MODERN TONTINES

A VIABLE ALTERNATIVE FOR RETIREMENT PLANS ?

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29/04/2020

ABSTRACT

In the context of global aging population, improved longevity and low interest rates, the question of pension plan under-funding and adequate elderly financial planning is gaining awareness worldwide, both among experts and in popular media. Additional emergence of societal changes - Peer to Peer business model and Financial Disintermediation – might have contributed to the resurgence of "Tontine" in various papers and the proposal of further models such as Tontine Pensions (Forman & Sabin, Survivor Funds, 2016), ITA - Individual Tontine Accounts (Fullmer & Sabin, 2018), Pooled-survival fund (Newfield, 2014), Pooled Annuity Funds (Donnelly, Actuarial fairness and solidarity in pooled annuity funds, 2015), and Modern Tontines (Weinert & Grundl, 2016) to name a few.

In this paper, we revisit the mechanism proposed by (Fullmer & Sabin, 2018) - which allows the pooling of Modern Tontines through a self-insured community. This "Tontine" generalization retains the flexibility of an individual design: open contribution for a heterogeneous population, individualized asset allocation and predesigned annuitization plan. The actuarial fairness is achieved by allocating the deceased proceedings to survivors using a specific individual pool share which is a function of the prospective expected payouts for the period considered.

After a brief introduction, this article provides a formalization of the mathematical framework and analyses simulated outcomes based on various assumptions. In particular, the methodology bias is reviewed, and some adverse selection limits are exposed (the "term Dilemma). Some solutions are then proposed to overcome scheme shortcomings and we then discuss more generally the requirements for a practical implementation.

GLOBAL ENVIRONMENT IS PUTTING MANY PENSION SCHEMES UNDER PRESSURE

Demographic Factors

- Aging Population
- Longevity

Economic Factors

- Low Interest Rates
- Low Returns

Sociologic Factors – Tomorrow's retiree

- Increasingly Tech Savvy
- Will require personalization
- More inclined to P2P/community-based solutions

- Pension plans underfunding epidemic – both public and private
- Need for Adequate elderly financial planning for longer life-span and dependence
- Life Annuity products are generally considered:
  - Too expensive by customers
  - Too risky by insurers

TONTINES: A CONTROVERSIAL HISTORY LEADING TO STRICT REGULATION AND VERY SMALL MARKET

"La Tontine n'est qu'un jeu, une gageure. Ce n'est pas une operation d'assurance."

Maurice Picard

"… The Tontine is perhaps the most discredited financial instrument in history"

Edward Chancellor

1650~1689: First "State" Tontines:

- Proposed by Tonti to Mazarin in 1650's as a government fund-raising
- 1st state Tontine issued 1689

1670~1760: "State" Issued schemes:

- 9 additional in France, with the same scheme and some variants.
- In Britain, 1st one in 1693 to finance war against France, 6 follow to 1789
- Forbidden in 1770 by Terray due to bankruptcy (ie Geneva speculation group…)

1760~1906: Private schemes and demise:

- Common fundraising tool
- Abusive clauses from insurers "Equitable Life Insurance Society" and Armstrong investigation in embezzlement

Popular Culture:

"The Wrong Box" from Stevenson & Osbourne (1889) later adapted as a film in 1966

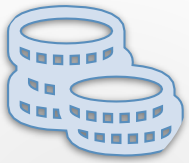
- Tontine launched primarily as fundraising tool
- Unsuccessful history due to fund bankruptcy, fraud, embezzlement and abusive clauses
- Sulfurous reputation: popular culture fiction and "gambling on other people death"
- Recent regain of interest in Tontines – as a **retirement scheme** instead of **fundraising tool**

McKeever, K. (2008). A Short History of Tontines. Fordham Journal of Corporate and Financial Law 15 (2), Article 5.

MODERN TONTINES: A SELF-HEDGED ANNUITY POOL WITH A HIGH DEGREE OF CUSTOMIZATION (1/2)

Generalization of a "classic" tontine → Mortality "proceedings" allocated among survivors at each time step. + Additional Features

Flexible Contribution



The pool is open ended- new comer can join at each period start and existing members can top-up (at current condition)

Heterogeneous Population

Population can be heterogeneous – proceedings will be allocated based on survival probabilities and account value

Customizable Annuity Plan

Annuitization schedule is customizable, such as Lump sum, Certain Term Annuity, Life Annuity or a Mix of above.

However, to avoid adverse selection, it **is fixed at onboarding**

Individual Unit Linked Allocation

Each member can select their Unit Link allocation as they see fit – and switch at any time.

The unit values is reflected on daily basis to each member Account Value

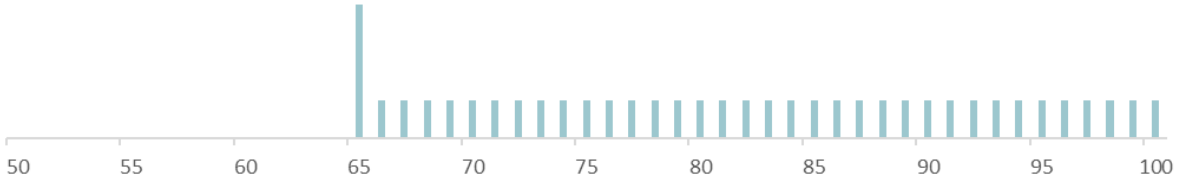
MODERN TONTINES: ILLUSTRATION

Example of Schedule

Case of a 50 year old, with regular contributions until 65 years old and a life annuity from retirement along with a capital at retirement date.

Contribution

Outgoes



Example of Statement

Statement for the period from 01/01/2020 to 31/12/2020

Financial Return:

Account Value at period start:	**75,797**
Financial Performance on the period:	1,634
Financial Return Rate	*2.16%*
Account Value at period end - before tontine returns:	**77,430**

Tontine Return:

Total Pool Value at period end	7,579,657,840
Total Redeemed Amount	113,694,868
Your share	1,137
Tontine Return Rate	*1.47%*

Account Value at period end	**78,567**
Total Return on the period	*3.66%*

MODERN TONTINES: ALLOCATION SCHEME AND ACTUARIAL FAIRNESS (1/3) - THE INTUITION

The mortality "Proceeding" allocation key is the cornerstone of the model

In order to be "fair" in the actuarial sense, the allocation key is based on the survival probabilities on the considered period

The resulting formula is familiar: the $\frac{q}{(1-q)}$ factor is recurrent in actuarial mathematics and probabilities

*An intuitive way to grasp the principle is to ensure that the **expected gain** is neutral (TontShare being the mortality proceeding allocated to the member):*

$$E[Gain] = 0$$

$$Loss_{Death} + Gain_{Surv} = 0$$

$$-q.AV + TontShare(1-q) = 0$$

$$\boldsymbol{TontShare = \frac{q}{(1-q)} AV}$$

MODERN TONTINES: ALLOCATION SCHEME AND ACTUARIAL FAIRNESS (2/3) – THE FORMALISATION

The allocation key – the expected tontine gains for member n on the period t_c:

$$TontShare_{t_c}^{n} = \left(\frac{q_{x_n}}{1 - q_{x_n}}\right) AV_{mop}^{n}$$

***NOTE**: The allocation key is calculated based on the Account Value after including individual returns on the period, noted AVmop*

The mortality "proceeds" on the period t_c :

$$TontRedeem_{t_c} = \sum_{i:Death} AV_{mop}^{i}$$

The Tontine returns of period t_c allocated to survived member n :

$$TontReturn_{t_c}^{n} = TontRedeem_{t_c} \frac{TontShare_{t_c}^{n}}{\sum_{i:Surv} TontShare_{t_c}^{i}}$$

MODERN TONTINES: ALLOCATION SCHEME AND ACTUARIAL FAIRNESS (3/3) – WHY DOES IT WORK ?

Is the allocation fair ?

In order to be exactly fair*, the **expected tontine gains** (Tontine Share) should be equal to **the allocated mortality proceeds** (Tontine Returns) on a member by member basis.

In practice, this is not the case: there exist a **bias**** in the finite population case since the total mortality proceeds (Tontine returns) depends on the individual member status.

Bias Analysis

For each member, the bias can be noted:

$$\forall n \in [\![0, N]\!] \qquad bias_n = \frac{E\left[TontReturn_{t_c}^{n}\right]}{E\left[TontShare_{t_c}^{n}\right]} - 1$$

*Experimentally, we found that the bias significantly reduces when the size and homogeneousness of the pool increases. A proxy used*** in the study to predict the bias was:*

$$bias_n \sim -\frac{TontShare_{t_c}^{n}}{\sum_{i:Surv} TontShare_{t_c}^{i}} + \frac{1}{N}$$

*Fair from actuarial mathematics prospective

** This bias is further discussed in (Donnelly, Actuarial fairness and solidarity in pooled annuity funds, 2015) and (Forman & Sabin, Survivor Funds, 2016)

*** Further work is needed to confirm whether this proxy can be generalized

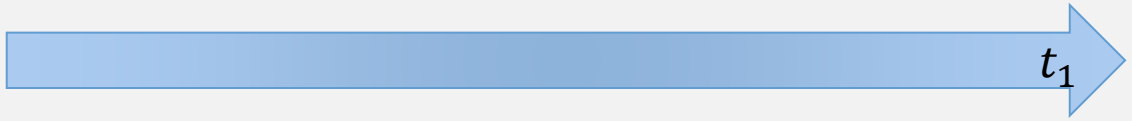
MODERN TONTINES LIMIT: THE TERM DILEMMA

The Term dilemma arises from the fact that it is possible to "breakdown" a given investment in 2 sub-terms while maintaining the equivalent Tontine Returns.

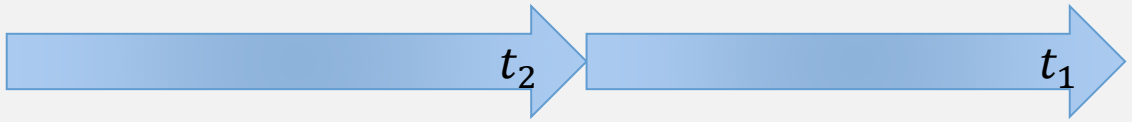
Case1: term t_1

Survival Expected Payout:

$$SEP_{t_1}^{1} = AV.\frac{1}{{}_{t_1+1}p_x}$$



$\Leftrightarrow$



Case 2: term t_2 then reinvest proceedings to t_1

$$SEP_{t_2}^{2} = AV.\frac{1}{{}_{t_2+1}p_x} \qquad SEP_{t_1}^{2} = SEP_{t_2}^{2}.\frac{1}{{}_{t_1+1}p_{x+t_2}}$$

- **Moral hazard***: It is then possible to maximize gains by selecting the shortest investment possible and then elect to re-invest until not healthy to avoid a Tontine Redemption upon death
- **Possible mitigations**
  - Introduce Selection factors on first 5 ~10 years
  - Limit minimum term to at least 5~10 years

**for non-compulsory schemes only*

It can easily be shown that both case are equivalent in terms of return:

$$\boldsymbol{SEP_{t_1}^{2}} = SEP_{t_2}^{2}.\frac{1}{{}_{t_1+1}p_{x+t_2}} = AV.\frac{1}{{}_{t_2+1}p_x}.\frac{1}{{}_{t_1+1}p_{x+t_2}} = AV.\frac{1}{{}_{t_1+1}p_x} = \boldsymbol{SEP_{t_1}^{1}}$$

MODERN TONTINES: MODELISATION & ILLUSTRATION (0/5) – HYPOTHESIS & CONVENTIONS

Python Powered

Conventions

Annual Step
Stochastic scenarios – both financial & mortality (5000 to 10,000 depending on projection)
3 funds (low, mid and high vol)

Population

5,000 new members per year for 10 years
40 to 70 years old entry age
Distributed contribution (Single, 5, 10, 20)
Distributed Annuitization schemes: lump sum to annuitization from 65 up to 100
Random allocation in the 3 funds – with rebalancing of asset at each step with the initial member allocation

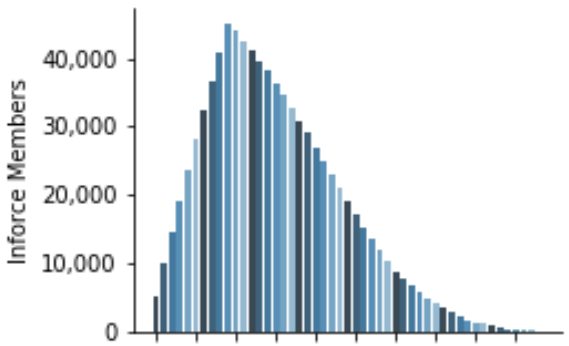
Algorithm / Pool Mechanism

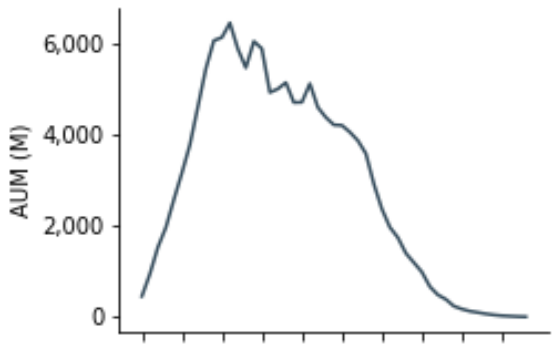
1/ Start period:
- New members
- New contributions

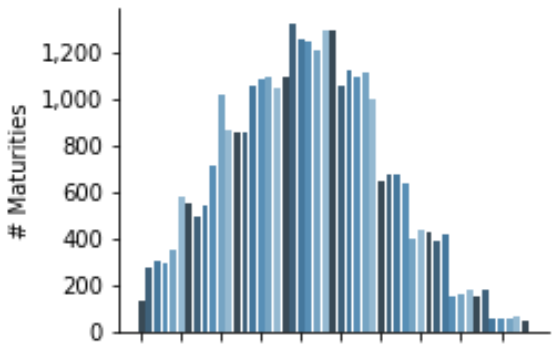
2/ "Mid" period:
- Financial Returns
- Allocation key

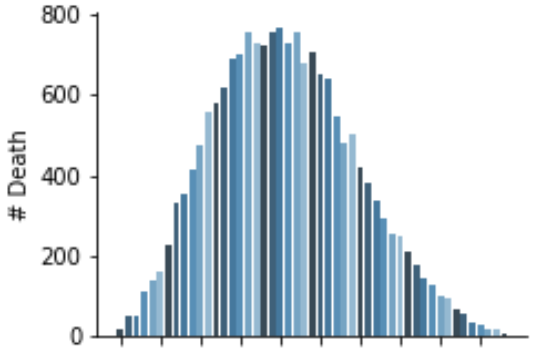
3/ End Period
- Mortality Proceeds
- Remove deceased members
- Allocate Mortality Proceeds
- Pay scheduled Outgoes

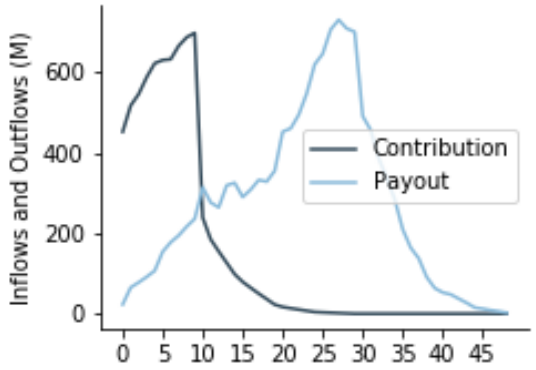
MODERN TONTINES: MODELISATION & ILLUSTRATION (1/5) – STANDARD PROJECTION – SINGLE SIM OVERVIEW

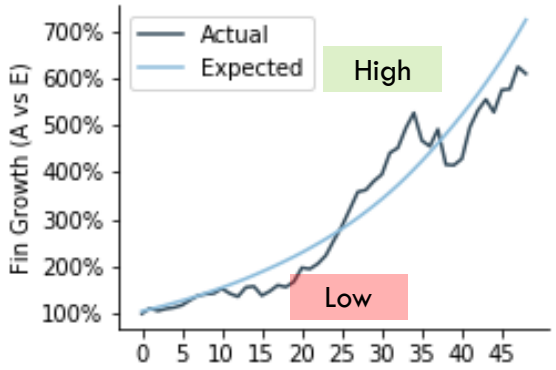


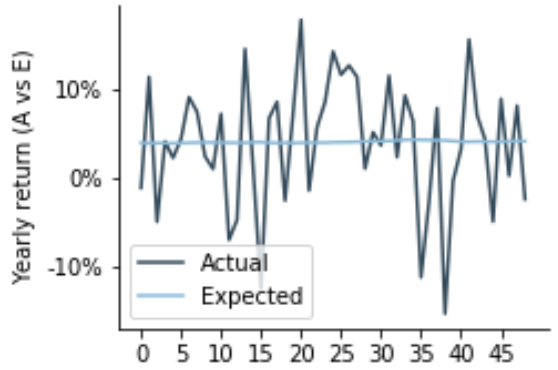


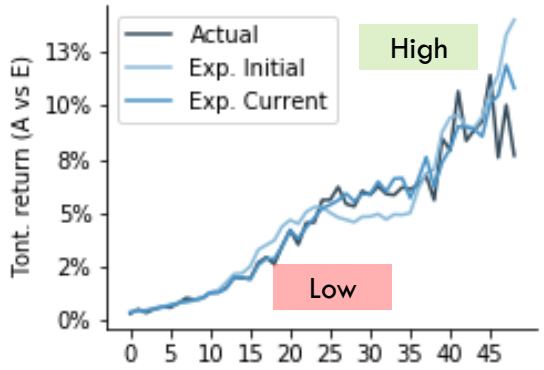












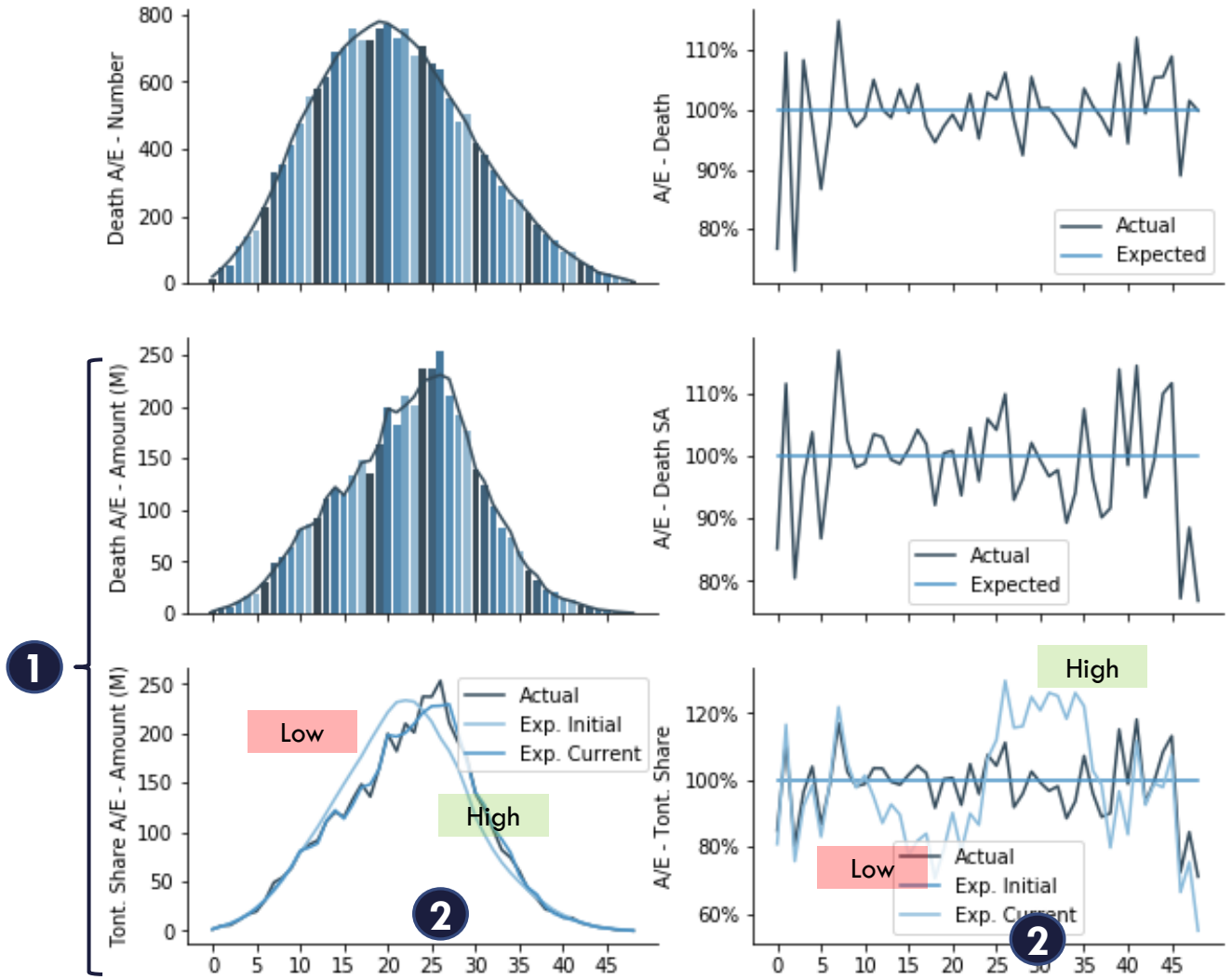
- As expected, Tontines Returns increase with population age – and deviates increasingly when fund size is low

- The Tontines Returns deviate from:
  - "current return" benchmark mostly due to mortality volatility
  - "at issue" benchmark, mostly due to fund return

Projection:

5000 simulations

MODERN TONTINES: MODELISATION & ILLUSTRATION (2/5) – STANDARD PROJECTION - SINGLE SIM OVERVIEW



1. As expected, The Tontines returns are closely linked to mortality

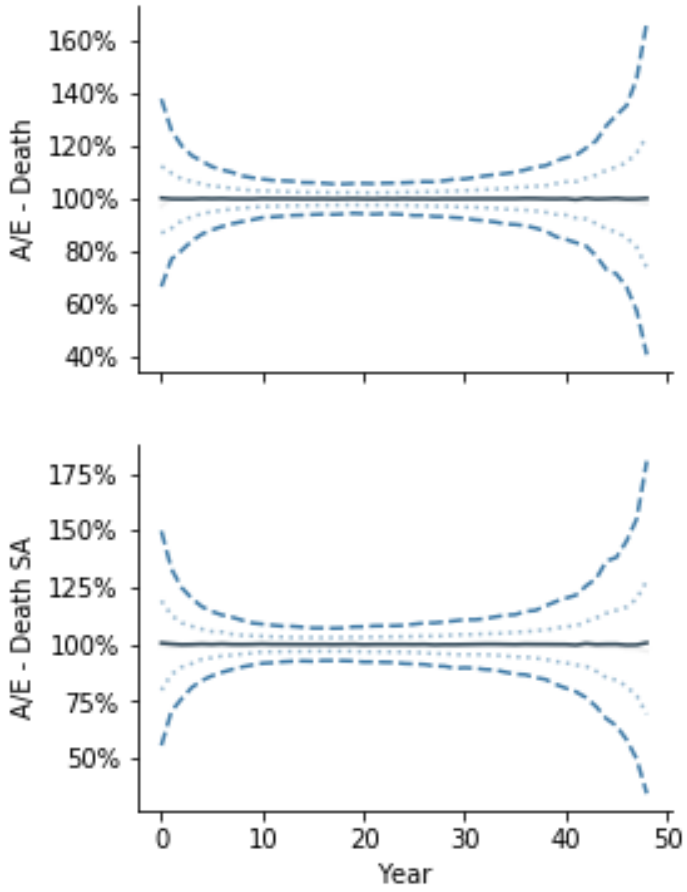
2. As mentioned in previous slide, the Tontine return – when compared with the expected return at issue - is impacted by the fund evolution and the overall financial returns

***Note**: Expected Tontine returns are compared with 2 benchmarks:*

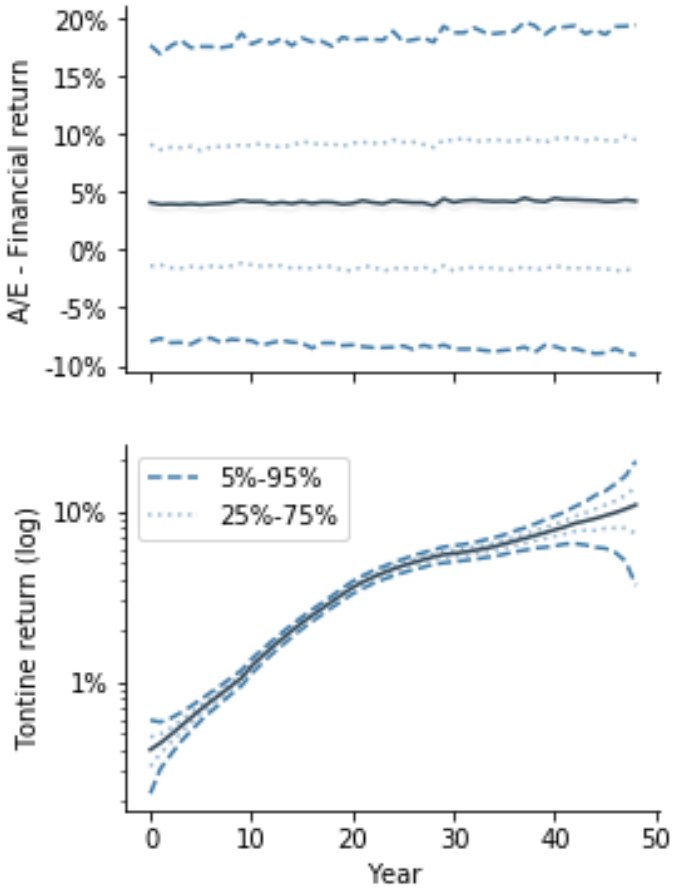
- *The "current" fund situation*
- *The "initial" view, ie the expected returns assuming a mean financial return and mortality*

MODERN TONTINES: MODELISATION & ILLUSTRATION (3/5) – STANDARD PROJECTION – MEAN & PERCENTILE

Mortality Distribution



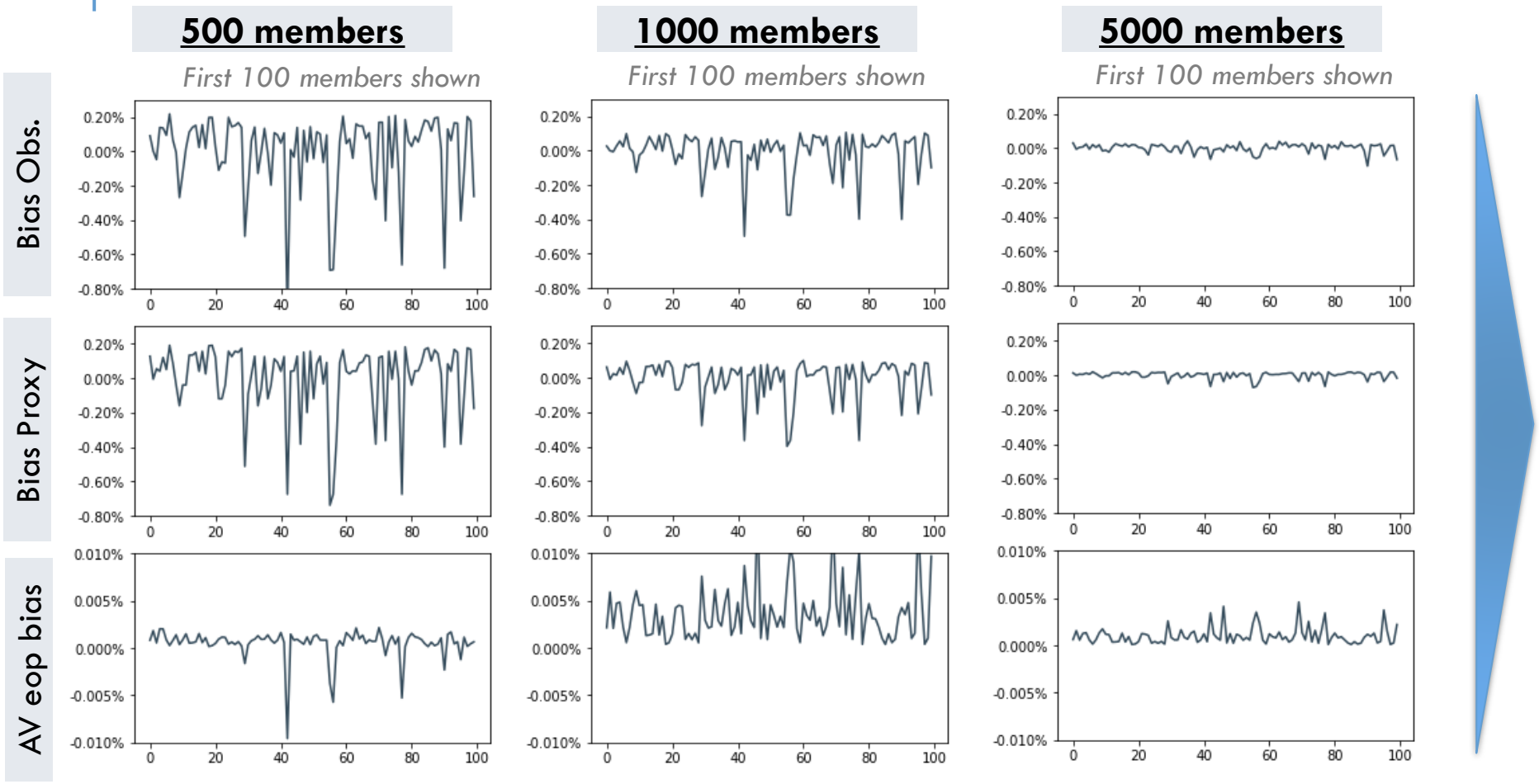
Returns



As expected, The Tontines returns are closely linked to mortality:

- Volatility of Tontine Returns increases at start and end of projection due to idiosyncratic mortality variation (smaller sample size)
- Tontine Returns increase with time – logically due to aging member population (run-off after first 10Y)
- Volatility of Tontine returns are fairly small thanks to the size of the fund, while Financial returns are expectedly much more volatile

MODERN TONTINES: MODELISATION & ILLUSTRATION (4/5) – ACTUARIAL FAIRNESS BIAS



- Impact of Fund Size is evident
- Bias Proxy approximation (based on IPA share) is satisfying in this case
- To control the bias - we can propose to ensure that the **individual Tontine Share** doesn't exceed a given threshold (0.5% - 1%) .

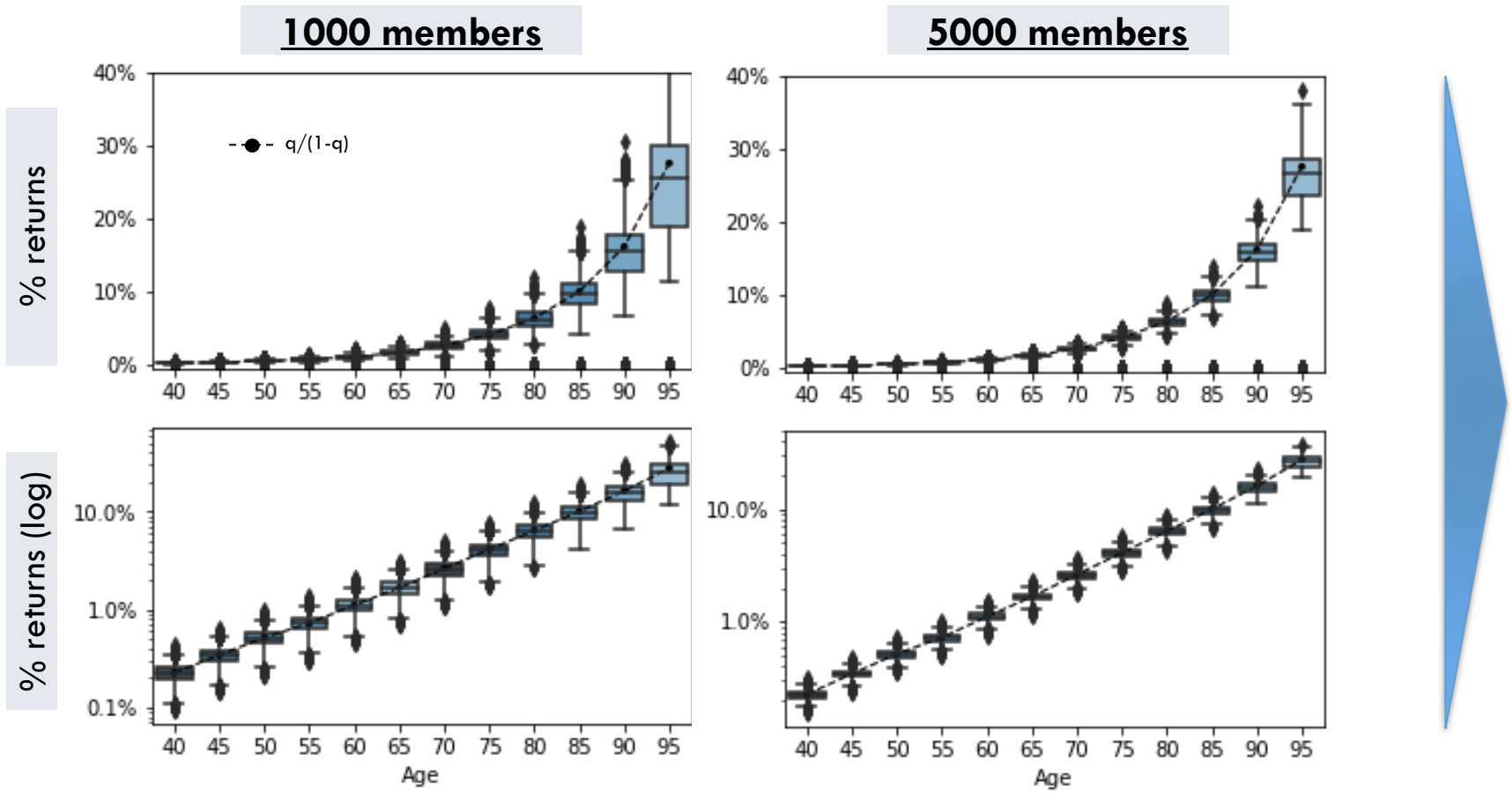
Actionable on:

- Entry Age / Gender
- Amount
- Maximum Age

***Projection**: One year single step analysis, 10,000 simulation, Financial Return forced to 0, Standard population demographic distribution.*

MODERN TONTINES: MODELISATION & ILLUSTRATION (5/5) – ADDITIONAL TONTINE RETURNS

Tontine Returns by Age compared with q/(1-q)



- Tontine Returns are consistent with q/(1-q) in the "average mortality" scenario
- Impact of Fund Size is evident on stability of Tontine Returns – both due to bias and idiosyncratic mortality risk => ***fund size and Tontine Share atomization matters***
- Additional returns material after 65 – low before 40 (not a surprise)
- From commercial perspective – the Annuity schedule intensity could be adjusted to smooth the exponential increase of returns

***Projection**: One year single step analysis, 10,000 simulation, Financial Return forced to 0, Standard population demographic distribution. Mortality: Taiwan TSO 2011 - Male*

PROS AND CONS OF MODERN TONTINES FROM POOL MEMBERS AND ADMINISTRATOR PERSPECTIVE

	Advantages	Limits & Attention Points
Pool Member	• Additional Gain thanks to Tontine Returns • Lower charges – no risk premium • Flexibility (payments, scheme and investment) • Transparency of mechanism • "P2P" community: no need for a carrier	• No Benefits upon death & no redemption possible • Volatility of returns (Longevity, Idiosyncratic Mortality, Market risk) • Complexity of mechanism to be exposed
Pool Administrator*	• No underfunding risk (Longevity, Market risk) • Synergies with Asset management activity	• Regulatory framework • Term dilemma & Adverse selection • Mortality table choice & selection factors • Survival checks

**Since no risk is retained by the "Modern Tontines" manager – "Administrator" seems more suited than "Insurer"*

LIMITS OF MODERN TONTINES & POSSIBLE MITIGATION

Technical

Limits	Mitigation
Allocation Bias	⇒ Limit individual Tontine Share at 1%: - Pool Size - Entry Age and Amount set accordingly
Idiosyncratic Mortality Risk	*Same as above*
Term Dilemma	⇒ Create pools by maturity (inefficient) Or ⇒ Introduce Selection Factors on new contribution ⇒ Set minimum term for lump sum and fixed term annuities
Adverse selection	⇒ Introduce Selection Factors on new contribution ⇒ Set minimum term for lump sum and fixed term annuities
Step length selection	⇒ Balance technical, operational and commercial consideration – most likely monthly / quarterly

Practical / Commercial

Limits	Mitigation
Regulatory Framework	⇒ Communicate on "Modern Tontines" ⇒ Raise Interest of reputable financial groups
No Benefit upon death	⇒ Propose a "with bequest" alternative with the same framework but without the Tontine returns
Complexity of Mechanism to be exposed	⇒ Communication is key ⇒ Regular Monthly Statements with transparent mechanism exposed
Mortality Table & Selection Factors	⇒ Experience analysis & update (should an update impact existing members ?)
Regular Survival Checks	⇒ Leverage Technology

THANK YOU ! MERCI ! 謝謝 !

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