Retirement Tontines:

Using a Classical Finance Mechanism as an Alternative Source of Retirement Income

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ABSTRACT

We explore how a classical finance mechanism—the tontine—could help retirees manage their assets. Tontines are investment pools where members commit funds irrevocably and where the interests of members who die are given to those who survive. Tontines were popular in the U.S. in the late 19th and early 20th centuries, until they were effectively prohibited in response to insurance company mismanagement. Tontine-inspired products are receiving renewed attention around the world as efficient, transparent ways to finance retirement. Unlike fixed income annuities, tontine pooling does not guarantee future payments, but should pay more on average per dollar invested, with less costly regulation.

"Considered as a financial innovation, it [the tontine] was very successful. Considered as insurance, it was actuarially sound. Considered as a gamble, it was a 'fair bet' … Considered as a life-cycle asset, it proved to be an excellent investment."

— Ransom and Sutch (1987).

I. Introduction

Households face two related but distinct financial challenges as they prepare for retirement: first accumulating enough retirement savings during their working years, and then spending down their assets wisely after retiring. A substantial literature reaching a wide range of conclusions examines the extent to which households are saving adequately for retirement.[1]

But there is more consensus about the challenges households face when deciding how best to spend down their savings. People do not know how long they or their spouse will live (not to mention what their health care costs and investment returns will look like), which makes them prone either to consuming too much too soon, leaving them with insufficient resources as they age, or consuming too little and thus having a lower standard-of-living in retirement than they could have afforded.[2]

Managing assets in retirement has become a more widespread problem over time as lifespans have increased and as more retirees depend on defined contribution (DC) retirement savings rather than defined benefit (DB) pensions. DB plans pay benefits at regular intervals, typically monthly, for a retiree's lifetime. This pension annuity ensures that beneficiaries will not

[1] Engen, Gale, and Uccello (1999); Scholz, Seshadri, and Khitatrakun (2006); Munnell, Hou, and Sanzenbacher (2018); Biggs (2020); and Bipartisan Policy Center (2016).

[2] Of course, people may want to provide bequests to others. Even so, given a level of desired bequests, people face the same problem of ensuring they do not consume their resources too quickly or too slowly.

run out of income as they age.[3] DC plans rarely provide annuities.

Despite these trends, take-up of private annuities remains low.[4] Other financial products, such as managed payout funds, have certain advantages but are not yet available in most retirement plans.[5] These circumstances leave many households without satisfactory ways to convert their retirement savings into income.

In this paper, we explore the potential for a different financial product—a tontine—to help people manage their assets in retirement. Tontines are investment pools where members commit funds irrevocably and where the resources and income claims of members who die are given to members who survive. Tontines can be adapted to a wide variety of financial structures. They have financed everything from European wars to colonial-era capital projects to Americans' retirement. They were quite popular in the United States in the late 1800s and early 1900s until they were effectively (though not literally) outlawed in response to corrupt insurance company management.[6]

The "tontine principle"—that surviving group members benefit financially from the death of other members—can evoke strong reactions, and has inspired murder plots in novels, movies, and even a *Simpsons* episode.[7] But the mechanisms involved are not very different from how group annuities operate, and members of modern tontines would be mutually anonymous in any case.

[3] However, commercial annuities are rarely indexed for inflation, so the inflation-adjusted income flow from most annuities declines over time.

[4] Iwry et al. (2019).

[5] John et al. (2019).

[6] For an overview, history, and analysis of tontines, see Milevsky (2015).

[7] See "Raging Abe Simpson and His Grumbling Grandson in 'The Curse of the Flying Hellfish.'"

In recent years, analysts have revisited tontines as a theoretical tool, and several countries have created pension plans that incorporate tontine principles. Some current retirement products in the United States have a tontine-style structure as well.

Our central premise is that tontine-style products could play a significantly broader role in financing the retirement of U.S. households, assuming that certain operational questions can be resolved. Such products could provide higher returns than annuities do, but with less security. They would be valuable to those seeking some insurance against their own longevity without requiring a certain level of future income.

Section II briefly reviews existing products for managing retirement income. Sections III and IV discuss theoretical and practical considerations regarding tontines as a way to finance retirement income. Section V compares tontines to annuities and managed payout funds. Section VI concludes.

II. Current Options for Managing Income in Retirement

Several financial products—chiefly annuities and managed payout funds—can help people manage the assets they have accumulated for retirement. These products differ in how they address longevity risk and investment risk.

Annuities eliminate longevity risk by paying the annuitant guaranteed income for life. Immediate annuities begin payments soon after they are purchased, while deferred annuities begin payments later, generally at a pre-determined age. Annuities address investment risk in various ways: some provide a constant nominal payout, some increase the payment regularly over time as a rough hedge against inflation, and others make variable payments based on the

returns of the assets underlying the annuity.[8]

In addition to commercial annuities, which are provided by insurance companies, DB plans also pay retirement income in the form of annuities. DC plans—including 401(k)s—do not independently promise their participants income for life, although a small percentage of DC plans provide a lifetime income option by purchasing commercial annuities for participants.[9]

Although annuities provide a way to resolve the competing risks of consuming too little or too much, the private annuity market is small. Only 1% of people who reach retirement age choose to annuitize any portion of their private wealth, and only 2% of retirement assets are held in lifetime annuities.[10]

The managed payout fund, or retirement income fund, is an alternative way to manage investment and longevity risk in retirement.[11] These funds, which have recently emerged in the United States and other countries, are diversified, professionally-managed investment pools designed to provide relatively consistent retirement income. They *manage* but do not eliminate longevity risk and investment risk; thus, unlike annuities, managed payout funds do not guarantee continued payments for life, and they target, but do not guarantee, a specific annual income level. Largely because they lack these guarantees, they are not subject to the capital reserve and other insurance regulatory requirements and costs that apply to annuities. To further address longevity risk, people could combine managed payout funds with a longevity annuity,

[8] Except where the context indicates otherwise, the term "annuity", as used in this paper, refers to "income" annuities, as opposed to most "variable annuities," which are actually used to confer tax-favored treatment on otherwise taxable equity investments while seldom providing a stream of income.

[9] Iwry et al. (2019); Iwry and Turner (2009).

[10] Benartzi and Shu (2019). Iwry et al. (2019) discuss the "annuity puzzle"—why so few people purchase annuities even when it seems that doing so would benefit them.

[11] John et al. (2019)

which provides income continuing for life, starting at age 80 or 85.[12]

Besides annuities and managed payout funds, retirees can follow various "do it yourself" withdrawal strategies. For example, an investor might use simple rules of thumb (the "4% rule") or follow the required minimum distribution rules that apply to IRA and DC balances even though the rules were not created to optimize retirement consumption choices. These approaches provide no protection against either market risk or longevity risk. A different strategy is to hold a series of high-quality bonds maturing at times that match the retiree's cash flow needs. This can eliminate market risk but not the risk of outliving one's assets. In addition, holders of an all-bond portfolio would have sacrificed significant rates of return over time relative to holding equities.[13]

All these products and strategies can play useful roles, but none of them provides a complete solution to households' needs for asset management in retirement. As a result, some recent attention has turned to another alternative: the tontine.

III. Tontines: Theoretical Considerations

A. Some simple examples

The basic idea behind a tontine is that a group of people pool their investments and when members of the group die, their share of the pool and its earnings are divided among surviving members. Investing in a tontine, therefore, differs from purchasing an ordinary asset in two ways. While an investor can buy or sell an ordinary asset at any time, the tontine investment is irrevocable. If contributions to the tontine could be revoked, members could withdraw their

[12]The Treasury Department and IRS permit such deeply deferred annuities to be provided in qualified plans and IRAs, where they are known as "qualified longevity annuity contracts" (QLACs). See Treasury (2014); U.S. Department of the Treasury, "Treasury Issues Final Rules Regarding Longevity Annuities," (July 1, 2014) at https://www.treasury.gov/press-center/press-releases/Pages/jl2448.aspx. See also John et al. (2019); Horneff, Maurer, and Mitchell (2019); Horneff, Maurer, and Mitchell (2018); and Munnell, Wettstein, and Hou (2019).

[13] See "Historical Returns on Stocks, Bonds, and Bills" (2019). Other options for retirement income are in development phase, including reverse mortgages (Baily, Harris, and Wang 2019) and the "selfie" bond (Merton and Muralidhar 2020).

funds if they received bad news about their life span, such as an unexpectedly grim medical diagnosis. Second, while ordinary assets can be bequeathed to heirs, the investment in a tontine, upon the investor's death, does not pass to the investor's heirs or estate but instead is allocated to surviving members of the investment pool.

The simple tontine principle can manifest itself in various ways. Consider a stylized example. Suppose each of 10 people who are identical for mortality purposes (e.g., same age, race, sex, etc.) irrevocably invests $100,000 to create a $1 million investment pool. The pool buys a bond that pays 4% interest a year. But in this simplest and most extreme form of tontine, no current payouts are made. The interest is reinvested every year. As each participant dies, they forfeit their interests and get nothing. Once there remain only, say, 3 survivors in the pool, they could divide up the entire balance of the investment, including all accrued interest and the principal, and the arrangement would terminate.

Now suppose that instead of reinvesting the 4% bond interest each year, the pool pays it out as an annual dividend.[14] The aggregate annual interest of $40,000 is divided equally among the members of the pool. Each member's annual $4,000 dividend ($40,000/10 = $4,000) could be called their "base return." No principal is paid out until the arrangement terminates.

As shown in Figure 1A, each member's annual $4,000 income continues until one of them dies. Then the deceased member's annual $4,000 base return is divided equally among the 9 surviving members, so that each receives an additional $444 ($4,000/9) per year as a "mortality credit" in addition to their regular $4,000 base return. Thus, for example, after 4 members have died (forfeiting a total of $16,000 annually), each of the remaining 6 would receive annual mortality credit payouts of $2,667 (= $16,000/6) in addition to their $4,000 base return.

[14] In these examples, we assume that there are no administrative costs or fees.

Over time, the aggregate annual interest payment of $40,000 stays the same but is divided among fewer and fewer survivors. As the number of survivors shrinks, each survivor's annual payout grows. When the group reaches a specified terminal condition, such as only 3 survivors remaining, the bond is sold, the revenue from the sale is divided equally among surviving members, and the arrangement terminates.

Although each member receives income for life, like an annuity, this structure would be unsuitable as a retirement income tool because the return to survivors as they age rises sharply as more pool members die. In contrast, most theory and evidence suggest that people prefer age-consumption profiles that are constant or decline in retirement.[15]

B. Flattening the Curve – The Level-Payout Tontine

To address these retirement income needs, Piggott, Valdez, and Detzel (2005), Sabin (2010), Milevsky and Salisbury (2015), and others have proposed a tontine in which the total return to survivors stays constant over time, which they call a "natural tontine," and which we refer to as a "constant-payout" or "level-payout" tontine.

Their approach is simple and elegant: Invest the tontine in zero-coupon government bonds with maturities and returns that generate cash flows to the pool that decline over time at a rate that matches the expected mortality in the group. The base return will therefore *decline* over time at a rate expected to offset the *increasing* level of mortality credits. As a result, the expected total income each member receives—base returns plus mortality credits—remains approximately constant over time, approximating the constant expected payout of a fixed-income life annuity.

[15] Evidence suggests that consumption tends to decline as retired households age, until a sharp increase in medical expenses that might occur at the very end of life. See Butrica, Goldwyn, and Johnson (2005) and Banerjee (2014). In models with stochastic lifespan, the optimal rate of increase in consumption is given by $r - \partial - m$, where r is the rate of return, ∂ is the rate that individuals discount the future, and m is the current period mortality risk. As people age, m rises, so that optimal consumption growth slows and may go negative. See Hurd (1987).

Forman and Sabin (2015) propose a similar level-payout "tontine annuity" but, instead of offsetting the increasing level of mortality credits by structuring declining investment returns over time, they would offset those increases by having the investment pool annually repay members a declining portion of their initial contributions.

Figure 1B depicts payouts for a level-payout tontine. The decline in the base return over time offsets the rise in the mortality credit over time, and the fund dissolves at the same terminal condition, 3 survivors, as the example above.[16] This level-payout tontine offers the same expected lifetime payout as the tontine with a constant base return described above, but better matches most retirees' needs and preferences by paying retirees more total income in early years and less in later years than the tontine with a constant base return.

In practice, of course, the pace at which tontine members actually die is uncertain and will vary from expectations, so if the declining base return schedule is set in advance, based on ex ante expected mortality probabilities of the pool, the actual total return payout from the level-payout tontine will vary over time. Figure 2 shows this variation in actual total return payouts that would occur in a pool of 1,000 65-year old men who joined a tontine in 2017 where the rate of decline of the base return is set in advance, based on expected aggregate mortality probabilities.[17]

To generate Figure 2, we ran 1,000 stochastic scenarios for how actual mortality and investment returns would evolve over time, using published mortality data and historical asset performance.[18] The figure reports the median, 10th percentile and 90th percentile outcomes for the

[16] Milevsky and Salisbury (2015) do not specify the terminal condition for their level-payout tontine.

[17] Note that the x-axis in Figure 2 shows time, whereas in Figures 1A and 1B, the x-axis represents number of deaths.

[18] See the Appendix for details.

evolution of total return payouts over time. As can be seen, there is little variation, even given stochastic mortality and investment return risk. For example, at age 85, the total payout under the 10th percentile and 90th percentile scenarios are 5.00 percent and 5.48 percent, respectively. At age 100, when only about 7 percent of the original pool would still be alive, the 10th percentile outcome is 4.56 percent, and the 90th percentile outcome is 6.08 percent. Thus, even over long periods of time, setting the declining base return pattern based on ex ante mortality data should not cause major variations in total payouts for a tontine where a large pool of participants are all of the same age and gender.

When the remaining pool of survivors exceeds 100 years of age, there is more variability in outcomes (not shown), because the sample size is so small that relatively small shocks to mortality translate into relatively large changes in sample size and hence mortality credits. We interpret this as suggesting that when the surviving pool members reach age 100, the pool should be terminated, and the proceeds distributed to survivors.

In Figure 2, the rate of the decline in the base return is pre-set for the full multi-year period, based on the pool's *expected* aggregate mortality probabilities. Instead, the base return could be adjusted annually based on the *actual* previous mortality experience. For example, if the tontine began operating in year 0, the rate of decline in the base return between year t - 1 and year t could be based on the observed mortality experience between year 0 and year t -1.[19]

[19] For instance, assume that the initial investment return for a tontine consisting of 100 people was set at 4% to keep total annual return at about 4%. If, according to actuarial tables, 10% of the pool is expected to die in the first year, then if the annual base return is set in advance, it would have been set at 3.6% for the first year, 10% lower than the initial base return. But if the base return is determined and adjusted annually based on actual (rather than expected) mortality, and if only 5% of the pool dies in the first year, the base return for the first year would actually be adjusted to be 3.8%, 5% lower than the initial base return. This leaves the total return of 4% unchanged. In contrast, if the base return for each year is pre-set and not adjusted for actual mortality, and if only 5% of members die the first year, then the total return to survivors would be only 3.79% (4% * (90%/95%).

Figure 3 shows a tontine pool with characteristics and assumptions identical to those in Figure 2, except that the rate of decline in the base return is adjusted annually to reflect actual mortality experience to date. These annual adjustments virtually eliminate the variance in total returns over time.[20] For the entire duration of the pool, survivors earn a constant nominal total return of 5.23% per year, regardless of whether mortality outperforms or underperforms expectations, and even allowing for variation in the return on underlying assets. Because annual adjustments of base return income offset the variance in mortality credits, total return mirrors the constant total return of the theoretical level-payout tontine in Figure 1B. Thus, a tontine with a declining base return adjusted annually to reflect realized mortality could produce stable retirement income much like an annuity.

C. Pooling Heterogeneous Participants

In the examples above, each tontine member is assumed to be identical in terms of mortality risk—the same age, sex, race, etc. In those circumstances, mortality credits would be actuarially fair if they were divided equally for each dollar invested. But suppose the members face different mortality risks, for example because they differ by age, sex, and race. In that case, allocating mortality credits equally per dollar invested would favor those with low mortality risk and disfavor those who face high mortality risk. As a result, how mortality credits are allocated to the survivors is central to whether heterogenous individuals would want to sign up for a tontine in the first place.

A tontine covering a heterogeneous group of participants can be designed so that the

[20] In theory, substantial shocks to the underlying portfolio could result in the insolvency of the tontine, leading to periodic total return income for survivors that rapidly declines to zero. But many of the simulations run experienced periods of negative investment returns and the tontine remained solvent, leaving survivors' income constant. In practice, in most circumstances a tontine experiencing investment losses would be able to avoid exhausting its assets and continue paying income by reducing, to the extent necessary, the amount of income it pays out.

terms of the gamble are a fair bet and avoid favoring one participant over another. Milevsky and Salisbury (2016) show how retirement income tontines can combine heterogeneous cohorts in a single pool in an equitable manner. For example, a tontine-type pool can consist of shares that have equal rights to income but that are sold to investors or participants in the pool at different prices designed to adjust for the different life expectancies associated with different ages.

Sabin (2010) and Forman and Sabin (2015) show that in a "fair tontine," for each participant alive at the start of each period, the expected gains of being in the pool should equal the expected losses. Satisfying this "fair tontine" constraint determines the appropriate allocation of mortality credits and allows people with differing life expectancies and initial balances to participate on an equalized or equitable basis.

For example, let $p_i(t)$ be the probability that participant *i* dies in period *t*, so 1-p(t) is the probability that participant *i* survives period *t*. Let $B_i(t)$ be the balance in participant *i*'s tontine account at the beginning of period t and let $C_i(t)$ be the mortality credit participant *i* can expect if they survive the period. Therefore, for participant *i* during period *t* (dropping the subscripts*),* the expected value of the gross loss is $p * B$, the probability of dying during the period times the loss upon death, and the expected value of the gross gain is (1-p)*C, the probability of surviving the period times the mortality credit to be gained if they survive. Thus, for any given period, a "fair tontine" requires that $p*B = (1-p)*C$, implying that, in each period, a survivor's *expected* mortality credit, C, is equal to (p*B)/(1-p).

Two aspects of a fair tontine are worth emphasizing. First, the expected mortality credit depends *only* on the participant's probability of surviving and initial balance. Should they survive the period, those members with higher ex ante probabilities of dying would expect to receive higher credits, as would those with higher initial balances. This makes sense, as they are

risking more by participating in the pool in the first place. As a result, in general, surviving members of different ages do not receive equal mortality credits.[21]

Second, both p and B are likely to be readily observable: a simplified version of p could be derived from mortality tables (based on age and gender), and B could be tracked in tontine records. This implies that *in theory,* requiring a tontine to be fair does not create significant administrative hurdles.[22] We discuss practical concerns below.

D. Further Applications

The analysis above focused on closed investment pools used to finance retirement.[23] An emerging literature, however, envisions mortality credit pooling in open-ended pools that continue to admit new members and in concert with other financial instruments, while also creating a "fair tontine," as described above.

A tontine annuity tool could be molded into a "tontine pension," paying retirement income funded by employer contributions over the participant's career, like DB plans.[24] But since a tontine, unlike a DB plan, would not guarantee a specified monthly payment for life, tontine participants' pension benefits would vary based on the pool's mortality experience and investment experience. Because the other members of the pool could live longer than expected, and because the pool's investments could lose value, a tontine pension would occupy a different

[21] In the tontines illustrated in Figures 1-3, the balances of participants who died were split equally among all surviving members. This would be consistent with a fair tontine only if all pool members had the same actuarial probability of death in a given period and the same balance.

[22] In addition, as discussed in the examples above, because actual mortality experience (how many die and who they are in terms of size of balances) will ordinarily differ from actuarially expected mortality experience, actual realized mortality credits will differ accordingly from expected fair mortality credits in a given period.

[23] Milevsky and Salisbury (2015).

[24] Forman and Sabin (2015).

place on the risk-return spectrum than a commercial fixed-income annuity or a DB pension plan, both of which generally protect against investment and longevity risks, promising a fixed monthly payment for life.[25]

"Individual tontine accounts" (ITAs) offer another example of the flexibility of fair tontines.[26] While the decision to join an ITA would generally need to be irrevocable, ITAs, like IRAs, would allow participants to select their own contribution level, investments, and payout rate, and to change them, subject to certain constraints. For instance, they could be permitted to reduce, but not increase, their payout rate. The ITA would be attached to a regular investment account that is not governed by tontine principles, that could receive amounts from the ITA and allow them to be withdrawn at any time. When the saver died, ITA assets would be forfeited and reallocated to surviving participants, while the funds in the adjacent regular investment account would remain part of the decedent's estate. Pooled ITA mortality gains would supplement investment returns, thereby accommodating a potentially higher safe rate of withdrawal than could other forms of similarly invested funds, such as managed payout funds.

More generally, survivor income pooling could serve as the centerpiece of a standalone fund—a 21st century tontine—or, as one component of a broader retirement strategy, could be combined with or incorporated into a managed payout fund or other investments.[27]

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[25] Employer-funded tontine-style survivor income pooling would also raise other issues. One question is whether and how ERISA would apply to such a vehicle. Another issue is portability of benefits. While such a tontine-style vehicle could work for those who spend most of their career at a single employer, it would be harder to implement unless many employers used such an arrangement. If tontine-style pensions became common and were offered in multiple-employer arrangements that any employer could join, portability would be less of a concern. The portability challenge applies also to commercial annuities, although federal legislation has taken some steps to mitigate it in that context.

[26] Fullmer and Sabin (2019).

[27] John et al. (2019) describe a retirement income strategy that, in addition to social security benefits, would combine a managed payout fund, an emergency savings account, and a QLAC. A tontine could finance any of these products.

IV. Tontines: Practical Considerations

The sections above argue that, in theory, tontines could be an effective way to finance retirement income. But could they work in practice?

A. A Brief History

The current status of, and prospects for, tontines—named after 17th century Italian financier Lorenzo de Tonti—are related directly to their long and colorful history.[28] Since their inception four centuries ago, tontine-structured investments have taken a variety of forms, financing capital investments, wars, retirement income, and life insurance.

Capital investment tontines were popular revenue-raising schemes in Europe from the 17th to the 19th century, helping governments and monarchies raise money for public works and wars.[29] They even made inroads into the United States, as Alexander Hamilton proposed a capital investment tontine to pay off Revolutionary War debt. Although the federal government declined to pursue this option, many communities in the Colonial Era used tontines to finance local investments, and a capital investment tontine financed the construction of the original home of the New York Stock Exchange in the Tontine Coffeehouse.[30] Tontines enabled governments to pay lower interest rates than they had to offer on other types of investment because surviving investors received not only the promised interest rate but also mortality credits, in exchange for

[28] It is unclear whether the tontine was named after de Tonti because he actually invented it or was its most prominent early promoter.

[29] Examples include King William's tontine; ten French national tontines offered from 1689 - 1759; three Irish tontines offered in 1773, 1775, and 1777; and hundreds of tontines sponsored by Dutch and German city states in the late 17th and early 18th centuries. See Milevsky (2015) and McKeever (2009) for specifics.

[30] McKeever (2009). Lange, List, and Price (2004) explore the use of tontines as a method of financing public goods.

giving up the right to pass their investment interest on to their heirs.[31]

The life-insurance style tontine came to prominence in the U. S. in the late 1800s. Under these arrangements, policy holders paid premiums during a term (typically 20 years). If the policy holder died during the term, their beneficiaries would receive a payout. Policy holders who survived the term were entitled to a life annuity or equivalent lump-sum payout funded by the remaining pooled premiums from their deceased counterparts after insurance payouts to their beneficiaries as well as premiums from those whose policy had lapsed for failure to make a required premium payment at any point.[32] This product drove the broad uptake of life insurance in the U.S. in the late 1800s and proved to be an effective vehicle for accumulating retirement savings before the advent of Social Security or private pensions. By 1900, two thirds of life insurance policies in the U.S. were tontine-style products, accounting for 7% of national wealth.[33]

The popularity of life-insurance-style tontines, which essentially left large amounts of capital in the hands of insurers for decades, combined with a lack of regulation and oversight, made these policies ripe for corruption. The 1905 Armstrong Commission investigation in New York uncovered substantial embezzlement and misuse of funds, as well as unduly draconian triggers for lapse or forfeiture of the policy, leading New York lawmakers to effectively outlaw life insurance tontines as they then existed. This essentially ended the use of tontine-style

[31] Tontines with a constant base return held out the possibility of astronomical returns, more closely resembling a lottery than a conventional investment. Adam Smith observed that there is a part of human nature that is quite drawn to tontine-style investment and the possibility of winning big. See Smith (1776). While this may help explain the tontine's longtime popularity, it may also help account for its somewhat unwholesome image.

[32] Ransom and Sutch (1987).

[33] Ransom and Sutch (1987), Christie (1957).

products nationwide, since New York had regulatory authority over 95% of the national insurance market.[34] Ransom and Sutch (1987) argue that the policy amounted to "throwing out the baby with the bathwater" and that the better response would have been to allow tontines while overseeing and regulating them more effectively.

B. Legal Uncertainty

The legal status of tontines remains unclear, though contemporary proposals are fundamentally different from the instruments effectively banned over a century ago. The New York statute, still on the books, prohibits only tontine-style investments that pay out less frequently than once a year, suggesting the possibility that many kinds of tontine-style products might still be lawful.[35] It appears that only a few state statutes explicitly bar tontines.[36] But because of tontines' history and reputation, financial service providers remain wary, consistent with the widespread assumption that tontines are or may well be unlawful.[37] Nevertheless, for present purposes, we proceed on the reasonable assumption that applicable U.S. law will not flatly prohibit all financial products that include pooling and allocation of mortality credits.

C. Current Examples

One reason to be optimistic about the future legal status of tontines is that relevant activity in the U.S. has long included financial products with tontine-like features. For example, "participating life annuities" pair an income guarantee with a variable surplus distribution

[34] McKeever (2009).

[35] Wettstein (2018**).**

[36] McKeever (2009).

[37] Fullmer (2019).

depending on realized mortality of the pool of investors.[38] Similarly, some life annuities in the U.S., like some offered by TIAA, periodically adjust the value of payouts based on the realized mortality of the pool of annuitants, so the annuitants— not the insurance company—bear the risk of the pool living systematically longer than expected.[39] In addition, an optional variable fund offered by one of the state retirement systems includes tontine-like elements.[40]

Despite these inroads, the U.S. is lagging the rest of the world in tontine-like arrangements. European Union member states permit tontines, usually as a supplement to government-paid or occupational benefits.[41] The pension for former employees of SwissAir is structured as a tontine.[42] In Sweden, the national pension system redistributes the accrued pension wealth of the deceased among all survivors of the same age cohort.[43] In Japan, some workers pay into a tontine-like annuity from their 50s until retirement, when they begin receiving payouts to supplement their national pensions; when they die most of what they have contributed is reallocated among the other policy holders.[44] Tontine-style funds are explicitly legal in the UK. Canada paved the way for tontine-style products when its 2019 budget proposed legislation to permit them under the name Variable Payment Life Annuities.[45] In South Africa, a tontine-

[38] Maurer et al. (2016)

[39] Forman and Sabin (2015).

[40] See Wisconsin Department of Employee Trust Funds (2020), pg. 9: "After the year's returns are final, ETF's actuary determines the effective rates to apply to members' account balances. Then they use the effective rates, 5% assumed rate, and actuarial factors (death rates, previous year carryover, etc.) to calculate the annuity adjustments."

[41] "Directive 2009/138/EC of the European Parliament" (2009).

[42] White (2002).

[43] See Milevsky (2015).

[44] Hayashi (2020),

[45] "Permitting Additional Types of Annuities Under Registered Plans" (2019).

style investment designed to improve retirement security for poor workers has begun enrolling participants.[46]

D. Operational complexity and transparency

In theory at least, most tontine pooling is straightforward, transparent, and fair, especially in comparison with commercial annuities. In practice, of course, complications will arise.

First, specifying mortality risk correctly may be difficult because people who are willing to buy into a tontine pool are likely to have longer than average life spans. However, the extent to which that is the case may not be clear ex ante. Mortality risk, of course, is one of the key determinants of the mortality credit in a "fair tontine." The more diverse the pool's participants, the more difficult this will be. As a result, creating tontines for homogeneous age- and gender-based groups could simplify the actuarial calculations, though it would still be necessary to attract enough investors to reduce the impact of random shocks.[47]

Second, and related, adjusting the base return over time to avoid fluctuations in annual payouts will require additional complex calculations. Third, because a simple bond investment would not be likely to generate the returns necessary to compete with other types of retirement income products, a tontine may require some management of its portfolio, which will further add to both complexity and costs.[48]

As many financial professionals, including variable annuity providers, have discovered, financial plans may work in normal times but not when markets are disrupted. Because tontines

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[46] Nobuntu (2020).

[47] Identity of age or gender might make the mortality pooling and allocation system seem more intuitively fair and appealing.

[48] This might take the form of a managed payout fund enhanced by mortality credit pooling, as noted below.

will need to provide income over several decades, at some point serious market disruptions or other unexpected developments are almost certain. It remains to be seen whether adjustments made in the interest of actuarial fairness, equitable allocation of mortality credits, and level retirement income would be administratively feasible and practical. The adjustments could also compromise, in the eyes of potential investors, the basic advantage of tontine structures over commercial annuities in terms of transparency, simplicity, and apparent fairness.[49]

While these operational complexities will require some effort to resolve, they are not fatal problems. Tontines, including level payout tontines, are feasible and could offer a greater variety of retirement income solutions for many future retirees.

E. Profiting from the Death of Others

The survival-contingent payout that underpins the tontine is both highly controversial and utterly ordinary. The idea of deliberately arranging to profit from other people's death naturally makes people squeamish, and all the more so if members of the pool know one another. As noted, incentives to kill off other members of a tontine pool have inspired novels, television shows, and movies.[50] But a little perspective is warranted. First, the perverse incentive that supplies the necessary element of drama for such fictional accounts is absent when the group participating is sufficiently large or, even if small, when members are mutually anonymous.[51]

[49] Of course, the same concerns about complexity and fairness also apply to annuities and other retirement income products. While it is fairly simple to go on the website of an annuity provider and determine the monthly income that a simple, fixed-income annuity would pay, it is virtually impossible to understand exactly how that amount was determined, and challenging to determine its actual cost to the investor, especially where more complex products and features are involved.

[50] See e.g., *The Wrong Box*, by Robert Louis Stevenson and Lloyd Osbourne and its film adaptation; *4.50 From Paddington* by Agatha Christie; and The Simpsons episode "Raging Abe Simpson and His Grumbling Grandson in 'The Curse of the Flying Hellfish.'"

[51] Apparently, there have been no successfully recorded episodes of actual attempts to kill off other members of a tontine. See The Economist (2017).

Second, other financial products regularly pool mortality credits without controversy. For example, annuitants with shorter lifespans effectively subsidize those who live longer.[52] Conversely, owners of certain types of life insurance policies who live longer effectively subsidize the benefits of those who die sooner. In both cases, the mortality credits are less visible because they go through the insurer, which also takes a portion of the credit as increased revenue. DB pension plans also pool longevity risk.[53] By contrast, in a tontine, the mortality credits directly benefit the survivors rather than being partially hidden in the role of the financial intermediary. The difference is largely a matter of visibility.

F. Spousal Protections

Tax-qualified retirement plans provide protection for spouses. DB and certain other pension plans must pay pre- and post-retirement survivor annuities to a surviving spouse after a married participant's death unless the participant and the spouse agree to waive that right. In 401(k)s and most other DC plans, a deceased participant's spouse inherits by default the participant's full account balance unless the spouse agrees to the designation of a different beneficiary.[54] In both cases, the spouse's agreement generally must be written and either notarized or witnessed by a plan official.

Tontines could provide similar protection. An unmarried participant and a married participant whose spouse agreed to waive these rights could participate in the tontine as an

[52] Fullmer (2019).

[53] While surviving participants do not receive mortality credits that increase their benefit amounts when other participants die, they can benefit indirectly if those deaths result in additional funding becoming available for plan benefits generally. The effect might also be to reduce employers' funding obligations.

[54] See ERISA (1974) § 205 (29 U.S.C. § 1055), "Qualified Pension, Profit-Sharing, and Stock Bonus Plans" (26 U.S.C. § 401(a)(11)), and "Definitions and Special Rules for Purposes of Minimum Survivor Annuity Requirements." (26 U.S.C. §417).

individual.[55] But a tontine might also provide that a married couple that did not waive the spousal protections could participate in a tontine as a single unit, receiving payments and mortality credits until the second spouse's death, at which point the couple's interest in the pool would be reallocated to surviving participants. For example, the life expectancy of a 65-year-old male is about 84, but if married to a 65-year-old female, the couple's "last survivor life expectancy" is 91.[56] In allocating mortality credits, the couple could be treated as a single participant with a life expectancy of 91.[57]

G. Equity and Discrimination

An equitable allocation of mortality credits would ensure that tontines do not discriminate against people with shorter life expectancy or in favor of those with longer life expectancy. Life

[55] It remains to be seen how the 401(k) and other qualified plan rules would apply to the pooling of mortality credits. One issue is whether there would be any reason to treat the reallocation of a participant's benefits upon death as a "forfeiture" for purposes of the prohibitions on 401(k) plans forfeiting employees' elective contributions on account of death and on qualified DB plans using forfeitures upon a participant's death to increase other participants' benefits. See "Qualified Pension, Profit-Sharing, and Stock Bonus Plans." 26 USC § 401(a)(8); 26 CFR 1.401-7. If there is a possibility that the forfeiture rules apply here, a possible approach to avoid the issue might be to appropriately structure the mortality pooling and credits as a beneficiary designation whereby participants interested in joining a plan's mortality credit pool could voluntarily (though irrevocably) designate the plan's qualified trust (or the surviving participants in the mortality pool) as their death beneficiary(ies). Such a designation would be made in accordance with explicit plan provisions prescribing how the mortality credits resulting from the benefits of a deceased participant who chose to make such a designation would be allocated to the surviving participants who had chosen to participate in the mortality credit pool. Some might also ask whether mortality credit pooling (implemented without employer discretion) could be viewed as raising any issues under the requirements that qualified plan benefits be "definitely determinable". See "Qualified Pension, Profit-Sharing, and Stock Bonus Plans." 26 CFR § 1.401-1(b)(1). An analysis of these and related legal issues is beyond the scope of this paper.

[56] See IRS Publication 590-B (2019), Table II (Joint Life and Last Survivor Expectancy). Life expectancies vary slightly depending on which actuarial table is used.

[57] The mortality credit allocations would also need to consider the adjusted levels of retirement income payable while both members are alive and then to the surviving spouse. A retiree who is entitled to income of $1,000 per month if payable as a single life annuity (a stream of payments only for that retiree's lifetime) could, if married, receive a joint and survivor annuity payable to the retiree for life and then continuing to the surviving spouse for life. However, the payments made while both spouses are alive generally would be reduced (for example, to $900 per month) in order to fund the survivor benefit, and the survivor benefit frequently would be a fraction (often 50% or 75%) of the $900 per month joint benefit. Other aspects of such a spousal protection tontine would also need to be addressed, including how actuarially fair mortality credit allocations should take into account the fact that married individuals tend to have longer life expectancies than unmarried and the possibilities of divorce, the spouse predeceasing the participant, or the couple's waiver of post-death spousal protections.

expectancy varies with age, gender, race, ethnicity, income level, marital status, and other factors. As discussed above, if tontines could take all these factors into account, they could generate equitable allocations of mortality credits.

Existing law may forbid some adjustments of this type, even if intended to favor traditionally disadvantaged groups, like Black Americans, that tend to have shorter life expectancies. For example, commercial annuities and other insurance products are generally allowed to engage in price discrimination because of life expectancy differences based on age and gender but not race. In contrast, employer-sponsored pensions are not allowed to discriminate in benefits or contributions based on gender or race and can only discriminate because of life expectancy differences based on age in certain specific ways.

For tontines that are offered neither by insurance companies nor by an employer-sponsored plan, it is unclear how current law would apply to all the possible adjustments for mortality risk. Racial disparities in life expectancy present a particular problem for tontines, as well as for any product that pays benefits until a person dies, including Social Security, commercial annuities, and defined benefit pensions. Because Black Americans, for example, tend to have shorter life expectancies than white Americans, Black participants in a tontine would likely be disadvantaged compared to white participants if no adjustment were made to offset this disadvantage.

We highlight this issue because it must be addressed when implementing tontines, but we do not attempt to resolve it here. Determining how current law should be interpreted, clarified, or changed raises complex and difficult questions that are beyond the scope of this paper.

V. Comparing Tontines and Other Financial Products

How useful tontine-style pooling will be in helping people manage assets and income in retirement depends in part on how they compare to existing retirement income options. Table 1 provides a detailed summary of the differences across retirement income options.

A. Tontines vs. Income Annuities

Tontines and income annuities are similar in many respects. Both generally require irrevocable investments to control the risk of adverse selection, both instruments pool mortality credits. The central difference is that a tontine typically will not provide the income guarantee that an annuity can, but instead provides a higher average return, greater transparency, less complexity, and lower cost.

A fixed income life annuity guarantees a specified dollar amount per month to last for life. By contrast, while the level-payout tontine can be invested to minimize market risk, and can provide considerable longevity risk protection, it does not guarantee either an exact amount of income or the lifelong duration of that income.[58]

Different parties bear the risks if things do not go as predicted. If annuitants, as a group, live longer than expected, the insurer bears the costs through extended payments. If a pool of tontine members, as a group, lives longer than expected, the surviving members bear the costs through lower than expected payments. In other words, annuities insure participants against systematic longevity risk, like an unexpected cure for cancer, but tontines do not. Similarly, with its income guarantee, the annuity provider assumes the risk of poor investment performance, while members of the tontine pool bear this risk. The rate of return insurers can provide on

58 Milevsky et al. (2018) reported (at 33-34), after performing a hypothetical Canadian case study, that the answer to which vehicle would provide the higher payout "isn't quite clear-cut". The result was "neck-and-neck" when both used government bonds as their underlying asset, but retirement income tontines would have yielded higher payouts when using a corporate bond curve. In any event, the authors concluded that their results were uncertain because they could not take regulatory costs, fees, and other institutional factors into account, and that the tontine should not be considered cheaper or more cost effective than a commercial life annuity but instead provided an alternative on the "longevity risk-return spectrum."

annuities is reduced by allowances to cover these risks, to provide reserves, and to comply with other regulatory requirements.

Another distinction is that tontine mortality gains are triggered by actual deaths as they occur and hence are more transparent than annuity mortality gains. In a commercial annuity, pooling takes place "behind the curtain" with the intermediation of an insurance company. It calculates income based on an actuarially expected rate of mortality in the pool, combined with other financial flows, assumptions, and adjustments. The insurance company also adds a series of fees to ensure profitability. It is not annuitants who are seen as profiting from the demise of their fellow annuitants: it is the insurance company.

Of course, real-world annuities should not be compared to just an idealized version of tontines. As history illustrates, tontines too would require consumer protections and regulatory safeguards, with attendant costs. These costs can be expected to be lower than the costs of annuity-type guarantees, although complex actuarial fairness adjustments could call for more regulatory oversight.[59]

B. Tontines vs. Managed Payout Funds

Tontines and managed payout funds allow retirees to convert savings to income but differ in how they address longevity risk and investment risk. By its nature, a tontine reduces longevity risk. The extent to which a managed payout fund would reduce longevity risk depends on how the fund is managed.

Neither instrument provides income guarantees but the nature of the risks differs in the

[59]One other factor could change the comparative analysis: If a QLAC longevity annuity were combined with a tontine-style fund, the QLAC, by guaranteeing a specified payment for life starting at age 85, could fill in much of the missing protection at far lower cost than an immediate annuity. See John et al. (2019).

two instruments. Both face investment return risk and "sequence of return risk,"[60] and each faces a type of risk stemming from participants' mortality experience. Simply put, the later that participants die, the higher that raises the bar for managed payout funds to provide sufficient income as long as it is needed, and the lower the tontine's mortality credits and hence its returns for surviving tontine participants.

Managed payout funds may be more likely to be actively managed and more heavily invested in equities to pay higher levels of income, and therefore may be more likely to involve some level of market risk. But this is not necessarily the case, as it would depend on how the managed payout fund investment portfolio and the tontine investment portfolio are constructed (and they could be composed identically).

As noted earlier, investment in a tontine is irrevocable and leaves nothing for heirs, while managed payout funds allow withdrawals and bequests.

VI. Conclusion

Everything old is new again, as the adage goes. More than 300 years after being introduced as a way to finance war and capital projects, tontine-inspired structures are now receiving attention around the world as tools to finance retirement income because they are efficient and transparent—with mortality credits accruing to pool members directly and

[60] "Sequence of returns" risk refers to the risk that even if market downturns are followed, as they generally are, by eventual market recoveries, retirees cannot count on recouping their portfolio losses if the downturns come earlier in their retirement. This is because, when account owners are steadily spending down their balances, the sequence of down and up markets can make a big difference. If significant losses in market value come first, then – even if the percentage of market gains equals the earlier percentage of market losses – later gains will be insufficient to recoup those losses for investors who have been steadily spending down. (If, instead, market gains precede equal percentage market losses during spenddown, more assets will remain at the end.) Sequence of returns matters more during spenddown because a later percentage increase in market values will be applied to a shrinking account balance (or capital base) –smaller than the account balance (or capital base) to which the earlier losses applied. This risk results from the retiree having no choice but to fund monthly spending by selling market assets while their value is temporarily depressed in a falling market, so that later market recoveries in a similar percentage will be operating on a diminished capital base. However, in a tontine-type mortality credit pool, the inflow of mortality credits would help offset some of the outflow from spending, thereby mitigating any sequence-of-returns loss during spenddown.
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traceably—and outside commercial annuities' insurance system.

While commercial annuities guarantee a specified income for life, tontine pooling offers less but still meaningful protection at what should be a lower cost. Tontines should pay more in expected income for each dollar that is invested than annuities do. They would not require the charges insurers need to impose or the reserves they need to maintain to cover their annuity payment guarantees and insurance against systematic longevity risk. Tontines would also require less and less costly regulation. For many people, the marginal value of *complete* insurance against both investment and longevity risk that a fixed-income annuity provides may not be worth the marginal costs involved, especially as historically low interest rates have depressed annuity returns.[61]

Public policy is only beginning to grapple with the challenges of effectively managing retirement security in a market currently dominated by 401(k) and IRA account structures and lump-sum payouts rather than DB plans. The retirement system stands to benefit from more transparent and effective tools for survivor income pooling. Creative thinking and financial engineering—particularly by Milevsky, Forman, Sabin, and Fullmer—have made a strong case for this.[62]

But the extent to which tontines will penetrate retirement systems or other asset structures in the U.S. depends not only on the theoretical soundness of the tontine design, but also on the willingness of retirement plans and financial providers to offer such products. In addition to the operational complexity of some tontine types, there is a perception of daunting federal and state regulatory, and perhaps legislative, obstacles, but some of these concerns appear to be unfounded

[61] Friedman and Warshawsky (1990); Mitchell et al. (1999).

[62] See for example, Milevsky (2015), Milevsky and Salisbury (2015), Forman (2018), Forman and Sabin (2018), Fullmer and Sabin (2019), Milevsky et al. (2018), Fullmer (2019), Fullmer and Forman (2020).

or overblown. Furthermore, any lingering air of disrepute in the U.S. is attributable to corruption in the age of the robber barons; it should be seen as an artifact of pre-modern tontine structures rather than anything inherent in tontine principles or in the project of consensual longevity risk pooling.

The fact that several other countries and at least some retirement systems in the United States now use survivor income pooling to augment and allocate pension income suggests that the tontine option can be valuable. Survivor income pooling—as a standalone product or as a tool that increases yield in managed payout funds or other retirement income vehicles—could help expand the market for managing longevity risk. Tontine-like structures need not be the entire or main retirement income solution, but can be useful as part of a broader strategy, especially for those who do not have or have otherwise handled any need for spousal protection or other bequests. Accordingly, given the limited diffusion of annuities and managed payout funds, tontines offer an attractive alternative that should have a place among the options households can access to finance retirement income.

Appendix: Simulation Methodology

The models used for this paper are intended to illustrate and compare different types of lifetime income. They are built upon mortality patterns and investment patterns, and assume time is discrete (everything that happens in a particular year happens at the exact same time).

The mortality mechanism is based on data from the Human Mortality Database, which provides mortality statistics for people of every age from 1933 to 2017, covering people born as early as the 1820s. To extrapolate these insights into the future, we regressed each cohort's life expectancy at age 65 on their mode age of death, and then used this relationship to predict the mode age of death of every living cohort older than age 65 in 2017 (birth years 1907 – 1952). We then used this extrapolated mode age of death as the M parameter in the Gompertz hazard function, where M is the mode age of death, b is the periodic increase in mortality risk, and x is the age of interest:

$$G(x;\ M, b) = be^{b(x-M)}$$

We then solved this function for the b parameter that would generate a cumulative death rate at age 65 that matched the observed cumulative death rate from the Human Mortality Database's data. This provided the foundation for a complete series of lifetime mortality curves where mortality under age 65 is observed, and mortality over age 65 is extrapolated using the Gompertz hazard function. We generated a different set of parameters—and thus a different lifetime mortality curve—for each gender/birth-year cohort. For example, the cohort of men who turned 65 in 2017 used to generate the figures in this paper were assumed to have a mode age of death, *M*, of 83.14, and a periodic increase in mortality, *b*, of .0834.

These lifetime mortality curves were used to generate projected mortality rates and stochastic years of death for members of specific age-gender cohorts. The random generator

assigned a “mortality percentile” to each member, and then assigned that member a year of death based on which year people of that percentile are projected to die. This facilitated the stochastic mortality models used to test the different lifetime income tools. Note that this simple model does not account for the effects of exogenous mortality shifts or correlation between increasing mortality within a cohort, so we may be understating variation in mortality.

The second major mechanism involves investment returns. The values of the S&P500 index from 1927 to the present were used to derive the mean and standard deviation of stock returns, while the yields on 10-year Treasuries were used to derive the mean and standard deviation of bond yields. The models of investment returns assume a 50/50 split between investment in the S&P 500 fund and in the 10-year Treasuries, and generate random growth factors for each of these investments over the relevant horizon and combine them to obtain an indexed value of the assets any time during the window. This assumes that annual stock and bond performance are independent of previous years’ performance and one another’s performance, which—though not strictly empirically defensible—provides a straightforward model for projecting the performance of different investment tools.

These simulations were done in R version 3.6.1 and RStudio version 1.2.5001 for Mac. The models used the tidyverse and rootSolve R packages. The underlying data and code are available upon request.

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Table 1
Characteristics of Selected Retirement Income Vehicles from Retiree's Standpoint

	Level-Payout Tontine	Commercial Life Annuity	Managed Payout Fund
Handles retiree's need to convert savings to income	Yes	Yes	Yes
Individual ("idiosyncratic") longevity risk (risk that a particular individual will outlive life expectancy)	Individual's risk generally "diversified away" — protected by pooling of mortality credits in a sufficiently large pool	Individual is insured (insurer bears risk)	Individual is exposed but risk can be mitigated by management over time
Systematic longevity risk (risk that group will in aggregate outlive its life expectancy)	Individual exposed	Individual is insured (insurer bears risk)	Individual exposed but risk mitigated by management over time
Risk of adverse selection	Individual exposed to adverse selection by others so that pool could have above-average life expectancy	Individual protected – insurer bears risk of adverse selection	N/A
Guaranteed return	Not guaranteed but targeted	Yes - guaranteed	Not guaranteed but targeted
Investment (including sequence of returns) risk	Depends on how invested; could be exposed although mitigated by mortality credits	Individual insured (insurer exposed but it invests in bonds, reserves	Depends on how invested; could usually expect some exposure
Provides mortality pooling gains in addition to investment returns	Yes– and expected return might be further increased if has equity investments	Yes - lower overall return if fixed income annuity and higher premiums to pay for guarantees	Not usually
Inflation risk	Exposure can be limited by investments	Exposure can be limited by purchasing increasing annuity	Exposure can be limited by investments

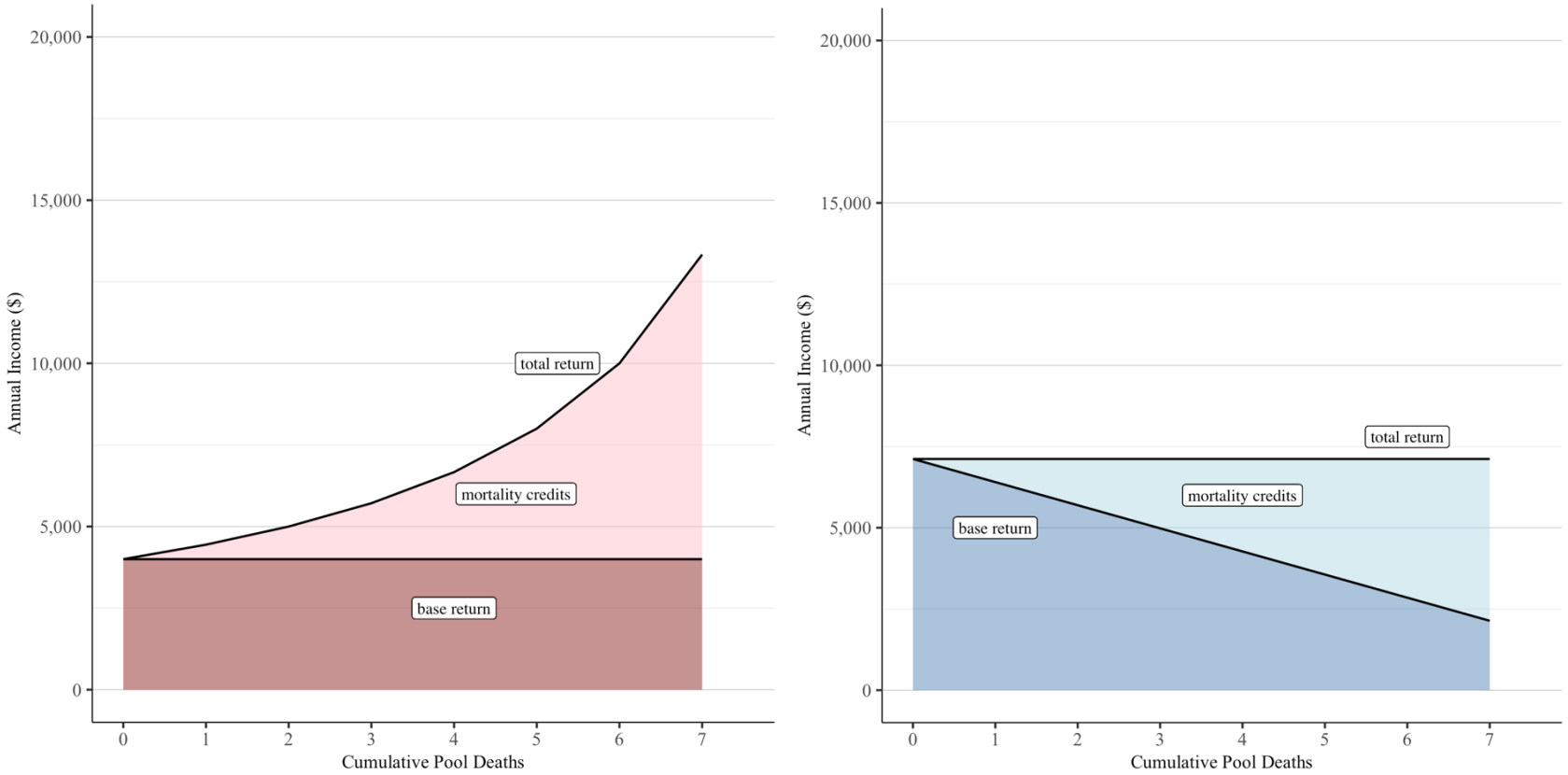
	Level-Payout Tontine	Commercial Life Annuity	Managed Payout Fund
Counterparty credit/default risk (long-term risk of provider insolvency, underfunding of promised benefits, or breach of contract)	Very limited as participants do not depend on provider for specific promised payments – unlike annuity, like DC plan	Some. Risk from insurer insolvency limited by regulation and state guarantees; litigation risk reduced by fiduciary safe harbor	Some
Illiquidity risk (lack of flexibility to meet shocks)	Exposed because irrevocable – for liquidity/flexibility, need to rely on other investments	Exposed because irrevocable. For liquidity/flexibility, need to rely on other investments	Investment is quasi-liquid
Health/Long-Term Care shock risk	Exposed because irrevocable investment in regular income – for liquidity/flexibility, need to rely on other investments	Exposed because irrevocable investment in regular income. For liquidity/flexibility, need to rely on other investments	Investment is quasi-liquid
Cognitive decline risk	Risk limited because investment is irrevocable and on autopilot	Risk limited because investment is irrevocable and on autopilot	Fairly limited: investment is managed, but individual could exercise some choices
Cost	Probably least: assumes fewer risks than annuity, but some oversight will be needed + possible legal advice in early days	Highest, especially because of need for reserves to back up guarantees. May be hard to ascertain (hidden fees)	On higher side because generally more discretionary professional investment and payout management
How transparent and how comprehensible to consumers	Basic concept transparent and easy to grasp (although actuarial adjustments could be complex, less transparent, less understandable)	Fixed income product can be straightforward, but typical GLWB GMWB and fixed index options can be complicated, confusing, nontransparent, possible hidden fees	Relatively good but would depend on specific arrangements; might attract customers when structured as a familiar, easily accessible mutual fund

Availability to consumers as of 2020	Minimal	Highly available but choices complex to navigate	Somewhat limited but rapidly expanding

Figure 1. Tontine Income by Pool Mortality

A. Constant base return

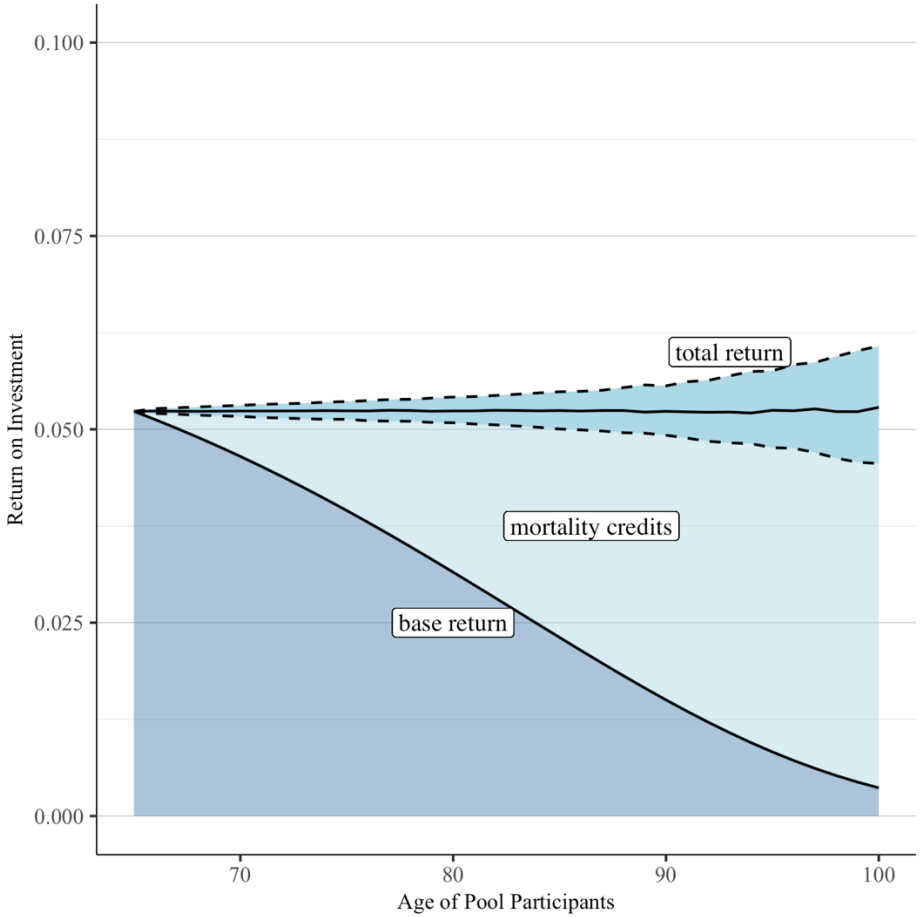
B. Constant-payout (with declining base return)



Notes: This figure compares the behavior of two stylized tontines with 10 participants who have each contributed $40,000 to the pool. In the "constant base return" tontine (A), the fund disburses 4% of the overall investment annually, creating a guaranteed 4% base return per survivor each year. Over time, as more participants die, their base return is redistributed to the survivors in the form of mortality credits, generating an escalating total return for survivors over time. In the "constant-payout" or "level-payout" tontine (B), the base return is designed to decline over time to offset the increase in mortality credits, so that the total return to a survivor remains constant over time.

Figure 2. The Distribution of Returns on Level-Payout Tontines

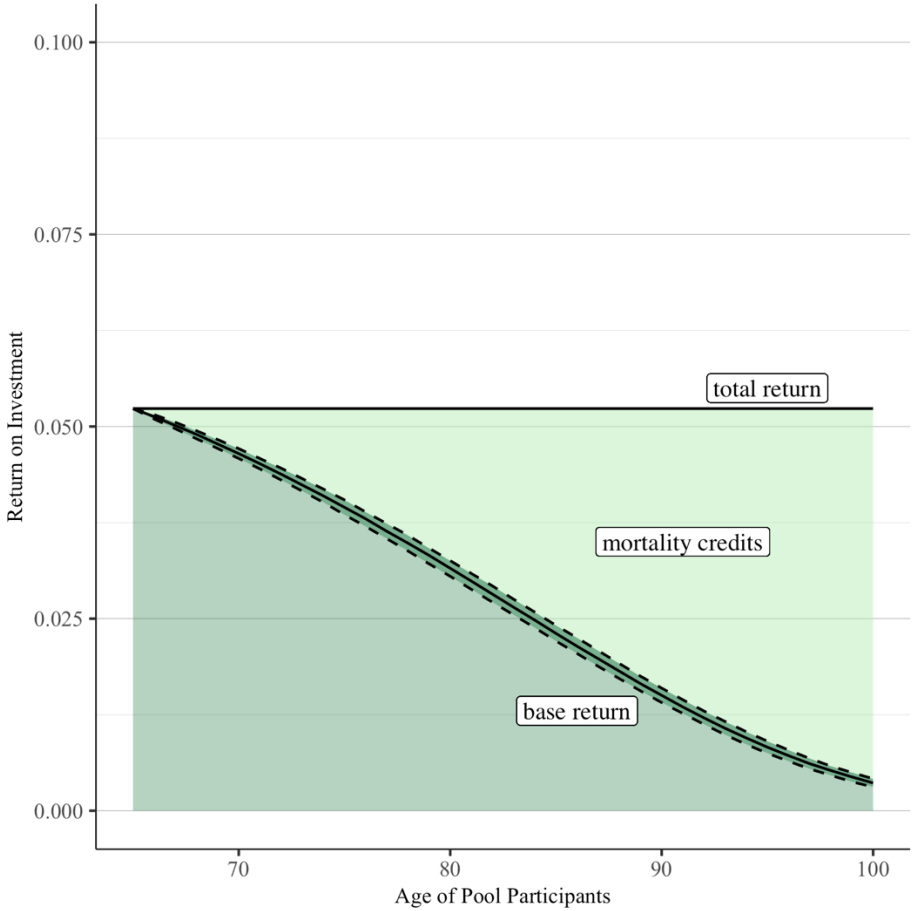
Using Ex Ante Mortality Rates



Notes: This figure depicts the simulated behavior of a level-payout tontine where the annual disbursement is set in advance to decline inversely proportional to predicted pool mortality. Because actual mortality will differ from predicted mortality, the mortality credits are variable, making the total return variable. The pool is formed by 1000 men who turned 65 in 2017. The simulation was run 1000 times. The solid lines indicate the median behavior among the simulations, while the dotted lines indicate the bounds of the 10^{th} and 90^{th} percentile total returns.

Figure 3. The Distribution of Returns on Level-Payout Tontines

Using Realized Mortality Rates



Notes: This figure depicts the simulated behavior of a level-payout tontine where the annual disbursement is adjusted to match realized mortality. The pool is formed by 1000 men who turned 65 in 2017. The simulation was run 1000 times. The solid lines indicate the median behavior among the simulations, while the dotted lines indicate the bounds of the 10^{th} and 90^{th} percentile base returns.