Fair evaluation of insurance contracts with performance depending on different investment funds with automatic remixing mechanism

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- an example of such a policy is represented by a contract with performance depending on two investment funds with an automatic remixing mechanism
- it is offered in the Italian insurance market but we are aware that similar contracts are present also in other European countries
- the policy works as follows: the first investment fund is characterized by low volatility and is less risky than the second one that has a higher volatility

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- at the end of equally spaced time intervals, $t_k, k = 1, \dots, m$, an automatic rebalancing mechanism between the two funds acts as follows
- if the low-volatility fund accrues interest at a rate greater than the target rate, the insurer transfers the surplus into the high-volatility fund

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- at each remix date a fee is applied by the insurer

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- the automatic rebalancing mechanism acts at each anniversary of the contract
- a guarantee is embedded into the contract assuring that the low-volatility fund accrues interest at the target rate
- the sum invested in the low-volatility fund is $100 \times (1 + 0.035)^{-5} = 84.2$, while the sum invested in the high-volatility fund is $100 - 84.2 = 15.8$

The contract

year	LV fund return	LV fund value	HV fund return	HV fund value	total policy value
0	-	84.2	-	15.8	100
1	5.2%	87.14	2.8%	16.63	103.77
2	4.8%	90.19	6.4%	17.74	107.93
3	3.2%	93.35	4%	17.06	110.41
4	1.8%	96.62	2.7%	14.81	111.43
5	−0.5%	100.00	3.5%	10.35	110.35
6	−1.2%	100.00	1.3%	8.19	108.19
7	−2.7%	100.00	−4%	4.11	104.11
8	−3%	100.00	−8%	0	100
9	3.2%	100.00	–	2.17	102.17
10	4.2%	104.2	5%	2.28	106.48

This table reports an example ragarding to a possible scenario of the evolution of the policy value

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- α is the annual fee, I is the indicator function and $r_L(t_k)$ is the rate of return of the low-investment fund in the time interval $[t_{k-1}^+, t_k]$

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$$q_{uu} = q_L q_H + \frac{\rho}{4}, \quad q_{ud} = q_L(1 - q_H) - \frac{\rho}{4},$$

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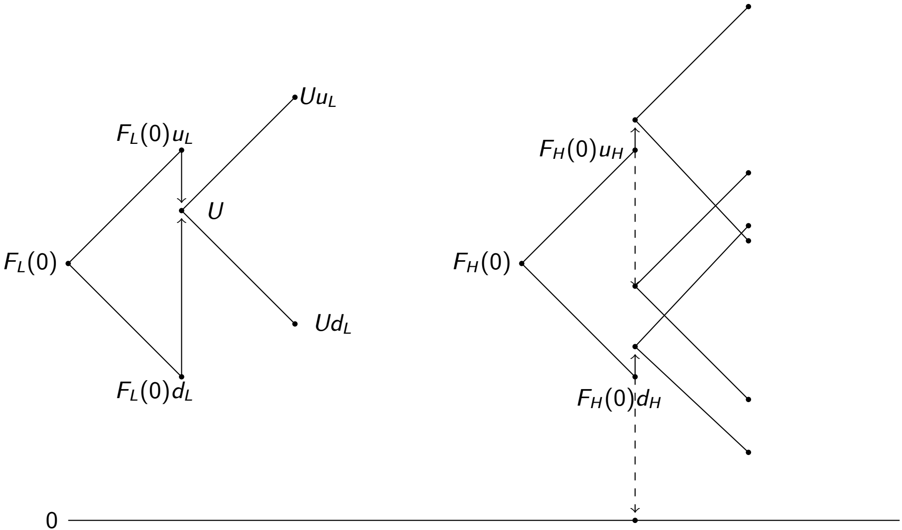

An example of the fund dynamics with two time steps

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- the low-volatility fund may assume one of the values

$$F_L(i,j) = G(\lceil i/h \rceil - 1) u_L^{i-(\lceil i/h \rceil - 1)h-j} d_L^j (1 - \alpha I_{\{i=kh\}}),$$

$$i = 0, \ldots, N, \quad j = 0, \ldots, \bar{j}_L(i) \equiv i - (\lceil i/h \rceil - 1)h.$$

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- for the first h time steps the remaining representative values coincide with those generated by the recombining binomial tree describing the evolution of the high-volatility fund
- from time step $h+1$ onward, the remaining representative values are fictitious values generated in such a way that the difference between two consecutive fund values is proportional to $F_H(0)\Delta t$

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- The policy value at maturity is set equal to $W(N,j,l) = F_L(N,j) + F_H(N,l)$, $j = 0, \ldots, \bar{j}_L(N)$, $l = 0, \ldots, \bar{l}_H(N)$

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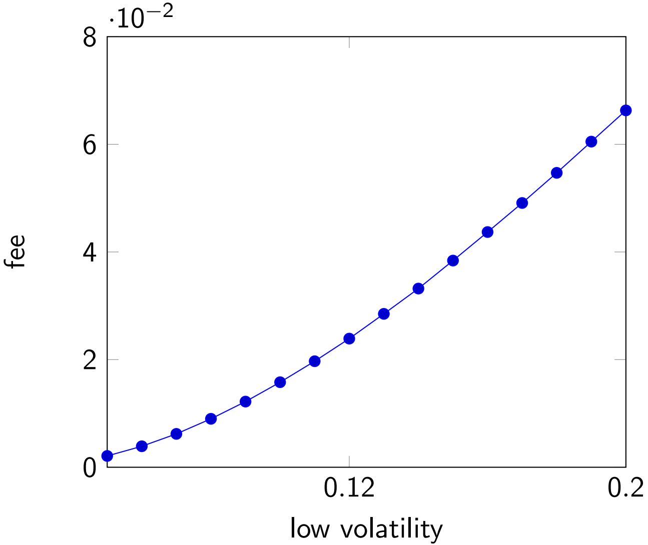
- this can be done through common numerical root-finding schemes

Numerical Results

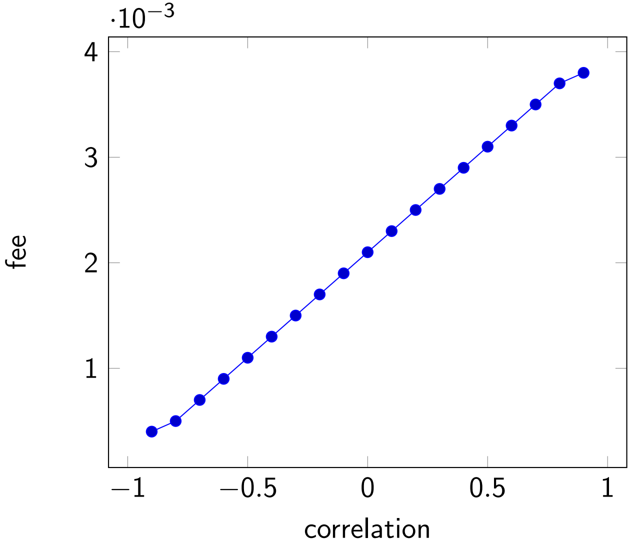
	T				
	2	4	6	8	10
L	100.7844	100.6940	100.5748	100.4954	100.4483
MC	100.7858	100.6939	100.5754	100.4836	100.4309
s.e.	(0.0042)	(0.0077)	(0.0123)	(0.0183)	(0.0265)
fee	0.0108	0.0021	0.0012	0.0008	0.0006

in this table we consider policies with maturities, $T = 2, 4, 6, 8, 10$ years. In all cases, the target date, τ, is set equal to $T/2$, and the target rate, i_g, is 3.5% per year. The remaining parameters are set as follows: the continuously compounded risk-free interest rate is $r = 4\%$ per year, the high volatility is $\sigma_H = 0.3$, the low volatility is $\sigma_L = 0.05$, and the correlation is $\rho = 0$. The row labeled L contains the policy values at inception computed by the proposed model. The row labeled MC reports the corresponding values obtained by Monte Carlo simulations, while in the row labeled s.e. the standard error is reported in brackets. The last row, labeled fee, contains the fair fees computed with the proposed method.

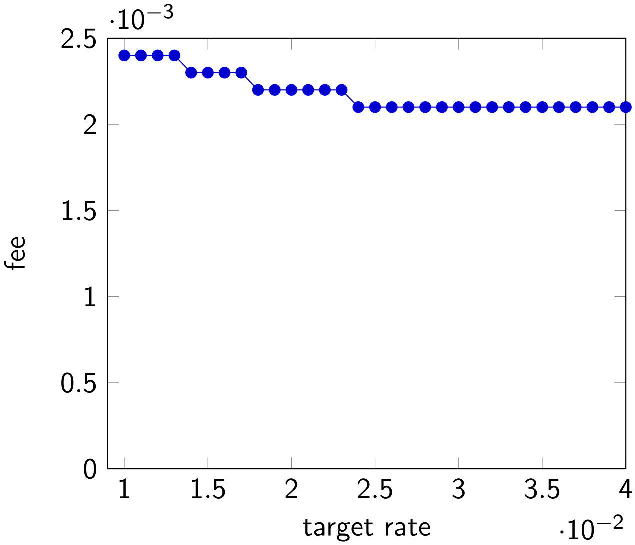
Numerical Results



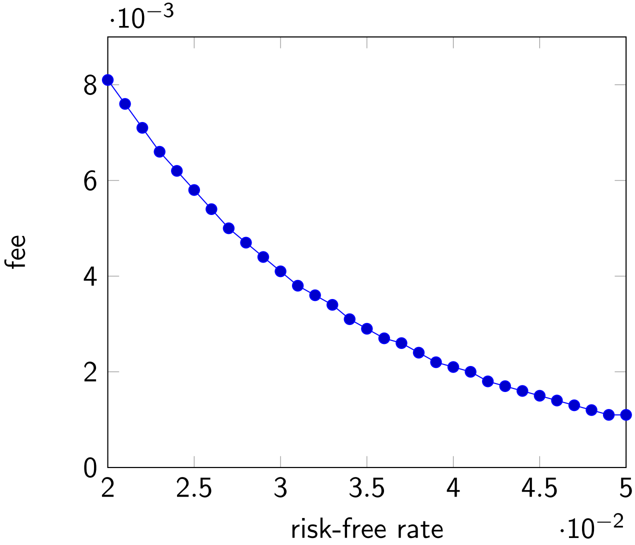
Numerical Results



Numerical Results



Numerical Results



Thank You for Your attention!