

# Consumption over the life cycle: The role of annuities

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## Abstract

We explore the quantitative implications of uncertainty about the length of life and a lack of annuity markets for life cycle consumption in a general equilibrium overlapping generations model in which markets are otherwise complete. Empirical studies find that consumption displays a hump shape over the life cycle. Our model exhibits life cycle consumption that is consistent with this pattern. Our calibrated model, which includes an unfunded social security system, displays a hump shape but the peak occurs later in the life cycle than in the data. Adding a bequest motive causes this decline to begin at a younger age.

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## 1. Introduction

Among the many sources of uncertainty that an individual faces when planning for consumption in old age, one of the more significant is uncertainty about how long the individual will live. This source of uncertainty could be easily insured against if the individual were to purchase an annuity that provides a constant flow of income until death. But, annuity markets in the US are quite thin. A standard explanation for the lack of annuity markets is adverse selection—those with long expected lifetimes will be attracted to annuities, which might cause them to be unattractively priced for most people.<sup>1</sup>

In this paper we explore the quantitative implications of uncertainty about the length of life and a lack of annuity markets for life cycle consumption in a calibrated general equilibrium overlapping generations model where markets are otherwise complete. A large literature has documented that individual household consumption increases early in life, with a peak sometime around age 50 and a decline after that.<sup>2</sup> This is generally regarded as posing a puzzle for

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<sup>1</sup> See, for example, Friedman and Warshawsky (1990) and Mitchell et al. (1999).

<sup>2</sup> Thurow (1969) is an early example from this empirical literature. More recent contributions include Attanasio and Browning (1995), Attanasio et al. (1999), Gourinchas and Parker (2002), and Fernández-Villaverde and Krueger (2002). In addition, a recent paper by Aguiar and Hurst (2005) argues that, while consumption expenditures may be hump shaped, home production is used to smooth actual consumption relative to expenditures.

a standard life cycle model of consumption because, with complete markets, the model implies that consumption should be smooth over a lifetime. Depending on the relative magnitudes of the household's time discount rate and the market interest rate, consumption can be constant, or monotonically decreasing or increasing as an individual ages.

If an annuity market (or its equivalent) is unavailable, this intuition no longer applies. If survival probabilities decrease as an individual ages, individuals will more heavily discount the future as they grow older. This allows for the possibility, depending on the value of the interest rate, that consumption might increase early in life when survival probabilities are high and the effective rate of discount is low. As survival probabilities fall, the slope of the consumption profile may become negative.

Because social security provides some insurance against uncertain lifetimes and may provide an adequate substitute for missing annuity markets, we study the shape of the consumption profile in a model with a pay-as-you-go social security system as in the US. In this model, consumption peaks later in the life cycle in comparison to estimated consumption profiles and a similar model that abstracts from social security. Introducing a joy of giving bequest motive decreases the age of the hump in consumption.

We are not the first to note the impact of annuity markets on consumption over the life cycle. Yaari (1965) is perhaps the first to study the impact of uncertain lifetime on the shape of the life cycle consumption profile in an overlapping generations model. Levhari and Mirman (1977) extend Yaari's work by providing results on how risk averse consumers respond to a change in the distribution of lifetime uncertainty. They obtain results showing how uncertain lifetimes affect the level of consumption at a particular age, as opposed to how consumption changes over the course of the life cycle. Barro and Friedman (1977) demonstrate in the context of a simple life cycle model that, when perfect insurance markets are allowed, life cycle consumption under uncertain lifetime is the same as under certainty.

Davies (1981) may be the first to use a life cycle model with uncertain lifetimes to interpret actual consumption and savings behavior, in particular the savings behavior of retired individuals. More recently, İmrohoroğlu et al. (1995) develop an applied general equilibrium model with long but randomly-lived households to study the welfare effects of social security reform. They were able to generate age-consumption profiles with a hump by closing annuity markets, though they also had individual income uncertainty and borrowing constraints. Büttler (2001) provides a continuous-time overlapping generations model and gives an example of how a lack of annuity markets can yield a hump-shaped consumption profile. In this paper, our goal is to assess, using a calibrated general equilibrium model with social security, the extent to which a lack of annuity markets by itself can account for the observed hump shaped consumption profile.<sup>3</sup>

Most of the consumption literature, however, has explored other factors that potentially play an important role in determining how consumption changes over the life cycle. One possibility is that the hump shape may be due to demographic factors—Attanasio and Browning (1995) and Attanasio et al. (1999) argue that the change in the size of a household over time is a significant determinant of the hump in consumption. However, more recent research has generally found that demographic factors alone cannot account for the pattern of lifetime consumption.<sup>4</sup>

Thurow (1969), for example, suggested that the age-consumption profile may be hump shaped due to borrowing constraints. That is, individuals are prevented from shifting as much wealth as they would like from later in life to finance consumption earlier. Another possibility is that individuals face income uncertainty and must die with non-negative assets. This creates a motive for precautionary savings that could lead to consumption rising with income early in life. Both Attanasio et al. (1999) and Gourinchas and Parker (2002) emphasize this point. Fernández-Villaverde and Krueger (2001) argue that households accumulate durables early in life as a way of insuring against income uncertainty. In their model, the stock of durables provides insurance by acting as collateral for consumption loans.

Heckman (1974) and Bullard and Feigenbaum (2003) explore the possibility that substitutability between consumption and leisure, rather than market incompleteness, may play an important role. That is, if preferences are such that consumption and leisure are substitutes, individuals may choose to consume more during the periods of their life when they spend the largest fraction of their time engaged in market work.

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<sup>3</sup> A recent paper, Feigenbaum (2007), expands on the analysis presented in this paper by studying the role of mortality risk in a continuous time life cycle model where labor supply is inelastic and households are borrowing constrained.

<sup>4</sup> For example, compare the findings of Attanasio and Browning (1995) with those of Attanasio et al. (1999). The first paper concludes that the hump can be entirely explained by demographic factors while the second finds an important role for income uncertainty.

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