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The Role of Tontines in Retirement Decumulation

Peter Hieber, **HEC Lausanne, Switzerland**,

8th International Pension Research Association (IPRA), Conference, Paris, 14.06.2023

Agenda

1. Motivation: Mutual (life/pension) insurance products = tontines

2. How to design **heterogeneous** mutual (**life/pension**) insurance
   a. Share common cash-flow
   b. Combine actuarially fair individual accounts

3. Extensions and interesting research questions

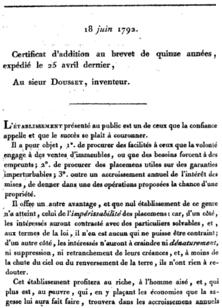
Past and future of tontines?!. . .

- **Mutual insurance** = Risks are shared within a pool.

  Tontines, pooled annuities, survivor funds, group self annuitization (used as synonyms).

- **Dominant insurance** several hundred years ago.

- **Similar popularity** soon**!?** (digitalization, risk regulation).



18 *juin* 1792.

Certificat d'addition au brevet de quinze années, expédié le 25 avril dernier,

Au sieur Dousset, inventeur.

L'établissement présenté au public est un de ceux que la confiance appelle et que le succès se plaît à couronner.

Il a pour objet, 1°. de procurer des facilités à ceux que la volonté engage à des ventes d'immeubles, ou que des besoins forcent à des emprunts; 2°. de procurer des placemens utiles sur des garanties imperturbables; 3°. outre un accroissement annuel de l'intérêt des mises, de donner dans une des opérations proposées la chance d'une propriété.

Il offre un autre avantage, et que nul établissement de ce genre n'a atteint, celui de l'*impérissabilité* des placemens: car, d'un côté, les intéressés auront contracté avec des particuliers solvables, et, aux termes de la loi, il n'en est aucun qui ne puisse être contraint; d'un autre côté, les intéressés n'auront à craindre ni *dénaturement*, ni suppression, ni retranchement de leurs créances, et, à moins de la chute du ciel ou du renversement de la terre, ils n'ont rien à redouter.

Cet établissement profitera au riche, à l'homme aisé, et, qui plus est, au pauvre, qui, en y plaçant les économies que la sagesse lui aura fait faire, trouvera dans les accroissemens annuels

- Li, Y., & Rothschild, C. (2020). Selection and redistribution in the Irish tontines of 1773, 1775, and 1777. **Journal of Risk and Insurance**, 87(3), 719-750.

- Milevsky, M. A. (2015). King William's tontine: Why the retirement annuity of the future should resemble its past. Cambridge University Press.

. . . they start a revival today:

The New York Times

When Others Die, Tontine Investors Win

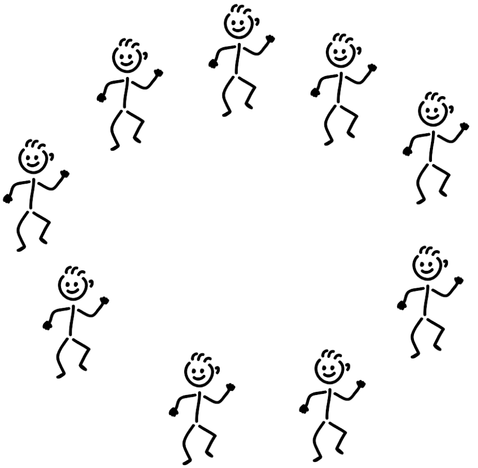
By Tom Verde

March 24, 2017

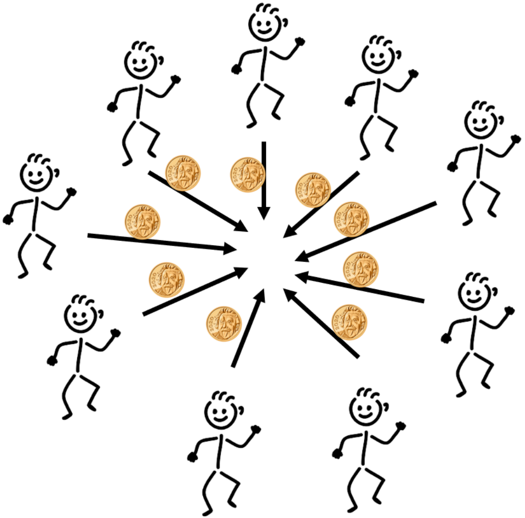
Living a long life is its own reward. But when you invest in a tontine, there's an added benefit: You collect money that would have gone to people who have died.

That is part of the macabre appeal of the tontine, a 350-year-old investment vehicle that fell into disfavor more than a century ago but is now getting fresh consideration as a way to help people receive steady income in retirement.

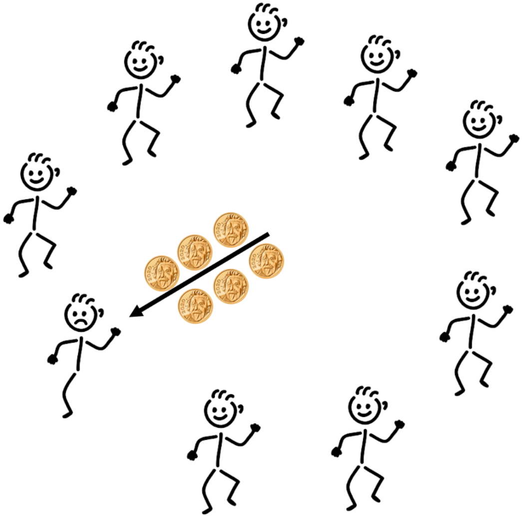
Mutual insurance: Premium payments



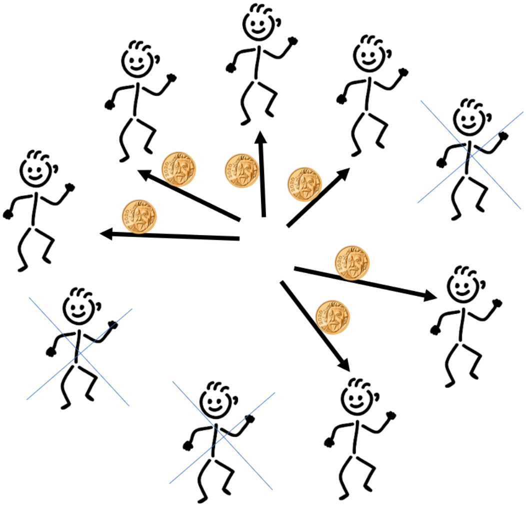
Mutual insurance: Premium payments



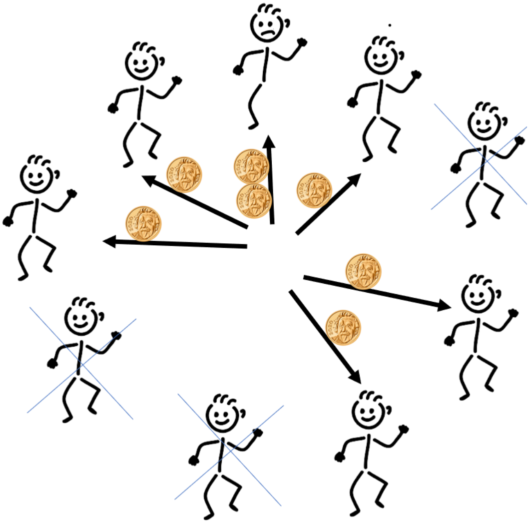
Mutual insurance: Disability benefit



Mutual insurance: Modern tontine



Mutual insurance: Modern Life-Care tontine



Trends in life and pension products

World-wide trend for **life and pension products**:

- Transparent.
- Cost-efficient.
- Defined-contribution **(mutual insurance instead of guarantees)**.
- Participate in capital markets (stock investments).

See also **pan-European Personal Pension Product** (**PEPP**) (EU) 2019/1238.

Examples follow on next slides.

Many initiatives to move to tontine-like products

- **Superannuation** fund: Australian retirement trust (formerly QSuper).
- **Variable payment life annuities** (VPLAs) in Canada.
- **CPF LIFE Scheme** in Singapore.
- **Le Conservateur** in France.
- **Tontine Trust** in Ireland.
- . . .

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Designing **heterogeneous** mutual insurance schemes

We want to:

- Design single-premium mutual insurance schemes that pay **1 for life**.
- Pool members are **heterogeneous** (by age, health).
- This is a **multi-period scheme**.
- (For now), we **ignore financial risk** and consider **mortality risk of individuals** as **independent**.

Designing **heterogeneous** mutual insurance schemes

There are three (similar but different) approaches:

(a) **Share common cash-flow in a survivor pool**
special case: "**natural tontine**" (Milevsky, Salisbury [2015])

(b) **Combine actuarially fair individual tontine accounts** (see, e.g., Sabin, Fullmer [2010, 2018], Donnelly, Guillén, Nielsen [2013, 2014], Denuit [2019], Hieber, Lucas [2022], Denuit, Hieber, Robert [2022] and many more).

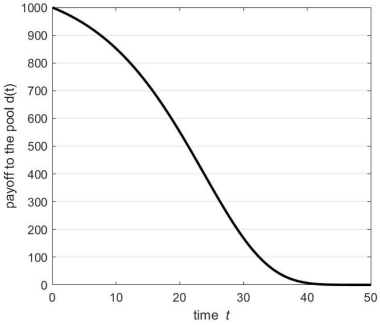
(c) **Adjust realized vs. projected mortality**
(see, e.g. Piggott, Valdez, Detzel [2005], Qiao, Sherris [2013]).

(a) Share common cash-flow

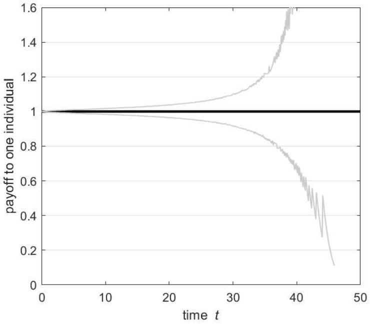
Introduce “**natural tontine**”: homogeneous pool of n receives ($n = 1\,000$, $x = 65$)

$$d(t) = n \cdot {}_tp_x \,. \qquad \text{(\textbf{pool} payoff)}$$

pool



individual

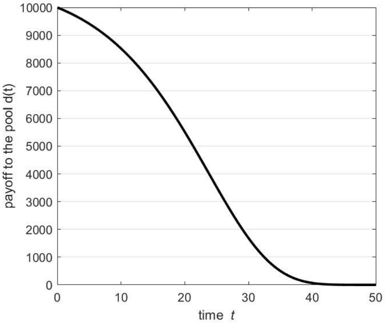


(a) Share common cash-flow

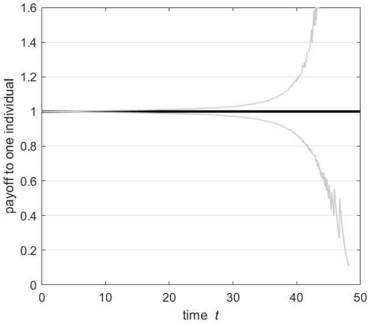
Introduce "**natural tontine**": homogeneous pool of n receives ($n = 10\,000$, $x = 65$)

$$d(t) = n \cdot {}_t p_x \, . \qquad \text{(\textbf{pool} payoff)}$$

pool



individual



(a) Share common cash-flow

- Payoff $d(t)$ is a purely financial payoff, no mortality risk!
- Payoff to individual is risky.
- Extension to heterogeneous pools (for example by age) is possible (Milevsky, Salisbury [2016]).
- This is a closed-pool: Decreasing pool-size leads to high volatility for high ages. ($\Longrightarrow$ **ton**(tine-ann)**uity**.)

*Chen, A., Hieber, P., Klein, J. K. (2019). Tonuity: A novel individual-oriented retirement plan. **ASTIN Bulletin**, 49(1), 5-30.*

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(b) Combine actuarially fair individual accounts

- Pool members $\mathcal{L}_0 = \{1, 2, ..., n\}$. Time in periods $t = 0, 1, 2, \ldots$.
- The financial market is deterministic at an annual return δ_t.
- Individual $j \in \mathcal{L}_0$ contributes single premium $c_j(0)$ at time 0.
- Each year $t = 1, 2, \ldots$, individual withdraws $s_j(t)$ from its individual account $c_j(t)$:

$$\boxed{c_j(t) = e^{\int_{t-1}^{t} \delta_s \mathrm{d}s} c_j(t-1) - s_j(t)}.$$

- The account is lost upon death.

(b) Combine actuarially fair individual accounts

We sum over the accounts of deceased in $(t-1, t]$ (**mortality credits**):

$$X(t) = \sum_{j \in \mathcal{D}_t} e^{\int_{t-1}^{t} \delta_s \mathrm{d}s} c_j(t-1)\,.$$

A survivor $j \in \mathcal{L}_t$ receives in t: $\boxed{W_j(t) = s_j(t) + \beta_j\big(X(t)\big)}$, where:

- $s_j(t)$: individual, fixed withdrawal amount,
- $\beta_j\big(X(t)\big)$: collective part of the benefits, i.e. the mortality credits.

(b) Combine actuarially fair individual accounts

Key assumptions on the sharing rule β_j:

- **Self-sufficiency property**: $\sum_{j\in\mathcal{L}_{t-1}} \beta_j\big(X(t)\big) = X(t)\,.$
- **Actuarial fairness property**:

$$\mathbb{E}_{t-1}\left[\beta_j\big(X(t)\big)\right] = \underbrace{q_{x_j+t-1}}_{\text{probability to die in } (t-1,\,t]} \cdot \underbrace{e^{\int_{t-1}^{t}\delta_s \mathrm{d}s} c_j(t-1)}_{\text{amount at risk at time } t}\,. \qquad (1)$$

*Denuit, M. (2020). Investing in your own and peers' risks: The simple analytics of P2P insurance. **European Actuarial Journal**, 10(2), 335-359.*

*Hieber, P., & Lucas, N. (2022). Modern life-care tontines. **ASTIN Bulletin**, 52(2), 563.*

Example: Sharing rule

Share linearly according to (1) **death probability** and (2) **amount invested**.

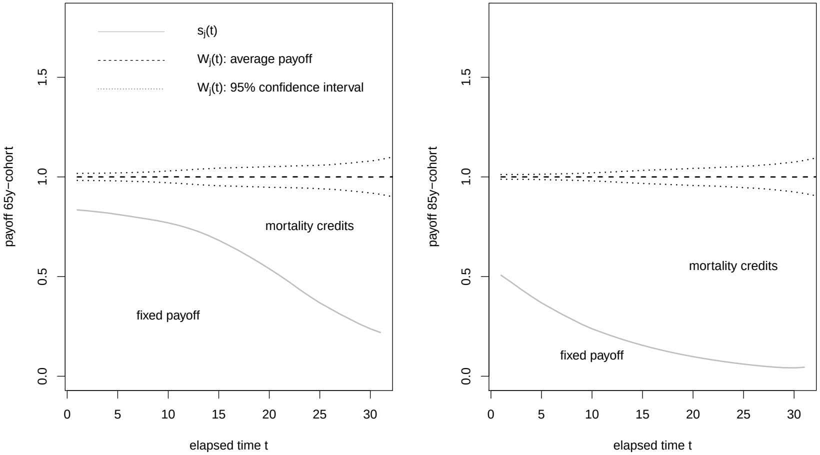
Example (Linear risk sharing rule)

At time t, each individual $j \in \mathcal{L}_{t-1}$ receives the mortality credit:

$$\beta_j(X(t)) = \frac{q_{x_j+t-1} \cdot c_j(t-1)}{\sum_{j \in \mathcal{L}_{t-1}} q_{x_j+t-1} \cdot c_j(t-1)} \cdot X(t)\,. \tag{2}$$

(see, e.g., Donnelly, Guillén, Nielsen [2013, 2014], Schumacher [2018])

Numerical example, two groups/cohorts



Actuarial fairness: Insurer's view

For each $t = 0, 1, \ldots$, the premium equivalence holds: (pool view)

$$\underbrace{\sum_{j=1}^{n} c_j(t)}_{\text{total account values}} = \sum_{j=1}^{n} \underbrace{\sum_{s=t+1}^{\omega - x_j} e^{-\int_t^s \delta_u \mathrm{d}u} W_j(s)}_{\text{discounted future benefits individual } j} . \qquad (3)$$

- Right hand side: **random** (big letter!)
- Left hand side: **deterministic.** (this determines mutual insurance!)

Actuarial fairness: Individual's view

For each $t = 0, 1, \ldots$, the contract is fully-funded: (individual view)

$$\underbrace{c_j(t)}_{\text{retrospective reserve}} = \underbrace{\mathbb{E}_t\left[\sum_{s=t+1}^{\omega - x_j} e^{-\int_t^s \delta_u \mathrm{d}u} W_j(s)\right]}_{\text{prospective reserve}}. \quad (4)$$

Expected present value of future benefits equals the current account value.

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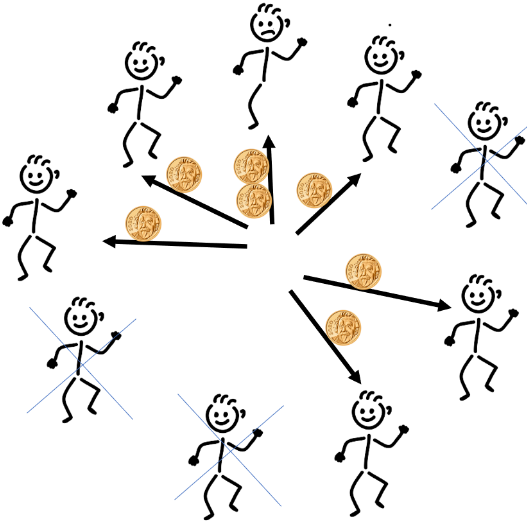
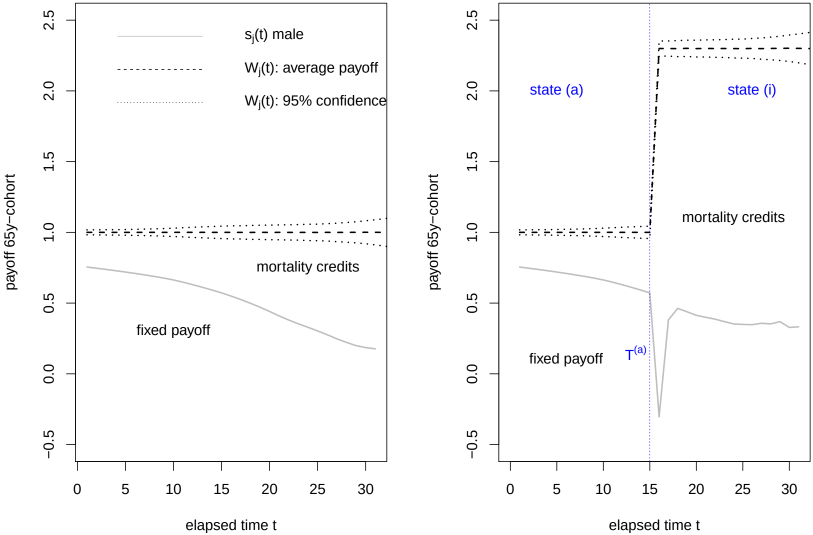
Modern Life-Care tontine

- An ageing population faces **longevity risk**, **demographic risk** but also **morbidity risks** (long-term care).
- **Idea**: Offer a combined product with higher payments in dependency.
- **Why?**:
  - Mortality and morbidity risks are *negatively correlated*.
  - Cost reduction due to **reduced adverse selection**!
- **How?**: Mortality rates account for dependency
  $\Longrightarrow$ Higher mortality credits for dependent people.

Hieber, P., & Lucas, N. (2022). Modern life-care tontines. ***ASTIN Bulletin****, 52(2), 563.*

Modern Life-Care tontine





s_j(t) male
W_j(t): average payoff
W_j(t): 95% confidence
mortality credits
fixed payoff
payoff 65y−cohort
elapsed time t
state (a)
state (i)
mortality credits
fixed payoff
T(a)
payoff 65y−cohort
elapsed time t

Some comments:

- There is need to extend this also to financial risk (random return δ_t). (see Donnelly, Guillén, Nielsen [2014]).
- Actuarial fairness at all times allows people to join later.
- Mortality tables are used to fairly assign mortality credits. If there is agreement, the tables can be updated over time.
- It is possible to design a tontine with premium refund option. This simply reduces risk sharing. *(important element of QSuper Australian pension fund)*

Thank you!

(b) individual accounts, (a) shared cash-flow

(b) Hieber, P., Lucas, N. (2022). Modern life-care tontines. **ASTIN Bulletin**, 52(2), 563.

(b) Denuit, M., Hieber, P., and Robert, C. Y. (2022). Mortality credits within large survivor funds. **ASTIN Bulletin**, 52(3), 813-834.

(b) Denuit, M. (2019). Size-biased transform and conditional mean risk sharing, with application to P2P insurance and tontines. **ASTIN Bulletin**, 49(3), 591-617.

(b) Donnelly, C., Guillén, M., and Nielsen, J. P. (2014). Bringing cost transparency to the life annuity market. **Insurance: Mathematics and Economics**, 56, 14-27.

(a) Milevsky, M. A., and Salisbury, T. S. (2016). Equitable retirement income tontines: Mixing cohorts without discriminating. **ASTIN Bulletin**, 46(3), 571-604.

(a) Chen, A., Hieber, P., and Klein, J. K. (2019). Tonuity: A novel individual-oriented retirement plan. **ASTIN Bulletin**, 49(1), 5-30.

(a) Chen, A., Hieber, P., & Rach, M. (2021). Optimal retirement products under subjective mortality beliefs. **Insurance: Mathematics and Economics**, 101.

Questions? Comments?

?

Modern Life-Care Tontine

Using real mortality/disability (France), we compute the quotient

$$\alpha(T^{(a)}) = \frac{\ddot{a}_x^{\text{active}}}{\ddot{a}_x^{\text{disabled}}},$$

as a function of the time until disability $T^{(a)}$: