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Age-dependent investing: Optimal funding and investment strategies in defined contribution pension plans when members are rational life cycle financial planners ☆

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ABSTRACT

A defined contribution pension plan allows consumption to be redistributed from the plan member's working life to retirement in a manner that is consistent with the member's personal preferences. The plan's optimal funding and investment strategies therefore depend on the desired profile of consumption over the lifetime of the member. We investigate these strategies under the assumption that the member is a rational life cycle financial planner and has an Epstein–Zin utility function, which allows a separation between risk aversion and the elasticity of intertemporal substitution. We also take into account the member's human capital during the accumulation phase of the plan and we allow the annuitisation decision to be endogenously determined during the decumulation phase.

We show that the optimal funding strategy involves a contribution rate that is not constant over the life of the plan but is age-dependent and reflects the trade-off between the desire for current versus future consumption, the desire for stable consumption over time, the member's attitude to risk, and changes in the level of human capital over the life cycle. We also show that the optimal investment strategy during the accumulation phase of the plan is 'stochastic lifestyling', with an initial high weight in equity-type investments and a gradual switch into bond-type investments as the retirement date approaches in a way that depends on the realised outcomes for the stochastic processes driving the state variables. The optimal investment strategy during the decumulation phase of the plan is to exchange the bonds held at retirement for life annuities and then to gradually sell the remaining equities and buy more annuities, i.e., a strategy known as 'phased annuitisation'.

1. Introduction

1.1. The role of the pension plan in allocating consumption across the life cycle

A typical individual's life cycle consists of a period of employment followed by a period of retirement. Most individuals therefore need to reallocate consumption from their working life to retirement if they wish to avoid poverty in old age.

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A defined contribution (DC) pension plan can achieve this reallocation in a way that is consistent with the preferences of the individual plan member.[1,2]

There are three key preferences to take into account. The first relates to the desire to smooth consumption across different possible states of nature within any given time period. The second relates to the desire to smooth consumption across different time periods. The third relates to the desire for current versus future consumption; saving for retirement involves the sacrifice of certain consumption today in exchange for uncertain consumption in the future. This uncertainty arises because both future labour income and the returns on the assets in which the retirement savings are invested are uncertain. The plan member therefore needs to form a view on both the trade-off between consumption in different states of nature in the same time period and the trade-off between consumption and consumption variability in different time periods. Attitudes to these trade-offs will influence the optimal funding and investment strategies of the pension plan.

In a DC pension plan, the member allocates part of his labour income earned each year to the pension plan in the form of a plan contribution and, thus, builds up a pension fund prior to retirement. Then, at retirement, the member uses the accumulated pension fund to finance consumption in retirement by purchasing a life annuity, by keeping the fund invested and drawing an income from it, or some combination of these.[3] The decisions regarding the size of the contribution rate in each year before retirement[4] (i.e., the funding strategy) is driven by the member's preference between current and future consumption. As a consequence, the optimal funding strategy might involve a contribution rate into the plan that is not, as in most extant plans, a fixed percentage of labour income, but is, instead, age-related.

The investment strategy prior to retirement (i.e., the decision about how to invest the accumulating fund across the major asset categories, such as equities and bonds) will influence the volatility of the pension fund (and, hence, the amount available for consumption in future periods), and so will depend on the member's attitude to that volatility, both across states of nature and across time. After retirement, hedging longevity risk becomes an important additional consideration, so the investment strategy will now include annuities as well as the traditional asset categories.

In this paper, we investigate the optimal funding and investment strategies in a DC pension plan assuming the member is a rational life cycle financial planner. The model we use has three key features.

The first key feature of the model is the assumption of Epstein and Zin (1989) recursive preferences by the plan member. This allows us to separate relative risk aversion (RRA) from the elasticity of intertemporal substitution (EIS). Risk aversion is related to the desire to stabilise consumption across different states of nature in a given time period[5] and EIS measures the desire to smooth consumption over time.[6] Thus, risk aversion and EIS are conceptually distinct and, ideally, should be parameterised separately.

Within the commonly used power utility framework, the EIS is given by the reciprocal of the coefficient of relative risk aversion (e.g., see Campbell and Viceira (2002)). This restriction has been criticised because it does not appear to reflect empirical observations. For example, based on the consumption capital asset pricing model of Breeden (1979), Schwartz and Torous (1999) disentangle these two concepts using the term structure of asset returns. Using US data on discount Treasury bond returns, equity market returns and aggregate consumption for 1964–1997, their best estimate for the coefficient of RRA is 5.65 (with a standard error of 0.22) and their best estimate of the EIS is 0.226 (with a standard error of 0.008). Thus, a high coefficient of RRA tends to be associated with a low level of EIS, but the estimated parameter values do not have the exact reciprocal relationship assumed in the power utility framework. Similarly, Blackburn (2006) rejects the reciprocal relationship on the basis of a time series of RRA and EIS parameters estimated from observed S&P 500 option prices for a range of different expiry dates between 1996 and 2003.[7]

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[1] The extent of this reallocation will be influenced by the level of pension benefits provided by the state and by the level of non-pension (e.g., housing) wealth owned by the individual.

[2] Defined contribution pension plans are now the dominant type of pension plan in the private sector in most countries, having taken over from defined benefit plans over the last 20 years or so. However, the latter type is still dominant in public sector plans.

[3] Some jurisdictions place restrictions on some of these options. Some plan members might wish to exercise a further option, one which arises from a 'bequest motive', i.e., the desire to leave a bequest on death. We do not consider this further here, since bequests are usually satisfied outside of a pension savings framework and pension wealth is typically not bequeathable.

[4] In the case where the plan member can exercise some choice.

[5] An individual with a high degree of risk aversion wishes to avoid consumption uncertainty in a particular period and, more specifically, the reduction in consumption that would be required in an unfavourable state of nature, such as one with a large fall in equity prices.

[6] An individual with a low EIS wishes to avoid consumption volatility over time and, in particular, a reduction in consumption relative to the previous time period. EIS is defined as

$$\varphi = -\frac{d[\ln(c_{t_1}/c_{t_2})]}{d[\ln(U'(c_{t_1})/U'(c_{t_2}))]}$$

where c_{t_i} is consumption in period t_i and $U'(c_{t_i})$ is the marginal utility of c_{t_i}. The sign and size of the EIS reflects the relationship between the substitution effect and income effect of a shock to a state variable, such as an increase in the risk-free interest rate. The substitution effect is always negative, since current consumption decreases when the risk-free rate increases because future consumption becomes relatively cheap and this encourages an increase in savings. The income effect will be positive if an increase in the risk-free rate (which induces an increase in the income from savings) leads to an increase in current consumption; it will be negative otherwise. If the income effect dominates, the EIS will be negative and an increase in the risk-free rate leads to an increase in current consumption. If the substitution effect dominates (which is the usual assumption), the EIS will be positive and an increase in the risk-free rate leads to a decrease in current consumption. If the income and substitution effects are of equal and opposite sign, the EIS will be zero and current consumption will not change in response to an increase in the risk-free rate: in other words, consumption will be smooth over time in the presence of interest rate volatility.

[7] In particular, Blackburn (2006) found that, over the period 1996–2003, the RRA changed dramatically, whilst the EIS stayed reasonably constant.