

Longevity Biomarkers and Financial Industry



Biomarkers for Financial Market

The value of the information derived from the biomarkers cannot be reduced to the scientific only. Many **financial instruments can be optimized using biomarkers-based longevity and/or mortality indices**. Such instruments show great value for a whole variety of entities, both governmental and privately held, providing optimized hedging solutions.

Besides different types of financial instruments, biomarkers assessment can become a **crucial part of the valuation and due diligence processes for Longevity- and Pharma-related companies**. It is well known that companies participating in drug development are highly exposed to the risks related to the human validation (i.e. clinical trials). It is often hard to predict and assess whether a solution provided by a given company is relevant to the market. In this case, biomarkers-derived information might play a crucial role in the assessment of the company's performance, allowing to evaluate how its services affecting human Longevity.

These two different approaches suggest great improvements in the financial market enabling **optimized risk management** both in terms of Longevity risks hedging, and investment risks reduction.

Who can benefit?



Independent
Financial Advisors



Private Equity
Funds



Private Banks &
Wealth Managers



Corporations



Asset Management
Companies



Venture
Capital Funds



Challenger
Banks



Retail
Banks



Pension
Funds



Insurance
Companies

Reverse Mortgage

A reverse mortgage is a type of loan that is used by homeowners at least 62 years old who have considerable equity in their homes. By borrowing against their equity (at rates starting at less than 3.5% per year), seniors get access to cash to pay for cost-of-living expenses late in life, often after they've run out of other savings or sources of income. In comparison with traditional asset-backed loans, **reverse mortgage loans provide the elderly with a means of hedging longevity risk by helping to maintain a sustainable level of retirement income**, while retaining tenure in the home.

From the borrower's perspective, the most notable merit of a reverse mortgage is clearly that the borrower is not required to repay the loan until he or she dies or leaves the home. Another favorable feature is the "non recourse" clause. When the loan is terminated, the borrower (or his or her estate) only needs to repay the loan amount or proceeds from the sale of the house price: whichever is the lesser sum.

There are some challenges for the Longevity economy which drive the popularity of reverse mortgages for retirees: **a low-interest financial environment** that provides insufficient returns on pension savings, **generous retirement age** and **early withdrawal rules**, **a great fluctuation in the labor market**, **an erosion of traditional family support systems** and **a significant proportion of one-person households**

How Does a Reverse Mortgage Work?



You're 62 or older and have equity invested in your home



You need to access to that equity to pay your daily expenses



A reverse mortgage allows you to borrow against your home's equity with no monthly payment required as long as you stay in your home



The loan is repaid once the house is sold

Crossover Risk for Reverse Mortgage Lender

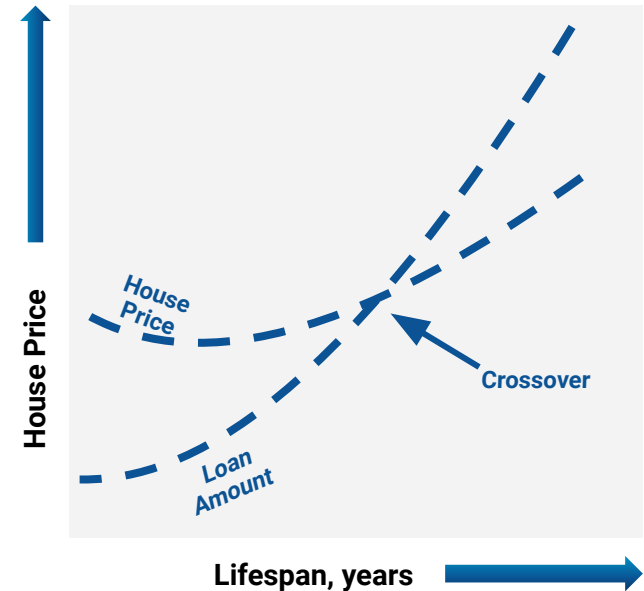
Although **reverse mortgage loans** provide many attractive benefits to retirees, they also **involve many risks** from the lender's perspective. The risk in reverse mortgage loans can be summarized **as the "crossover risk"**.

If the loan value exceeds the collateral house value at any point of contact time, the lender is limited to recover only the proceeds of the sale of the house equity when a reverse mortgage loan is terminated. **Any excess is therefore considered a loss to the lender.** Since the interest rate is usually higher than the house price value increasing, the loan value will undoubtedly exceed the house value at some future point.

On the other hand, however, **if the loan is terminated before the crossover**, any excess of the proceeds from the sale will revert to the borrower rather than becoming **the lender's gain**. This feature of reverse mortgages is reminiscent of options contracts.

Due to the dramatic **improvement in the mortality rate** since the 1970's, **longevity risk has become the most crucial risk** in a reverse mortgage product, as a result, banks and other lenders should form reserve capital to cover the longevity risk or it to capital markets via insurance contracts, longevity derivatives etc. In both cases **the effective measure of longevity risk**, such as biomarkers-based biological age prediction models is a key aspect of the lender policy.

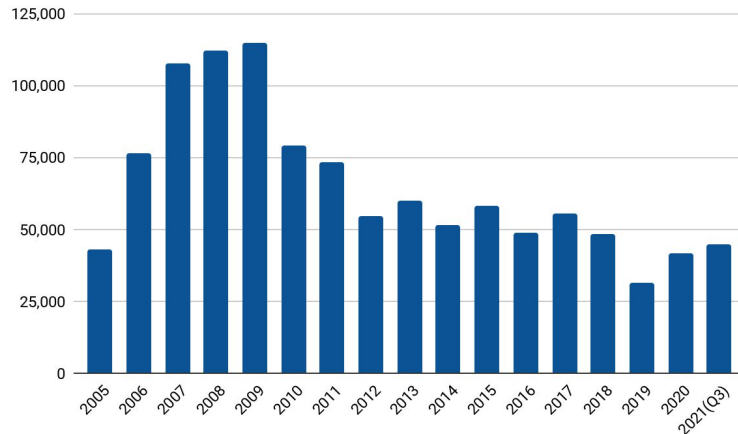
Crossover Risk Scheme



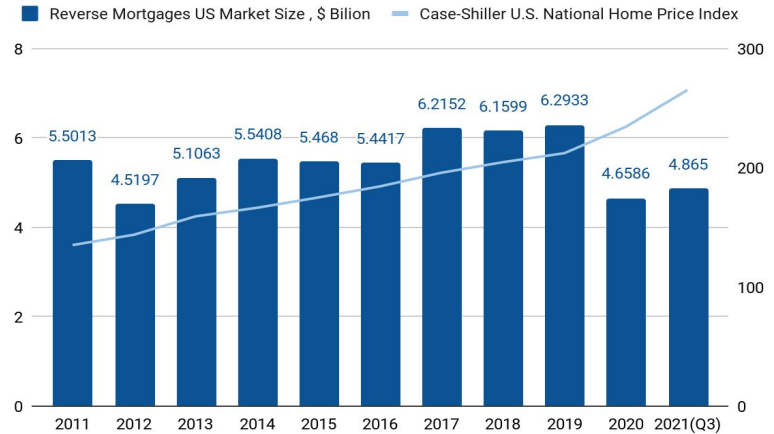
The USA Market of Reverse Mortgages

The **Home Equity Conversion Mortgage**, or HECM, is the federally insured **reverse mortgage product**. It is insured by the Federal Housing Administration (FHA), a branch of the U.S. Department of Housing and Urban Development (HUD). HECMs account for nearly all reverse mortgages made today in the U.S. **On the left graph** there is the number of HECMs made in each year since the program began. Due to the bubble on the American real estate market and the World Financial crisis 2008, the big banks and other financial institutions became indifferent to this financial instrument, as they couldn't find an efficient way to deal with some specific idiosyncratic risks. However, **increasing demand for reverse mortgages** due to drives described early and more efficient risk-management algorithms will undoubtedly increase the volume of loans and their market value soon. Over the past two years, the decline in market size is due to weakened demand due to the pandemic and the completion of transactions (sales of mortgaged real estate), concluded more than ten years ago.

Annual HECM Endorsement, Number of Deals



Total U.S. Market Volume and Home Price Index



Longevity Risk / Longevity-derived Financial Instruments

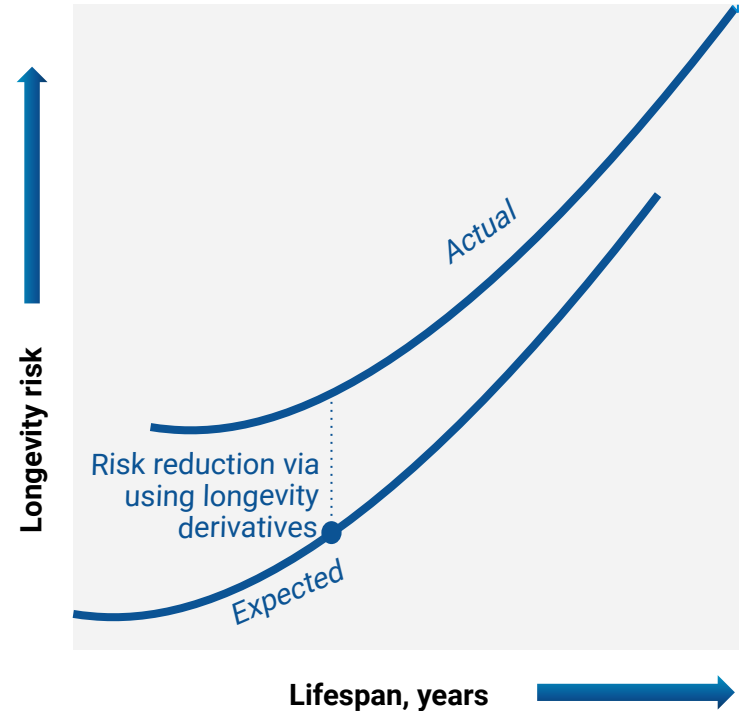
A new global capital market, **the Life Market**, is developing and “longevity pools” are on their way to becoming the first major asset class of the twenty-first century. **Longevity risks arrive due to inaccurate predictions of the level of mortality rate and numbers of retirees.**

Thus, **Longevity-derived financial** instruments are used in order to hedge such risks. In general, these derivatives are designed to **generate income for investors due to increased Longevity**, as well as reduce the negative impact for companies suffering from Longevity risks. Longevity risks have a weak correlation with other financial risks.

Although the **Longevity Derivatives Market has many economic agents**, the main ones are **hedgers** (pension funds and insurance companies, have an incentive to transfer Longevity risk off their books), **speculators**, and **arbitrageurs** (investment banks and hedge funds are interested in acquiring exposure to longevity risk since it has a **low correlation with classic market risk factors**, therefore small beta coefficient attracts investors a lot).

New opportunities are opening up for all these agents because of the increased accuracy of risk assessment and forecasting and selection of the correct risk management tool.

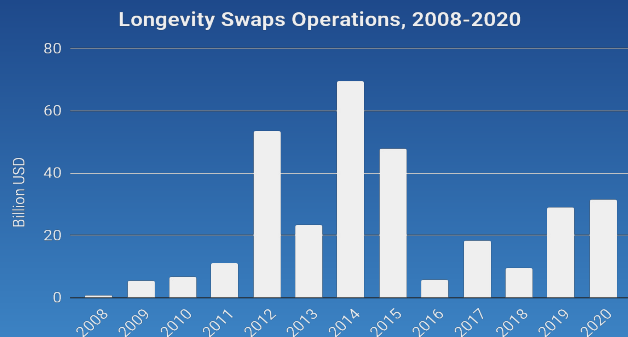
Hedging with Longevity Derivatives



Longevity Risks for Companies and Governments

Longevity risks are of great interest for both governmental and private institutions

The graph below depicts the dynamics of **longevity swaps' operations** in the period of 2008-2020 years. During this period, deals for the amount of \$313 billion had been struck. The amount of new operations correlates with life insurance market size. For example, the insurance market size in the US also significantly dropped after the 2015 year and slightly recovers during the 2016-2020 years (IBISWorld, 2020).



Governments tend to have a **two-dimensional interest in Longevity securities**. First, **for hedging** financial institutions sensitive to such risks, second, **for securing** its own exposure, as it is a significant holder of the Longevity risks: via the pay-as-you-go state pension system; via its obligations to provide health care for the elderly and for other similar reasons.

Ensuring an efficient annuity market and efficient capital market for Longevity risk transfers means that government can affect and reduce concentration risk and provide construction of national longevity indices.

Government helps **to share Longevity risk fairly** across generations and provides **a fair risk premium**. When issuing longevity derivatives based on biological age, the government could insure age-related diseases and implement more advanced and actionable metrics for pension programs.

Government

= Insuring age-related diseases + Minimising of spended resources + Using accurate and realistic health indicators

Longevity-derived Swaps and Forwards

By definition, **a swap is a financial instrument**, namely – derivative contract through which two parties **exchange the cash flows or liabilities from two different financial instruments**. Swaps said to have two legs, where each cash flow comprises one leg of the swap.

As for Longevity swaps, **Longevity swap is a reinsurance structure** where the client pays a fixed pre-agreed annual premium to the reinsurer plus an annual fee. The premium consists of the expected annuity payment and a margin. The annuity payment time is based on the Longevity of the given pensioner.

Longevity swaps have a number of features making them interesting for all parties involved, namely, they allow dealing with Longevity risks aside from the investment risks, this, in turn, allows trustees to diversify their risks and operate more efficiently. Longevity swaps also **allow excluding the upfront funding practice** and hence to reduce counterparty risks. Probably, one of the most important things about Longevity swaps is their symmetry. The risk distribution related to the Longevity swaps is much more fair in comparison to some other financial instruments on the market.

The Advantages of the Longevity Swaps



Investment and
longevity risks
separation



No upfront
funding



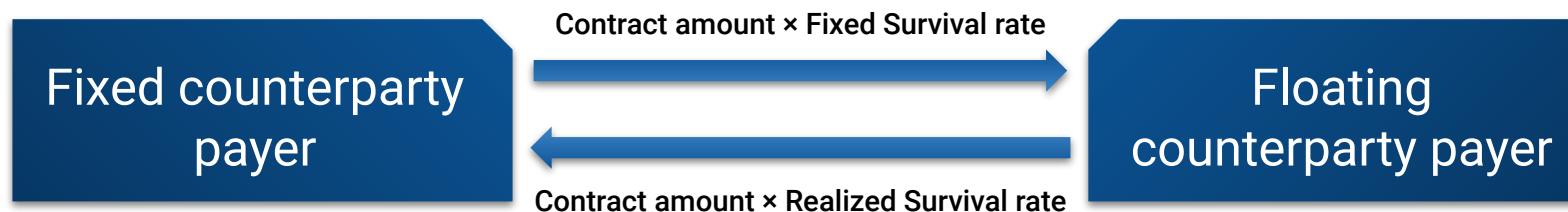
Symmetrical
risk distribution
among
counterparties



Counterparty
risk reduction

Longevity-derived Swaps and Forwards

A **survivor swap** is an agreement **to exchange cash flows in the future** based on the outcome of **at least one survivor index** [Dawson, P. et al. "Survivor Derivatives: A Consistent Pricing Framework.", 2010]. It can be broken down into a collection of a more simple derivative – **the survival-forwards**. An **S-forward** is **an agreement** between two counterparties **to exchange** at a future date, an **amount equal to the realized survival rate** of a given population cohort (floating leg), in return for a fixed survival rate agreed at the inception of the contract (fixed rate payment). The use of the forward's structure is rooted in the fact that this financial instruments are well-known to be easily customizable, allowing to tailor them to a specific commodity and date.



The payoff of the S-forward is then given by:

$$Payoff(T) = p_x - \hat{p}_x$$

Where p_x is the realized survival rate (F_T measurable), and \hat{p}_x is a fixed probability of an individual aged x at time 0 to be alive at age $x + T$.

At the same time, forward contracts (Longevity forwards included) are known "to bring" higher default risk, since they tend to become incoherent to the real market as time passes.

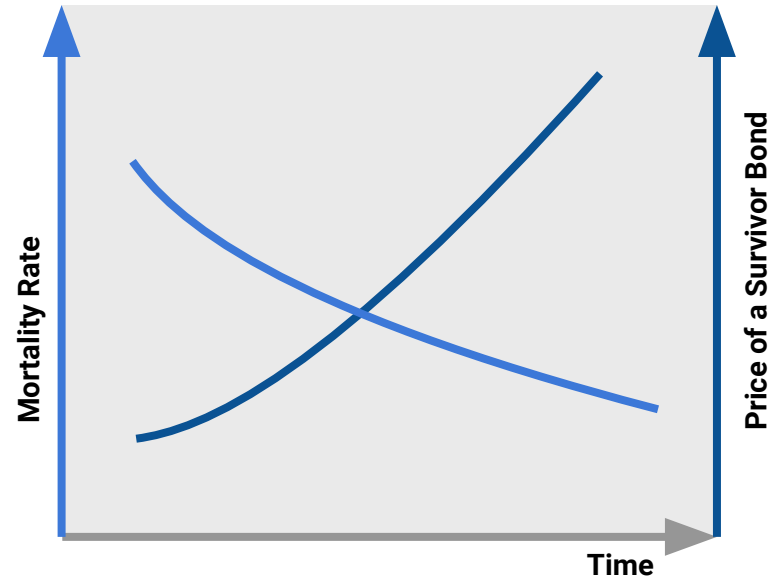
Longevity-derived Bonds

The evolution of financial market instruments has brought a number of **new risk-diversification options** to the attention of investors and new hedging options to companies that carry some specific risks, like longevity risks for insurance companies and pension funds. One of them is a survivor (longevity) bond in which coupon payments are connected to the percentage of a defined population group, especially retirees alive on the day of coupon payment. **The higher survivorship of an aging population causes higher payouts to them, and a more valuable S-bond is a suitable risk-managing instrument.**

There are also **types of longevity bonds** with conditions which can meet different needs:

- **Survivor bonds** continue to pay until the last member of the reference population dies
- **Principal-at-risk bonds** with fixed or semi-floating coupons, principal repayments are connected to a survivor index
- **Inverse bonds** whose price behavior are inversely proportional to traditional longevity bonds.

Correlation between the Mortality Rate and the Price (Coupon) of a S-Bond



In 2003, for the first time in history, Swiss Re issued Longevity principal-at-risk bonds, with a coupon pegged to LIBOR, and a principal pegged to a weighted index of mortality rates in its countries.

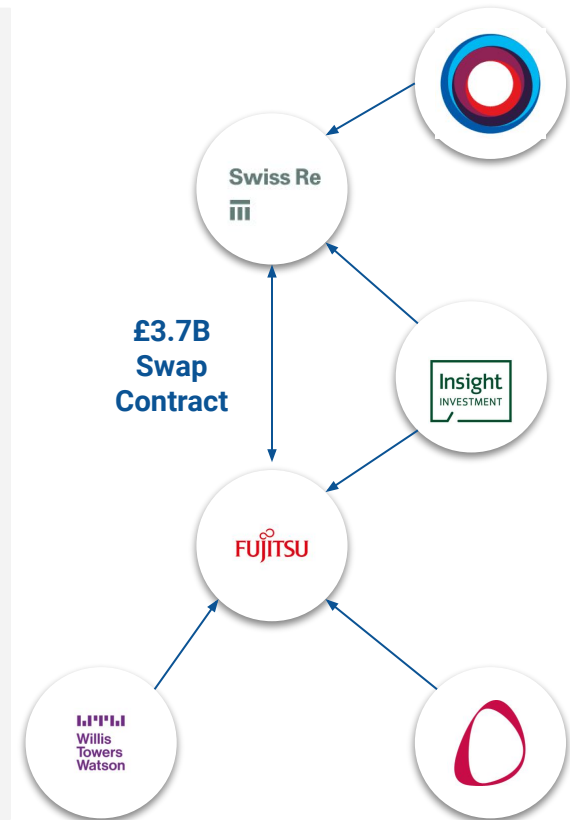
Examples of Longevity Derivatives Users' Activities

Financial institutions which wanted to make a profit from arbitrageurs fees have started to issue longevity derivatives in 2003. Global reinsurer **Swiss Re** offered a three-year mortality bond whose principal payment was tied to an international mortality index. Swiss Re continues making big deals on the longevity derivatives market.

The last deal using longevity swap was signed in May 2021 between **Swiss Re as an arbitrageur** and **The Trustee of the ICL Group Pension Plan, a Fujitsu pension scheme, as a hedger**. This longevity risk transfer insured **£3.7 billion of hedgers' liabilities** and covers pensions in payment for approximately 9,000 members. **Other institutions** of the swap deal infrastructure include:

- **Willis Towers Watson** as actuarial and transaction adviser to the hedger.
- **Gowling WLG LLP and Momentum Investment Solutions and Consulting** as legal and investment adviser to the hedger.
- **Pinsent Masons LLP** as legal adviser to the hedger.
- **Insight Investment** as calculation agent, collateral manager, and collateral valuation agent.

Daniel Harrison, Global Head of Longevity Solutions at Swiss Re says: 'There is a compelling rationale for pension plans and insurers to transfer their longevity risk to reinsurers. We have a natural offset with our mortality business, the capacity to write the business onto our balance sheet, and the expertise to tailor the transaction to meet our client's needs.'



Longevity Biomarkers Financial Applications

Longevity Biomarkers show a great value for financial market, allowing engineering of optimized financial instruments and implementation of the biomarkers-based due diligence and valuation

As was shown, many financial instruments can be formulated in terms of the Longevity. This implies the importance of the development different quantifiable biomarkers' assessment approaches. As a result, such approaches can be used for:



It is important, that use of biomarkers in financial areas will positively affect not only institutional or other “big” players. Biomarkers can become a feasible solution for personal risk management too. Additionally, the active implementation of the biomarker-derived data will provide sufficient means for investment risks management, which will optimize the effectiveness of the allocation process. This, in turn, can provide better and more efficient Longevity solutions for the public.

When time is money, biomarkers are the means for wealth management.