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A Synthetic Cohort Analysis of Canadian Housing Careers

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SEDAP Research Paper No. 107

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A Synthetic Cohort Analysis of Canadian Housing Careers

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Abstract:

This paper uses a time-series of cross-sections drawn from three different surveys to explore life-cycle profiles of housing arrangements in Canada. Synthetic cohort (quasi-panel) methods are employed to disentangle age profiles from cohort effects. The results suggest limited `downsizing' in later life. Potential biases arising from changes in cohort composition are also explored.
Key words: Housing, cohorts, life-cycle models
JEL Codes: D91, R21

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1. Introduction

Housing is one of the most important goods that Canadian households consume.[1] At the same time, for many households, it is also the principal form of savings.[2] As individuals progress through different stages of their lives, their housing arrangements evolve. The changes in housing arrangements through life naturally lend themselves to the concept of a housing career, usually defined as the succession of dwellings occupied by individuals or households over their lives (Sweet [1990], Kendig [1990], Clark and Dieleman [1996]).

The life-cycle framework (Modigliani and Brumberg [1954], Modigliani [1986], Browning and Crossley [2001]) is the standard framework for thinking about saving and the allocation of consumption over time. It provides an important link between life-long individual savings and consumption decisions and aggregate trends. Basic life-cycle models suggest that wealth should be accumulated during the working life, and run down in later life. Needs-adjusted consumption should be maintained.[3] Thus life-cycle models make predictions about age patterns of housing arrangements. For example, simple life-cycle models predict that housing wealth should be dis-saved in later life, and housing consumption should also fall as needs diminish (with declining household size). Börsch-Supan and Pollakowski [1990] argue that because housing is an expensive good that usually requires mortgage financing, housing decisions are perhaps even more likely to be based on long-term life-cycle planning than other allocation decisions. However, housing is a complex good and unusual asset,[4] and thus warrants particular study. Given that housing is such a large component of many households' wealth, a key issue is whether or not households

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[1] In the 2000 Survey of Household Spending, the median household after-tax budget share of shelter expenses is 26% (authors' own calculations).

[2] Housing (principal residence) accounts for 38% of total household assets, a far larger proportion of household assets than the 29% comprised by all financial assets put together (Statistics Canada [1999].)

[3] More correctly, discounted marginal utility should be equalized across life. This implies constant needs adjusted consumption under additional assumptions: separable preferences over consumption and leisure and a subjective rate of time preference equal to the market interest rate.

[4] For example, it is exceptionally durable, spatially fixed and expensive to build and modify. Its value depends not only on the value of the dwelling unit itself but also on location, availability of services and local government policies. See Smith *et al.* [1988], Clarke and Dieleman [1996] for a detailed discussion

consider housing wealth to be an asset that they can use to fund general consumption in retirement (Venti and Wise [1989], [2001]).

The life-cycle framework also places a particular emphasis on the importance of cohort effects. For example, one of the basic implications of simple life-cycle models is that the effects of (anticipated) productivity growth takes place across generations but not over individual's lives (Jappelli [1999]), so that age-consumption and age-wealth profiles should have similar shapes for agents belonging to different generations as they pass through the same life stages.

Recently, Myers [1999], [2001] has emphasized the importance of accounting for cohort effects in the analysis of housing careers, and the utility of cohort studies as an important alternative to cross-sectional and longitudinal approaches to exploring housing patterns. Unlike cross-sectional analysis, synthetic cohort (or `quasi-panel' or `pseudo panel') analysis allows for the disentangling of life-cycle (or age) patterns from generational (or cohort) differences. At the same time, cohort analysis does not suffer from the data availability, attrition, and small sample problems that often limit longitudinal approaches (approaches using genuine panel data). The advantages of quasi-panel data are well illustrated by Myers [1999] who exposes three fallacies about home-ownership rates, housing prices and residential crowding that stem from cross-sectional analysis (see Section 2).

The goals of this study are (1) to construct, from a time-series of cross sections, a large quasi-panel for the study of housing careers in Canada, (2) to provide an analysis of the patterns of ownership, housing equity, residential mobility, and tenure transitions in that data, and (3) to compare those patterns with the predictions of simple life-cycle models.

The synthetic cohort approach has previously been employed in Canadian studies of nondurable consumption (Burbidge *et al.* [1989], Lin [2000] and Crossley and Pendakur [2002]), labour force participation (Beaudry and Lemieux [1999]), wages (Burbidge, Robb and Magee [2000] and Beaudry and Green [2000]) and immigrant assimilation (Baker and Benjamin [1994, 1997]). This is the first study of which we are aware that applies of quasi-panel methods to the study of housing in Canada.

In addition to its focus on housing, this study is novel in at least three other respects. First, we combine micro data from multiple years of three different Canadian surveys – the Family Expenditure Survey (FAMEX), the Household Income, Facilities and Equipment Survey (HIFE) and the Survey of Household Spending (SHS). The resulting quasi-panel consists of eighteen annual surveys and spans a thirty year period. As we describe below, this is possible because all three Statistics Canada data sets are based on the same sampling frame.

Second, we report an investigation of changes in birth cohort composition as cohorts age. Many researchers have pointed out that the synthetic cohort approach is valid only if the composition of cohorts does not change over time (so that subsequent cross sectional surveys sample from the same population). The composition of cohorts may change if there is differential mortality among different groups in a cohort, or if individuals with potentially different characteristics join a birth cohort over time. In Canada, the latter may occur through immigration. These issues have not been much studied in Canada, with the exception of Lin [2000], who examines the impact of differential mortality on quasi-panel estimates of the age profiles of saving and nondurable consumption.

Third, cohort studies of consumption, saving or wealth must decide what unit to follow because consumption, saving and wealth data are typically observed at the household, rather than individual level. A common practice is to follow cohorts of households or couples, where the age of the household or couple is taken to be the age of the household head (see for example Browning *et al.* [1985], Deaton [1997], Lin[2000] and Crossley and Pendakur [2002]). This is problematic in a study of housing because adjustments in housing arrangements may be contemporaneous with household formation and dissolution. Instead we take the approach of following cohorts of women across ages and attributing to each woman the housing of her household. The merits of this approach are discussed further in Section 3.2.

In our analysis we identify both age patterns and differences across birth cohorts of Canadians. Previous cohort based housing analyses (such as Myers's) are largely descriptive. While our aims in this paper are also largely descriptive, we do use econometric methods to disentangle age and cohort effects. The problem of decomposing age, year and cohort effects has a long literature in social studies and economics. It arises because of the linear dependency between age, survey year and cohort (see Mason and Fienberg [1985], Deaton [1997] for details.) We address the identification problem by introducing additional restrictions along the lines suggested by Deaton [1997]. This is discussed further in Section 3.3.

Our findings are only mildly supportive of the predictions of simple life-cycle models. Ownership does decline at older ages, but not steeply. Average housing equity declines as well, but more slowly than ownership, indicating that, conditional on continued ownership, housing equity is actually accumulated well past the age of retirement. Our results highlight some importance differences between cross section and quasi-panel profiles of housing arrangements. For example, cohort effects result in a spurious decline in housing equity at older ages in cross-sectional profiles. We also find that changes in cohort composition, particularly the increasing fraction of immigrants, can have significant effects on the shape of age profiles. Finally, we demonstrate that following cohorts of women leads to very different age profiles than following cohorts of couples. This suggests that many changes in housing arrangements coincide with household dissolution (perhaps including widowhood or the institutionalization of one partner).

The paper proceeds as follows. Section 2 discusses recent developments in the analysis of housing careers, especially with respect to the use of cohort of quasi-panel data. Section 3 considers the data and methods of our analysis, and presents a preliminary investigation of changes in cohort composition. Section 4 contains our main results. We present estimates of the age and cohort patterns of ownership, housing equity, and residential mobility. Finally, Section 5 concludes with a discussion of directions for future research.

2. Previous Life-cycle Housing Studies

Most theoretical and empirical studies of housing arrangements focus on specific events in housing careers, such as the tenure transition to ownership in early life, or "downsizing" in later life. Plaut [1987] and Henderson and Ioannides [1989] show that liquidity constrained households must postpone the transition to ownership until they have not only saved enough for a downpayment but until they have also accumulated sufficient assets to hedge against house price uncertainty. Chiuri and Jappelli [2002] examine the effects on age-tenure profiles of differences in financial markets and judicial efficiency across some European and North American countries and Australia. They find strong evidence that the timing of ownership transitions is related to country-specific down-payment ratios. Banks *et al.* [2003] argue that, given the demographic "ladder" of life-cycle increases in household size and hence housing need, greater house price volatility should result in earlier ownership transitions and larger shares of housing equity in the portfolios of young households. They confirm these predictions with data from the U.S. and U.K.

Turning to the later part of the life-cycle, a number of studies have examined tenure transitions and "downsizing" (reductions in housing equity) at older ages. Interest in housing arrangements in the later part of the life-cycle is often motivated by the potential role of housing equity in the household's life-cycle consumption and wealth patterns (Venti and Wise [1989], [2001]). A key question is whether housing wealth a part of household retirement savings and intended to be released for consumption in later life?

The sheer size of housing equity in the typical household portfolio suggests its probable relevance to retirement savings. According to the Statistics Canada (Statistics Canada [2001]), seventy-five percent of all households in the pre-retirement (age 55-64) category owned their principal residence in 1999, while sixty-seven percent held some assets in RRSPs.[5] Moreover, the median value of an owned principal residence for this age category was $130,000, almost triple the median value of $50,000 for RRSP assets (of those with such assets). With respect to financial assets outside of RRSPs, only 19 percent of pre-retirement age households invested in mutual funds, while only 13 percent invested in stocks and only 17 percent held bonds.

Nevertheless, there is no unanimity in the literature on whether housing equity should be considered part of retirement savings in discussions of savings adequacy. Hurd [1990] argues that if high mobility costs (including psychological costs of moving) result in low turnover, little can be learned about the desired housing consumption in later life from observed patterns, and more attention should be paid to changes in non-housing wealth. It appears, moreover, that even *conditional* on moving there is little evidence of downsizing. Feinstein and McFadden [1989], Venti and Wise [1990] argue that elderly households "don't want" to consume out of their housing wealth and prefer staying in their homes for as long as possible. Feinstein and McFadden also observe that mobility in later life is strongly correlated with the loss of spouse and widowhood. Venti and Wise [2001] provide a further review of this literature.

Regardless of whether housing wealth should be considered part of retirement savings, the life-cycle framework provides methodological insights which are important for the study of housing careers. Myers [1990] emphasizes this, and in particular, the importance of accounting for cohort effects.

Building on this idea, Pitkin and Myers [1994] criticize the much-publicized results of Mankiw and Weil [1989]. Mankiw and Weil predicted that house prices would decline by 47% by the year 2010 due to a decline in housing demand as the baby-boom generation enters retirement age. Pitkin and Myers show that Mankiw and Weil's use of cross-section data to infer life-cycle patterns is not valid as it ignores differences across generations in permanent income (productivity). Based on the U.S. Census data for 1960, 1970, and 1980 and data from the American Housing Survey for 1989, Pitkin and Myers demonstrate that the cohort view dramatically alters cross-sectional predictions of a sharp decline in housing demand after retirement. They find that for each cohort, the fall in the aggregate per capita house value in the U.S. (inflation adjusted) is much smaller than estimated by Mankiw and Weil.

These shortcomings of the Mankiw and Weil analysis are further discussed in Myers [1999]. Myers argues that "the cross-section profile creates only the *illusion* of future downward mobility because the observations of the older age groups were formed by earlier cohorts whose entire housing career had been characterized by lower consumption." He demonstrates, on the basis of cohort analysis, that the baby-boomers whose homes are of higher quality and value will retain high rates of ownership well into retirement and concludes that the 47% decline in housing prices when baby-boomers retire is greatly overstated.[6]

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[5] Almost all households reported having deposits in financial institutions. Such deposits, however, accounted for only a small fraction of all assets.
[6] Mankiw and Weil's analysis has been criticized on other grounds, such as the failure to take account of the response of supply to price. See for example, Fortin and Leclerc (2001).

Several important conclusions may be drawn from these previous studies. First, age-profiles of housing arrangements are strongly affected by country-specific factors including features of housing and financial markets. Our analysis is based on Canadian data and reflects financial and housing market conditions specific to Canada. Second, life-cycle patterns of housing arrangements – housing careers – are not only important for understanding housing markets, but also potentially crucial to understanding other aspects of life-cycle behaviour, including retirement saving. Thus this study is an important complement to studies of nondurable consumption and savings (Burbidge *et al.* [1989], Lin [2000]). Third, cohort differences play a particularly important role in the analysis of life-cycle housing dynamics. Our study uses a cohort approach that allows us to separate age and cohort effects. Our data and methods are described in the next section.

3. Data and Methods

3.1 Surveys and Sample Exclusions

The data we employ combines microdata files from the Family Expenditure Survey (FAMEX), the Household Income, Facilities and Equipment Survey (HIFE) and the Survey of Household Spending (SHS). The HIFE is not actually a survey as such but a series data files derived (by Statistics Canada) from four different surveys: the Labour Force Survey (LFS), the Household Facilities and Equipment Survey (HFE), the Survey of Consumer Finances (SCF) and the Rent Survey. All these surveys, including the FAMEX and SHS, are based on the same LFS sampling frame. This is crucial for our analysis, as it means that, in principal, each survey is a sample from the same population. The LFS sample is representative of the civilian, non-institutionalized population 15 years of age or older in Canada's ten provinces. Specifically excluded from the survey's coverage are residents of the Yukon and Northwest Territories, persons living on Indian Reserves, full-time members of the Canadian Armed Forces and inmates of institutions (Statistics Canada, [2003]). We exclude from our data households with multiple economic families.[7]

All of these surveys are stratified random samples, and in our estimates we employ final weights provided by Statistics Canada to account both for probability of selection into the sample and for factors including non-response and coverage error.[8]

Unfortunately, the FAMEX did not collect data on households living in rural and small urban (pop. <100,000) areas in 1974, 1984 and 1990; theses surveys are not included. Thus, the survey years in our combined sample are as follows: FAMEX - 1969, 1978, 1982, 1986, 1992, and 1996; HIFE - 1973, 1977, 1981, 1985, 1989, 1993, and 1996; SHS - 1997, 1998 and 1999. The full combined sample contains approximately 300,000 household observations.

The surveys differ in the information they collect. For instance, both FAMEX and SHS are expenditure surveys but HIFE is not. Over the years, the designs of FAMEX and HIFE have undergone several changes, so some information is available only for a fraction of available years, even for a given survey. For instance, the information on ownership is available in all surveys but the information on residential mobility, although available in all surveys, is not available for certain years in HIFE and is missing in the 1978 FAMEX survey. Table 1 summarizes the availability of different housing measures by survey and year.

There are differences in the way some housing concepts are defined in the surveys. We have attempted to derive consistent series. Some variables in some surveys or years were imputed based on available indirect information. For instance in FAMEX, it was possible to infer, with a reasonable degree of accuracy, the tenure status in the previous year from information about financial inflows and outflows from houses bought and sold. We checked the accuracy of this method on the SHS data in which information on previous tenure is available (as well as information about financial inflows and

[7] In some of the surveys the unit of report is a "household," while in others it is a "spending unit." The Statistics Canada definition of an economic family is consistent over the whole time period and for all surveys, so this exclusion gives us a consistent time series.

outflows from houses bought and sold.) In the course of our analysis we test for possible "survey effects"; the results of these tests are reported in Section 4.

3.2 Cohort Analysis: Defining and Following Cohorts

The framework of cohort analysis used in this study has a long history in different areas of social science including economics (an extensive discussion of the method can be found in Mason and Fienberg [1985] or Deaton [1997]). It has been extensively applied in welfare and consumption analysis (see for instance Deaton and Paxson [1994], [2000], Jappelli [1999]) but so far has had very few applications in the analysis of housing careers (Myers [1999], Venti and Wise [2001]). The method requires quasi-panel data, - a series of repeated cross-sectional surveys. The idea is that although individuals cannot be followed with cross-sectional data, groups of individuals (usually birth cohorts) can be followed over time in a way that is analogous to the way individuals can be followed in true panel data (Browning *et al.* [1985]). The advantage of this type of data is that unobservable (time invariant) characteristics of groups can be dealt with, just as individual "fixed effects" can be dealt with using true panel data. Cross sectional estimates of age profiles are biased by unobserved differences across cohorts because in a cross section age and birth cohort are (perfectly) correlated; the time-series element of quasi-panels allows age- and cohort- age- effects to be disentangled.

Cohort studies of consumption, saving or wealth must decide what unit to follow because consumption, saving and wealth are typically observed at the household (rather than individual) level. A common practice is to follow cohorts of households or couples, where the age of the household or couple is taken to be the age of the household head (see for example Browning *et al.* [1985], Deaton [1997], Lin[2000] and Crossley and Pendakur [2002]). As Deaton and Paxson [2000] note, it is not clear that the life-cycle predictions regarding individual savings patterns will apply to synthetic cohorts of households or couples. This is both because households (couples) may comprise individuals of different ages (for whom the theory may therefore make different predictions) and because household formation and

[8] Basic weights are defined as the inverse of the probability of selection. The basic weights are then adjusted by Statistics Canada to account for several factors including non-response and coverage error, leading to the final weights.

dissolution may generate severe selection effects. For example, if higher permanent income individuals marry later, synthetic cohorts of couples or households constructed from repeated cross sections will have increasing average permanent income (so that unobservable cohort average permanent income or productivity is *not* a time-invariant effect). These issues may be particularly problematic in a study of housing because adjustments in housing arrangements may be contemporaneous with household formation and dissolution (including widowhood, as suggested by Venti and Wise [1989] and Feinstein and McFadden [1989]).

In this study, we follow Deaton and Paxson [2000] in estimating the age-profiles of individuals. In particular, we focus on the life-cycles of women. By tracking households in which women are present (either as a 'head' or as a 'spouse'), we can observe women passing through different stages of their life-cycles; for example, young single women, married women and widowed women in later life. Thus this approach does not suffer from some of the selection problems noted above.

As we track birth cohorts of women through the data, we attribute to them the housing arrangements and other characteristics households in which they live. In this respect we depart from Deaton and Paxson [2000]. Deaton and Paxson [2000] essentially assume that savings are entirely private, and use econometric methods developed by Chesher [1998] to divide household savings among the members of the household.[9] By attributing to each woman all of the housing of her household, we are essentially assuming that housing is entirely public. This assumption is obviously extreme (as is the assumption made by Deaton and Paxson) and we return to this in our conclusion. Our approach is also related to the "attributional" approach that Duncan and Hill [1985] describe for longitudinal studies.

With respect to the decision to follow women (rather than men), Hurd [1990] points out that the issue of the adequacy of household savings is particularly important for women because they live longer and tend to marry older men. While approximately three quarters of older men live with their wives, only

[9] The assumption is that a household's demand for savings is simply the sum of the savings demands of the individual members. Savings are "private" in the sense that there are no returns to scale: a household demands the same total savings as the members would (in aggregate) if they each lived singly. The linearity of this assumption is crucial to the feasibility of ascribing household savings to individual members.

forty percent of older women live with their husbands. Poverty rates among widows are substantially higher than among other demographic groups.

To construct age and cohort housing profiles, we group women into 5-year cohorts, i.e. those born between 1905 and 1909 (1st cohort), 1910-1914 (2nd cohort) and so on. Our working sample contains women born between 1905 and 1974. We also grouped women by age into 5-year groups starting at 20. The choice of the 5-year age and cohort bands is, of course, arbitrary. Essentially, the choice is a trade-off between a larger number of cohorts, a larger number of observations per cohort, and a larger number of observations in each cohort-age cell (Browning *et al.* [1985]). 5- or 10-year age and cohort bands are typical in cohort studies. In our econometric specifications the reference woman is one that belongs to the 4^{th} age group (age 35-39) and 9^{th} cohort (born between 1945 and 1949).

3.3 Econometrics of Cohort Analysis: Age, Year, and Cohort Decompositions

Quasi-panels have two dimensions of variation (across cohorts and through time), and so offer hope of disentangling pairs of effects (such as age and cohort) which cannot be separated in cross sectional data (which varies in only one dimension). However, it is often thought in studies of life-cycle dynamics that three processes might be relevant: duration (age effects), entry- or origin-related (cohort effects) and instantaneous (period or year effects). Thus an identification problem remains. A basic "age-year-cohort" model can be written as

$$\omega_{ACY} = f(A, C, Y)$$

where ω_{ACY} is the variable under investigation, and $f(A,Y,C)$ is a polynomial in age (A), year (Y) and cohort respectively (C). The identification problem that results from the linear dependency of age, cohort and year is well known in the literature (Mason and Fienberg [1985], Deaton [1997]). Specifically, if cohorts are identified by the year of birth (as is usually the case) $C = Y - A$.

The only solution to the problem is to introduce some additional information. This typically comes in the form of restrictions on the way in which various effects enter the model. For example, one might set year or cohort effects to zero. Chiuri and Jappelli [2002] use this approach. Another possibility is to parameterize one or more of the effects as a function of observable variables, as in Kapteyn *et al.* [1999].

The approach that we take is less restrictive than Chiuri and Jappelli [2002] and more agnostic about the nature of different effects than Kapteyn *et al.* [1999]. We follow the suggestion of Deaton and Paxson [1994] (see also Deaton [1997]), and attribute growth to age and cohort effects and cyclical (business-cycle) fluctuations to year effects. Specifically, we restrict year effects to be orthogonal to a time trend. Details are provided in the appendix.

The discrete nature of variables such as ownership suggests a *probit* specification for the age-cohort-year decomposition in which the set of dependent variables is the set of age and cohort dummy variables as well as transformed year-dummy variables

$$\Pr(ownership = 1) = \Phi\left(\alpha + \sum_{q=13} \beta_q A_q + \sum_{r=14} \gamma_r C_r + \sum_{s=18} \delta_s Y_s\right),$$

where q is the number of age groups ($q \neq 4$), r is the number of cohorts ($r \neq 9$) and s is the number of years ($s \neq 1,2$); Φ is the cumulative normal distribution function. The age affect for the q^{th} age group for a base individual can be calculated as $age \quad effects^{*}_{q,r=9} = \Phi(\alpha + \beta_q) - \Phi(\alpha)$. Cohort effects can be calculated similarly. For continuous dependent variables, age, cohort and year effects are calculated from linear (OLS) regression coefficients.

We also illustrate differences between cross sectional (unadjusted) and quasi-panel (cohort adjusted) age profiles. For most aspects we present four figures. First, we show several cross sectional age profiles. Second, we plot the age profile of each cohort separately, which allows a visual separation of age and cohort effects. Finally, we plot the separate cohort and age profiles derived from the econometric model described in the previous section.

3.4 Changes in Cohort Composition

As noted in the introduction, the synthetic-cohort or quasi-panel approach assumes that the composition of cohorts remains unchanged over their life-cycles, so that each cross-section samples from the same population.

One reason that the composition of a cohort is likely to change is immigration. The proportion of immigrants in a cohort born, for instance, between 1930 and 1934 is a stock variable that increases in value every time a new immigrant born between 1930 and 1934 arrives in Canada and decreases in value when an immigrant born between 1930 and 1934 returns to her country of origin or emigrates to a third country. When the inflow of new immigrants is greater than the outflow of past arrivals, the proportion of immigrants in a cohort will increase with the age of the cohort. This will bias estimated age profiles (relative to the profile of a constant composition cohort, or individual agent) if immigrant and native born agents differ with respect to the outcome of interest (in our case, housing arrangements). This is a particular concern in Canada where the immigration rates increased dramatically in the mid-1970s and have remained high since.

As a first check on this issue we examine, in Fig. 1, the proportion of immigrants in our sample by age. The top left-hand panel displays several cross-sectional age-profiles of immigrant proportion, but these confound age effects and cohort differences. The top right-hand panel plots individual cohort paths. The bottom left- and right-hand panels show the cohort-adjusted age profile and estimated cohort effects. These are estimated using the age-cohort decomposition described in Section 3.3. The important message from Fig. 1 is that the proportion of immigrants in a cohort in our quasi-panel rises substantially as the cohort ages. In our main analysis (reported in the next section) we check the sensitivity of our estimated age profiles to the exclusion of immigrants from the sample.

A second concern is the possible effect of differential mortality between the rich and the poor. If longevity is correlated with wealth then at the end of the life-cycle the cohort average will be dominated by wealthier agents (who have survived.)[10] The issue of a possible bias in cohort analysis due to differential mortality between the rich and the poor is probably more important in developing countries with malnutrition problems and limited access to health care than in a developed country like Canada which has a good quality, universal health care system. Nevertheless, in a study of life-cycle savings in Canada, Lin [2000] finds that this type of differential mortality does make a difference in estimates of

[10] Shorrocks [1975] was the first to point out this problem.

life-cycle behaviour. Several US studies (Coronado *et al.* [1999], Attanasio and Hoynes [2000]) also find an important relationship between wealth (or income) and mortality.

To correct for differential mortality, Attanasio and Hoynes [2000] employ a statistical model of mortality rates and then use weights that are equal to reciprocal of estimated survival probability. Our analysis of the possible bias due to differential mortality is different from the approaches suggested in the literature. We attempt to make an inference about the presence of differential mortality on the basis of patterns of cohort average educational attainment of cohorts in later life. Our analysis is based on the observation that education level, while correlated with income (across individuals), does not usually change (for a given individual) in later life. If differential mortality is an issue we should observe increases in the average level of education in a cohort towards the end of the life-cycle. To investigate this possibility we subjected the proportion of university graduates in data to the age-year-cohort decomposition described in Section 3.3. The bottom left panel of Fig. 2 shows the 'university'-age profile, net of cohort effects. While there is some suggestion of increasing average education levels in later life, the effect is not statistically significant.

4. Results

4.1 Patterns of Ownership and Home Equity

All three surveys used in this study - FAMEX, HIFE and SHS - contain information on ownership. Fig. 3 presents the age and cohort patterns of ownership in the data. The top left panel of Fig. 3, shows four cross-sectional age-ownership profiles. These profiles increase steadily until around 40 years of age and are fairly constant at between 70 to 80% ownership until 55. The cross sectional profiles seem to suggest a substantial decline in lower ownership rates after retirement. However, these profiles confound cohort and age effects.

The bottom panels of Fig. 3 present the age-ownership profile net of cohort effects (bottom left) and the pattern of estimated cohort effects (bottom right). These estimates are based on the age-cohort-time decomposition described in Section 3.2. It is worth noting that this decomposition imposes a common age profile on all cohorts. However, there is little evidence against the restriction in the top right panel of Fig. 3, which traces out the age profile of ownership for each cohort individually.

Returning to the bottom panels of Fig. 3, the age-ownership profile net of cohort effects is clearly downward sloping in later life. The ownership rate declines approximately by 15 percentage points (or about 19%) from the peak of 80% at the age of 50-55. Confidence intervals are provided for the estimated age profiles and cohort effects. Tests on regression coefficients indicate that the first statistically significant drop from the ownership peak is in the 60-65 year age range.[11] The decline in ownership after retirement is qualitatively consistent with life-cycle models which suggest that we should observe at least some transition from ownership to renting in later life as a form of "downsizing."

We test for "survey effects" by including dummy variables for HIFE and SHS in our models (FAMEX is the omitted group). Both coefficients are positive and significant on the 95% level, though we remind the reader that we are working with some 300,000 observations. Economically, the "SHS effect" is the greater of the two, but the exclusion of SHS surveys has no observable effect on the shape of the estimated age profile.

The bottom right panel of Fig. 3 suggests small but significant cohort effects in ownership. Some, but by no means of all of the lower ownership rates at older ages observed in the cross sectional profiles (top left) are attributable to negative cohort effects (lower ownership rates at all ages) among the three oldest. This is why the estimated, net of cohort effects, age profile (bottom left) declines by less than the cross sectional age profiles (top left). Interestingly, recent cohorts also appear to have negative cohort effects (lower ownership rates, controlling for age). The 1930-1934 birth cohort has the highest ownership rate, and the 1940-1944 and more recent cohorts exhibit cohort effects that are (statistically) significantly below this peak.

Fig. 4 explores the robustness of estimated age-ownership profiles to some of the issues raised in Section 3. The top left panel of Fig. 4 reproduces (from Fig. 3) our "base" estimate of the cohort-adjusted

[11] For brevity's sake, individual regression coefficients and tests of equality between coefficients have not been reproduced here; the results have been summarized graphically. Full results are available from the authors.

age profile. In Section 3.3 we noted that that the quasi-panel methods employed here assume constant cohort composition, and that, in contrast to this assumption, the proportion of immigrants in a birth cohort rises with age. To investigate this issue, we estimated separate (cohort-adjusted) age profiles for immigrants and non-immigrants. These are presented in the top right panel of Fig. 4. The immigrant profile lies above the profile for native born, particular at later ages. Because the fraction of immigrants is also rising with age, our base estimates are biased up at later ages by a compositional effect, and thus underestimate the decline in ownership at later ages that a (constant composition) cohort experiences. The age-profile of native-born Canadians clearly declines more steeply than the pooled profile.

A second issue of cohort composition that we raised in Section 3.3 was differential mortality. If wealthier individuals live longer, then at older ages we are sampling from a wealthier population and our quasi-panel estimates of age profiles will be biased upwards relative to the age-profile of a given individual (or constant composition cohort). We investigated this possibility in Section 3.3 by estimating the age profile of the university educated fraction in our cohorts, where we take education to be a marker for wealth. Our estimates suggested that, consistent with differential mortality, the university educated fraction in each cohort rises slightly at older ages. However, the effect was not statistically significant.

The bottom left panel of Fig. 4 provides the complement to this analysis. We present (cohort-adjusted) age profiles by education group. The results are as one would expect: university graduates have lower ownership rates initially (presumably while they are still in school) but overtake non-graduates (who presumably have lower permanent income) by age 35. After age 35, the graduate profile lies everywhere above the non-graduate profile. However, these conditional profiles do not exhibit a decline that is noticeably steeper than the base profile presented in the top left panel. This suggests that differential mortality – at least in the dimension captured by education – is not a source of significant bias in our base estimate of the age-profile of ownership.

Finally, in this study we follow birth cohorts of individual women. A common alternative choice is to follow cohorts of households or married couples, where the age of the household or couple is taken to be the age of the household head. To illustrate the difference between these approaches, we applied exactly the same age-cohort-time decomposition to the ownership patterns in a quasi-panel of married couples. This quasi-panel of couples was constructed from the same cross sections as our quasi-panel of women. The results are presented in the bottom right panel of Fig. 4. In striking contrast to the cohort-adjusted age profile for women, the cohort-adjusted age profile for households exhibits no decline in ownership at older ages.

There are (at least) two reasons that this could be the case. First it might be that the transitions from ownership that women experience at older ages largely coincide with the loss (or institutionalization) of a spouse. Because the loss of a spouse would remove them from the couple sample, the resulting decline in ownership would not be observed in the quasi-panel of couples.

In addition, differential mortality may be at work here. Even if each couple exhibits declining ownership, if poorer couples (with presumably lower ownership) experience, on average, earlier deaths (of one member), then the samples from each cohort in the couple quasi- panel will contain couples with progressively higher permanent incomes (on average) as the cohort ages. This would impart an upward in ownership at older ages in the couple quasi-panel. The contrast between the age profile for women and the age profile for couples could arise if differential mortality were more important in cohorts of couples than in cohorts of women.

It seems likely that both of the mechanisms just described operate to some degree. To sort out their relative importance would require true panel data.

If housing wealth is considered an asset that can be used to finance general consumption, then life-cycle models predict that housing wealth should be drawn down in later life. Transition from ownership to renting is only one way in which this can be accomplished. Housing equity can also be released for general consumption by downsizing to less expensive accommodation (while still owning), or by increasing housing debt.

An analysis of net housing equity - the value of an owned dwelling net of outstanding mortgage - requires data on house values. Unfortunately, only FAMEX has this information. Our FAMEX sample is based on six annual surveys (see Table 1). We deflated dollar amounts of net equity by the general consumer price index (not by a housing price index), with 1992 as the base year. (Because we are thinking about housing equity an asset in the household portfolio and its potential role in funding general consumption in retirement, it makes sense to deflate this wealth by the price of general consumption.) Women with no housing equity (including renters) are included in the calculations as zeros, so that the patterns that emerge summarize changes both in ownership propensity and in real equity conditional on ownership. Fig. 5 presents several cross sectional age profiles of net housing equity (top left), and cohort specific age-profiles (top right). It also presents our estimated cohort-adjusted age profile (bottom left) and estimated cohort effects (bottom right). The cross sectional age profiles in the top left panel suggest significant declines in housing wealth in later life, but these are, again, confounded by cohort effects, and the three subsequent panels demonstrate that cohort effects are much more important for net equity than they were for ownership. The cohort-adjusted age profile peaks after the retirement age (65-69 age group), and much later than the cross sectional profiles. Moreover, the drop from the peak to the oldest (75-79) age group is just barely statistically significant. This unconditional drop in net equity is 6%. However, given that ownership falls by 19% over the same age range, this means that, conditional on continued ownership, net equity is rising. These increases in equity, however, probably represent "passive" saving, a point about which we will have more to say below.

The cohort effects are also interesting. They suggest rapidly rising levels of (age-adjusted) real housing wealth for success cohorts born prior to the Second World War. However, the cohort profile is largely flat (and perhaps even declining) for those born during and after WWII (including "baby boomers".)

Fig. 6 presents a sensitivity analysis of the estimated (cohort-adjusted) age-profile, parallel to that which we reported for ownership. In the top left hand panel we again reproduce our base estimate. The top right hand panel presents age-profiles for immigrants and non-immigrants separately, and the bottom left hand panel presents age-profiles for university graduates and non-graduates. Graduates have higher net equity than non-graduates beyond about age 32, and immigrants have more housing equity than non-immigrants at all ages.[12] Nevertheless, all of these profiles share the features of our base profile: a peak at or shortly after retirement age followed by a slow decline. Thus the overall conclusions - that some housing equity is liquidated after retirement but that substantial housing equity is retained at quite old ages - is borne out.

As with ownership, the cohort-adjusted age profile of net equity estimated from the quasi-panel of couples is very different from the profile estimated from the quasi-panel of women. Indeed, the cohort-adjusted age-profile of net equity for couples is upward sloping at all ages. The mechanisms that may underlay this are the same as those for ownership (discussed above) and it serves to emphasize again the importance of following cohorts of individuals.

4.2 Residential mobility and tenure transitions

In addition to examining rates of ownership and levels of net equity, we can also analyze mobility (transitions between residences) and transitions between renting and owning.

All of the FAMEX surveys, except 1978, as well as all of the SHS surveys and the 1989, 1993, and 1996 HIFE surveys have information on residential mobility (whether the household in which the women is a member changed residence during the year.)[13] Fig. 7 presents the patterns of residential mobility in our data. As with home ownership and net equity, we present cross sectional age profiles (top left), cohort specific age profiles (top right), estimated cohort-adjusted age-profiles (bottom left) and estimated age-adjusted cohort effects (bottom right).

Residential mobility is monotonically decreasing with age and decreases rapidly until mid-life. Cohort effects are not very important, and the cross sectional age profiles, cohort specific age profiles and estimated cohort-adjusted age-profiles are all very similar. There does seem to be an increase in age-adjusted mobility for the most recent cohort in our data.

[12] The latter may reflect the greater urbanization of immigrants.

[13] Note that residential mobility is a derived variable in the FAMEX (see section 3.1). Moveover, our measures of residential mobility miss moves that occur when a woman joins a household that was already in the survey.

We next break down mobility into different kinds of transitions. Fig. 8 presents the cohort - adjusted age-profile of different hazards. The hazard is the probability of making a particular kind of transition, conditional on being the risk set for that transition. For example, the bottom right hand panel presents the cohort-adjusted age-profile of the rent-to-own hazard. These are the estimated age effects in the probability of moving from renting to owning, conditional on starting the year as a renter.

The top two panels show the hazards for owners: for moves that involve continued ownership in the top left panel, and for moves that involve a transition to renting in the top right panel. The bottom two panels show the hazards for rents: for moves that involve continuing as a renter on the bottom left, and for transitions from renting to owning on the bottom right. As one would expect, a comparison of the top and bottom panels suggests that renters are more mobile.

With respect to the predictions of simple life-cycle models, the top left panel of Fig. 8 suggests that there are very few transitions involving continued ownership in later life. This suggests that older Canadians do not often "downsize" while continuing to own, and is consistent with our earlier finding that equity falls more slowly than ownership. At the same time, it suggests that the increases in equity conditional on continued ownership noted above reflect passive rather than active saving (that is, the increases in housing wealth are unrealized capital gains.) The right hand side panels show that the hazard from ownership into renting rises after the retirement age while the hazard from renting into ownership falls with age. These results are of course just the transition counterpart of our finding that ownership rates decline after the retirement age.[14]

Finally, Fig. 9 examines transitions involving continued ownership in more detail. Since both the FAMEX and SHS have information about house values, for those households that sold a house during the year and purchased another, we can calculate whether they moved to a less valuable home or a more valuable home. The left hand panel plots the cohort-adjusted age profile of net changes in (real) value and the right hand panel plots the cohort-adjusted age profile in the probability that a change in value is

[14] The change in the ownership rates as a cohort ages relates to the hazard as follows: $O_a - O_{a-1} = r_a R_{a-1} - o_a O_{a-1}$ where O_a is the fraction of owners at age a, R_a is the fraction of renters, r_a is the 'rent-to-own' hazard rate and o_a is the 'own-to-rate' hazard rate.

positive ("upgrading"). Both panels show that transitions involving continued ownership up to the age of 50 largely involve moving to more valuable residences. This upgrading may relate to the idea of a "property ladder", as discussed in Banks *et al.* (2003). Upgrading seems to cease around age 50, though cohorts (on average) do not then appear to switch to downsizing. The figures suggest a move back to "upgrading" at quite old ages. This might be related to cohabitation with younger generations. However, from Figure 8 we know that these points are based on quite small numbers of observations.

5. Conclusions and Directions for Future Research

In this study we have constructed a quasi-panel using 18 cross sections drawn from 3 different Canadian household surveys. This quasi-panel, which covers a 30 year period, allows us to disentangle age and cohort effects in life-cycle profiles of various aspects of housing. This is the first quasi-panel analysis of Canadian housing careers of which we are aware.

Our findings are only mildly supportive of the predictions of simple life-cycle models. Ownership does decline at older ages, but not steeply. Average housing equity declines as well, but more slowly than ownership, indicating that, conditional on continued ownership, housing equity is actually accumulated well past the age of retirement. These findings are consistent with U.S. studies such as Feinstein and McFadden [1989] and Venti and Wise [1989].

We do find – as Myers [1990, 1999] has with U.S. data – that there are some importance differences between cross-sectional and quasi-panel profiles of housing arrangements. For example, in cross-sectional profiles cohort effects result in a spurious decline in housing equity at older ages.

Our analysis also shows that changes in cohort composition, particularly the increasing fraction of immigrants, can have significant effects on the shape of age profiles. This may be important for other outcomes as well (for example, nondurable consumption), and in other countries with significant immigration (such as the United States and Australia).

We also demonstrate that following cohorts of individuals – in our case women – can lead to very different age profiles than following cohorts of couples. We find more dis-saving of housing wealth, and hence more support for simple life-cycle models in individual profiles. In this respect, our findings echo those of Deaton and Paxson [2000] who study savings (income – consumption). In the case of housing arrangements, this discrepancy suggests that many changes in housing arrangements coincide with household dissolution (perhaps including widowhood or institutionalization of one partner), as previously suggested by Venti and Wise [1989] and Feinstein and McFadden [1989].

The age-cohort-time decompositions that are the core of our analysis are both simple and essentially descriptive. They could be extended in several ways. Changes in housing arrangements are driven, at least in part, by changing needs as household size rises and falls over the life-cycle. This implies that housing is not fully public, as we have assumed in this analysis. However, housing has aspects of a public good within the household, and it seems uncontroversial that housing needs do not vary linearly with household size (as Deaton and Paxson assume savings do). In other work (Crossley and Ostrovsky [2003]) we use the same quasi-panel to investigate the extent to which agents appear to smooth their consumption of housing services over the life-cycle when we take careful account of changes in the demographic composition of households over the life-cycle, and formally allow for returns to scale in the consumption of housing services.

The age-cohort-time decomposition that we employ imposes a common age profile on all cohorts. As noted above, this is consistent with the simplest life-cycle models in which anticipated productivity growth shifts profiles across generations but does not change their shape. It is also not obviously contradicted by a visual inspection of the cohort specific age-profiles for ownership and equity (the top right panels of Figures 3 and 5). Nevertheless, there are good reasons to suspect that cohorts do experience different age-profiles of housing arrangements. First, not all productivity growth is anticipated. Second, cohorts have experienced different histories of interest rates, financial market institutions, housing market conditions and government policies over their lifetimes. Because changes that occur at a particular time occur at different ages for different birth cohorts, changes in these factors can lead to differences in age profiles across cohorts. Thus cohort differences in age profiles and the relationship of such differences to the factors just listed is another issue we hope to pursue in future work.

Finally, we are left with the task of understanding the patterns of housing arrangements observed in the data and their relationship to life-cycle models. Why isn't housing wealth dis-saved more rapidly, and more substantially, after retirement? Because housing is both an asset and provides a flow of consumption services, there is a tension between life-cycle motives: housing wealth should be run down but housing consumption maintained ("smoothed"). However, we have already noted that the decline in housing needs that comes from declining household size mitigates this tension. Moreover, were markets perfect, this tension would not exist: households could separate their investment and consumption decisions (for example by renting housing services in excessive of what is provided by housing owned to satisfy the investment motive, or by holding more mortgage debt).

One way forward is to consider "richer" life-cycle models, that maintain features of the life-cycle framework (that agents are forward looking, and try to make the best use of the information available at a given time) but which incorporate more realistic features of the assets agents hold, the goods they consume, and the markets in which they operate (Browning and Crossley [2001]). With respect to housing, it might not be (constrained) optimal for a forward looking agent to separate their housing investment and consumption decisions, and this in turn may limit the extent to which housing equity is run down after retirement. Hurd [1990] provides a nice discussion of a number of reasons why this might be the case, including the possibility that owned housing provides a hedge against uninsurable rental price risk.

In this spirit, we note that many assets (pensions in particular) that are held by older persons (including older Canadians) are annuitized, so that housing wealth may be the asset that is used to meet precautionary savings and bequest motives. Housing wealth is treated differentially by tax systems. Housing wealth and is often excluded from asset tests in benefit schemes. In Canada, however, seniors' benefits tend to be income (means) tested but not asset tested.

This last observation is a reminder that perhaps the most convincing way to test "richer" models in the life-cycle framework is through cross country variation in policies and market institutions. If such models are correct, then behaviour should differ across countries in ways that can be predicted on the basis of policies and market details. A number of recent papers have taken up this approach. Examples include the Banks, Blundell and Smith [2003] and Chiuri and Jappelli [2002] papers which were noted in Section 2 and which exploit cross-country variation in house-price risk and down-payment ratios respectively. These papers focus on housing arrangements and housing wealth accumulation in early life, but similar comparisons could equally be made for later life behaviour.

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Appendix: Restrictions to identify Age, Time and Cohort effects.

Our approach to identifying age, cohort and year effects follows Deaton and Paxson [1994] and attributes growth to age and cohort effects and cyclical (business-cycle) fluctuations to year effects. This is accomplished by restricting the year effects to be orthogonal to a time trend and to sum to zero. If υ is the time vector and δ is the set of year effects, the restrictions are $\upsilon'\delta = 0$ and $\sum_j \delta_j = 0$.

The time trend vector depends on the spacing between the annual surveys. For example, for the combined data based on FAMEX, HIFE and SHS the time trend vector is υ = (0, 1, 2,
.25, 3, 3.25, 4, 4.25, 5, 5.75, 6, 6.75, 7, 7.25, 7.5). The two restrictions can be implemented by applying the following transformation to the year dummy variables:

$$Y^*_{year} = Y_{year} - D \cdot Y_{73} + (D-1) \cdot Y_{69},$$

where $D = \dfrac{year-69}{73-69} = \dfrac{year-69}{4}$.

The effect of the transformation is clear if we assume that there is only one observation in each year. The following data:

	Y_{69}	**Y_{73}**	**Y_{77}**	**Y_{78}**	**Y_{81}**	**…**	**Y_{99}**
69	1	0	0	0	0	…	0
73	0	1	0	0	0	…	0
77	0	0	1	0	0	…	0
78	0	0	0	1	0	…	0
81	0	0	0	0	1	…	0
…	…	…	…	…	…	…	…
99	0	0	0	0	0	…	1

would be transformed into:

	…	**…**	**Y_{77}**	**Y_{78}**	**Y_{81}**	**…**	**Y_{99}**
69	…	…	1	1.25	2	…	6.5
73	…	…	-2	-2.25	-3	…	-7.5
77	…	…	1	0	0	…	0
78	…	…	0	1	0	…	0
…	…	…	…	…	…	…	…
99	…	…	0	0	0	…	0

For *year* = 73 the year effect is $\delta_{73} = -2\delta_{74} - 2.25\delta_{77} - ... - 7.5\delta_{99}$, which is identical to the first restriction above. That is:

$$\upsilon'\delta = 0 \cdot \delta_{69} + 1 \cdot \delta_{73} + 2 \cdot \delta_{77} + 2.25\delta_{78} ... + 7.5 \cdot \delta_{99} = 0$$

For *year* = 69, the year effects is $\delta_{69} = \delta_{77} + 1.25\delta_{78} + ... + 6.5\delta_{99}$. The second restriction is also satisfied because

$$(\delta_{77} + 1.25\delta_{78} + ... + 6.5\delta_{99}) + (-2\delta_{77} - 2.25\delta_{78} - ... - 7.5\delta_{99}) + \delta_{77} + ... + \delta_{99} = 0\,.$$

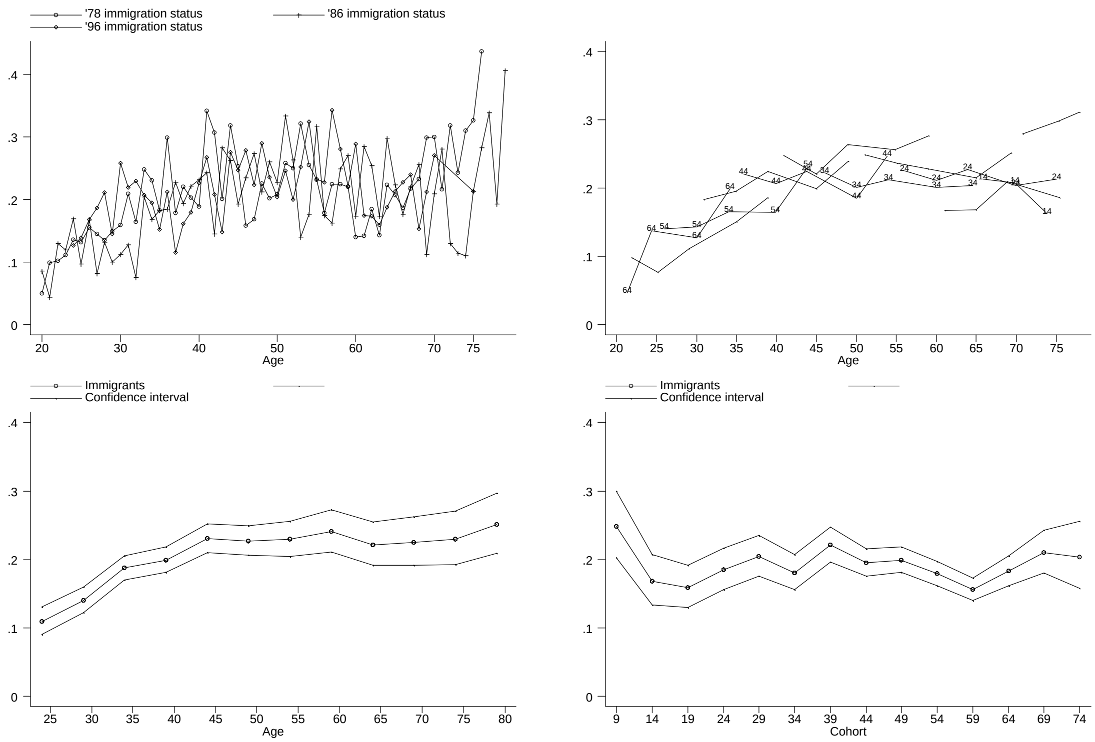

Figure 1. Proportion of immigrants: cross-sectional and cohort profiles (top), age and cohort effects (bottom).

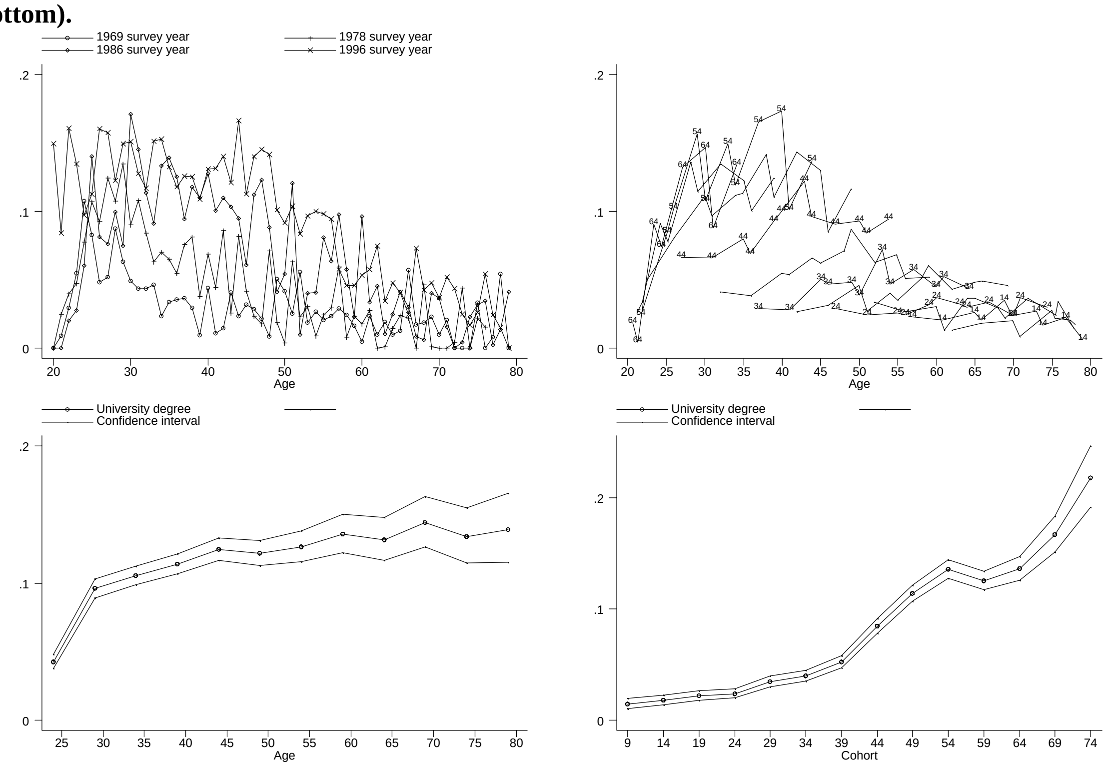

Figure 2. Proportion of university graduates: cross-sectional and cohort profiles (top), age and cohort effects bottom)

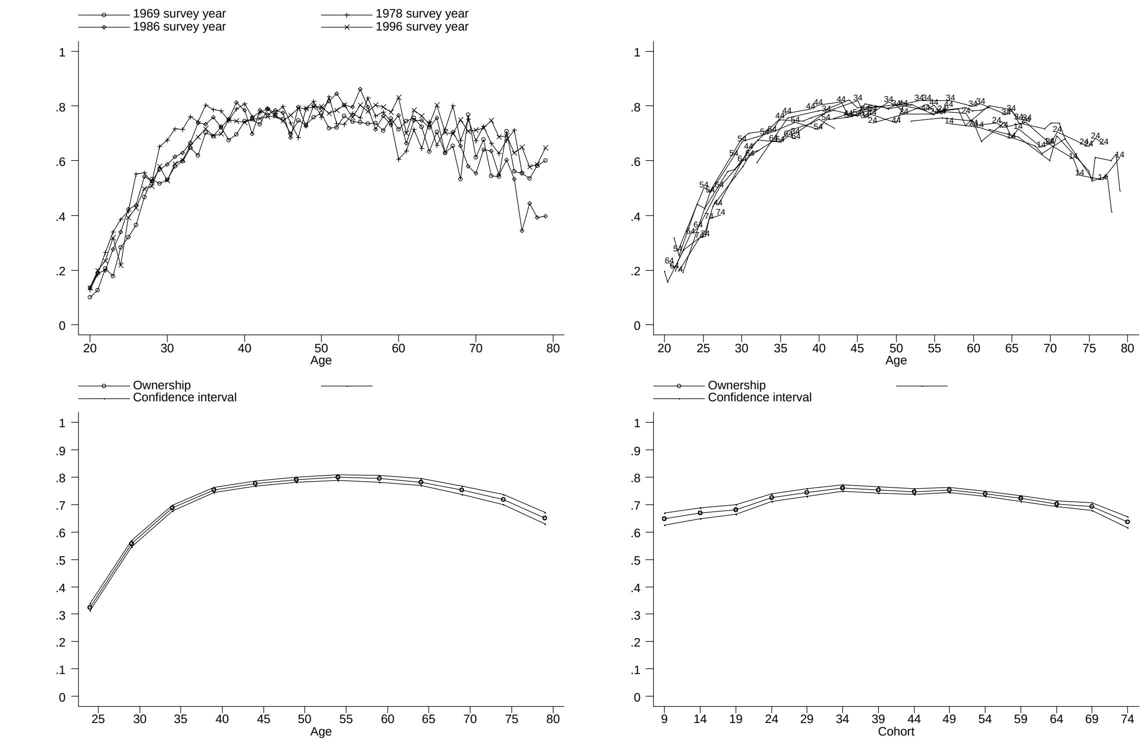

Figure 3. Proportion of homeowners: cross-sectional and cohort profiles (top), age and cohort effects (bottom).

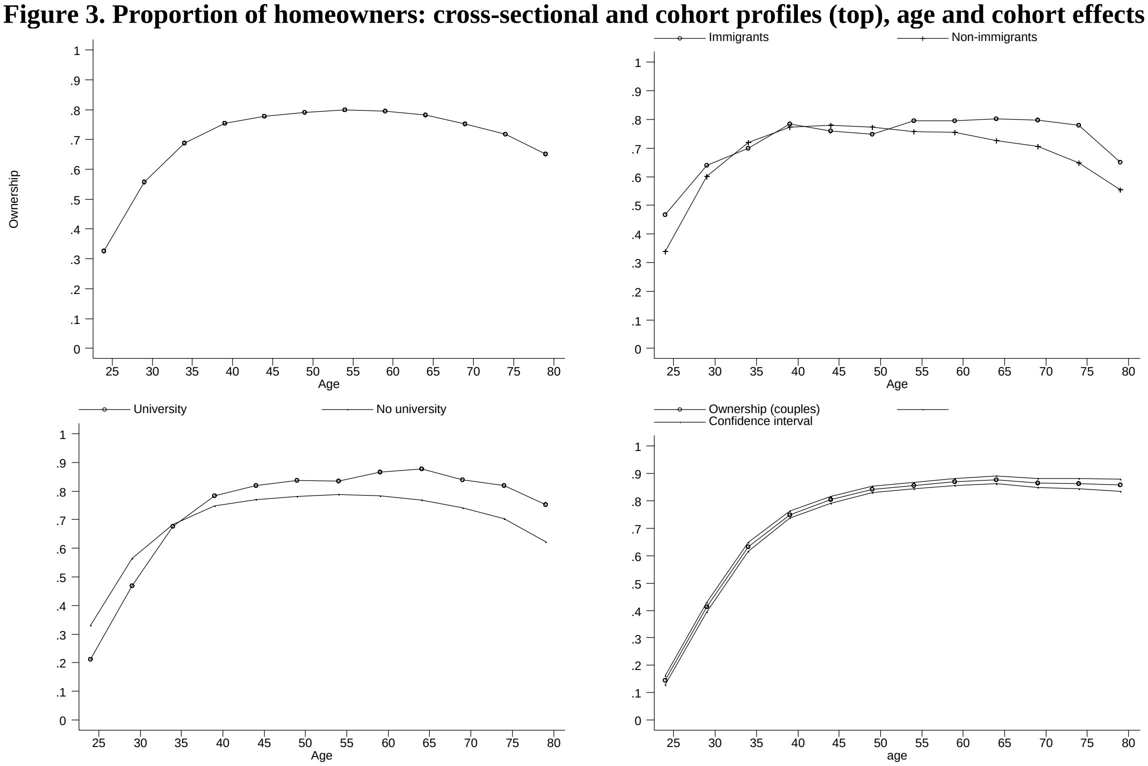

Figure 4. Ownership. Age effects for women (top left), immigrants and non-immigrants (top right), university graduates and non-graduates (bottom left) and married couples (bottom right).

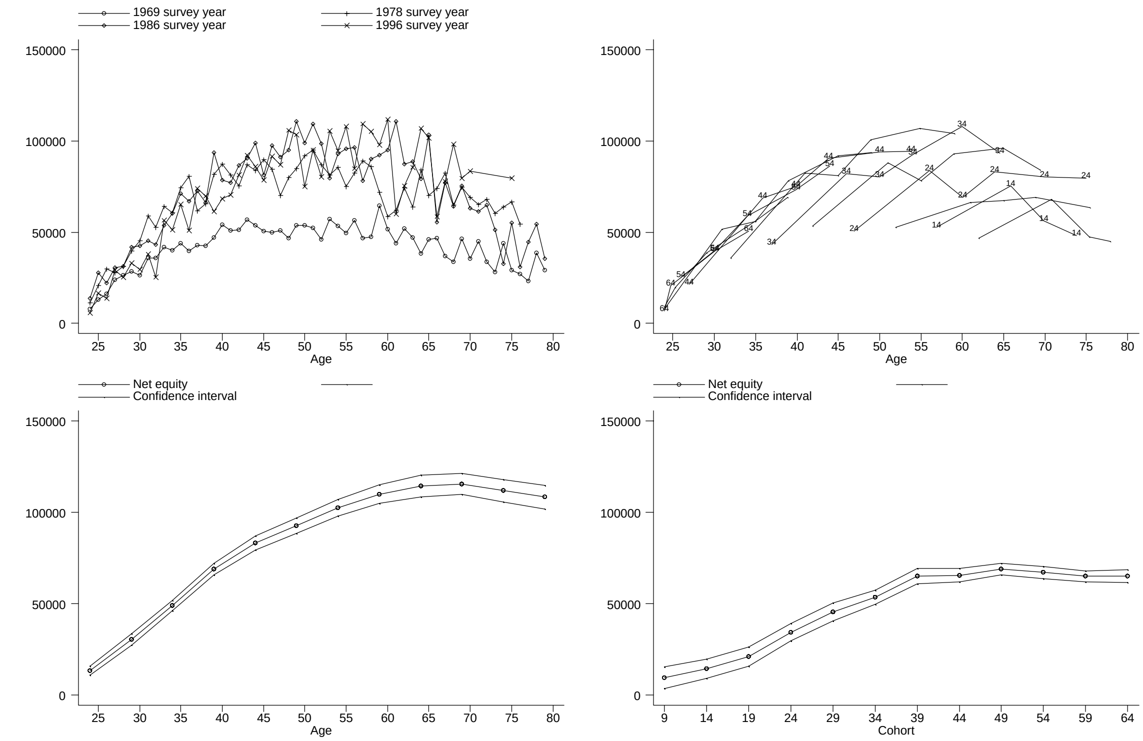

Figure 5. Net housing equity: cross-sectional and cohort profiles (top), age and cohort effects (bottom).

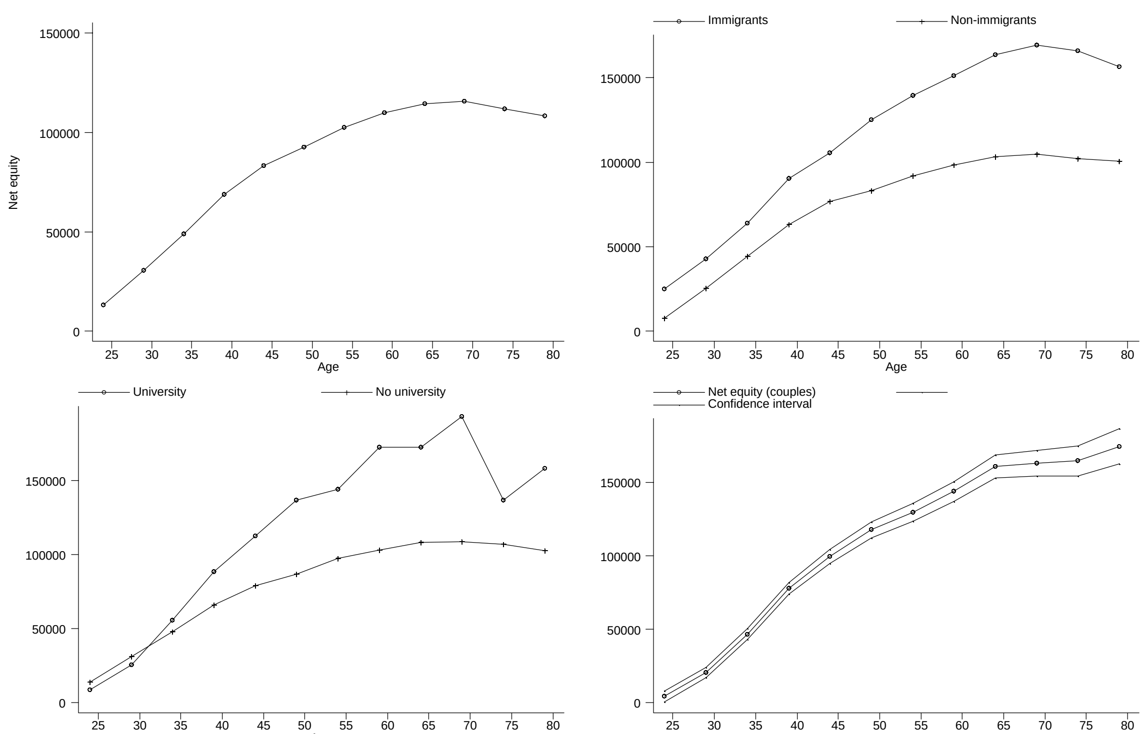

Figure 6. Net equity. Age effects for women (top left), immigrants and non-immigrants (top right), university graduates and non-graduates (bottom left) and married couples (bottom right).

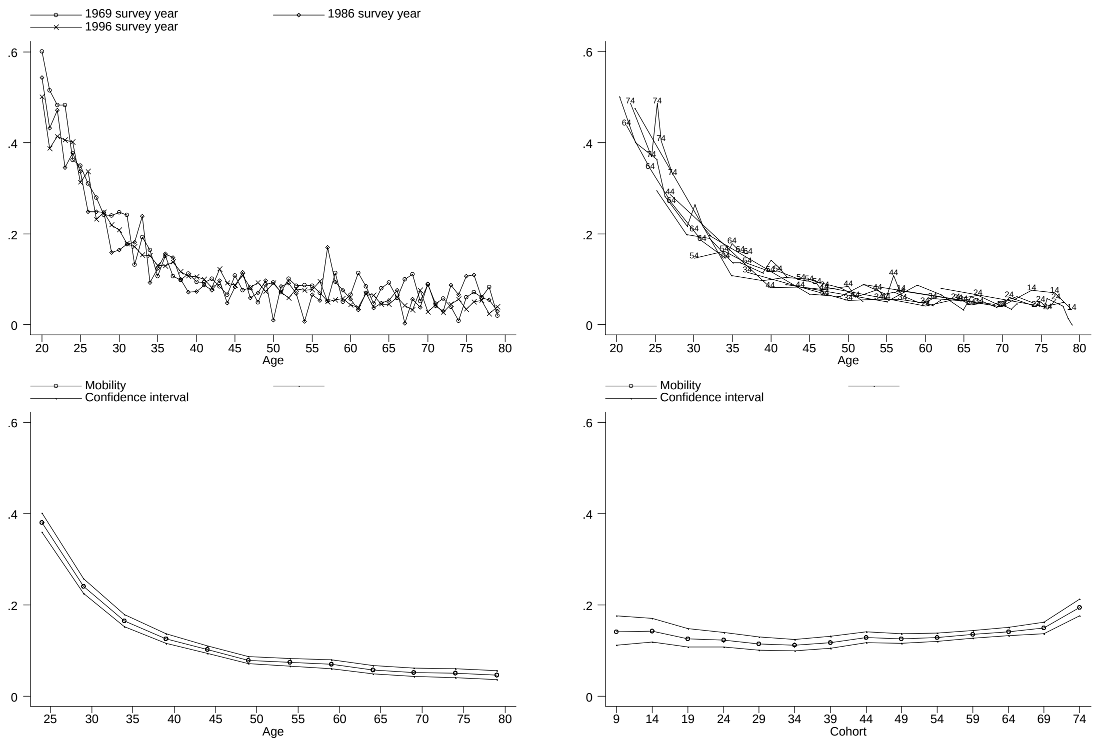

Figure 7. Mobility: cross-sectional and cohort profiles (top), age and cohort effects (bottom).

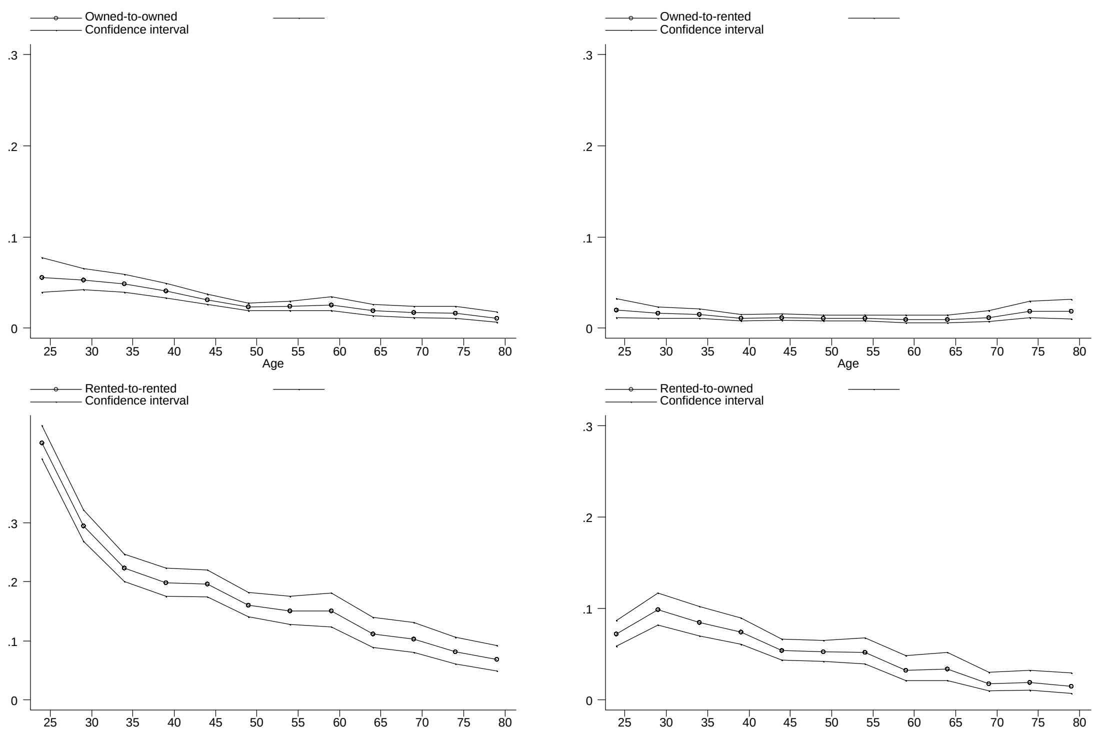

Figure 8. Tenure transitions. Age profiles conditional on ownership in the previous year (top), and renting in the previous year (bottom).

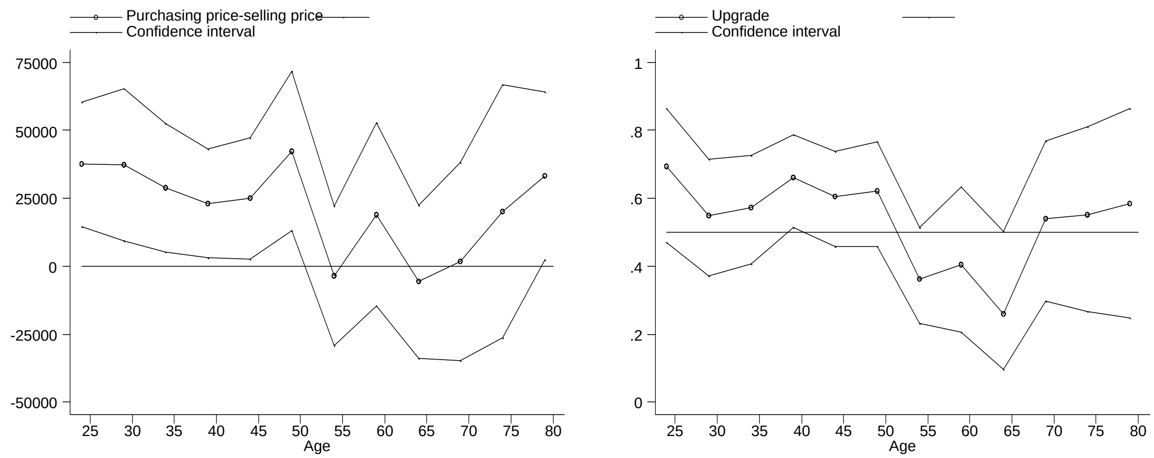

Figure 9. Housing upgrade. Buying/selling price difference: age and cohort effects (top); probability of upgrade: age and cohort effects (bottom).

	FAMEX	HIFE	SHS
Years	69	73	97
	78	77	98
	82	81	99
	86	85	
	92	89	
	96	93	
		96	
Ownership	yes	Yes	Yes
Residential mobility	yes	yes, except ’73, ’77, ’81 and ’85.	Yes
Equity	yes	No	No
Mortgage	yes	No	No
Tenure transitions	yes	yes, except ’73, ’77, ’81 and ’85.	Yes
Shelter expenditure	yes	No	No
Dwelling upgrade	yes	No	Yes

Table 1. The Content of the Surveys Used to Construct the Quasi-panel.

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