Inter-individual variation in lifetime accumulation of income, consumption, and transfers in aging countries*

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1 Introduction

Among the many events that characterize individuals of different ages as they progress through the life cycle are economic events, including the receipt of income, and the consumption of goods and services. These economic events represent transfers between different groups within society, or among individuals of different generations. Against the background of population aging in most industrialized countries studies on this topic are numerous. They are based on the idea that an individual has some level of income, consumption, and deficit (the difference between income and consumption), and that aggregated over a population, these generate transfers of resources among age classes (Lee, 1994; Lee et al., 2006; Lee and Mason, 2011).

National Transfer Accounts (NTAs)[1] are collections of data that report important economic variables by age. Using these data, it is possible to picture the economic life cycle of individuals and to study, e.g., the impact of changes in the age structure on the economy. Studies of these transfers typically report labor income and consumption for a representative individual by age. They often determine those periods in which labor income is insufficient to finance an individual's consumption (i.e., periods of dependency), and how those periods are changed by public and private transfers or asset-based reallocations (e.g. Lee and Mason (2011)).

Periods of dependency are generally longer than the periods of surplus production in developed countries. In welfare states like Germany, with high public transfers to the dependent young and elderly through education or pension programs, labor income exceeds consumption for only 30 years while life expectancy equals 80 years on average. The NTA approach has lately started to incorporate differences by gender for some countries, but it still masks heterogeneity among individuals by region, or due to socio-economic status or educational attainment. This is especially important as the costs of an aging society also depend on the decomposition of the population. One important example is educational attainment that might alter consumption and income patterns on the macroeconomic level in case lower and higher educated individuals have very different budget constraints or preferences and the ratio of the subgroups changes over time.

In this paper, we present a perspective that examines two new aspects of economic transfers.

- First, we will use the trajectories of age-specific income, consumption, and deficit to compute

[1] For more details see www.ntaccounts.org.

individual lifetime accumulations of these quantities. This calculation integrates the trajectories of age-specific quantities with the mortality schedule. The lifetime accumulation of, say, income, for an individual of age x depends not only on the income received at each age from age x onward, but also on the mortality risks to which the individual is exposed form age x onward. These lifetime accumulations do not seem to have been given a name. They are directly analogous to indices such as the net reproductive rate R_0 or the total fertility rate TFR, which measure accumulated reproduction over a lifetime (with, or without, accounting for mortality, respectively).

- Second, we recognize that the lifetime accumulation is a random variable, and so we will go beyond the mean accumulation to focus on variation among individuals. Two identical individuals, experiencing identical mortality risks and receiving income from the same age-specific distributions, will differ in their lifetime accumulation because of the random outcome of those processes. Such variability is called *individual stochasticity* (Caswell 2009). To quantify individual stochasticity, we will calculate the variance, standard deviation, coefficient of variation, and skewness of lifetime accumulated transfers.

Analysis based solely on expected values provides no information on the risks associated with variable outcomes. Knowing the mean lifetime income or consumption does not reveal how variable that accumulation will be among members of a cohort, and hence says nothing about how common unusually high or unusually low values will be among members of a cohort. Skewness (the standardized third moment about the mean) provides extra information beyond variance; positive skewness implies a distribution with a long positive tail, and negative skewness implies the opposite. The approach we will introduce provides, if desired, all the moments of remaining lifetime accumulation, so kurtosis and other functions of the higher moments could also be calculated (Caswell 2011).

Individual stochasticity is not the same as, nor does it imply, heterogeneity among individuals. Empirical measurement of the variation in accumulated rewards will reflect both individual stochasticity and heterogeneity; one of the values of our approach is the potential to separate the two sources of variation (Caswell 2011).

2 Data and Methods

For our analyses, we use National Transfer Account estimates for Germany. National Transfer Accounts are usually used to provide information about the impact of institutional settings on the economic life cycle of individuals in a given country. The data include consumption, income, public and private transfers, and asset-based reallocations. The detailed estimates, by single years of age, are very important to quantify transfers between generations and the impact of population aging for example. The results are based on the German Income and Expenditure Survey (Einkommens- und Verbrauchsstichprobe, or EVS) of 1978, 1993, and 2003. The EVS has been conducted by the Federal Statistical Office since 1978 at five year intervals, and is based on a representative quota sample of Germany's private households.

We analyze lifetime accumulated rewards using the approach introduced to demography by Caswell (2011) in the context of reproductive output. This is based on the mathematical framework of *Markov chains with rewards* (MCWR), introduced by Howard (1960) in the context of dynamic programming and greatly extended since (Benito, 1982; Sobel, 1982; Puterman, 1994; Sladkỳ and van Dijk, 2005). The idea is simple but powerful: an individual moves among states according to a finite-state Markov chain. In our case, the states consist of age classes, plus an absorbing state representing death. The probability of transition from age class i to age class $i+1$ is the survival probability p_i, and the probability of transition from age class i to death is $q_i = 1 - p_i$. At each transition until absorption, the individual accumulates a "reward," which is itself a random variable. Caswell (2011) shows how to compute all the moments of the lifetime accumulation of this reward. We analyze income, consumption, and deficit (income - consumption) as rewards, and calculate the mean, standard deviation, coefficient of variation, and skewness of lifetime rewards remaining at each age.

3 Applications

Education is well known to effect levels of income (Miller, 1960; Becker and Chiswick, 1966; Hause, 1975) as does occupation (Wilkinson, 1966). Lifetime earnings also play an important role in the area of intergenerational mobility (Dunn, 2007). We expect that it may also influence the variability in lifetime accumulated income. To explore this, we analyze data from the Income and Expenditure

Survey 2003. We estimate the labor income for individuals with high, medium and low educational attainment. We grouped individuals without completed degree in the low education category. All individuals having attained university or *Fachhochschule* fall in the high education category. The remaining are grouped into medium education. Figure 1 shows first results of the mean, standard deviation, CV, and skewness of age-specific income for the low, medium, and high education level categories. As expected, mean income is ordered from low to high income. The standard deviation follows the same pattern, but the CV is very similar for all three groups. Figure 2 shows the statistics of lifetime accumulation. The mean remaining lifetime income shows a similar pattern for all three education groups. The standard deviation falls with age, and the CV combines the mean and standard deviation into a pattern that differs little among education groups.

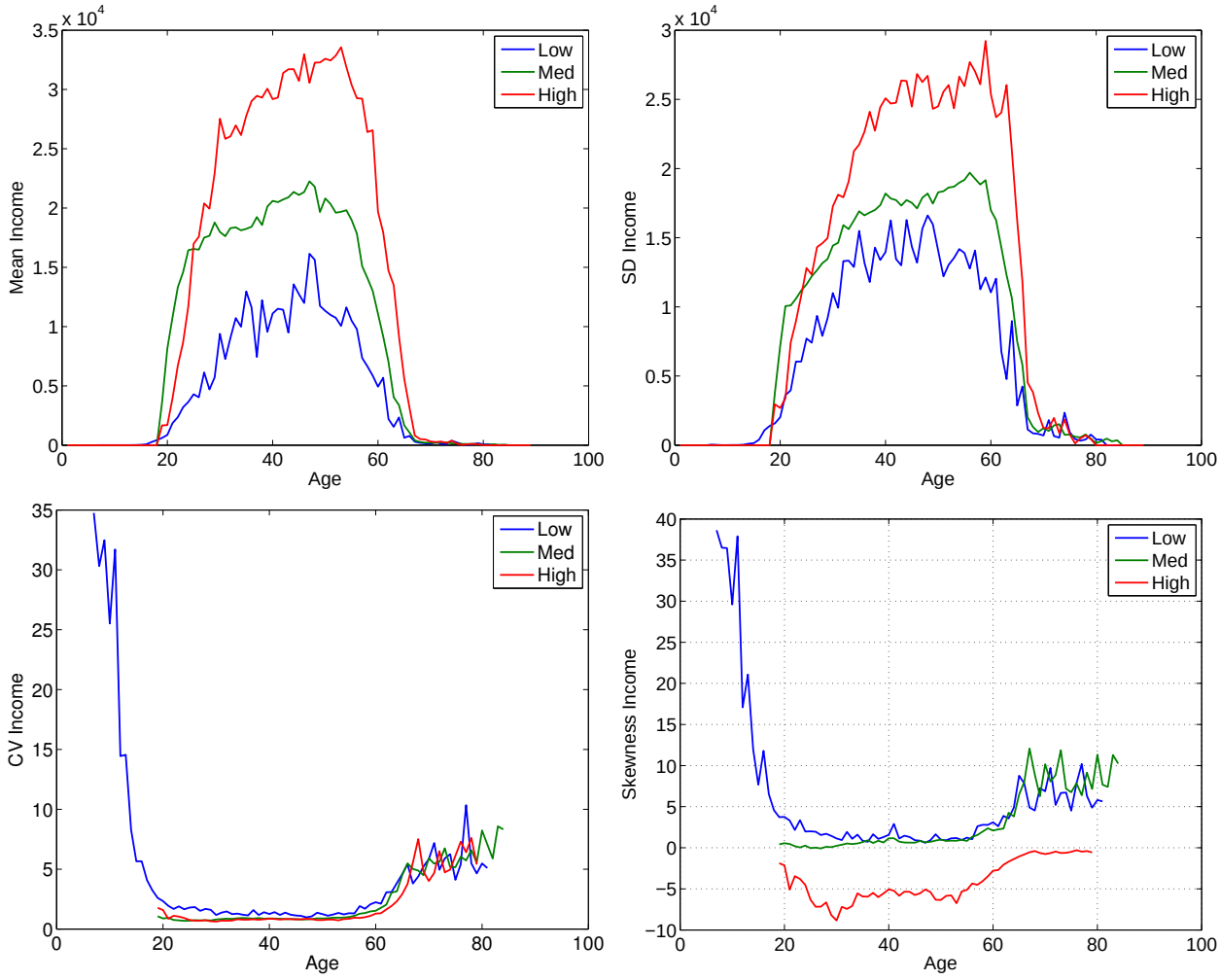

Figure 1: Statistics of the age schedule of income for low, medium, and high educational levels.

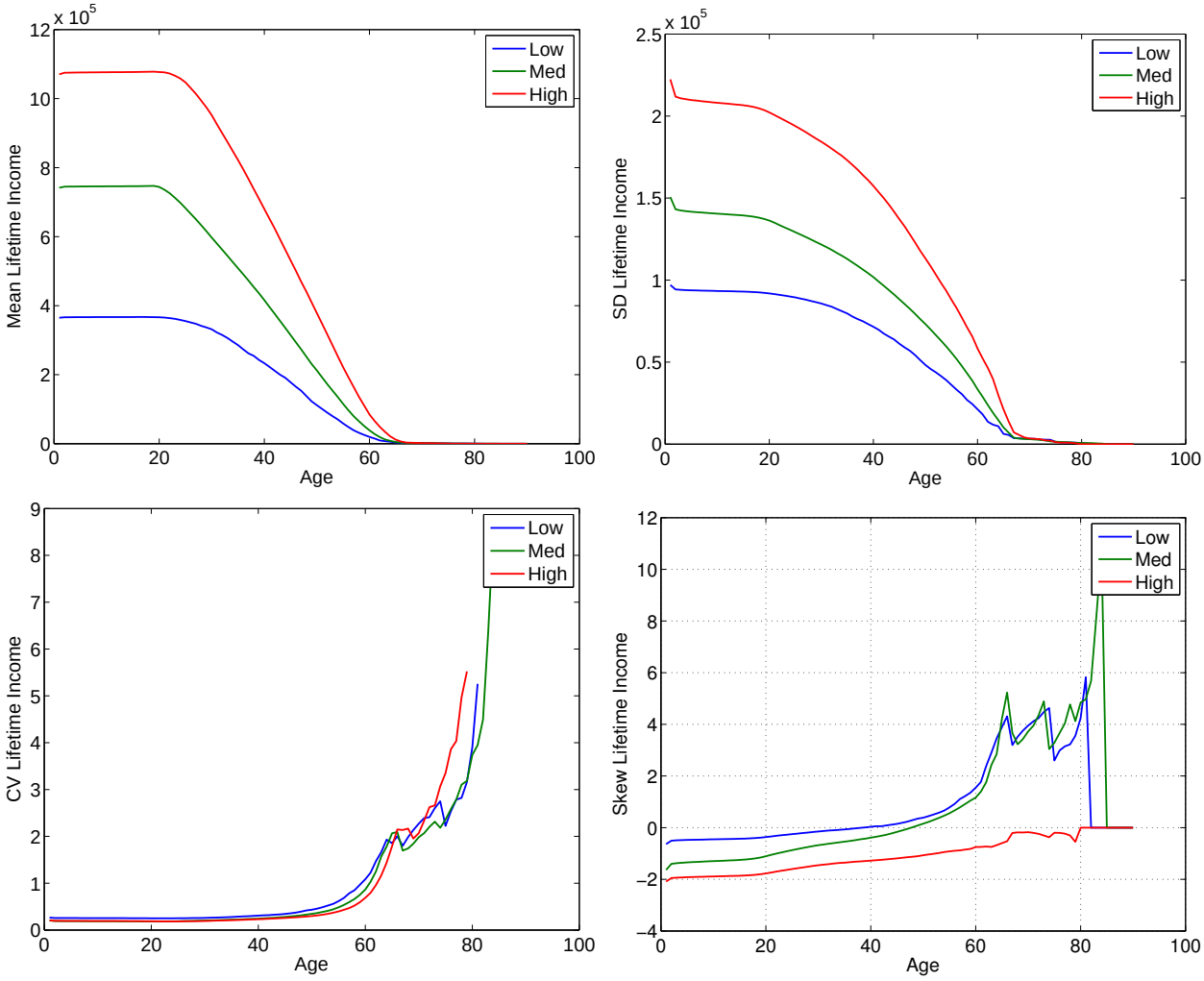

Figure 2: Statistics of lifetime accumulation of income for low, medium, and high educational levels.

In addition to the effects of education, we would like to estimate regional variations, income variation across time as well as corresponding consumption and deficit schedules. Furthermore, we will show the impact of the mortality schedule on the expected results.

4 Discussion

This study is an important step to estimate differences in key economic variables for individuals that belong to different population subgroups, facing alternative mortality schedules or simply realize other outcomes due to individual stochasticity (luck or decisions made that impact your expected stream of income). We will show how income varies between different socio-economic groups and regions and how this affects their expected lifetime accumulation of economic variables. We will furthermore show the importance of the mortality schedule for our results. Against the background of population aging, a decomposition of results for individuals having different characteristics is very important. The study adds individual stochasticity and lifetime estimates to the valuable results of National Transfer Accounts.

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