.6	--
		Q5	--	--	--	31.2	15.0	11.3	--
		Total	--	--	--	100.0	100.0	100.0	--
		Median	--	--	--	3.1	2.2	2.0	--
ATCX	1995-15	Q1	41.8	17.7	14.6	16.8	24.1	13.0	14.1
		Q2	31.2	16.0	12.7	12.8	16.8	32.5	38.4
		Q3	19.8	21.4	18.0	17.4	20.8	25.4	22.4
		Q4	6.2	24.5	23.4	22.0	19.9	17.1	14.2
		Q5	1.0	20.4	31.3	31.0	18.4	12.0	10.9
		Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
		Median	1.3	2.8	3.2	3.1	2.4	2.2	2.0

Note: See note to Table 5.

Table 8. Income Quintile Group Medians by Year and Age, Showing Cohort Attachment, ATC Cohorts (Ref B)

	Current age												
Year	24	29	34	39	44	49	54	59	64	69	74	79	84
							Both sexes						
1995	***1.3 (95)***	2.3 (90)	***2.7 (85)***	3.0 (80)	***3.1 (75)***	3.2 (70)	***3.1 (65)***	2.6 (60)	***2.1 (55)***	2.1 (50)	***2.0 (45)***	1.9 (40)	1.7 (35)
2000	1.3 (00)	***2.3 (95)***	2.7 (90)	***2.9 (85)***	3.1 (80)	***3.2 (75)***	3.1 (70)	***2.6 (65)***	2.1 (60)	***2.1 (55)***	2.0 (50)	***1.9 (45)***	1.7 (40)
2005	***1.2 (05)***	2.4 (00)	***2.8 (95)***	2.9 (90)	***3.0 (85)***	3.1 (80)	***3.1 (75)***	2.7 (70)	***2.2 (65)***	2.0 (60)	***1.9 (55)***	1.8 (50)	***1.7 (45)***
2010	1.2 (10)	***2.4 (05)***	2.9 (00)	***3.0 (95)***	3.0 (90)	***3.0 (85)***	3.0 (80)	***2.7 (75)***	2.3 (70)	***2.0 (65)***	1.9 (60)	***1.8 (55)***	1.7 (50)
2015	1.1 (15)	2.4 (10)	***3.0 (05)***	3.2 (00)	***3.2 (95)***	3.1 (90)	***3.0 (85)***	2.7 (80)	***2.3 (75)***	2.1 (70)	***2.0 (65)***	1.8 (60)	***1.7 (55)***
							Males						
1995	***1.6 (95)***	2.8 (90)	***3.4 (85)***	3.6 (80)	***3.8 (75)***	3.9 (70)	***3.7 (65)***	3.3 (60)	***2.8 (55)***	2.6 (50)	***2.5 (45)***	2.2 (40)	1.9 (35)
2000	1.6 (00)	***2.9 (95)***	3.4 (90)	***3.6 (85)***	3.7 (80)	***3.8 (75)***	3.7 (70)	***3.3 (65)***	2.7 (60)	***2.5 (55)***	2.4 (50)	***2.3 (45)***	2.0 (40)
2005	***1.5 (05)***	2.9 (00)	***3.4 (95)***	3.6 (90)	***3.7 (85)***	3.7 (80)	***3.7 (75)***	3.3 (70)	***2.8 (65)***	2.4 (60)	***2.3 (55)***	2.1 (50)	***2.1 (45)***
2010	1.4 (10)	***2.8 (05)***	3.4 (00)	***3.7 (95)***	3.6 (90)	***3.6 (85)***	3.6 (80)	***3.3 (75)***	2.9 (70)	***2.5 (65)***	2.3 (60)	***2.2 (55)***	2.0 (50)
2015	1.3 (15)	2.8 (10)	***3.4 (05)***	3.7 (00)	***3.8 (95)***	3.7 (90)	***3.6 (85)***	3.3 (80)	***2.9 (75)***	2.6 (70)	***2.4 (65)***	2.1 (60)	***2.0 (55)***
							Females						
1995	***1.1 (95)***	1.9 (90)	***2.0 (85)***	2.3 (80)	***2.5 (75)***	2.5 (70)	***2.2 (65)***	1.6 (60)	***1.3 (55)***	1.6 (50)	***1.7 (45)***	1.6 (40)	1.5 (35)
2000	1.1 (00)	***1.9 (95)***	2.1 (90)	***2.2 (85)***	2.4 (80)	***2.5 (75)***	2.3 (70)	***1.8 (65)***	1.2 (60)	***1.6 (55)***	1.6 (50)	***1.6 (45)***	1.5 (40)
2005	***1.1 (05)***	2.1 (00)	***2.3 (95)***	2.4 (90)	***2.4 (85)***	2.5 (80)	***2.4 (75)***	1.9 (70)	***1.4 (65)***	1.5 (60)	***1.5 (55)***	1.5 (50)	***1.5 (45)***
2010	1.1 (10)	***2.1 (05)***	2.5 (00)	***2.5 (95)***	2.6 (90)	***2.5 (85)***	2.5 (80)	***2.1 (75)***	1.6 (70)	***1.5 (65)***	1.5 (60)	***1.5 (55)***	1.5 (50)
2015	1.0 (15)	2.1 (10)	***2.6 (05)***	2.8 (00)	***2.7 (95)***	2.6 (90)	***2.5 (85)***	2.2 (80)	***1.8 (75)***	1.7 (70)	***1.6 (65)***	1.5 (60)	***1.5 (55)***

Note: A figure in brackets represents cohort attachment by indicating the year in which members of the cohort were 24 years of age. For example, the both sexes entry for year 2010, current age 34, is 2.9 (00), indicating that the members belong to the cohort that was aged 24 in 2000. Each diagonal sequence in the table represents the age/time progression of a particular cohort. Selected individual cohorts are marked in bold.

Table 9. Prospective Percentage Income Distributions at Ages 44 and 64 for Individuals Starting Out in Selected Income Groups at Age 24, CSD Cohorts (Ref B)

	Income group	Q1 at 24 (lower half)		Q1 at 24 (upper half)		Q2 at 24 (lower half)		Q2 at 24 (upper half)	
		at 44	at 64	at 44	at 64	at 44	at 64	at 44	at 64
Both sexes	Q1	19.1	27.0	15.5	25.2	13.1	23.6	10.8	21.9
	Q2	14.9	16.7	13.6	16.3	12.2	15.8	10.5	15.2
	Q3	19.2	20.5	19.4	20.7	18.6	20.7	17.1	20.6
	Q4	22.0	18.8	24.1	19.6	25.0	20.3	25.6	21.0
	Q5	24.8	16.9	27.4	18.1	31.1	19.5	36.0	21.4
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	2.8	2.3	3.1	2.4	3.3	2.5	3.5	2.6
Males	Q1	16.0	19.4	10.9	17.1	8.6	15.8	6.6	14.5
	Q2	11.8	14.1	9.9	13.3	8.5	12.7	7.0	12.1
	Q3	17.5	21.4	17.0	21.2	16.0	20.9	14.1	20.4
	Q4	23.3	22.0	25.3	23.0	25.9	23.4	25.6	23.8
	Q5	31.4	23.1	36.9	25.5	41.0	27.1	46.7	29.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	3.2	2.8	3.5	2.9	3.7	3.0	3.9	3.1
Females	Q1	21.0	32.5	18.5	31.3	16.2	29.8	14.1	28.2
	Q2	16.7	18.9	16.0	18.8	14.7	18.4	13.2	18.0
	Q3	20.4	20.1	21.1	20.4	20.6	20.6	19.6	20.7
	Q4	21.6	16.7	23.4	17.2	24.6	17.9	25.7	18.7
	Q5	20.2	11.9	21.0	12.3	23.9	13.3	27.5	14.4
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Median	2.6	1.9	2.7	2.0	2.9	2.1	3.1	2.2

Note: Figures in the table are calculated by sequential multiplication of P matrices starting at age 24 (see text). They apply to individuals surviving to age 44 or 64.