Designing guarantee options in defined contribution pension plans

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Abstract

The shift from defined benefit (DB) to defined contribution (DC) is pervasive among pension funds, due to demographic changes and macroeconomic pressures. In DB all risks are borne by the provider, while in plain vanilla DC all risks are borne by the beneficiary. For DC to provide income security some kind of guarantee is required. A minimum guarantee clause can be modeled as a put option written on some underlying *reference portfolio* of assets and we develop a discrete model that optimally selects the reference portfolio to minimise the cost of a guarantee. While the relation DB-DC is typically viewed as a binary one, the model can be used to price a wide range of guarantees creating a continuum between DB and DC. Integrating guarantee pricing with asset allocation decision is useful to both pension fund managers and regulators. The former are given a yardstick to assess if a given asset portfolio is fit-for-purpose; the latter can assess differences of specific reference funds with respect to the optimal one, signalling possible cases of moral hazard.

We develop a general and computationally tractable model for pricing the cost of alternative embedded guarantee options in DC pension funds. The model determines the asset allocation choice that is optimal for a given guarantee, in that it minimizes the cost of the guarantee. The model is tested using real-world data to illustrate the effect of the design parameters of the guarantee on the cost of offering the option. Results illustrate the effect on the option of (i) level of guarantee, (ii)

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amount of equity, and (iii) participation of the beneficiaries in any portfolio upswing above the guarantee. We also show how the model can be used to benchmark existing portfolios by applying it to test portfolios of State and local government pension funds from the literature. Our results are in agreement with empirical findings of existing literature, but also attribute the precise cost of the guarantee. We also show how the model can be used to calculate risk premia for risk sharing. The model we implement and test can be extended to cover a broad range of guarantees that increasingly resemble DB, thus providing a continuum of funds in the hitherto dichotomous relation DC-DB. Some extensions are straightforward to build and calibrate, while others are provided as areas for further research.

Keywords: Pensions, minimum guarantee, defined benefit, defined contribution, embedded options, risk sharing, portfolio selection, stochastic programming.