Optimization-based guidelines to retirement planning and pension product design - DTU Orbit (24/12/2018)

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Pension systems differ across countries and are subject to country specific regulations. In addition, various countries offer different types of pension plans to their citizens. In some pension plans individuals have a lot of flexibility regarding managing their savings; in others, pension funds or life insurers manage the members' savings without taking into account the individuals' preferences. Nevertheless, in most of the pension plans individuals face some challenges. They have to decide on the investment and consumption of their retirement savings either by choosing a pension product and a specific pension product, or by choosing a particular annuity, and, possibly, a life insurance policy. In some countries they have to make decisions as soon as they are employed; in other countries, not until they approach the time of retirement. To help individuals make the right decisions regarding their retirement savings, this thesis presents some optimization techniques that could be applied by pension providers and financial advisers to provide individuals with such guidelines. For a given objective function and a number of constraints, we search for the optimal solution, which indicates, for example, how to invest the savings, which annuity to purchase, and which level of death benefit to choose. In most of the papers we follow a classical approach and maximize the expected CRRA utility of either the final wealth, or the consumption and bequest amount. Scholars refer to the aforementioned decisions as the consumption-investment problems. A classical approach to solving these problems is stochastic optimal control (SOC), which aims to find a closed-form solution to a given problem. However, as the explicit solution exists only for relatively simple models, this approach cannot be applied to the problems considered in this thesis. Therefore, in this thesis we use a multi-stage stochastic programming (MSP) approach that is known for its practical applications and thus broadly used in operations research. In a few chapters of the thesis we apply a mixed approach, i.e., a combination of the MSP and SOC approaches, and in one of the chapters we apply Monte Carlo simulations. Each chapter of the thesis focuses on different challenges that individuals face, given a different set of constraints, determined either by national regulations or by individuals' personal preferences. The first two chapters deal with defined contribution pension plans, where an individual makes the consumption, investment, and life insurance decisions, both before and after retirement. Our results indicate that retirement savings management differs for each individual, and that it should not only depend on the individual's degree of risk aversion or time left to retirement, but also on characteristics such as current wealth, expected income before and after retirement, expected pension contributions, impatience factor, lifetime expectancy, and preferences regarding portfolio composition and the level of death benefit. Consequently, pension providers should offer variable life annuities that are tailored to the individuals' needs in terms of the underlying asset allocation, the payout profile, and the level of death benefit. The next three chapters discuss the purchase of the right annuity. We start with investigating whether individuals should wait until retirement to purchase a life annuity providing fixed payments, whether they should invest in this annuity already some years before retirement by purchasing a deferred annuity with the same fixed payments, or whether they should invest their savings in stocks and bonds. Despite simple model assumptions, our findings indicate that individuals should invest part of their savings in deferred annuities. The proportion in these products increases with the degree of risk aversion and the expected lifetime, and decreases with the bequest motive. Afterwards, we investigate the optimal annuity choice under inflation risk, which is often ignored both by practitioners advising on the retirement planning and by scholars investigating the consumption-investment problems. We search for an optimal level of retirement income in real terms, given investment opportunities in inflation-linked, nominal, and variable annuities, as well as in stocks and bonds. Our findings show that real annuities are a crucial asset in every portfolio, and that trying to hedge inflation without investing in inflation-linked products leads to a lower and more volatile retirement income. In the last chapter discussing the annuity purchase, we differentiate between a wide variety of annuities. In addition to stocks and bonds with different maturities, we search for the optimal investment in annuities contingent on a single and joint lifetime, with fixed and variable payments, with immediate and deferred payments, and with temporary and life long payments. We conclude that the optimal portfolio for a single and a two-person household not only requires frequent rebalancing, but also consists of too many different assets. Accordingly, we argue that despite so many annuities available in the market, the products that individuals need the most are not available. Finally, in the last chapter of this thesis we apply Monte Carlo simulations to investigate the value of the interest rate guarantee incorporated in the Danish with-profit products. In these products the pension provider offers its members a guaranteed interest rate as well as some bonus rate that depends on the pension provider's realized investment returns. We argue that with-profit products with such a bonus mechanism often provide lower returns than pure unit-linked products without any guarantee because, to meet the solvency requirements, the pension provider has to invest individuals' assets more conservatively.

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