A metamodelling approauch to estimate the fair market value of a Variable Anuity

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Problem

- Variable Anuity(VA) is life insurance product that comes with garantees;

- Monte Carlo simulation can be used to value the VA protifolio, but it is extrely time-consuming;

- A metamodeling is a alterntive aproach to avoid running time problem...

- It consists in:
    - Define a subset of representative VA contract;
    - Compute the FMV for this represntative set using MC simulation;
    - **Fit a model based on the characteristics and FMV of the contracts**;
    - Use the estimated model to predict the the FMV of the remaining VA contracts.

Variable Anuity

- VA is as insurance product created and sold by insurance companies as a tax-deferred retirement vehicle to adress many people's concerns about outliving their assets.

- Two phases:
  - **Accumulation:** policyholder makes purchase payments to the insurance company.
  - **Payout:** policyholder receives benefit payments from the insurance company.

- A major feature of VA is that it includes gurantees or riders.

- These guarantees can be divided into two broad categories: death benefits and living benefits.
  - **GMDB** guarantees a specified lump sum to the beneficiary uppon the death of the policyholder.
  - **GMWB**, **GMIB**, **GMMB** and **GMAB** are some of the most popular living guarantees.

Variable Anuity Datasets

- It is difficult for researchers to obtain real datasets from insurance companies to assess the performance of those metamodeling techniques.

- **Solution:** Synthetic Datasets (GAN and A.VALDEZ - 2017)

- Synthetic Datasets are large portfolios of VA contracts based on the properties of real portfolios of VA.

- Properties typically observed on real portfolios of VA contracts:

    - Different contracts may contain different types of guarantees.
    - The contract holder has the option to allocate the money among multiple investment funds.
    - Real variable annuity contracts are issued at different dates and have different times to maturity.

Synthetic Dataset

- VA contracts in the synthetic portfolios:

Product	Description	Rider Fee
DBRP	GMDB with return of premium	0.25%
DBRU	GMDB with annual roll-up	0.35%
DBSU	GMDB with annual ratchet	0.35%
ABRP	GMAB with return of premium	0.50%
ABRU	GMAB with annual roll-up	0.60%
ABSU	GMAB with annual ratchet	0.60%
IBRP	GMIB with return of premium	0.60%
IBRU	GMIB with annual roll-up	0.70%
IBSU	GMIB with annual ratchet	0.70%
MBRP	GMMB with return of premium	0.50%
MBRU	GMMB with annual roll-up	0.60%
MBSU	GMMB with annual ratchet	0.60%
WBRP	GMWB with return of premium	0.65%
WBRU	GMWB with annual roll-up	0.75%
WBSU	GMWB with annual ratchet	0.75%
DBAB	GMDB + GMAB with annual ratchet	0.75%
DBIB	GMDB + GMIB wwith annual ratchet	0.85%
DBMB	GMDB + GMMB with annual ratchet	0.75%
DBWB	GMDB + GMWB with annual ratchet	0.90%

Synthetic Dataset

- Parameter values used to generate the synthetic portfolio.

Feature	Value
Policyholder birth date	[1/1/1950,1/1/1980]
Issue date	[1/1/2000,1/1/2014]
Valuation date	1/6/2014
Maturity	[15,30]years
Initial account value	[50000,500000]
Female percent	40%
Fund fee	30, 50, 60, 80, 10, 38, 45, 55, 57, 46 bps for Funds 1 to 10
M&E fee	200 bps

Synthetic Dataset

- 10,000 synthetic variable annuity policies were generated for each of the guarantee types.

- The Synthetic portfolio contains 190,000 policies.

- There are 45 fields in total, including 10 fund values, 10 fund numbers and 10 fund fees.

Field	Description
recordID	Unique identifier of the policy
survivorShip	Positive weighting number
gender	Gender of the policyholder
productType	Product type
issueDate	Issue Date
matDate	Maturity date
birthDate	Birth date of the policyholder
currentDate	Current date
baseFee	M&E (Mortality & Expense) fee
riderFee	Rider fee
rollUprate	Roll-up rate
rollUprate	Guaranteed benefit
rollUprate	GMWB balance
wbWithdrawalRate	Guaranteed withdrawal rate
withdrawal	Withdrawal so far
FundValuei	Fund value of the ith investment fund
FundNumi	Fund number of the ith investment fund
FundFeei	Fund management fee of the ith investment fund

Synthetic Dataset

- Monte Carlo simulation engine to calculate the fair market values (FMV), partial dollar deltas and partial dollar rhos of the guarantees for the synthetic portfolio.

- The total fair market value is positive, because the guarantee benefit payoff is more than the risk.

- Since the VA contracts are usually long-terms contracts, the guarantees are more sensitive to long-term interest rates than to short-term interest rates.

- The total amount of those variables are described above:

Quantity Name	Value	Quantity Name	Value
FMV	18,572,095,089	Rho2y	167,704
Delta1	-4,230,781,199	Rho3y	85,967
Delta2	-2,602,768,996	Rho4y	2,856
Delta3	-2,854,233,170	Rho5y	-96,438
Delta4	-2,203,726,514	Rho7y	546,045
Delta5	-2,341,793,581	Rho10y	1,407,669
Rho1y	40,479	Rho30y	62,136,376