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SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

# THE IMPACT OF HIGH AND LOW INTEREST RATE ENVIRONMENTS AND INFLATION ON LIFE-INSURANCE COMPANIES WITH RISK MITIGATION MEASURES

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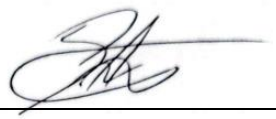
Ljubljana, 4.7.2025 Author's signature: 

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## LIST OF ABBREVIATIONS

**ALM** – Asset-Liability Management

**BI** – Business Interruption (Insurance)

**COVID** – Coronavirus Disease

**CPI** – Consumer Price Index

**DB** – Death Benefit

**ECB** – European Central Bank

**EIOPA** – European Insurance and Occupational Pensions Authority

**FED** – US Federal Reserve

**FRED** – Federal Reserve Economic Data

**GDP** – Gross Domestic Product

**GMDB** – Guaranteed Minimum Death Benefit

**IMF** – International Monetary Fund

**IRS** – Interest Rate Swap

**LIBOR** – London Interbank Offered Rate

**OPEC** – Organization of the Petroleum Exporting Countries

**OTC** – Over-the-Counter (Derivatives)

**PH** – Policyholder

**RBC** – Risk-Based Capital

**RORAC** – Return on Risk-Adjusted Capital

**SCR** – Solvency Capital Requirement

**SII** – Solvency II (Insurance Regulation)

**ULIP** – Unit-Linked Insurance Plan

# 1 INTRODUCTION

The price of borrowing money – the interest rate, is the thing that keeps the economy moving by encouraging people to lend, borrow and ultimately spend. Interest rates vary between different loans, markets and time. They are constantly subject to change, since there are many forces that influence it literally by the minute. Central bank policies, inflation, economic conditions, market sentiment, supply & demand for credit are but a few of many factors that cause constant moving of the interest rate levels. There are two extremes: low interest rate periods and high interest rate periods. We had a low interest rate period after the 2008 crisis, which aimed at decreasing the cost of investing and decreasing unemployment over time. Recently, in 2023, we were in the period of interest rate growth, which acted as an economic activity brake for inflation that was "ravaging". Changes in interest rate aim to achieve broad macroeconomic policy objectives and fix the problems mentioned above, but as a side effect many industries are affected. They influence a wide range of industries including: financial industry, housing & real estate, retail, export dependent industries and many more, insurance business being one of them. Individual sectors may be more or less sensitive to changes in interest rates and the impact on them will vary (Heakal, 2022).

As mentioned above, one of the major "victims" of interest rate changes is the insurance business. Especially life insurers since they sell long-term products whose present value depends on interest rates. Life insurance companies generally cater to two major objectives for customers: protection from adverse financial consequences from loss of life and saving for the future, usually in a tax-advantaged way. Customers expect to receive an expected amount of cash from their policies years after contracts are underwritten, so insurers have to invest in a collection of long-term assets, mostly fixed-income, such as bonds, since their liabilities are largely fixed in size. The risk arises as interest rates change and the value of insurer's assets and liabilities change with them. Perfectly balancing the interest rate sensitivity of assets and liabilities is not always possible, since assets often do not have maturities as long as liabilities. An additional complication are the embedded guarantees or attached riders that promise a minimum return over the policy duration. When interest rates decrease, these guarantees affect how sensitive the product is to interest rate change. Changed policyholder behaviour is also one of the consequences of interest rate changes. It is more difficult to sell certain products to them, such as some annuities, when interest rates are too low. They are also more likely to act on their policies, for example, contribute additional funds or to close out a contract (Berends, et al., 2013).

There is another phenomenon tightly related to interest rate behaviour: inflation. This too has a rather specific influence on insurance companies that needs to be addressed. Prices of most services and commodities remain fairly correlated with the general inflation rate, but the effect on insurance claim payments may be dramatically different. Increases in retail prices are separated into pure price effects and additional manufacturing costs that appear as a result of technological advances. When inflation is measured, the reported Consumer Price

Index (CPI) does not take into account these additional costs. If the automobile price increases by 25%, the component of the CPI related to automobiles may indicate a much lower increase, for example, 10%, ignoring the costs of a more advanced technology that is used. Insurance companies then have to pay more than what is implied in the CPI (Ahlgrim & D'Arcy, 2012).

The key question here is: What can insurance companies do in order to mitigate the effects of these two forces: interest rates and inflation, which constantly fluctuate up and down and simultaneously affect each other. The thesis will analyse how the insurance companies fared during the 1970s–1980s, in the period of the so-called Volcker Shock, which has seen record breaking high interest rates. It will investigate how did they survive the period following the 2008 financial crisis and the subsequent period of low interest rates. Based on these past periods the thesis will present what insurance companies can do today, in order to mitigate the negative effects of the current financial climate.

Risk management is now a vital part of every financial institution and has evolved tremendously in the last few decades. A life insurance firm uses risk management to identify assess and ultimately mitigate various risks in order to ensure its ability to meet the obligations to its policyholders. It encompasses credit risk, market risk, liquidity risk, operational risk, foreign exchange risk and of course interest rate risk, on which I will turn the spotlight.

Changes in interest rates can strongly affect the expected value of insurance liabilities and the impact can be very complex and difficult to estimate.

The purpose of this research is to take a closer look at the principles of interest rates changes and explore in depth how this phenomenon influences the insurance industry. The focus will be placed on 3 different time periods:

- Volcker period during the 1970s – 1980s, with extremely high interest rates,

- post 2008 crisis period, which marks a time of low interest rates,

- current post-covid period, which again sees inflation and interest rates rising.

I will investigate how insurance companies were/are affected during these periods and what they could/can do to mitigate the interest rate risk typical for each period.

I will explore exactly how life insurance companies can manage interest rate risk by matching the cash flows of assets and liabilities and use derivatives to hedge some of the risk, although this can prove to be expensive. The derivatives in question are mostly Interest Rate Swaps (IRS) and Forward Starting Swaps (Forward). I will also explore derivatives such as Interest Rate Options, Swaptions, Futures Contracts, Options on Futures, Constant Maturity Swaps and others. Insurers use these kinds of derivatives to take offsetting positions with derivative holdings and therefore protect themselves against interest rate changes. I will also investigate to what degree life insurers are exposed to interest rate risk and use a two-factor market model to estimate it.

Finally, I will analyse the unique effect that inflation has on insurance companies. It is very important for insurance companies to explore mitigation strategies for extreme inflation or deflation scenarios, which is the only way for them to respond quickly when economic conditions change (Berends, et al., 2013).

My goals are:

- Explain the principles of changing interest rates.
- Explore the Volcker period, post 2008 period and post-covid period in terms of interest rates.
- Investigate how life insurance companies were affected during the listed periods.
- Review interest rate risk mitigation strategies in general and apply them to the listed periods.
- Explore the ways inflation affects insurance claim payments.
- Specify insurer risk mitigation strategies for high inflation and deflation.

The master's thesis will be theoretical in nature. I will read, review and use corresponding scientific articles, papers and academic material used during my master's degree courses. The thesis will mostly be based on the descriptive method, since I will only gather and demonstrate data to reinforce key findings about all the different ways interest rate change and inflation can influence insurance industry.

I will divide the thesis into multiple parts. Firstly, a detailed look at interest rates in general where I intend to explain the principles behind their constant change and their connection to inflation. I will then explore the causes of high inflation rates during the Volcker period, the causes of low inflation rates during the post-2008 crisis and take a detailed look at the current interest rate and inflation situation — the post-covid time. The next part will be a detailed look at all the different ways interest change and inflation influence the life insurance industry, which I will do so for each of the listed periods. The research will then continue to explore and propose different ways to mitigate interest rate risk, specifically for high interest rates and low interest rates environments. Finally, I will apply the gathered data from past examples and try to apply the knowledge to the present time and make suggestions for life insurers in order to battle current rising interest rates and inflation. For the final part, I will focus a bit more on the ways inflation affects insurance claim payments and which mitigation strategies can they deploy in the cases of extreme inflation or deflation scenarios. The different strategies will be divided into three categories: actuarial aspects of risk mitigations, operational aspects of risk mitigation, and investments strategies.

# 2 INTEREST RATE CHANGE BACKGROUND

## 2.1 Interest rates in general

Sometimes you are a saver of money, sometimes you are a borrower of money. If you are saving your money through a bank deposit or a financial security, you get a "reward", a percentage of your savings. You are rewarded for lending your money to a bank, a company or some other institution for a certain period of time. On the other hand, if you are borrowing money, it is now you who has to pay the price. A certain percentage of the whole loan. Institutions that lend you money naturally need compensation for accepting a risk of you not being able to return the money (Bank of England, 2023).

Both percentage amounts described above are calculated based on the interest rate. The interest rate tells you how high the cost of borrowing is or how high the rewards are for saving. (Bank of England, 2023) It keeps the economy moving, since it encourages people to borrow and spend as well as save and lend. Of course, the interest rate is not set in stone. It is always changing and tilting from encouraging borrowing to encouraging saving, and the other way around. Interest levels are a factor in the supply and demand of credit, which means that an increase in the demand for money or credit will raise interest rates, while a decrease in the demand for credit will decrease them. Consequently, an increase in the supply of credit will decrease interest rates, while a decrease in the supply of credit will increase them. The more money we keep in our bank account, the more can be lent forward by the said bank. This causes more available credit or rather an increase in the supply of credit, which decreases the price of borrowing: interest rates. On the other hand, when borrowers decide to defer the repayments of their loans, they are not only increasing the amount of interest rates they will have to pay, but also decreasing the amount of credit available in the market, which causes increased interest rates, since the demand for credit is now larger (Heakal, 2022).

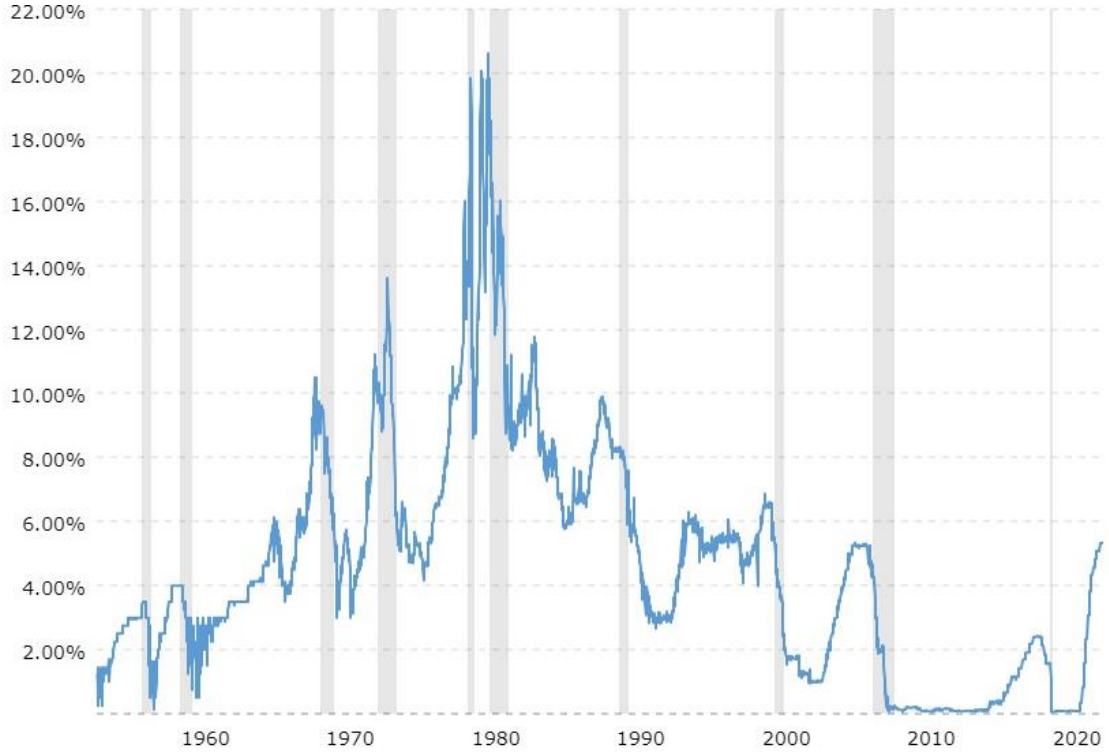
Another two influences on interest rate change are inflation and governments. Interest rates rise together with inflation. With increasing inflation, the purchasing power of money decreases. Consequently, the lenders of credit will demand higher interest rates as compensation for decreasing value of money, which for them basically continually decreases the value of interests. The government on the other hand can influence the interest rate in both directions (Heakal, 2022). Central banks buy treasury securities; therefore banks are injected with more money, which increases their capability of lending. The supply of credit is therefore larger, rendering lower interest rates. This is part of the expansionary monetary policy, enforced by central banks, whose main goal is to kickstart the economy in times of a slowdown or recession. Lower interest rates make saving less attractive and consumer spending increases. When the government sells these securities back to banks, there is less money to lend, therefore we have lower money supply, larger demand of credit in interest

rates that are now higher. This is part of a contractionary monetary policy, which is usually enforced by central banks when the inflation runs too high (Investopedia, 2023).

Interest rate changes therefore influence spending, lending, saving, borrowing, etc. It basically drives the whole economy and every industrial sector is affected. The sensitivity among these sectors varies, as some are more influenced than others. Financials usually benefit from higher rates through increased profit margins and brokerages see an increase in trading activity when the economy improves and higher interest rates cause higher interest income. Industrials and retailers also benefit from interest rates moving higher, while some sectors such as real estate cool down during interest rate hikes. (Bloomenthal, 2023). One of the more exposed sectors are also life insurers, since they sell long-term products whose present value depends on interest rates. Their customers are expected to receive cash from their policies years after they have been issued. Life insurers must invest customers' payments in such a way that the funds are available to satisfy policyholders in the future. To achieve that, life insurers need to invest in a collection of long-term assets that mostly consist of bonds. They generally invest in fixed-income securities, since their liabilities are also largely fixed in size. Life insurer's portfolio usually contains mostly corporate and foreign bonds. These are highly impacted by interest rate change and can put the company in quite a risky position. Companies in general do acknowledge the interest rate risk, but they are not always able to balance the interest rate sensitivity of their assets and liabilities. Oftentimes assets do not have long enough maturities in comparison to insurance liabilities (Berends, et al., 2013).

Interest rates never stand still; they are always fluctuating. A 69-year historical chart shows us the daily level of the federal funds rate all the way back from 1954. The federal funds rate is the interest rate at which banks and credit unions lends reserve balances to other depository institutions. In the graph we see many upswings and dips. The most notable upswing is in the 1980s, during the "Volcker Era". A period of extremely high inflation and consequently high interest rates that were there to calm the inflation down. The most notable interest rates dip is present in the year 2008, after the global financial crisis and a time of a great recession, which meant a longer period of low interest rates, due to governments trying to encourage lending and spending and eventually kickstarting the economy. These are the two extreme interest rate environments in the past 69 years, which we will explore both in detail. Both extremes happened because of unusual historical events, which are: The Vietnam war, Johnson's war on poverty and Nixon's ending of the "gold convertibility" of the dollar that caused Volcker's Shock, risky mortgage products and faulty credit rating agencies that assigned high credit scores to risky mortgage backed securities that caused the 2008s financial crisis. In the last few years, we have seen another two unusual events heavily influence the inflation rate and therefore interest rates: Global Coronavirus pandemic in 2020, followed by the Ukrainian-Russian war. We will also take a closer look at where the inflation and interest rates are today and how do they move (Macrotrends, 2023).

*Figure 1: Federal Funds Rate – 62-Year Historical Chart*




*Source: Macrotrends (2024).*

### 2.2 High-interest rate environment: The Volcker period

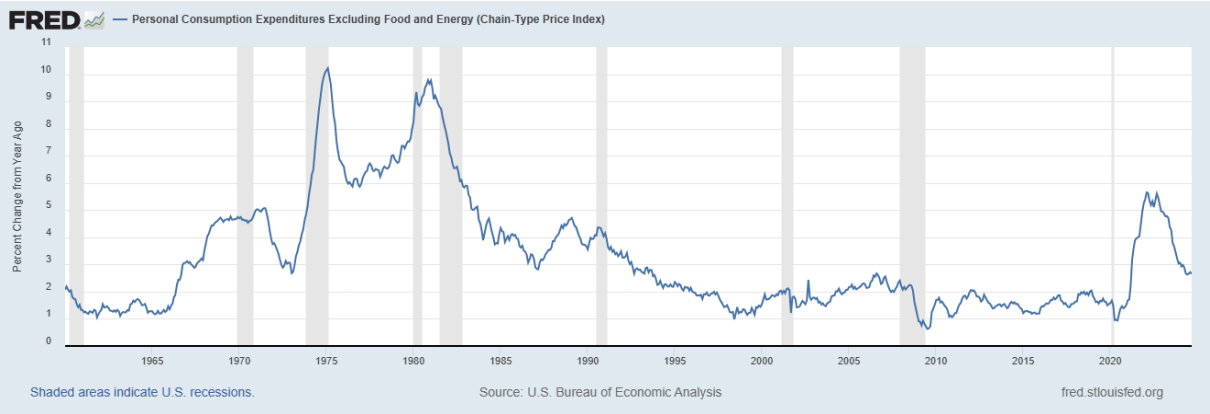
Before 1965 in the US, interest rate was calmly hover around 2%. Inflation was relatively stable, also moving at around 2%. This was the time when President Lyndon Johnson came to power and with him big increases in government spending in the name of war on poverty and escalating war in Vietnam. The majority of it was not funded by newly set taxes, which meant greater deficits. This led to more money in circulation at a time of near full employment. Prices started to move up (Matthews, 2022).

Then came Richard Nixon, who continued spending in the name of the Vietnam war, while also deciding to end the system of "gold convertibility" for dollars in 1971. Prior to that the Bretton Woods system stabilized global exchange rates, as most Western nations pegged their currency to the dollar, which in turn was pegged to gold at a rate of 35$ per ounce. What happened is that there were more dollars floating around than the US had gold to back them up with. Other countries began to demand conversions of dollars to gold at a level that the US simply couldn't handle. Panic ensued as certain countries, like West Germany, exited the system altogether (Matthews, 2022).

Nixon did announce wage and price controls, which would hold back inflation for a little bit, but once they gave way, instability followed. The tipping point was in 1973, when OPEC

countries put the oil embargo on the West, as a means of punishing the US and other nations for supporting Israel in the Yom Kippur War. Between October 1973 and January 1974, the price of gas nearly quadrupled. That was the first spike, followed by the recession ending in 1975. Inflation then ramped up again in 1979, due to surging energy and food prices. This is where Paul Volcker came in (Matthews, 2022).

*Figure 2: Personal Consumption Expenditures Excluding Food and Energy*




*Source: FRED (2024).*

Before August 1979, the Federal reserve (Fed) tried to make small increases in the interest rate, but couldn't tame the prices. Paul Volcker, a vice chair at the time, was pushing for major action. He eventually replaced William Miller as chair, and soon after, started to deploy more dramatic measures. He called a surprise meeting on October 6, 1979, where it was determined that the Fed will allow a much wider band on interest rates, higher than ever before. They also announced regular recalibrations of policies in response to money supply changes, basically saying that if the money supply will grow too rapidly, they would crack down even harder. Volcker wanted to crush the inflation at any cost (Matthews, 2022).

The interest rate increases began. In October 1979 the rate was at 13.7% and by April next year it was already at 17.6%. In 1981 it almost reached 20%. The idea was to limit spending and slow down the economy. An unpopular side effect, of course, was mass unemployment. When Fed raises the interest rates, everything from credit card debt rates to mortgage rates rise. Businesses contract and hire less when they are unable to take out a business loan. People buy fewer homes when mortgages are more expensive. They spend and charge less when credit card rates are high. Less spending, less inflation equals slower growth.

Volcker's strategy took two tries to reach its goal. The first try slowed economic activity down enough, so that by January 1980, the US was in recession. After April, Fed interest rates began to fall sharply, which limited the effectiveness of the strategy. Fed then tried again, tightening even harder and sparking another recession in July 1981, which was far

worse than the first. In 1980 unemployment was at 7.8% and in December 1982 it was at a devastating 10.8%. This was higher than at the peak of the Great Recession in 2009.

Volcker's measures were unpopular, but necessary. The policy regime of raising the interest rates to extreme heights would become known as the "Volcker shock". He left office in August 1987 with inflation down to 3.4% from its peak of 9.8% in 1981. Persistent low inflation followed ever since, or rather until 2022, which was the first year to see inflation above 5% after the Volcker era. Volcker's work was not without its fair share of criticism. Then-Senate Majority Leader Robert Byrd accused Volcker of throwing legions of people out of work and shutting down shifts in factories and mines. He labelled the policy as hopeless. There was also protest from building contractors, carpenters, farmers and many more. The program defiantly had a huge human cost, shocking various industries. Many questioned if Volcker could have broken the back of inflation in a more humane way, without triggering such a catastrophic unemployment. A lot of businesses also drew foreign money since US banks offered interest rates that were simply too high. Volcker shock set off a debt crisis in Latin America. Since many Latin American governments had borrowed from US banks, after Volcker's interest rate hikes, they couldn't keep up with the interest payments anymore. In 1982 Mexico defaulted on its debts, followed by many others. The International Monetary Fund stepped in as a lender of last resort, bailing out Latin American governments, which had to promise to lower deficit spending and adopt structural economic reform. Some governments also had to cut health and other social services, which provoked the critics even further. They claimed that the policy cost human lives by weakening healthcare systems (Matthews, 2022).

### 2.3 The low interest environment: Post 2008 crisis period

The Volcker period was marked as the period with the highest interest rates in the last 69 years, while the period with the lowest interest rates in that same time frame belongs to the Great Recession, which lasted from late 2007 to mid-2009. The period of low interest rates was quite lengthy, stretching into mid-2015. The main goal was that low interest rates reduce the cost of investing and increase its presence in the US. Consequently, unemployment would go down, spending would increase and economy would start to grow again (Berends, et al., 2013).

There are several culprits for the Great Recession. The first one would be a failure on the part of the government in regard to financial industry regulation. The Fed was unable to stop banks from giving mortgages to people who proved to be a bad credit risk. In addition to that, shadow banking, which included investment firms, was in full swing and it was not under the same regulation and scrutiny as depository banking. Borrowing by consumers and corporations was excessive and the understanding of the financial system by the lawmakers was subpar. In the housing market, mortgages were extended at low interest rates to unqualified borrowers. This trend started as early as 2001, when the government tried to

stimulate the economy after the 2001 Dotcom bubble and subsequent World Trade Center attacks. The interest rates were lowered and subprime and adjustable mortgages were created in order to stimulate home ownership. The expectation, regarding interest rates, was that they will in fact remain low and home prices would continue to rise. This optimism persisted until 2004, when interest rates were raised in order to control inflation. Rates on existing adjustable mortgages and loans began to reset at a much higher rate than expected. Many borrowers realized they were not able to pay back the mortgages and the selling slowly commenced. The housing bubble slowly started to grow. Another thing during the housing boom were mortgage-backed securities and complex derivative products, which were massively sold by financial institutions, as profitable investments. As real estate collapsed in 2007, these securities dramatically lost value. Credit markets that helped finance the housing bubble, quickly followed the downward trajectory. Solvency of banks and financial institutions involved hit a breaking point with the collapse of the investment bank Bear Sterns in March 2008. The next major event was the bankruptcy of the country's fourth largest investment bank at the time: Lehman Brothers. The impact was felt in other economies around the world, especially Europe. The US lost more than 8.7 million jobs, with the highest unemployment rate since the Great Depression of the 1930s. Roughly $19 trillion was lost by the US households as the stock market fell (Boyle, 2023).

As a result, the Fed lowered a key interest rate to nearly zero in order to increase liquidity and provided banks with a shockingly high $7.7 trillion of emergency loans. US federal government also launched a massive program to stimulate the economy in the form of $787 billion in spending. The regulation was also tightened up. US congress passed the Dodd-Frank Act, which allowed the government more power to regulate the financial sector and make sure that similar scenario doesn't happen again. With these actions the economy started a slow process of gradual recovery. Unemployment did not fall to 5% until 2015 and real median household income did not recover to pre-recession levels until 2016. Interest remained essentially 0% until 2015 (Boyle, 2023).

### 2.4 The current state of interest rates: Post covid period

Things have played out slightly differently in the years 2022 and 2023. In 2020, the world had the COVID-19 induced economic downturn. In the period dubbed The Great Lockdown millions of people around the world entered a lockdown in March 2020, due to a highly contagious disease caused by the SARS-CoV-2 virus. Necessary steps were taken to bring the coronavirus outbreak under control and consequently the economy came to a halt. As people were forbidden to go outside and spend, certain industries such as travel and hospitality, as well as shops and restaurants basically stopped operating altogether. Airlines and cruise ship operators together with small businesses couldn't rely on tourism money anymore. Seemingly unrelated industries also felt the effect of social distancing, as manufacturers saw fewer orders as shopping slowed down, since the demand for nonessential goods naturally fell. Oil companies marked losses from plummeting gas prices,

since people couldn't leave the house and drive anymore, meanwhile, banks absorbed the losses of mortgage payments, due to governments enforcing forbearance rules in some countries. All of the above, was amplified by the constant fear of the unknown and cautious preparations for the potential financial aftershock. Even stable households limited their expenditure substantially (Kurt, 2021).

The Fed noted that the early economic slump was comparable to the early months of the Great Depression of 1929. Luckily, the economy bounced back quickly, since the introduction of unprecedented stimulus measures helped prevent the catastrophe with the already known outcome. The rebound started later in 2020 and was then additionally boosted by the swift arrival of vaccinations, which aimed to slow the spread of the virus. The coronavirus economic toll was nonetheless very severe, the main reason being the high level of contagiousness. Scientists quickly figured that the virus will in fact reach the whole world's population very quickly, if drastic control measures were not established. The sudden drop in economic activity increased unemployment in the US to as high as 14.8% in April 2020, with estimated 25.7 million US workers being impacted by the pandemic. The International Monetary Fund (IMF) revealed that the global economy contracted by 3.1% in 2020, with the record breaking gross domestic product (GDP) decrease of 9.1% in the second quarter of 2020. The signs of a recession started to show themselves, but the government acted quickly. Several stimulus legislations were established, US treasury was opened to send money to impacted individuals directly and interest rates were cut to boost liquidity. The Fed lowered the interest rate to near zero in March 2020 (Kurt, 2021).

The economy slowly started to get back on its feet in the late 2020 and 2021, as many Fed forecasters predicted, inflationary pressures started to appear as a consequence of the large fiscal packages that the US government has deployed. The demand for workers has increased, which put upward pressure on wages and those affected prices. The prices were the primary driver of 2021–2022 inflation, with commodity prices and sectoral price driven by a combination of pandemic induced glitches in supply chains and a big shift from service demand to mostly goods demand. Inflation naturally brought the increase in interest rates. The federal funds rate started rising from 0 in May 2022, and in November 2023 it set at 5.33%. It is nowhere near the record-breaking interest rates of the Volcker period, but nonetheless it is a steep climb (Blanchard & Bernanke, 2023).

In November 2023 the future seemed uncertain. The Fed was unclear whether it will raise rates again before the year's end. The argument is that these high interest rates are putting enough pressure on businesses and consumers to drive the economy into a recession in 2024. Many experts, like Aneka Beneby, portfolio manager and director at Julius Bär Group, did not think that the recession will happen. The argument is that the consumer price index data was lower than a year ago and that it confirmed the deflationary trend. The Fed rate hikes were expected to halt at the year's end and the economy would moderate. On the other hand, experts like Charlie Dougherty, senior economist at Wells Fargo, thought that, although the worst of inflation was behind us at that time, a recession still loomed for the second half of

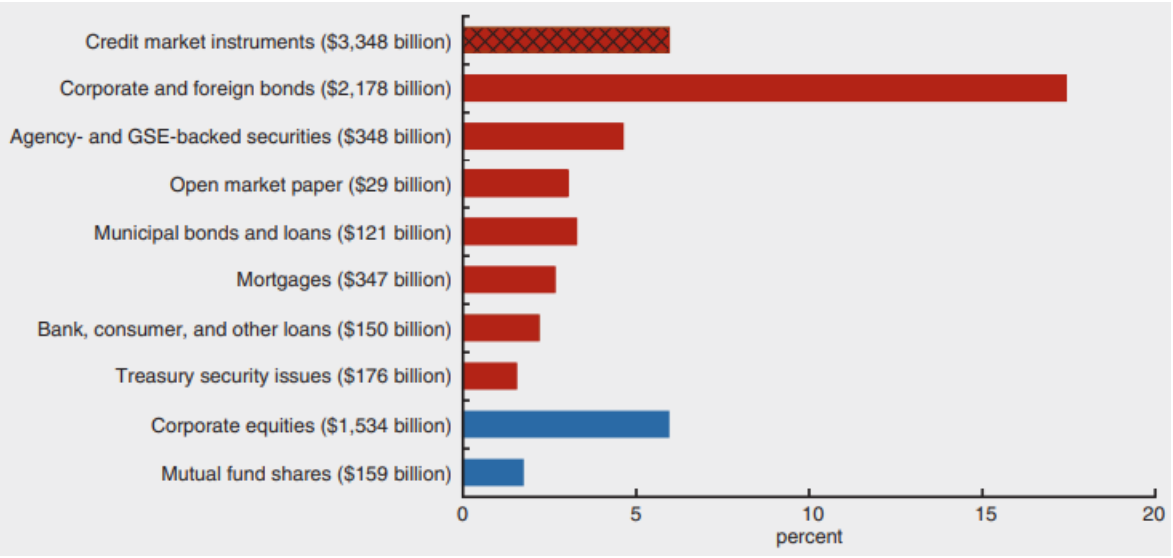
2024. He predicted that the Fed's cuts will in fact trigger a mild recession in order to reach its target inflation rate of 2% in the long run. Whatever happened, various industries remained alert.

## 3 INTEREST RATES AND LIFE INSURANCE

As described in the chapters above, we have seen incredibly high and incredibly low interest rates during the last 70 years. Many industries were affected, including the insurance industry. Interest rates changes especially affect life insurers, because they sell long-term insurance products whose present value depends on interest rates themselves (Berends, et al., 2013).

By buying life insurance policy, life insurers provide customers with protection from adverse financial consequences resulting from loss of life and by buying an annuity policy, life insurers provide protection from exhaustion of financial resources over time. Their additional objective is also to allow customers to save money for the future, usually in a tax-advantaged way. Life insurers are therefore expected to provide a certain amount of cash years after the policy has been issued and face the challenge of investing the customers' payments in a way that matches the promised amount in the future. This is achieved through investing largely in fixed-income securities, since their liabilities towards their customers are fixed in size, though not exclusively. Most of life insurers portfolios consist of corporate and foreign bonds. An example of Life insurer's aggregate share of assets:

*Figure 3: Life Insurance Industry's Aggregate Share of Assets*




*Source: Berends, et al. (2013).*

These are long-term assets, and the moving interest rate moves their value up and down constantly. The larger the time frame, the bigger the risk. It takes a lot of calculating and forecasting to achieve the desired amount in the end. We must also add the liability interest rate sensitivity in the equation, and we got ourselves a proper challenge. Life insurers are mindful of the interest rate risk, but they are not always willing or able to completely balance the interest rate sensitivity of their assets and liabilities. Interest risk management is therefore a must-have for any insurance company.

## 3.1 The effect of interest rate change on the insurance industry

Life insurer's long-term assets and liabilities are under direct influence of the interest rate changes. For example, we can take a whole life policy, where policy holders make a set of fixed payments over time and in exchange receive a larger fixed payment in the future. This future payment has an expected value today, which can be later altered by the interest rate changes. Especially in the case of lower interest rates, which can cause future payments to carry more weight and make insurer's liabilities larger in the end. The value of insurance company's assets must then match the values of their liabilities in order to back them, and the goal is that the interest rate sensitivity of the two also synchronises or at least sits close in the end. This is difficult to achieve, since the assets with maturities, as long as those of some liabilities, are not always available, especially in a life insurance policy. There are also some additional complications that arise, for example: one complication here can also be embedded guarantees or attached riders that promise a minimum return over the duration of their policies and can affect how sensitive these insurance products are to the interest rates. Interest rate risk is also magnified by the policyholder's behaviour, since their demand for certain products is affected by interest rates.

### 3.1.1 Interest rates and insurer's stock prices

As already pointed out, life insurance companies invest in fixed-income securities in order to obtain stable returns and pay out the promised amount to the customer on the chosen date in the future. Insurer's security of choice is, as mentioned, a bond. A bond's return is determined by the interest rate in that particular point in time. If a ten-year bond was released during Volcker's high-interest rate period, it will hold a determined high return for ten years and if it was released during post-2008 period, it will hold a low return for ten years. To demonstrate how interest rate changes indirectly affect stock prices of life insurers via bond prices we can place ourselves in Volcker's period of high interest rates. A certain amount of bonds with high returns was underwritten back then. Simultaneously, a certain amount of annuity contracts was underwritten. Insurance company immediately starts buying these bonds in order to ensure stable and adequate returns that will provide the future funds for the customers, as well as insurer's proportionate profit. But then implements measures,

described in the chapter: “2.2. High-interest rate environment: the Volcker period”, which drastically lowers interest rates. What happens is the following: the promised amount to the insured clients remains unchanged, but new bonds that are now available on the market, have much lower returns than before as a consequence of the interest rate reduction. But the insurance company still needs the same returns as before, otherwise the whole calculation doesn’t add up. The thing is, these older high return bonds are still on the market, but their price has jumped up, since they are now way more desirable and harder to get. Insurance companies still have to buy them, because assets and liabilities must match. Of course, this presents a drastically larger cost for the insurer and ultimately bites in its capital and consequently the stock price goes down. Therefore, publicly traded insurance companies must always analyse their stock price sensitivity to changes in bond returns. The relationship between life insurer stock returns and bond returns differs across life insurance firms of various sizes. We shift the focus to low interest rate environment: 2008 crisis. Before that point in time, life insurer’s stock prices and ten-year Treasury bond interest rates were not significantly correlated. Then the crisis happened, and a period of low interest rates followed. Stock returns of life insurance firms then showed a negative correlation with bond returns. When bond prices increased due to interest rates fall, stock prices decreased (Berends, et al., 2013).

### 3.1.2 Interest rate risk and embedded guarantees

Many of the products offered by life insurers have guarantees embedded in the policy or a guarantee attached as a rider. The most common case of a guarantee is a minimum periodic rate of return to the policy cash value. This ensures that the policy cash value will grow by at least some minimum percentage each period. The rate is specified at the exact moment that the policy is sold. It is said that the guarantee is either in the money or out of the money, comparing the guaranteed return with the return without the added guarantee (Berends, et al., 2013).

- In the money: If the guaranteed return exceeds the return from the policy's investments, the insurers funds the difference from its own assets.
- Out of the money: If the guaranteed return does not exceed the return from the policy's investment. In that case the investment return is also the final return that the customer receives.

When policies are sold, they are usually “Out of the money”, with the guarantee set below market interest rates. When interest rates drop, as in the post 2008 crisis period, the option goes “in the money” and that guarantee causes insurers to lose money, since they now have to compensate for the drop in value. In the year 2010, shortly after the crisis and with interest rate sitting close to 0 (0,20%), 95% of all life insurance policies and 70% of annuity contracts in the US contained a minimum interest rate guarantee of 3% or higher. The interest rate

drop, at that time, caused a big impact as they had to cover the policy payouts at a guarantee rate from their own pockets (Berends, et al., 2013).

#### 3.1.3 Interest rate risk and policyholder behaviour

Another factor that adds to the insurer's exposure to interest rate risk is the behaviour of its policyholders. Interest rates naturally affect policyholder's demand for certain insurance products. During low interest rate periods insurers can only offer annuities with low return, since that is the only way they can make money. Policyholders are naturally less interested in that, instead they are more inclined to wait for a better opportunity down the line (Berends, et al., 2013).

Policyholder behaviour causes another complication with previously explained guarantees, since they offer options to policyholders. When a guarantee is "in the money" and generates a higher return for the policyholder than the invested funds, then the policyholder has the motivation to deposit additional funds into the policy if the latter allows for flexible premiums. This causes even bigger expense for the insurer, who now has to increase the guarantee payments. It also works the other way around. Policyholder can limit cash withdrawals from the policy and wait for the more optimal time for the payout, which again leaves the insurer with a bigger expense. This also causes the lengthening of the maturity of liabilities and therefore even magnifies the discrepancy between assets and liabilities. Historically, policyholders do not always exercise their embedded options optimally, but they do magnify the degree to which minimum guarantees affect life insurers to interest risk, because they increase withdrawals from fixed deferred annuities, when interest rates rise and decrease withdrawals from them, when interest rates fall (Berends, et al., 2013).

### 3.2 The effect over the three periods

#### 3.2.1 The Volcker period

What happens to life insurers when the interest rate increases rapidly? At first glance, higher interest rates seem positive to life insurers, since the yields on new investments tend to increase and guarantees are usually "out of the money", which means that insurers do not have additional costs. But of course, it is not that simple. In the Volcker period, we saw an incredibly sharp rise in interest rates: from 13.7% rise in 1979 to nearly 20% in 1981. (Matthews, 2022). These are record breaking rates and the phenomenon introduced the so-called disintermediation risk, which refers to the potential that policyholders may relinquish policies due to rising interest rates. Policyholders started to surrender policies faster than expected, since they expected higher returns elsewhere. This resulted in cash flow

obligations for insurers that exceeded their returns on investment assets. This negatively impacted their balance sheets and caused a considerable impact on their equity value (IRMI, 2024).

Due to such policyholder behaviour insurers needed to reset rate guarantees, and pricing more frequently than they had in recent times in order to match market pressures. Equity-indexed life insurance and annuities in general became less attractive, because of high interest rates coupled with fluctuating equity markets punctuated by periodic crashes. As rates rise, insurers also had to offer substantially higher interest rate guarantees (Marra, et al., 2024).

As mentioned in the beginning, high interest rates do have their positives. Life and annuity providers will have less trouble covering legacy blocks of annuities and insurance products with high minimum rate guarantees. High interest rates also mean high return of the assets. Insurers may also offer fewer buyouts on products like fixed annuities. On the other hand, property & casualty (P&C) insurers could face difficulties with coinsurance terms, when interest rates rise along with inflation. Coverage in such environment may not be adequate to make policyholders fully compensated after a loss (Marra, et al., 2024).

The consequences of rising interest rates for insurers are:

- Less challenging pursuit for yield than when interest rates were close to zero. Insurers now have the freedom to rebalance their portfolio if they see fit. They can move back to more traditional and riskier investments and rely less on alternative asset classes.
- Greatly increased capitalization ratio, which assesses the proportion of a company's capital that comes from equity (ownership) compared to debt (liabilities). This relieves some of the pressure on insurers' assets performance, which causes insurers to avoid underwriting interest-rate-sensitive insurance policies, which can usually be more lucrative.
- Reinsurers may see a decline in their transactions, since insurers now have less need to insure themselves or transfer interest rate risks somewhere else.
- P&C insurers may experience fixed-income asset value deterioration, unpredictable claims trend and poor underwriting performance. This is apparent especially for insurers that maintain longer-tail casualty reserves. They are more likely to experience reserve volatility in a high-inflation environment, since medical costs greatly increase (Marra, et al., 2024).

### 3.2.2 Post 2008 period

What happens to insurers when interest rate decreases rapidly? There is a general belief — both among investors and insurers — that a period of low interest rates hurts life insurance firms the most. After the 2008 crash, the interest rates lows stretched far into the future, ending in the mid-2015. During that time, specifically between December 2010 and

December 2012, when market was strong, stock prices of life insurers were falling. Standard & Poor's (S&P) 500 Life & Health Index is used to track the stock performance of life and health insurance firms in the US and during that period it measured a 9% decrease, while S&P 500 Index, which tracks the stock performance of the top 500 publicly traded firms of the U.S. economy detected an 18.5% increase in other industries. This was all happening with interest rates being near zero. A survey was conducted and showed that 45% of life insurer's CEOs think that a prolonged low interest rate environment may be the biggest threat for their business (Berends, et al., 2013).

A prolonged period of near-zero interest rates caused life insurers' investment yields to be lower, which also made it harder for them to make new business, since yields on their products also had to be reduced, rendering them less attractive to new and existing customers. Berends, et al. (2013) in their study assessed the actual detrimental impact of low interest rates on life insurance companies stock prices. The authors studied publicly traded life insurance companies from August 2002 until December 2012. The purpose was to examine the sensitivity of the life insurance sector before and during the low-rate period. They analysed the sensitivity of insurers' stock prices to changes in bond returns, which were of course under the direct influence of interest rate changes. The relationship between the two factors changed over the course of their sample period and it also varied across different sizes of life insurance firms (Berends, et al., 2013).

Before the 2008 crisis, life insurance stock prices were not significantly correlated with ten-year Treasury bond interest rates, but after the crisis stock returns showed a negative correlation with bond returns. Interest rates fell and that made older pre-crisis bonds, containing higher yields, much more desirable and consequently more expensive. Life insurers desperately needed these kinds of bonds in order to match the returns of their assets with their liabilities, which were also underwritten before the crisis and therefore promised high returns to the insured. Life insurance firms were paying big money for these bonds and that caused a big financial impact. Their stocks fell simultaneously with the bond price increase, hence the negative correlation. The research showed that the more assets the firm held, the higher the negative correlation between its stock price and bond price. Presumably, because the number of more expensive older bonds, which they had to buy, was larger, and the financial impact was more significant. Smaller insurance firms, which themselves are no small companies, since they are nevertheless publicly traded, had essentially no correlation between their stock price and bond price (Berends, et al., 2013).

The conclusion of their research was that at least for large life insurance companies, low interest rate periods are extremely bad. Interest rates fall, which in turn increases bond prices, insurers then spend a lot of money buying these bonds and they suffer financial losses which in the end decrease their stock price. All this happens because liabilities are longer-lived than assets. The former were underwritten before the post-crisis low interest period; therefore, they promised higher yields to customers that they now have to fulfil (Berends, et al., 2013).

There is another complication that further hindered life insurers during the prolonged period of low interest rates after the 2008 crisis: Embedded guarantees or attached riders that promise policyholders a minimum return over their policy duration. In some cases, such as Germany, the minimum return guarantees and minimum profit participation rates are set by the regulator and cannot be changed during the contract's lifetime. The problem arises, because interest rates are constantly changing during this time and their drop puts the insurer in a problematic position, often even in danger of insolvency. A study conducted by Swiss Re in 2012 highlights that in some jurisdictions, such as the U.S., Germany and Italy, the exposure to interest rates risks of long-term savings products with guaranteed minimum returns appears to be alarmingly high (Berdin & Gründl, 2015).

A guaranteed minimum return is the amount that the policyholder is set to receive regardless of the actual returns from assets that cover the policy. It is set up as a safety net in case interest rates fall and the returns from assets fall with it. This increases the "safety" of the product, therefore making it more attractive to new clients. Insurers usually set the rate lower than the projections of the actual assets returns, for example: if a policy promises 10% returns from its assets, the guaranteed minimum return is usually set to 5%. If actual returns fall to 0%, the client still gets those 5%, which are then covered by the insurer itself. When the insurer has to cover the guarantee, due to the failure of their assets, we say the guarantee is in the money. If interest rates don't fall, the guarantee is covered by the assets themselves, and we say that the guarantee is out of the money. If the assets return is even higher than the minimum guarantee, for example 10% opposed to 5% minimum guarantee, the client will usually collect the total return, in that case 10% (Berends, et al., 2013).

A prolonged period of low interest rates that spanned from 2008 to 2015, caused a lot of insurers to battle with insolvency, since they had to cover all the "in the money" guarantees that they underwrote before the crisis. This also caused the maturity lengthening of their liabilities, since policyholders did not want to access the cash value of their policies. Putting the cash value in some other investment during the low interest rate period would mean less returns for them, so they rather stayed under the "cozy" guarantee receiving policy. For insurers this was catastrophic, since their capital was being eroded by these payments, which they were under contract to fulfil (Berends, et al., 2013).

In order to assess and quantify the effects that the low interest period had on life insurers, Elia Berdin and Helmut Gründl examined a collection of balance sheets of German life insurers in 2015. They generated a stochastic term structure of interest rates, which was used to simulate different real-life scenarios. They also set different stock market returns, in order to simulate investment returns of a life insurance company for a multi-period setting. They observed the evolution of a life insurer's balance sheets over time, specifically focusing on their solvency. During the study, they re-calibrated capital market settings and different setups of capital endowments, in order to create different scenarios that the life insurer might find themselves in. Their conclusions are matched with the 2013 study of stock returns vs. 10-year treasury bond, mentioned in the previous paragraph: A long duration of low interest

rates substantially affects a life insurer's solvency, as it struggles to maintain sufficient capital. The cumulative probability of default was estimated to be relatively high, especially for less capitalised companies. German life insurance regulation addressed the specified issue with the new reform, which has a beneficial effect on the said probability of default, as a direct consequence of the reduction of payouts to policyholders (Ruggirello, 2015).

Germany was chosen as the country of focus of this observation, since its exposure in regard to interest rate risk is one of the most prominent. As highlighted in the study by Swiss Re, Germany is one of the jurisdictions, where products with minimum guarantees are very popular and where the regulator imposes the minimum participation mechanism. As covered in the previous chapters, minimum return guarantees during low interest rate periods may be extremely detrimental for life insurers, since they have to cover the "in the money" guarantees from their own pockets. Regulatory imposed minimum profit participations certainly do not help the insurer's capital during these times. The profits that could be used for reinvestment and recovery of the company, must now be paid out to customers as well. In addition, the monetary policy conducted by the European Central Bank (ECB) in 2015, caused the fall of interest rates in the first place, as well as dragged down the value of German sovereign bonds. These are the bonds that usually account for a large portion of the aggregated asset portfolio of German life insurers, which then meant incredibly poor investment results and even bigger discrepancy between their assets and liabilities. A very similar scenario occurred in Japan in the 1990s. A combination of high guarantees on outstanding life insurance contracts and low interest rates. Japanese insurers issued policies that guaranteed returns of 5-6%, expecting that high interest rates would persist, however in the early 1990s the Japan's asset price bubble burst and consequently interest rates plummeted. With it, insurers' investments tanked, because they invested heavily in domestic stocks, real estate and corporate bonds. In addition, Japanese regulatory framework was relatively weak in the early 1990s, with lax oversight and insufficient capital adequacy requirements. There was also a demographic issue in the form of a shrinking and aging population causing increased payouts and slowed policyholder growth. Consequently, seven mid-size Japanese life insurers declared insolvency between 1997 and 2001, as profitability and solvency levels decreased drastically (Berdin & Gründl, 2015).

For their experiment Berdin and Gründl set up five different capital endowment situations. Five different balance sheets (BS) with an increasing amount of own funds at book values.

*Figure 4: Balance Sheet's Capital Endowment*

| | *BS 1* | *BS 2* | *BS 3* | *BS 4* | *BS 5* |
|---|---|---|---|---|---|
| $(CB_0)/(L_0^{P,BV})$ | 0.036 | 0.044 | 0.05 | 0.06 | 0.084 |
| $(E_0)/(L_0^{P,BV}+B_0)$ | | | 0.017 | | |
| $(E_0+CB_0)/(A_0^{BV})$ | ≅0.051 | ≅0.058 | ≅0.063 | ≅0.072 | ≅0.093 |

*Source: Berdin & Gründl (2015).*

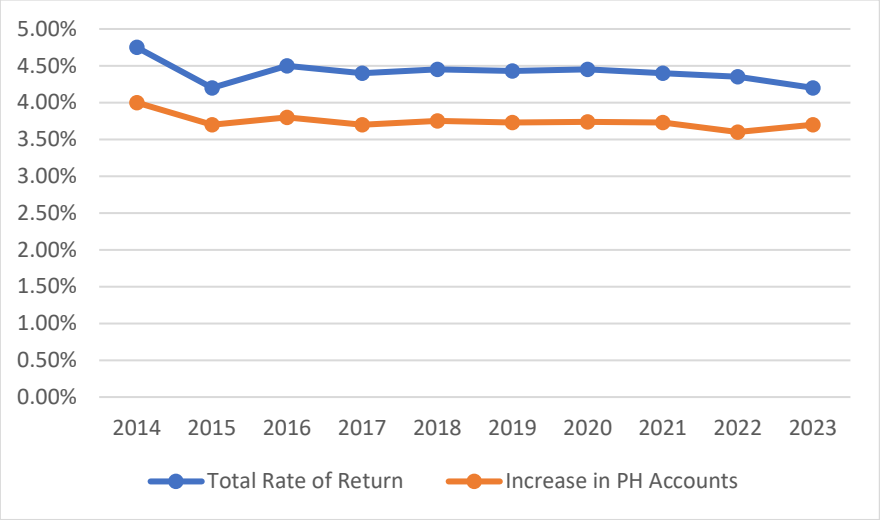
$CB_0$ stands for capital buffer and $L_0^{p,BV}$ stands for book value of liabilities, therefore each consecutive balance sheet has a larger capital buffer, which is used as an extra amount of capital held by the insurers, above their minimum regulatory capital requirement. It serves as a sort of a "cushion" that absorbs potential losses during problematic periods, such as a low interest rate period. $E_0$ stands for equity capital endowment, which represents the initial investments of equity or ownership by founders, investors or shareholders. $A_0^{BV}$ represents the book value of assets. In short, the table shows us that the listed balance sheets have an increasing amount of own funds at book values. Each of those five initial capital endowments (BS 1-5) presents a different capital insurance company balance sheet and each of them will then be put to the test through 3 different capital market calibrations, which we use to simulate 3 different capital market scenarios. The three capital calibrations are:

- Calibration 1: The baseline scenario, where interest rates stay at a similar level as in 2013 (0.75%) and then later recover to their long-term equilibrium.
- Calibration 2: The 1990s Japan-like scenario, where interest rates remain on a lower level and stay there indefinitely (In 1990s Japan interest rates fell from 6% to 0% and haven't changed significantly since).
- Calibration 3: The favourable scenario, where interest rates gradually recover towards a higher level (Berdin & Gründl, 2015).

Results for calibration 1

Capital market calibration 1 presents median values of interest rates in 2013, which is a baseline scenario. In May 2013, the benchmark interest rate in Germany, set by the European Central bank, was 0.75%. (Trading Economics, 2024) It's important to note that the research was conducted in 2015, therefore the data presented is strictly a forecast. This applies to all the following figures regarding this particular research paper. Figure 5 compares the total rate of return (of insurer's assets) with the actual growth rate of policyholder's accounts (insurer's liabilities). All 5 balance sheet endowments (BS 1-5) display a similar development regarding this category, since low interest rates lead to low returns of insurer's assets, which cause that policyholder's accounts grow in most cases, at their minimum guaranteed return, no matter the asset allocation.

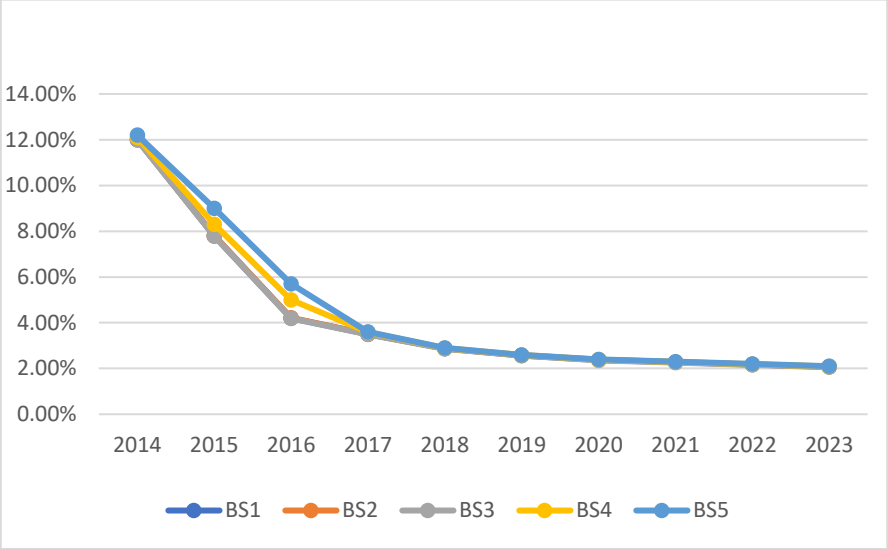
*Figure 5: Total Rate of Return and Increase PH Accounts (BS 1-5) – Calibration 1*




*Source: Berding & Gründl (2015).*

The insurer now must increase the level of technical reserves, since the discount factor (the reference interest rate) is now decreased and must then distribute part of the hidden reserves. As interest rates continue to remain at a low percentage, the discount factor adjusts downwards and the value of the insurer's asset portfolio actually increases, which implies the creation of additional technical reserves and an increase in policyholder's payout benefits. This is a mere accounting adjustment, and no actual change occurs in the final payout to the policyholders. The main consequence of creating additional technical reserves is the increased policyholder's claim, generated by the asset's side. This also means that fewer funds are left over for dividend payments and additional returns. In order to avoid or reduce the so-called *funding gap,* the insurer would always cash in the hidden reserves, if they exist. Figure 6 demonstrates how these reserves are supposed to be paid out to policyholders, in order to offset the lower return on assets. Under all capital endowment calibrations (BS 1-5) the decrease in hidden reserves follows a similar development. In the first three years, outstanding liabilities are very expensive and cannot be covered with the cash-flows alone. This is both because of the guaranteed returns that make insurers cover policyholders from their "own pockets", along with hidden reserve-sharing regulation. The latter has an impact, because when a lower capitalized insurer suffers a higher funding gap, more capitalised insurers need to share a proportionally higher amount of hidden reserves. These are the reasons why all different capital endowments move at a similar pace in this figure 6 (Berdin & Gründl, 2015).

*Figure 6:Hidden reserves in Percentage of BV of Assets – Calibration 1*



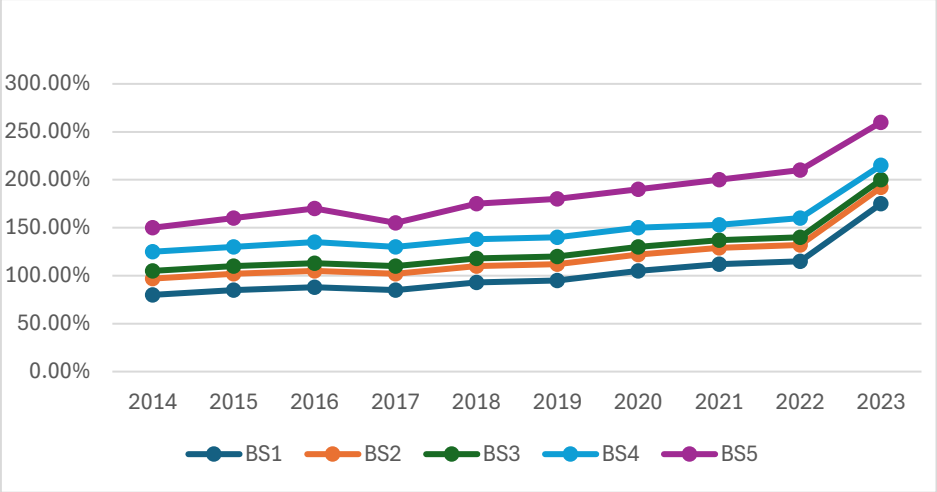

*Source: Berdin & Gründl (2015).*

Berdin and Gründl set up market calibration 1 using the stochastic process underlying the term structure that is featuring a mean reverting behaviour, which means that in this scenario interest rates eventually rise towards their long-term equilibrium, which in turn contributes to the eventual decrease in disposable hidden reserves, as seen on the figure 6. We can see a similar consequence in figure 7, which shows us that with each year, the Solvency Ratio gradually increases, and it does so for all 5 capital endowment calibrations (BS 1-5), although here we see that each consecutive balance sheet is higher on the graph. As previously mentioned, Capital Buffer size increases from BS 1 to BS 5. The larger the capital buffer, the higher solvency ratio is assigned to the balance sheet. Solvency ratio is defined as $(OFt)/(SCRt)$, with $OFt$ being the market value of own funds (the difference between the market valuation of assets and liabilities) and $SCRt$ being the solvency capital requirement (Berdin & Gründl, 2015).

As already pointed out, the duration of liabilities and assets in the insurer's balance sheets are mismatched, with liabilities generally having longer maturities compared to the assets that are used to cover them. In Calibration 1 scenario, the increase in the market value on the asset side is more than offset by the increase in the market value of liabilities. Higher average duration of the liability side results in higher sensitivity to interest rate changes. These liabilities carry the same interest for the whole duration, all the while different assets come and go and the latter all have different returns, which in the end creates a discrepancy between the two cumulative returns. A low interest rate environment also makes high return assets more expensive and harder to acquire. In other words, there is an increase in the value of liabilities compared to assets, which has strong implications for the solvency of the insurer. The higher present value of liabilities becomes damaging for the solvency situation for all different capital endowments (BS 1-5). In figure 7 we can see that both BS1 and BS2

already have on average below 100% of own funds, which means they are below the solvency capital requirement (SCRt) (Berdin & Gründl, 2015).

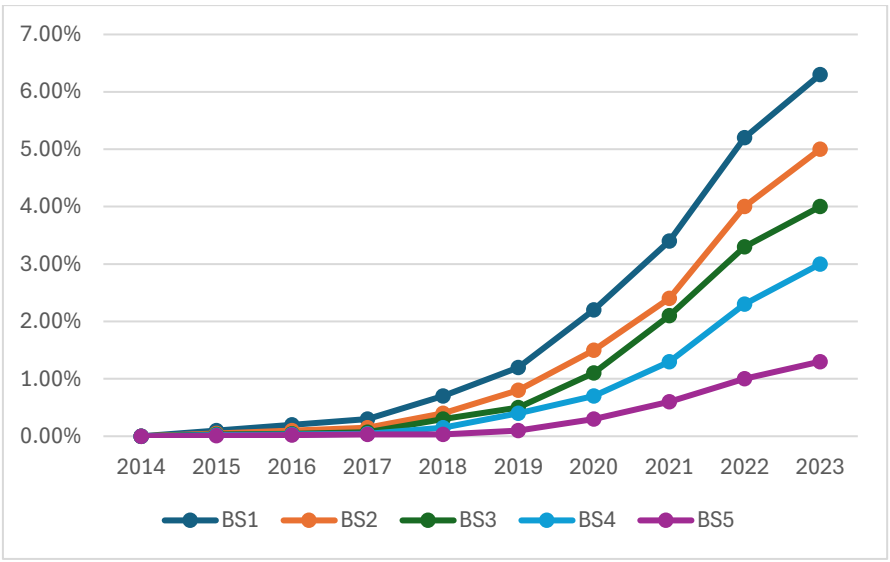
*Figure 7: Solvency Ratio – Calibration 1*




*Source: Berdin & Gründl (2015).*

During the years, the Solvency ratio gradually recovers, but since the interest rates remain on a low level, the cumulative probability of default, which is calculated as the number of iterations with negative OF (Own Funds), gradually increases, with the least capitalised capital endowment having the highest percentage of 6.5% in 2022. To get a more general picture, the calculated average of all 5 capital endowments is 3.95% at the end of 2023 (Berdin & Gründl, 2015).

*Figure 8: Cumulative Probability of Default – Calibration 1*



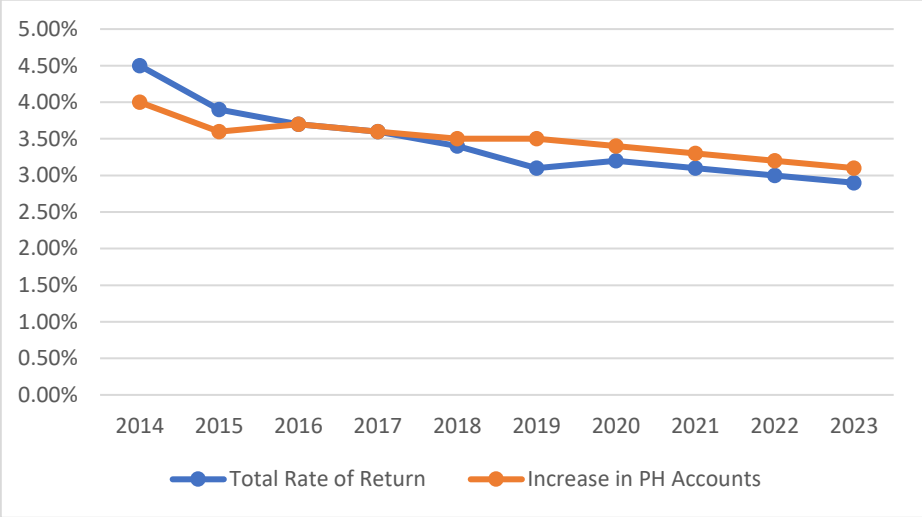

*Source: Berdin & Gründl (2015).*

Results for calibration 2

Capital market calibration 2 presents the most adverse scenario, where interest stay at an even lower level. It mirrors the mentioned Japan case in the 1990s, when interest rates fell from 6% in 1990 to 0.5% in 1996 and then eventually to 0% in 1999. They have since remained there, with small bumps here and there, but went even in the slightly negative territory with 0.1% in 2015 (Trading Economics, 2024). High minimum guarantees caused many life insurers to fall and declare insolvency. The capital market calibration 2 used in the research is a little more optimistic than the actual interest rate situation unfolding in Japan and therefore features an eventual recovery of the interest rates, albeit less prominent as in capital market calibration 1. This is why we are nevertheless able to see the eventual increase in solvency ratio through the years (Berdin & Gründl, 2015).

Here the total rate of return is lower than it was in Calibration 1. It also becomes lower than the Policyholders accounts and creates a funding gap, which vastly increases the amount of hidden reserves that have to be shared with policyholders. The two categories move pretty much the same for all 5 capital endowments (BS 1-5).

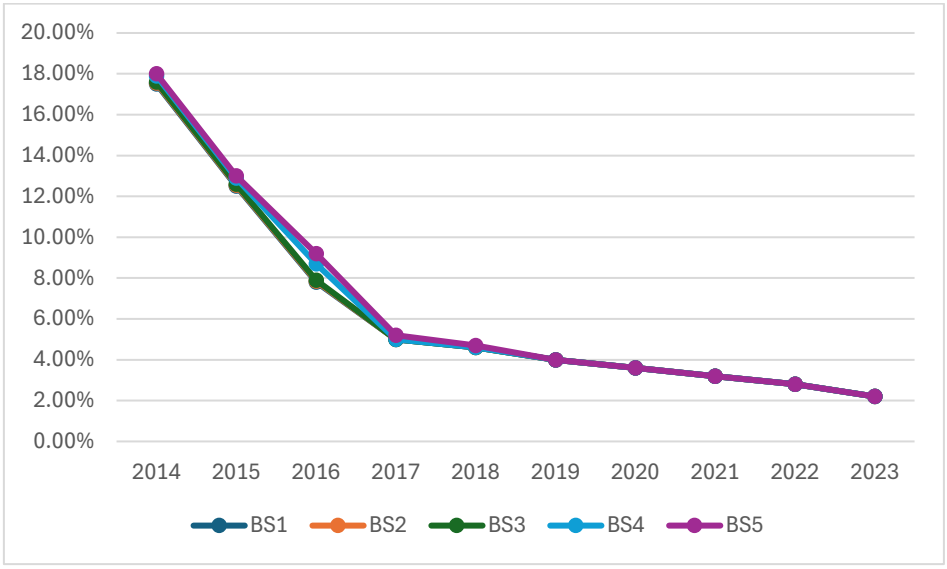
*Figure 9: Total Rate of Return and Increase PH Accounts (BS 1-5) – Calibration 2*




*Source: Berdin & Gründl (2015).*

The reduction of hidden reserves in this scenario is actually similar to the one in Market Calibration 1, only much higher. Hidden reserves decrease quickly during the first three years due to the bond portfolio adjustment to the new market interest rates, hidden reserves sharing and the funding gap.

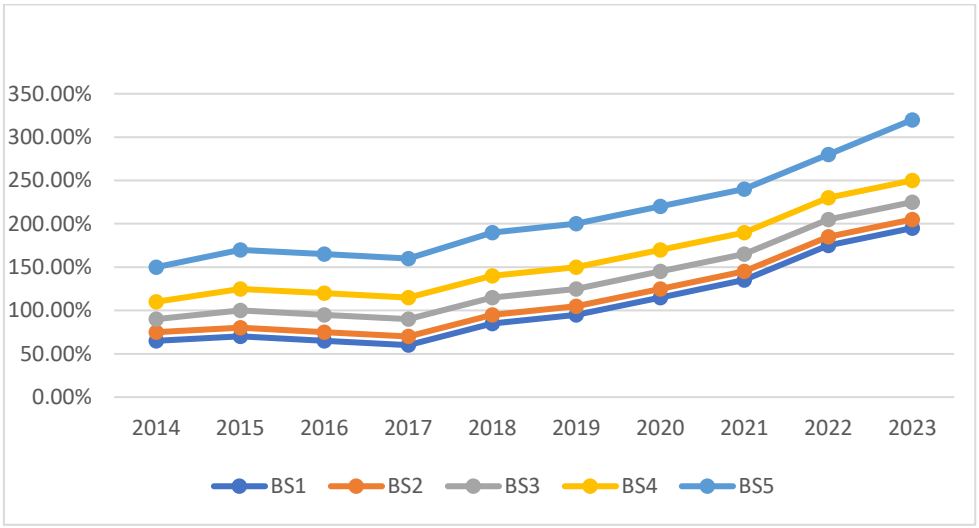
*Figure 10: Hidden Reserves in Percentage of BV of Assets – Calibration 2*




*Source: Berdin & Gründl (2015).*

In Calibration 2 scenario, the Solvency ratio situation becomes even worse, with now 3 capital endowments being below the 100% and with that below the Solvency Capital Requirement in 2014. Even BS3, which represents the median balance sheet, is not able to meet the requirement. This is all caused by an even lower level of interest rates, where an increase in present value of liabilities is even more prominent in comparison to Calibration 1 scenario. The discrepancies between the different capital endowments are now larger and the different Capital Buffers are now even more significant.

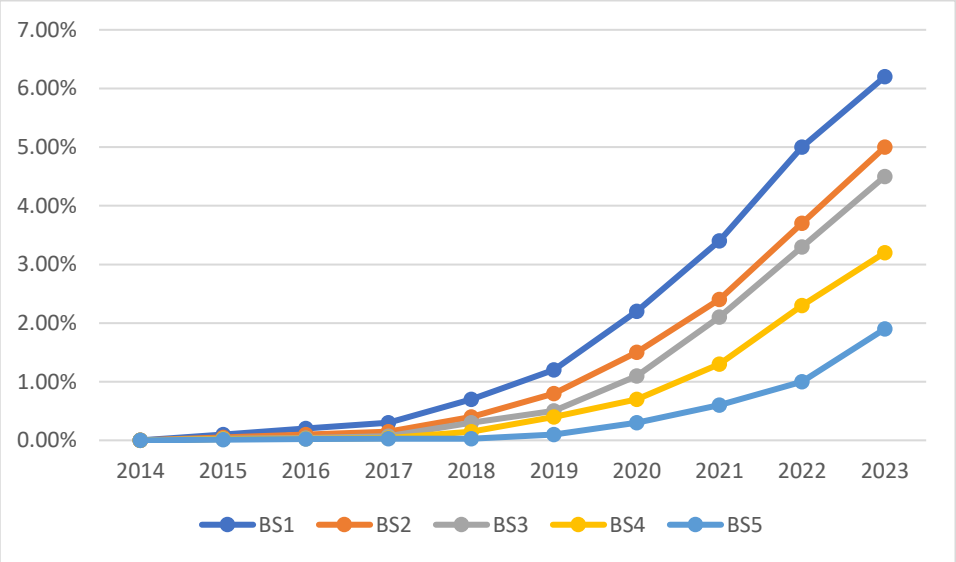
*Figure 11: Solvency Ratio – Calibration 2*




*Source: Berdin & Gründl (2015).*

As for the cumulative probabilities of default, the developments are similar to Calibration 1 scenario, but the defaults occur earlier, as seen in figure d). We can already observe defaults in 2016, a year earlier than in Calibration 1. The expected probability of default across all 5 capital endowments reaches 4,17% in 2023 (Berdin & Gründl, 2015).

*Figure 12: Cumulative Probability of Default – Calibration 2*

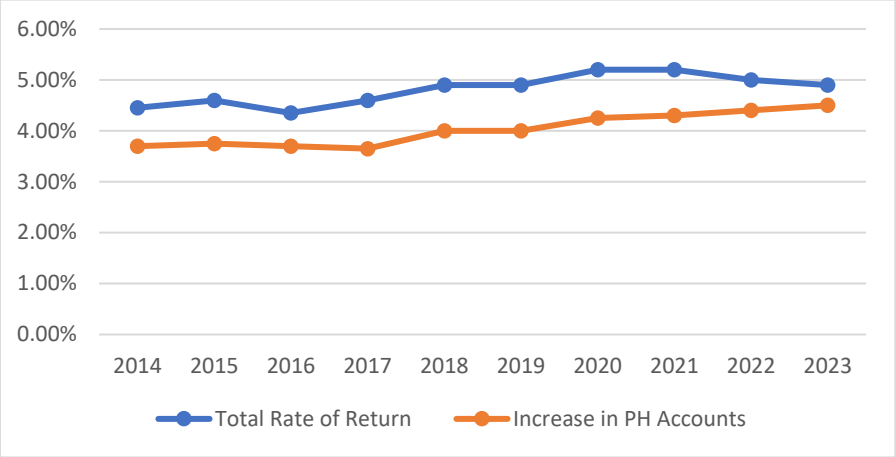



*Source: Berdin & Gründl (2015).*

Results for calibration 3

Capital market calibration 3 presents the most favourable scenario, where low interest rates are at a slightly higher level and recovering. In this scenario, the insurer enjoys a higher rate of return on assets and the amount of their own funds that need to be transferred to policyholders, because minimum guarantees and regulation are lower and not so damaging. Same as with other calibrations, different (BS 1-5) capital endowments move extremely similar.

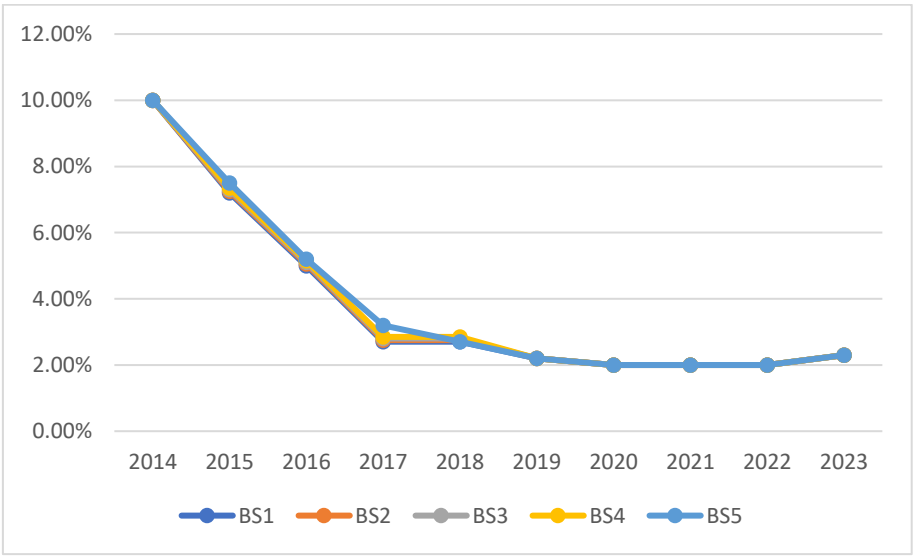
*Figure 13: Total Rate of Return and Increase PH Accounts (BS 1-5) – Calibration 3*




*Source: Berdin & Gründl (2015).*

The hidden reserves here are utilized at a lower percentage, as expected. They still fade out over the medium term, because in general the interest rates are still low, at least in the beginning. The insurer has to dissolve the hidden reserves, nevertheless. The other reason is that the old bonds come due and the market value of the asset portfolio adjusts to a new interest rate.

*Figure 14: Hidden Reserves in Percentage of BV of Assets – Calibration 3*

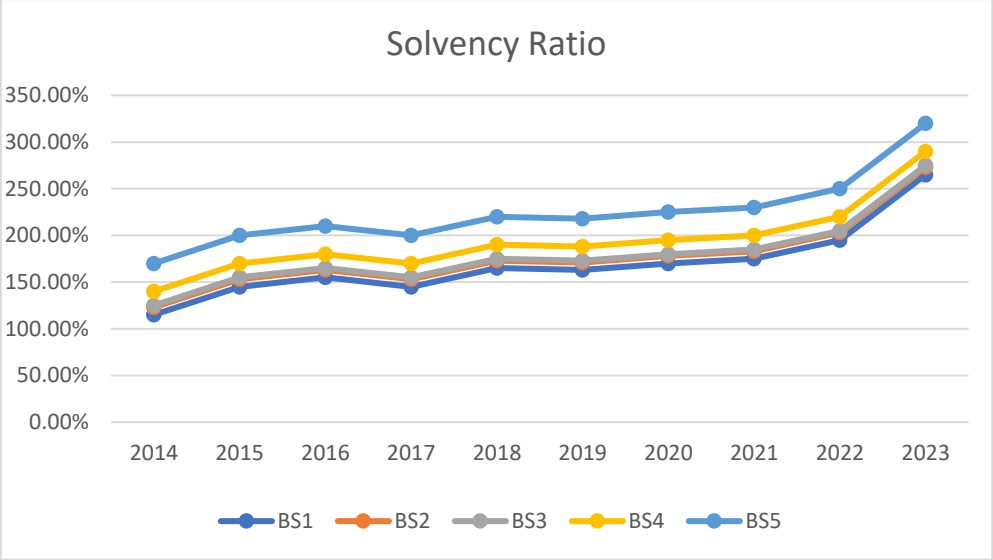



*Source: Berdin & Gründl (2015).*

The cumulative solvency ratio is much higher in this scenario, since all five different balance sheets boast with a higher percentage, because the decrease in the present value of liabilities is stronger than the decrease in the value of the assets. The discrepancy between them is also smaller, although larger capital buffers still influence the position of the curve. These developments are greatly beneficial for the solvency situation of the insurers and therefore

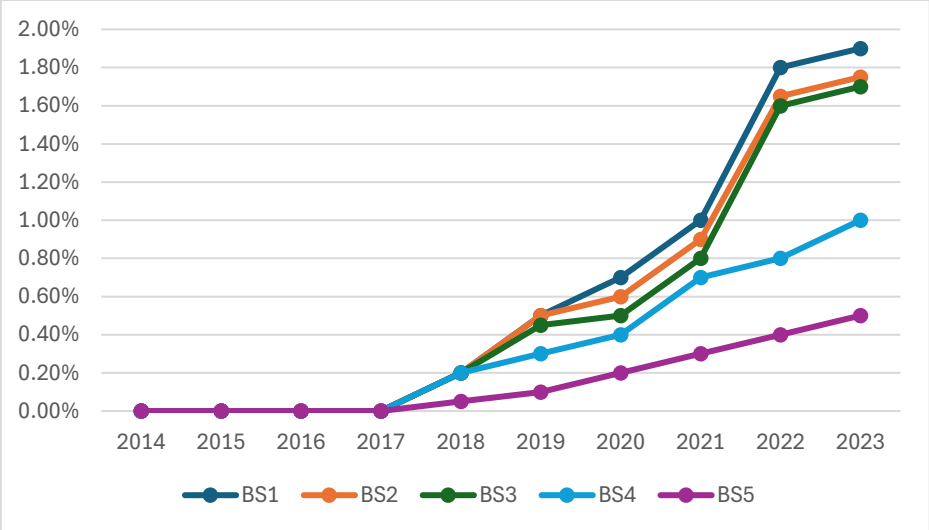
the cumulative probabilities of default are significantly lower, with the least capitalized balance sheet being at below 2% probability of default (Berdin & Gründl, 2015).

*Figure 15: Solvency Ratio – Calibration 3*




*Source: Berdin & Gründl (2015).*

*Figure 16: Cumulative Probability of Default – Calibration 3*




*Source: Berdin & Gründl (2015).*

Reform of the regulatory framework

In order to address the described low interest rate insurance situation, the German parliament introduced a regulatory framework of life insurance companies on the 1st of August, 2014. It implemented two major changes in German life insurance industry:

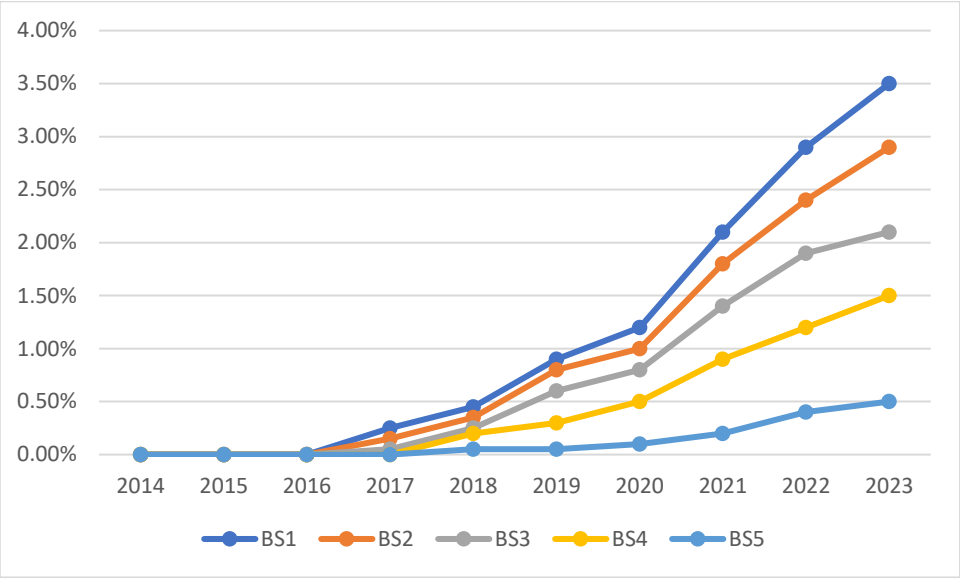
- The minimum share of yearly mortality profits (profits generated by the difference between premiums collected and claims paid out due to death benefits) received by policyholders increased from 75% to 90%. Negative results on the minimum profit participation, which is required by the regulator in Germany, can be compensated with mortality profits and other profits, allowing for cross-subsidisation among various profit sources of an insurer.
- Policyholders may be entitled to 50% minimum participation on hidden reserves when terminating the contract, but the reform of the regulatory framework makes this possible only under the condition that the insurer's bond portfolio exceeds the positive difference between the market consistent value of the underwriting portfolio and the technical provisions calculated at book value.

In short, the payouts to policyholders that came from hidden reserves, were now lower and negative results on assets returns could now be subsidized with other profit sources. This decreased both the cash outflows and the present value of liabilities, which consequently reduced the probability of insurer's default. Below, there are figures of cumulative probability of defaults for each of the three market calibrations, but this time, with the Reform of the regulatory framework in place. The effect is stronger under Calibration 2 than Calibration 1, since the interest rates are lower in the second scenario, therefore the reductions of both hidden reserves payouts and the minimum profit participation are stronger. As interest rates decrease, the value of liabilities increases, therefore reducing or even erasing the share of hidden reserves that needs to be distributed to the policyholders. The same happens with profit participation, where mortality or other profits can offset lower asset returns via cross-subsidisation. We must mention that the possibility of reducing the minimum profit participation in that way causes a "haircut" on the value of the accounts of the policyholders. The latter now have lower benefit payments, which may cause negative reactions from their side. This is the downside of such a reform, since such "haircuts" may cause substantial reputational loss costs of the insurer and they may lose clients over this (Berdin & Gründl, 2015).

The figures of cumulative probability of defaults clearly demonstrate that the Reform of regulatory framework has positive effects. In Calibration 1 the least capitalized insurer has a 3.6% probability of default in 2023, while the same scenario, without the reform in place, with the same balance sheet, has 5.4% probability of default. The median value sits at around 2.1% probability with the reform and at 4% without it. The difference is significant. The Calibration 2 has even lower percentages, due to reasons listed above. A 3.1% probability

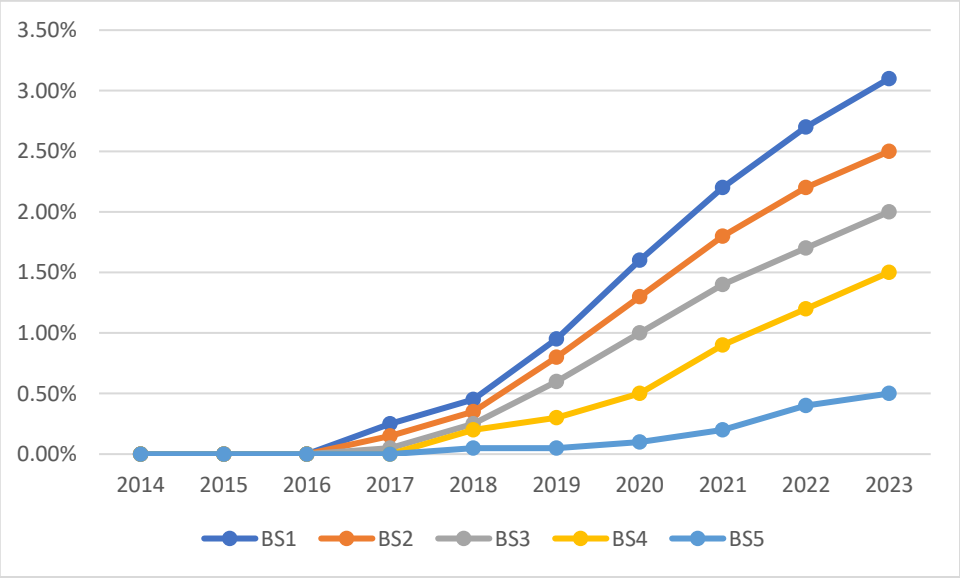
for the least capitalized insurer in comparison to non-reform probability of 6.1% and 2% probability for the median insurer in comparison to non-reform probability of 4.2%. The difference in market calibration 2 is the most significant. Market calibration 3 holds the least significant change, since the probabilities of default were already low pre-reform. 1.3% probability for the least capitalized insurer in comparison to non-reform 1.8% probability and 0.8% probability in comparison to non-reform 0.9% probability (Berdin & Gründl, 2015).

*Figure 17: Reform under Calibration 1 - Cumulative Probability of Default*



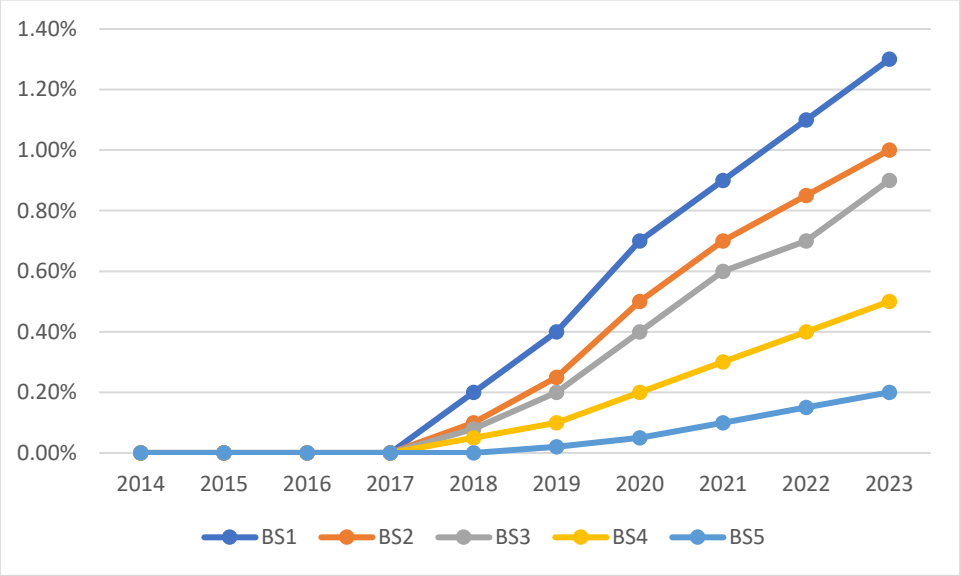

*Source: Berdin & Gründl (2015).*

*Figure 18: Reform under Calibration 2 - Cumulative Probability of Default*




*Source: Berdin & Gründl (2015).*

*Figure 19: Reform under Calibration 3 - Cumulative Probability of Default*

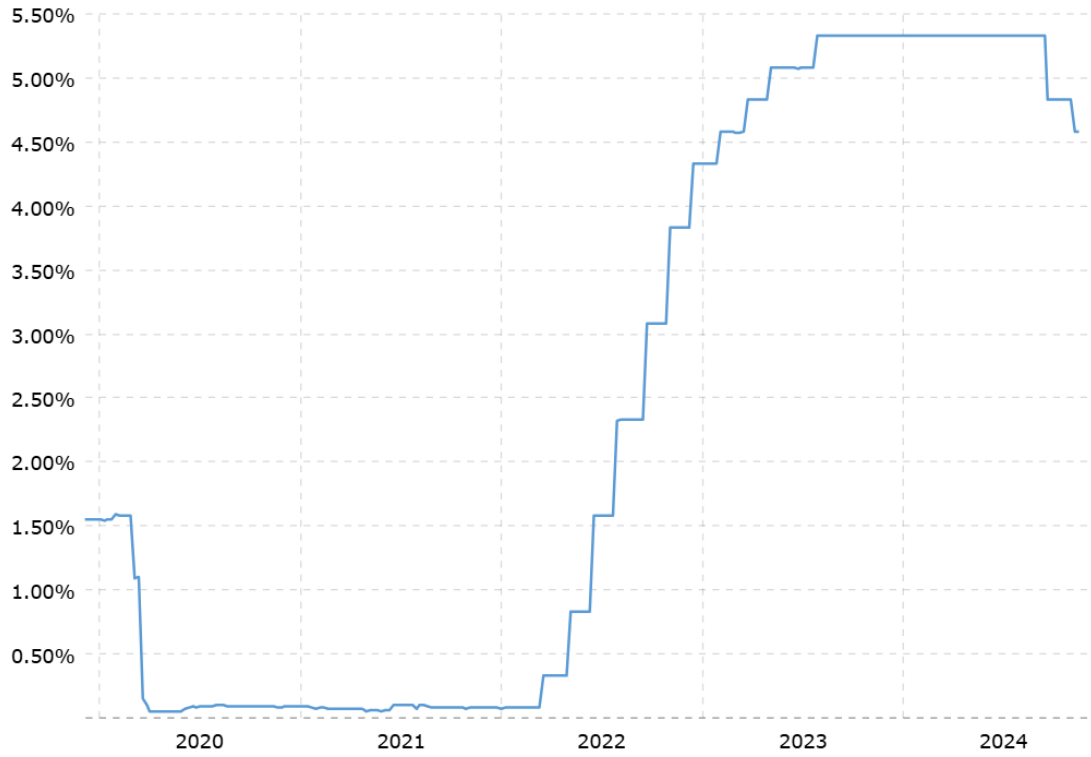



*Source: Berdin & Gründl (2015).*

### 3.2.3 Post covid period

We have reviewed what happens to life insurers in high interest environments like the Volcker's period and what happens to them in low interest rate environments, like the post 2008 crisis period. Now is the time to check the current state of interest rates and how do life insurers cope today. We live in an economy that is still recovering from the 2020 Covid-19 situation and the interest drop that came after it. The pandemic caused a major slowdown of the economy, since people were unable to go out and buy goods, travel, eat and spend money altogether. The overall global expenditure came almost to a stop. As an answer to the ongoing crisis, stimulus measures and liquidity incentives came along a near zero interest rate in March 2020, as determined by the Fed. The interest rate continued to sit near zero for the next two years and then it started to increase slowly in the spring of 2022. After that, it started to gradually climb between 0.5% - 1%, almost on a monthly basis, until it stopped at 5.33% in July of 2023 (Macrotrends, 2023).

*Figure 20: Federal Funds Rate - 62 Year Historical Chart*




*Source: Macrotrends (2024).*

The pandemic caused a fall in interest rates and equity markets, credit spreads have widened, and volatility has increased. The impact of COVID-19 on the risks for the insurance industry became slightly polarizing, negative for some insurance areas and positive for others. Without a doubt, the appetite for new insurance products declined, since consumers faced increasing temporary or permanent unemployment, losses of their income and increased market volatility. As already pointed out in the Post-2008 chapter, the attractiveness of insurance products also declines since the drop in interest rates provides lower returns, which discourages consumers, especially in such uncertain times. This is a consequence of the decline in global equity markets that have seen reduced investment returns. In short, the situation from 2008 repeated itself, where liability maturities were outmatching asset maturities and the funding gap scenarios appeared. Cash flows were also affected by the uncertainty and pessimism caused by the pandemic, the spillover effect of the overall decline in the market and the herd behaviour of investors which caused negative abnormal returns (Carannante, et al., 2022).

In certain cases, the COVID-19 outbreak may also have a beneficent effect. The demand for insurance contracts and their premiums may increase, since insurers are responding to the widening pandemic. Some classes of business are more exposed to COVID-19 than others, which is why the insurer's portfolio concentration of risk classes must be diversified, otherwise the claim expenses may be too large. With increasing medical problems, the health

insurance premiums continued to rise. Non-Life insurers also tried to adapt their policies to the new challenges caused by the COVID-19 crisis, providing the business interruption (BI) insurance, which became a critical area at that time. Property & Casualty (P&C) insurers have risen in scope, regarding both business and coverage, estimated USD 80 to USD 100 billion in the US. The pandemic had an impact in the automobile insurance field as well, where less overall driving meant fewer overall accidents. Auto insurers undertook major premium changes, which led to premiums refunds early during the pandemic (Carannante, et al., 2022).

The mortality and morbidity of the COVID-19 pandemic definitely affected the life insurance and annuity business in a negative way as well. Mortality improvements over past several decades have been muted due to COVID-19 sudden mortality shocks, while also affecting the post-covid mortality, due to long covid consequences. Life insurance companies were forced to significantly adjust their life insurance premiums, to accommodate increased mortality risk. On February 2021 observations by T. F. Harris, A. Yelowitz and C. Courtemanche showed evidence of premium increases for unhealthy older smokers, while the number of policies offered to individuals aged 75 or older were gradually removed from the market. It is crucial for life insurers to exercise effective mortality risk management strategy using actuarial assumptions and forecasting, in order to preserve the expected cash flows in the future. So, mortality risk combined with interest rate risk makes the whole situation even worse than the post 2008 period from a life insurer's perspective. After 2008 the situation was dire, but at least mortality didn't increase.

*3.2.3.1 Italian Life insurance profitability during COVID-19 period*

In 2022 Carannante, D'Amato, Fersini, Forte and Melisi conducted an analysis of Italian life insurance profitability, examining the long-run impact of COVID-19. For the analysis they used a variable immediate single premium annuity contract. To assess the effects depending on age, policyholders aged 20, 40 and 60 were considered. The stochastic mortality model was used to obtain the mortality table with two scenarios:

- The baseline scenario without the effects of the COVID-19 pandemic, which considers the entire Italian population for all ages, from 0 to 100, considering the historical series from 1950 to 2017.
- The alternative scenario with the acceleration of mortality due to COVID-19 pandemic, estimated through a multiplicative model: the projections of the accelerated probability of death, obtained from the product between the probabilities of the baseline scenario and the multiplicative factor (1) that depends on age and time.

The multiplicative factor mentioned above is a negative exponential function:

$$\pi(x,t) = \frac{\alpha(x)}{\rho(x,t)} \exp\left(\frac{-t}{12\rho(x,t)}\right) \quad (1)$$

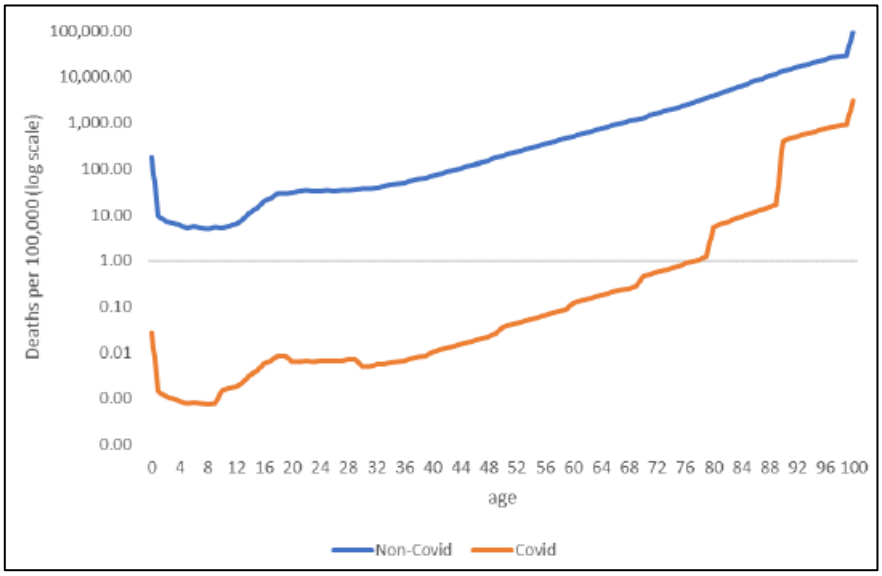
where:

$\alpha(x)$ presents the expected proportion of deaths by COVID-19 at age x,

$\rho(x,t)$ is the expected loss of years of life expectancy at age x and time t.

$\pi(x,t)$ is calculated as a negative exponential function and it is used as a multiplicative coefficient to recalibrate the obtained mortality projection. The Figure below demonstrates the death projections by age per 100.000 population in 2021. The orange curve represents the deaths due to COVID-19, and the blue curve represents the deaths due to all other causes. The data is presented in logarithmic scale:

*Figure 21: Non-Covid and Covid mortality projections by age in 2021*




*Source:* Carannante, et al. (2022).

We can interpret that the number of deaths caused by COVID-19 proportionally follows the trend in mortality for all other causes of death. The exception is older age, where the number of deaths is proportionally higher. This proves a relationship between age and mortality from COVID-19 and confirms a mortality shock.

The research investigated both good and bad consequences for insurance companies caused by the COVID-19 phenomenon. The potential good scenario is the fact that annuity contract profitability may actually increase with mortality acceleration. The reason, although slightly disturbing, is the early death of annuitants or policyholders who have purchased annuity contracts. In that case, the insurance company's liability to make future annuity payments decreases, which positively impacts the profitability of annuity contracts for the insurer. On the other hand, the opposite of a profitable scenario can be caused by the systemic or market

risk. It is the risk caused by external factors or events, in our case the global pandemic, and affects the entire market and is generally beyond the control of individual investors or companies. This is where we bring up the interest rate fall again, together with asset return drop and liabilities overshadowing them.

The research took both sides into consideration and for the first "favourable" scenario it showed that the pandemic phenomenon itself does not have a material impact on the profitability of annuity contracts. It rather has an instant impact, since during the pandemic there was an increase in mortality only in the first few years that is in 2020 and 2021, and maybe 2022. Consequently, medium and long-term contract annuities are not significantly impacted, and despite this effect of accidental and unsystematic nature, the changes in profitability, compared to the same contracts without COVID-19 effects, remain non-material.

For the second scenario, considering systematic/market risk, the material impact was found. This means that the contracts with added COVID-19 effects really did have a significantly lower profitability comparing to the same contracts with the same contractual conditions but without COVID-19 effects. The research concluded that systematic risk was significant for contracts with medium- and long-term durations. If we consider a contract with a very young insured, with a determined age x = 20, the returns are always negative. The research was conducted in 2021 and assumed COVID-19 would continue indefinitely, therefore it was calculated that negative returns would continually increase from 2022 to 2032. As a measure we can use RORAC, which stands for Return-On-Risk-Adjusted-Capital. Passing from the year 2022 to 2024, the profitability is negative and RORAC decreases by 13.4% without the COVID-19 effect, while with the COVID-19 effect loss of RORAC is equal to 13.5%. With each year, the differences become even more significant. In 2026 the loss is up to 26.6% without the COVID-19 effect, while with the COVID-19 effect, the loss is 26.8% (Carannante, et al., 2022).

#### *3.2.3.2 The impact of COVID-19 on the Indian Life Insurance Industry*

On the other side of the world, the situation was quite comparable. In India, both the new life insurance business premiums and the number of policies had negative growth during the first wave of the pandemic (From March 2020 to June 2020). It stabilized at around March 2021. R. Rajnikanth and Dr. S. Doss conducted a survey among the Indian life insurance executives in order to acquire information about their response to the COVID-19 crisis and their strategic perspectives on handling pandemic situations in general. The survey highlighted that not all segments of the life insurance were expected to have negative growth (Rajnikanth & Doss, 2021).

Segments with comparatively lower growth:

- Micro insurance, common in developing countries, is a type of insurance designed to cater to the needs of low-income individuals and families. It provides coverage for basic risks such as illness, injury, death and property damage. It has low premiums and simplified processes. As per the survey, 58% of the executives hinted that it would decrease up to 25% at least. A logical explanation would be a lower general expenditure and increased savings, both caused by the uncertainty of the pandemic.
- ULIP insurance, or Unit Linked Insurance Plan, combines investments and insurance in a single integrated plan. A portion of the premium is allocated towards the life insurance coverage, and the remaining portion is invested in various investment funds, which are usually managed by the insurance company. The opinions of the survey participants were conflicting this time, with 68% of the participants expecting that premiums collected under ULIP business would decrease up to 25%, 38% of the participants opined that the decrease would surpass 25% and the remaining 6 % of the respondents were advocating a positive growth in ULIP business.
- Endowment**,** which is a type of life insurance policy that provides coverage for a specified period, usually between 10 to 30 years. It has both a death and a savings component. Nearly 65% of respondents claimed that the premiums would decrease up to 25%.
- Group Insurance is a type of insurance coverage that protects a group of individuals under a single policy. Usually offered by employers, organizations and other associations. Around 43% of survey participants hinted at a decrease in premiums for 25% or more, while almost one third advocated that there would be no significant change.
- Pension & Annuity**,** financial products designed to provide a source of income during retirement. Pensions are usually sponsored by employers, while annuities are usually purchased by the customer for a lump sum or a series of payments. About 45% perceived that Pension & Annuity business would decrease up to 25% or more, while 32% expected no significant change in the business growth.

Segments with comparatively higher growth:

- Term insurance**,** is a type of life insurance that provides coverage for a specified period of time, called the “term”. It offers financial protection to policyholder’s beneficiaries in the event of the policyholder’s death during this term. Premiums for such insurance are considered more affordable, compared to permanent life insurance contracts. It does not build cash value over time, it only provides insurance coverage. At around 45% of survey participants agreed that term insurance premiums would increase during the COVID-19 period, while only 10% argued that premiums would fall for more than 10%. The main reason for premium growth during this period of time, is caused mainly by affordability

of these contracts, to which people gravitate towards, during the uncertainty of the pandemic times.

- Direct Marketing/Online business, where the sale of insurance products goes directly to consumers, without the involvement of various intermediaries, such as agents or brokers. It rather goes through online platforms, call centres, mail, television advertisements and other marketing channels. 42% of survey participants, which is the majority, agreed that companies would strongly push for the use of such channels and that the business would consequently increase up to 25% or more. The use of online channels makes perfect sense for the period, since eliminating the various intermediaries significantly reduced chances of Coronavirus infection. People were conducting insurance business form the safety of their own home.
- Health Insurance is a type of insurance that provides financial protection against medical expenses that occur due to illness, injury or other health related issues. It completely or partially financially covers hospitalization, doctor visits, prescription drugs, preventative care and other services. About 52% of participants estimated that health insurance would grow up to 25% or more in 2022, which would be aligned with the fact that coronavirus is seriously impacting collective health.

# 4 INSURER'S RISK MITIGATION STRATEGIES FOR INTEREST RATE CHANGE

During the last 60 years, various interest rate scenarios, like Volcker's period during the 1970s–1980s and the post-2008 crisis period, made insurance companies rethink their risk management strategies. The interest rate risk awareness increased dramatically, and the said risk was added to other highlighted risks in insurance business, such as credit risk, market risk, liquidity risk, operational risk and foreign exchange risk.

The question is what the insurance companies can do in such scenarios. What are the steps for a successful mitigation of interest rates changes affecting the expected value of insurance liabilities?

We will put the emphasis on persistent low interest rate periods, since this scenario is universally agreed to be the most compromising for Life insurance companies. Wilaiporn Suwanmalai and Simon Zaby (2022) took a deeper look at short- and long-term solutions that life insurance companies can put in action, to combat the prolonged low interest rates periods. They also came up with some general guidelines that insurers should employ to mitigate or prevent the consequences caused by interest rate sensitivity (Suwanmalai & Zaby, 2022).

As a core issue, Suwanmalai & Zaby emphasized the existence of the guaranteed minimum return on the saving component and policyholder participation in the profit-sharing scheme.

Hedging and appropriate valuation are required to keep the insurer solvent. As already mentioned, insurers preventively set the minimum guaranteed interest rates below the market interest rates at first launch, with an out-of-the-money option. This strategy leads to a risk management tool, which is widely adopted by life insurance companies: Asset and liability management framework (or ALM framework), which may mitigate interest rate risk in a persistent low interest rate environment. This approach was previously widely used in the banking sector. It is basically a duration matching approach, where the goal is to match the duration of the assets with the duration of the liabilities. This addresses the already highlighted challenge of life insurance companies: liabilities, as in policyholder's benefits, almost always have a longer duration in comparison to the assets. Furthermore, in the prolonged low interest period, policyholders are inclined to prolong the maturity of their policy, since the surrender yields a lower payout and the minimum guaranteed rate encourages the policyholder to even increase the premiums. The general objective of the ALM framework is to lengthen the duration of the fixed assets (preferably corporate and government bonds). This mitigates the interest rate risk in the short term (Suwanmalai & Zaby, 2022).

Preventive measures against the guaranteed rate being too high and too risky, were enforced in European Union and Japan. They have set the maximum allowable guaranteed interest rate, with an upper limit not exceeding 60% of the government bond's yield. France for example has their minimum guaranteed rates set notably lower than other European countries, although they compensate their offers with profit-sharing or a surplus appropriation scheme, to meet their policyholder's expectation (Suwanmalai & Zaby, 2022).

Another way for insurers to be less susceptible to interest rate risk is if they set the guarantee to be paid at maturity of the policy, rather than have it in annual payments for the insured. In this case no market adjustment is allowed (Suwanmalai & Zaby, 2022).

A long period of persistent low interest rates forces insurers to rethink their portfolio of products that they have on offer. They started gravitating towards the least investment return, or even no-guarantee products. Although sales had to suffer, with policyholders being less interested in such products, but the insurer had much less risk to worry about. In 2014, an analysis of the new business portfolio demonstrated that 30% of the sales volume moved towards new "dynamic hybrid" products, supporting a product shift strategy. It was moving the products toward a combination of participating endowment and unit-linked features. In participating endowment, bonuses do not derive only from the backing asset's performance, but also from the operational efficiency of the company. The recent product trend is also moving towards variable life insurance products, where investment risk is transferred to the policyholder. In this case the policyholder assumes risk, unlike in other forms of life insurers. The investment choices fall onto the policyholder; therefore, it is their responsibility if these choices result in a lower cash value of the policy and potentially even reduced death benefits. In this case, there is also no guaranteed cash value, so everything is based on the performance of the underlying investments. The insurer has no exposure to interest rate risk. We can see

that, the general idea here is that life insurers are gradually adopting the idea that they can't bet all on the performance of assets anymore. That is why they are offering bonuses from other sources of income, removing the guarantees and put the investment choices in the hands of the policyholders. In Germany, life insurers went even a step further and moved from traditional savings and deferred annuity products to protection-based products, such as disability income benefits and long-term care products. They also adopted the "alternative guarantee" concept, which lowers the guarantee to only the return on premiums at the end of the deferred period and minimizes annuity payouts during the annuity period. (Suwanmalai & Zaby, 2022).

In times of shifting interest rates, the company's reserves are of crucial importance. These are valued using the technical interest rate, also called actuarial interest rate or Valuation Interest Rate (VIR). It presents a conservative estimate of future investment earnings. The VIR is used as a discount rate for insurer's reserve calculation. The greater the VIR, the smaller the reserve amount. This follows the Lidstone's theorem, which states: When interest rates increase, the reserves may decrease, since the chances of the policy being covered increase. When interest rates are low, the reserves must increase, but the regulators in various countries have set upper limits for the VIR and dubbed it "maximum technical interest rate". This rate is usually subject to annual adequacy check, because it is an implicit determiner of the minimum guaranteed interest rate that insurers offer to their policyholders. The regulator determines the maximum VIR and consequently the pricing of new life insurance products in that jurisdiction. If the guaranteed interest rate exceeds the VIR at a time of the policy's inception, insurers are expected to hold higher reserves than the guaranteed interest rate. This is called an "undesirable positive initial reserve", and the insurer must be pre-financed for it. The regulator therefore uses the maximum VIR cap, to keep the insurers in check, regarding the minimum guaranteed interest rates. The insurers want to sell as much policies as possible and in doing so, they might be inclined to increase the minimum guarantees as much as possible, but the cap on their reserves prevents them from overdoing it. When the interest rate is less than the VIR, a negative initial reserve emerges, which is not recognized in the balance sheet, although insurers consider it as a receivable (Suwanmalai & Zaby, 2022).

The setting of the maximum VIR is approached differently from country to country:

- In Germany, Austria and Switzerland it is driven by long-term government bond yields. It is partially formula-based. In Germany, the regulator has moved from the 60% of the past ten-year average government bond yield to the past five-year average, to better reflect the current low interest rate situation. In Austria, the regulator has set the maximum VIR at 2%, which is based on 60% of the ten-year average of the secondary market of Austrian government bonds yields. Switzerland has similarly set the maximum VIR at 1.5%.
- In the US for example, the VIR is fully formula-based and driven by corporate bond yields, without any regulator involvement. It follows the so-called "Commissioner's

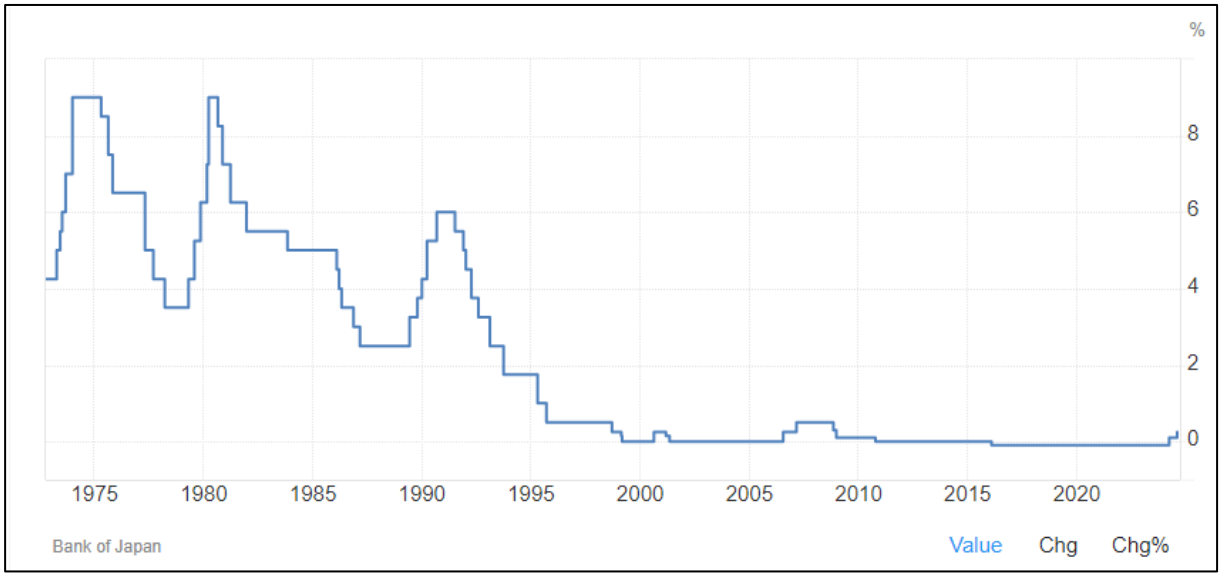
Reserve Valuation Method". According to the Standard Valuation Law, the maximum VIR differs by product type and cohort year based on the average US investment-grade corporate bond yields. The VIR set at the policy inception date, remains unchanged until maturity. This is the case for all the highlighted countries in this section.

- In the UK the maximum VIR relies on a company-specific principle-based approach, rather than a "one-size-fits-all" approach. The maximum VIR is determined from current and expected future earnings on insurance company-specific investment strategies, with certain allowances for margins, in case of any deviations taking place. The maximum VIR varies by product category, with traditional long-term life insurance products not exceeding 97.5% of the risk-adjusted return, assuming that these liabilities are asset backed.

In the year 2000, Japan and the European Union set the maximum VIR for new life insurance business at 2%. This low rate reflects a situation, where the capital market interest rate was lower than the guaranteed interest rate of the products. Regulators therefore began to adjust the maximum VIR based on solvency assessments and exposure to low interest rates. In 2013, Eling and Holder conducted a company-specific risk research and concluded that the maximum VIR should continue to decrease in the future. Japan responded with moving their asset allocation towards USD-denominated bonds, since their government bonds yielded negative returns (Suwanmalai & Zaby, 2022).

The negative interest rate period Japan lasted from January 2016 until March 2024, where it currently sits at 0.25% (Trading Economics, 2024). During 1997 – 2001 seven middle-sized life insurers in Japan declared insolvency due to a drastic decline in profitability. According to Nieder (2016), a combination of negative spread (the difference between investment profits and liability benefits), increased competition and loss of customer confidence in those seven insurers led to insolvency (Suwanmalai & Zaby, 2022).

*Figure 22: Japan Interest Rate*




*Source: Trading Economics (2024).*

Setting the maximum VIR rates is not the only way the regulator shields the insurers from interest rate risk. The European Union insurance regulators enforced a solvency regime called the "Solvency I (SI)" framework to address the issue. It forced the insurers to constantly hold 4% of the premium reserve and 0.3% of the capital at risk as a solvency margin or regulatory own fund requirements. Similarly to banking's "Basel III", "Solvency II (SII)", is the most recent risk-based framework. It strives to improve the transparency and stability of the financial system in the European Union. It helps guard against insurance products with a minimum guaranteed interest rate. The regulatory capital requirement is way more significant this time around, which makes it less likely for life insurers to promote products like this. Regarding this issue, Holsoboer (2000) recommended that life insurers should determine the minimum capital for different businesses, based on the risk profile of a particular business. The risk-adjusted return in capital should be the determinant for the amount capital needed for a particular business. The riskier the business, the higher capital insurers should hold aside, to compensate for business risk (Suwanmalai & Zaby, 2022).

Another regulatory entity was emphasizing the financial stability risk for insurance and pension companies, from 2009 to 2013: EIOPA (the European Insurance and Occupational Authority). In 2014, it implemented a low interest rate stress test, called a "Japanese-like-scenario". Its objective was to test the sustainability of interest rate guarantees embedded in life insurance products. EIOPA also addressed the Solvency Capital Requirement (SCR) ratio, interest rate exposures and profitability. Product design and segregated funds enable insurance companies to compute booked and realized values. In Italy, this approach assured relatively stable and non-volatile returns. Focarelli (2015) showed that the Italian insurance industry's SCR ratio outperformed the European average (Suwanmalai & Zaby, 2022).

According to International Accounting Standards, equity holdings should be determined at market value, while liabilities should be determined at book values. This may cause solvency issues in a persistent low interest rate environment. In order to provide the high guarantee promised to policyholders, insurer will adjust their assets portfolio quicker than the growth rate of liabilities. In a low interest rate environment, the only way to achieve this is to increase their asset allocation to a riskier asset class. This makes liabilities more volatile than assets, requiring bigger capital to support businesses. Risky investments are more likely to be affected by disruptions and/or variations and the inclination for riskier investment may negatively impact the insurer's financial stability. The riskier the investment, the wider the duration gap between assets and liabilities. ALM management becomes increasingly more challenging to execute. Regulators worldwide try to manage the described issue with enforcing a risk-based capital (RBC) framework, to help mitigate potential threats to insurers. The RBC framework establishes a minimum required capital that must be held by life insurance companies (Suwanmalai & Zaby, 2022).

### 4.1 Short-Term Solutions

Life insurance companies across the world need to have plausible actions on standby and use them in the case of a persistent low interest rate period. There are short-term solutions and long-term solutions. Short-term solutions that life insurance companies can deploy are as follows:

1. In the US, insurance companies used to reduce the interest component of their dividend crediting rate as a cautious response to low interest rates. The dividend crediting rate is used in the context of participating life insurance policies, usually whole life insurance. It presents the rate at which dividends are credited to the policyholder's account. Low interest rate means lower yields on the company's assets and that may cause possible failure to provide adequate dividend amount to the insured.
2. Insurance companies based in countries hit by the low interest rate times, may resort to moving their products to USD-, EURO- or AUD-denominated life insurance policies. This was the strategy deployed by Japan, which also moved their asset allocation to USD-denominated bonds. Allocation to other, more stable currencies should promise much higher interest rates, which then enable setting higher guarantees, making the products more appealing to customers. Such approach, however, can expose policyholders to exchange rate risk.
3. The most obvious mitigation measure, from the product implementation perspective, must be lowering the guaranteed interest rate on new products. Lowering of the guarantees must be proportional to the lowering of the interest rates.
4. Insurance companies conduct short-term financial monitoring and use the aforementioned ALM framework to assess and mitigate interest rate risk by lengthening the duration of the assets, since those are typically shorter in comparison to the liabilities.

The framework is an investment approach based on matching assets and liabilities duration, helping insurers confine potential exposures to interest rate risk.

5. Low interest rate environment sometimes forces insurance companies to raise additional equity, since that might be the quickest approach to gather sufficient equity funds. The insurer should always balance meeting policyholder's expectations (with participation rates) and at the same time maintain enough capital for itself.
6. General asset management philosophy should be when interest rates are decreasing, insurers should make long-term investments and lock-in asset duration. This will lower the duration gap between the liabilities and assets and consequently help protect insurer's equity capital. By contrast, when interest rates are high, insurers must quickly invest in shorter-duration assets to meet policyholder's expectations. Otherwise, the insurance company can expect premature policy lapses.
7. In the case of interest rates decrease, insurers modify their products differently, depending on the product type. Love and Miller (2013) compared potential corrective courses of action to alleviate the low interest rate impact, which differ between in-force (current) and new business blocks:

- WHOLE LIFE (BASE PLAN): The product is premium dependent. The current in-force block should potentially lower the death benefit growth, since the dividends that cover paid-up additions options to buy additional death benefits for policyholders are now lower, due to lower interest rates. The insurer should also lower the cash value that comes from dividends.
- WHOLE LIFE (WITH TERM RIDERS): The product is dividend dependent. The current in-force block should increase the percentage of out-of-pocket premiums (these refer to the portion of the insurance premium that an individual pays directly from their own funds, as opposed to having the premium covered from other means, for example: dividends, employer contributions, or government subsidies). The insurer should increase overall annual premium requirements and policy expenses while reducing the death benefit. For the new business block, the insurer should advertise higher illustrated premiums and prepare future policyholders accordingly.
- MODIFIED PREMIUM WHOLE LIFE: The product is dividend dependent. It features a lower premium during the initial years of the policy, which then increases to a higher premium for the remainder of the policy. The current in-force block should enforce additional out-of-pocket premiums and increase the amount of the ultimate premium. For the new business block the insurer should charge higher out-of-pocket costs (meaning that it must be covered by the policyholder) and set a lower death benefit growth.
- SUSPENDED PREMIUM WHOLE LIFE: The product is dividend dependent, where premiums can be temporarily suspended, without causing the policy to lapse. The death benefit is nevertheless guaranteed, and cash value continues to grow, although possibly at a reduced rate. The current in-force block should insist on the reappearing out-of-pocket premiums, while also increase their needed number. The insurer should also

reduce the cash value and death benefit. For the new business block the insurer should even block the option to suspend premiums, effectively erasing the product.

- UNIVERSAL LIFE WITH SECONDARY GUARANTEES: The product is premium-dependent. The secondary guarantee is an additional feature that provides a guaranteed death benefit for a certain period, even if the cash value is depleted, as long as the policyholder honours the minimum requirements. The current in-force block should lower the overall cash value but preserve the no-impact on a guaranteed death benefit. For the new business block the insurer should set higher premiums (especially for a sizable up-front fee). It should also set restrictions on the lump-sum amount. It is expected that in the low interest rate period less insurers would be able to offer such product.
- CLASSIC UNIVERSAL LIFE: The product is cash-value dependent. The current in-force block should lower the overall cash value and reduce the policy duration and take no additional premiums. The insurer should also increase the policy expenses paid by the policyholder. For the new business block the insurer should set higher illustrated premiums for the future policies.

- VARIABLE UNIVERSAL LIFE with DB guarantees (GMDB): The product is premium dependent. In this case the policyholder chooses where the assets are allocated and therefore carries the investment risk. The guaranteed minimum death benefit ensures that the death benefit is always paid out, even if the cash value critically drops. The current in-force block should ensure that a guaranteed death benefit remains unbothered. For the new business block the insurer should reduce the possibilities for additional premiums for guarantees. Certain restrictions should also be placed on allowable investment allocations with guarantees and therefore try to mitigate the investment risk manually, done by experts at the insurance company.
- VARIABLE UNIVERSAL LIFE without GMDB: The product is cash value dependent. It does not have the guaranteed death benefit safeguard. The current in-force block should lower cash values if the investment portfolio performs worse than expected. The insurer should promote earlier policy lapse and should block additional premium payments. Restrictions should be put on allocations to fixed accounts. For the new business block the insurer should lower guaranteed interest rates in fixed accounts options, while also put limitations on allocations to them.
- INDEXED UNIVERSAL LIFE with GMDB: The product is premium dependent. Here the cash value earns interest based on the performance of a market index, such as S&P 500, rather than through the direct investment in the stock market. Although safer, it still offers the guaranteed minimum death benefit, if the cash value dramatically drops. The current in-force block should keep the no-impact on the guaranteed death benefit. For the new business block there should be an introduction of products with limited long-term guarantees.
- INDEXED UNIVERSAL LIFE without GMDB: The product is cash-value dependent. The current in-force block should lower cap rates (the maximum limit on the interest rate

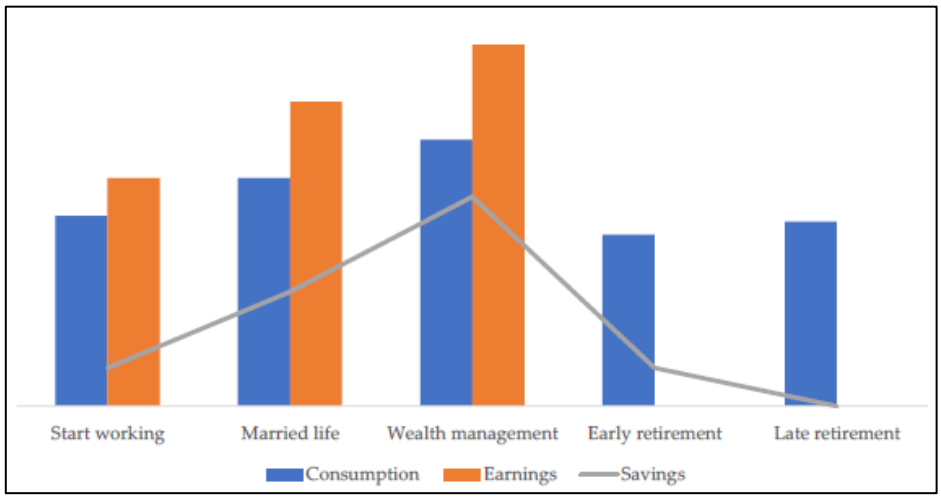
that the policyholder can earn from the market index performance) as well as participation rates, promised to the policyholder. The insurer should also reduce the policy duration in the absence of additional premiums. It should also increase the amount of expenses covered by the policyholder. For the **new business block** there should also be a lower cap or participation rates together with higher illustrated premiums.

### 4.2 Long-term solutions

Prolonged low interest rate periods force life insurance companies to adopt the long-term view. The long-term solutions for interest rate risk mitigation are the following:

1. Life insurance companies must be reluctant to provide a high guaranteed return on their new product development. Insurance companies in Germany have adopted alternative guaranteed product concepts, in the form of a return of paid premiums, minimum annuity payouts and payout from profit-sharing or participating products. One example of such a product is the guaranteed return of premiums for deferred annuities at the end of the deferral period. So regardless of the investment portfolio performance, the policyholder will at least receive back the total amount of premiums paid into the annuity.
2. The future product mix is obviously moving away from the guaranteed interest rate products, in order to reduce the explicit and implicit impacts of interest rate risk. Many insurers now focus on selling more unit-linked products that transfer the investment risk to the policyholders, since here it is them who choose the risk level of the asset portfolio. Focarelli (2015) supported the unit-linked products and proposed asset reallocation to mainly corporate and structured bonds, along with setting up new premiums to achieve sustainable minimum interest rate guarantees in a persistent low interest rate environment.
3. Countries can pivot from selling saving-oriented services to selling more protection-oriented services, due to their low claims. This was the strategy deployed by Japan.
   and Germany. Protection-oriented products are usually disability income, medical insurance, cancer insurance and long-term care products, which are best at meeting the needs of the aging customers. In addition to that, Focarelli (2015) encourages insurers to move toward new product features, based on customer's life cycle needs, to fill the gap between consumption and earnings. An example can be seen on the Figure 23.

*Figure 23: Customers' Life Cycle Needs*




*Source: Zuwanmalai & Zaby (2022).*

These kinds of products provide protection, income replacement and wealth accumulation at different stages of policyholders' life. They ensure financial stability and help individuals manage risks related to loss of income, health issues and longevity, while ensuring that they can meet their consumption needs even when earnings decline or come to a halt.

4. Insurance companies must implement a reasonable economic assumption for the expected credit rates that are consistent with the forecasts of asset portfolio earned rates. With that sorted, they must communicate reasonable expectations of the market interest rate environment to the policyholders, when selling products. In addition to that, the insurer should also implement an active monitoring policy, targeting the deviations of actual credit rates or dividend scales from expected rates.
5. For certain insurers, the solutions lie in increasing their response efficiency, to compensate for revenue compression when their investment yields decrease. When insurers switch their business portfolio to products with no minimum-guaranteed interest rate, the capital efficiency rises significantly. Insurers need to actively manage financial risk, assess their profitability and measure their market risk, which reflects the potential loss due to unfavourable market movements based on aforementioned value-at-risk (VaR).
6. Insurance companies should emphasize surplus appropriation schemes, which can cover the shortfall risk in shareholder values. In other words, life insurance companies use surplus profits in order to compensate any share value drops and keep shareholders and policyholders satisfied. Different schemes of surplus appropriation exist for determining fair dividend rates, such as increase in surplus appropriation for the remainder of the coverage period and increase in the following benefit payout and interest-bearing accumulation schemes. These schemes affect the dynamics of assets and liabilities; therefore, insurers should match the durations between assets and liabilities properly (Suwanmalai & Zaby, 2022).

### 4.3 Corporate hedging using financial derivatives

Life insurance companies have a variety of short-term and long-term strategies used to manage interest rate risk. In addition to listed strategies, life insurers, like other types of financial and non-financial firms, are increasingly using financial derivatives to manage risk. In fact, today the majority of life insurers use derivatives, especially medium and-sized life insurers. (pwc, 2024) The derivatives are primarily used to manage interest rate and exchange rate risk, in contrast to property & casualty insurers that use equity and foreign exchange derivatives markets to enhance their profits (Cummins, et al., 1996).

The most used derivatives that are reported at year-end positions in life insurance industry are:

- Interest rate swaps,
- Interest rate caps and floors,
- Bond futures.

The most used derivatives in life insurance industry that are used mostly during the year and rarely have open position at the end of the year:

- Bond calls,
- Bond puts.

Life insurers also actively engage in trading foreign currency forwards.

We will focus on each of the listed derivative instruments and describe how it is used by life insurers to hedge interest rate risk:

Interest rate swap: This derivative is a forward contract in which one stream of interest payments is exchanged for another, based on a specific principal amount. This instrument usually involves the exchange between a fixed interest rate payment and a floating rate payment, or vice versa. This either reduces or increases the participant's exposure to fluctuations in interest rates. This is also a way of obtaining a lower interest rate if your fixed interest rate seems too high. This of course always comes with a risk of it going the other way around. A swap can also involve an exchange between two floating rates, called basis swap, but this is not what life insurers usually use to hedge interest rate risk (Chen, 2024b).

Life insurance companies hold liabilities that usually offer fixed interest rates to their policyholders. These liabilities can be backed up by assets with floating interest rates. The insurer now has fixed interest payments to issue to its policyholders that need to be covered with floating interest rate income from the assets. Interest rates may go down for various reasons and with it the asset yields. The insurer must still cover for their fixed liabilities and if assets are not able to cut it, equity is hit. The insurer can avoid this with stepping into an interest rate swap agreement with a counterparty bank. The insurer pays the floating interest

rate asset yields to the bank and in exchange the counterparty bank pays the insurer a determined fixed rate, usually matched to the insurer's liability interest rate. If the interest rate goes up, the bank makes a profit, since the floating rate exceeds the fixed interest rate, but if the interest rate falls, then the bank must cover the gap between the determined fixed rate and the lower floating interest rate. The liability is now secured (Chen, 2024b).

Interest rate caps and floors: This derivative enables the buyer to receive payments at the end of each period in which the interest rates exceed or are below the agreed strike price. An example for an interest rate cap can be when the LIBOR rate exceeds 2.5%, then the buyer receives a payment. The same goes for interest rate floors, just the other way around: The buyer receives a payment when the interest rate goes below a certain percentage (Wikipedia, 2023).

Interest rate caps and floors can therefore be used to hedge against fluctuations of the interest rate. A life insurer that counts on 2.5% yield from its asset portfolio in order to cover for its liabilities, can use an interest rate floor to protect itself from unexpected interest rate decrease. If the interest rate goes below 2.5% and therefore compromises the asset's yield, the insurer gets a compensating payment (Wikipedia, 2023).

Bond Futures: This is a financial derivative that obligates the contract holder to purchase/sell a bond at a predetermined price on a specific date. A bond future is usually traded on a futures exchange market and is bought or sold through a brokerage firm that offers trading with futures. The price and expiration date of the derivative are set at the time of its sale. Bond futures are usually used by speculators to bet on the price of a bond or by hedgers to protect bond holdings (Chen, 2024a).

Life insurers can use bond futures to hedge interest rate risk by protecting the value of their bond portfolio from unexpected interest rate movements. Bond prices and interest rates move inversely, hence, when interest rates fall, the value of the bond increases and vice versa. When interest rates fall, an insurer should enter a long position, where it buys bond futures and benefits as bond value increases. When interest rates rise, an insurer should enter a short position and sell bond futures, which benefits as bond value goes down (Gratton, 2024).

Insurers can use these derivatives to hedge both rising and falling interest rates by taking positions in the futures market. If the insurer predicts that interest rates will rise and therefore decrease the bond portfolio value, they can hedge against that by entering a short position with selling bond future contracts. Bond portfolios will lose value, but at the same time the short bond futures position will gain in value, since the insurer sold the futures at a higher price and can buy them back at a lower price, therefore making a profit and cover the losses of the bond portfolio value decrease. If the insurer predicts that interest rates would fall and therefore increase the value of its liabilities, they can hedge against it by entering a long position with buying bond futures contracts. When interest rate fall, the value of the bonds the insurer plans to buy increases. This leads to higher costs for liabilities. At the same time,

the long bond futures positions will gain value as bond prices slowly rise as interest rates fall. Insurers bought these positions at a lower price and can sell them at a higher price and therefore make a profit. With that it can cover increasing liability costs (Gratton, 2024).

Bond Calls: A bond call refers to a Callable Bond. This is a bond that has an embedded call feature, which grants the bond issuer the right, but not the obligation, to take specific actions before the bond's maturity. A call is used, when interest rates are low. The issuer "calls" or repays the bond and after that issues another one, with a lower interest rate (Beers, 2022).

Some life insurance companies tend to write a lot of bond calls, selling the rights of a bond to another party, which is the option buyer. In exchange, the insurer receives a premium. Insurance companies do this to generate additional income, which can help them offset periods of lower investment returns, caused by low interest rates period (Cummins, et al., 1996).

Bond Puts: Similar to a bond call, a bond put is an embedded option that grants the right, but not the obligation, to take specific action on the bond before its maturity, not to the issuer, but to the bondholder. The latter can force the issuer to repurchase the security at a specific date before maturity. The repurchase price is usually at the face value of the bond. This option acts as an incentive for investors to buy a bond that has a lower return. That way, they are not bound to it (Chen, 2022).

If interest rates rise, bond value goes down. Put-able bonds can serve as protection. The bondholder exercises the put option and sells the bond back to the issuer at the put price, which is usually par value. With that, the bondholder avoids the market value loss that would otherwise occur. Such options are also good for quick liquidity, if it is needed. Similarly to writing bond calls, insurance companies can also write bond puts, which means that they sell options to act on a bond to someone else. With that, they generate additional income from the premium paid by the buyer. This helps compensate lost bond values that come from interest rate increases (Cummins, et al., 1996).

Foreign Currency Forwards: This derivative is an over the counter (OTC) instrument known also as an "outright forward". It is a foreign exchange market contract that locks the exchange rate for the purchase/sale of a currency on a specific future date. This derivative is popular among individuals that prefer taking long-term positions and want to avoid incurring overnight funding costs. They can have customized terms and are generally used for hedging (Halgrave, 2024).

Life insurance companies can use foreign currency forwards to manage interest rate risk, as well as currency risk. The two are correlated, since exchange rate movements are actually driven by interest rate differentials between countries. When a life insurance company holds foreign-denominated assets or liabilities, interest rates change in those countries can affect the exchange rates, exposing the insurer to both currency risk and interest rate risk. For example if Japan holds assets in yen but has liabilities in U.S. dollars, then the changes in

interest rates between Japan and U.S. can lead to exchange rate fluctuations, which can affect the value of their investments. Foreign currency forward deals with the currency risk straightforwardly, with locking the two currencies in advance, but it can also provide a hedge against interest rate risk. We can look at it through the concept of interest rate parity. This represents the theory that the difference in interest rates between two countries is reflected in the forward exchange rate between their currencies. Therefore, any shift in interest rate expectations can affect forward exchange rates. By using foreign currency forwards, the insurer locks the future cash flows and stabilizes the expected returns or costs related to foreign investments or liabilities that are possibly impacted by interest rate changes in different countries. The insurer also avoids negative currency impacts from interest rate differentials, which impacts foreign currency movements. The foreign forward contracts therefore hedge against this combined risk (Halgrave, 2024).

The determinants for derivative use in life insurance sector are, similar to the banking sector, the economies of scale. In other words, larger life insurance firms are much more likely to use derivatives than smaller firms. In addition to that, insurers that are members of groups where at least one insurer uses derivatives, are significantly more likely to engage in derivatives trading, in order to hedge risk or enhance profits. The use of derivatives is also consistent with managing the positive duration gap (assets have longer duration than liabilities) that characterizes insurer equity. Insurance firms that write more guaranteed investment contracts and hold more individual life reserves and annuity reserves are more frequent derivative users. There is also a positive correlation between bond portfolio maturity and derivative use. The interest rate risk hedging allows insurers to take on longer bond maturities. Collateralized mortgage obligations and privately placed bonds are hedged using derivatives. Insurers can also use derivatives as part of equity income enhancement strategy, but this is less common with life insurers and more common with property and casualty insurers. Insurers also use derivatives to hedge against convexity risk (Cummins, et al., 1996).

Convexity risk: It refers to a non-linear relationship between interest rates and bond prices, especially when interest rates significantly change. Convexity measures how the bond duration changes as interest rates change. Because this relationship is not linear, convexity risk arises at times of large interest rates movements, leading to unpredictability in bond prices (Wikipedia, 2024).

The use of derivatives is different between joint stock insurers and mutual insurers, which are two distinct types of insurance companies, with different structures, ownership and operational models:

- Joint Stock Insurers: They are owned by the shareholders, i.e., the investors that bought the company's stock, either through public or private offering. They are therefore the owners of the company. Profits are distributed among them in the form of dividends, which are based on the company's performance. The capital is raised through issuing

more shares of stock. The company is guided by a board of directors, elected by the shareholders. The latter also carry the financial risks.

- Mutual Insurers: They are owned by its policyholders, i.e., the individuals or entities that buy insurance policies from the company. This kind of insurer does not have shareholders. When an individual buys the insurance policy, he/she becomes a part owner of the company. He/she is entitled to a proportional part of the profits, paid out in the form of a policyholder premium or a reduced premium. In contrast to stock insurers, mutual insurers do not distribute profits to external shareholders. This kind of insurer raises capital not through issuing stock, but trough retained earnings and policyholders' contributions. Their ability to raise capital is therefore quite limited. The board of directors is elected by the policyholders. The latter are usually informed about the company's performance (Rosen, 2024).

The way these two kinds of insurers take derivative positions during the year is different. Stock companies display little difference between within year and end-of-year positions, while Mutual insurers display more end-of-year positions in comparison to their during-the-year positions. The derivative holdings of the Stock companies remain fairly stable throughout the year and don't significantly increase or decrease, because the share prices reflect the information about the company's performance. Consequently, managers have less incentive to manipulate their end-of-year positions using derivatives, because that would be very likely be noticed and scrutinized by the market and the shareholders. On the other hand, mutual companies do not have shareholders, and their financial performance is not shown in stock prices. They cannot be as "exposed" as the stock companies, therefore the market is less likely to scrutinize them. The managers of mutual companies may have more incentive to manage year-end positions because of that. They can use this advantage to perhaps present stronger financials to regulators or policyholders. Nevertheless, stock companies in general still tend to engage in more derivatives trading, which is consistent with the managerial discretion hypothesis. The reason that stock companies engage with more derivatives trading are:

- Incentives: Managers in stock companies are usually compensated based on shareholder value and stock price performance.
- Access to capital: As mentioned, stock companies raise capital more easily, using the issuing of new shares.
- Market competition: There is a lot more competitive pressure put on stock companies, as they need to deliver strong short-term results to meet the shareholder's expectations.

On the other hand, Mutual companies might act a bit more conservative here, since their focus lies more on maintaining long-term financial stability and take care of their policyholders' interests. Regarding stock companies, the managerial discretion hypothesis states that managers in stock companies enjoy more freedom and incentives to engage in complex financial activities, such as derivatives trading, therefore stock companies in

general engage in more derivative trading in comparison to their mutual counterparts (Cummins, et al., 1996).

The research conducted by Cummins, Phillips & Smith (1996) focused on various derivatives used by life and P&C insurance companies in order to mitigate interest rate risk, but they emphasized that in research like this, the use of hidden embedded derivative features in financial instruments is usually understated. Especially structured notes, which are fixed income securities with derivative characteristics, enable insurers to utilize derivatives in their investment strategies without having to specifically identify their usage. An example could be a 5-year structured note, for which the coupon rate is tied to S&P 500 index, instead of a more traditional fixed rate coupon. This security combines a "plain vanilla" 5-year bond with an embedded swap contract paying fixed rate and receiving the variable return of the S&P 500 index. This kind of security is usually not distinguished enough from other, more traditional products, which do now have embedded derivative features, therefore the statistics of actual popularity of such products remains relatively undetermined. This is a worthwhile avenue for future research that should definitely be pursued (Cummins, et al., 1996).

# 5 INFLATION AND LIFE INSURANCE

The odd thing in economics is that the prices keep rising throughout time. This phenomenon is called inflation, the thing that makes you pay more and more change for your coffee every year. But of course, it is not only a cup of coffee that is affected. Real estate, services, cars, phones, food etc. are all slowly increasing their prices every month and every year. In a household where income remains unchanged, its purchasing power diminishes swiftly. 1.000€ suddenly "feels" more like 500€. The good news is that wages established by contract also increase with inflation, but not always with the same rate. If the discrepancy between price increases and wage increases is too big, individual purchasing power drops. In extreme cases hyperinflation can occur, where inflation rate can go up to 1.000% or more. This recently occurred in Zimbabwe and Venezuela, where both countries had to completely change their official currency as well as implement rigorous measures in order to solve the issue. On the other side of the spectrum, we also have deflation, which is undesirable as well. In this case the prices are falling, and consumers delay making purchases, anticipating lower prices in the future. This means less economic activity and lower economic growth. The general consensus among the vast majority of economists is that low, stable and predictable inflation is best for an economy. In this case it is easier to capture it in price-adjustment contracts and interest rates (Oner, 2023).

Mainly we have two general explanations for price increases:

Demand-pull inflation, which is usually present in growing economies and caused by increases in consumer demands which may outpace available supply. People are willing to pay more, since they have confidence in market expansion.

Cost-push inflation, where exogenous shocks to supply affect the cost of production, materials, commodities and labour. Elevated prices are then passed on to consumers. (Ahlgrim & D'Arcy, 2012).

Inflation is usually measured as a percentage change in overall level of prices over a 12-month period. Government agencies conduct household surveys to identify a basket of representative goods. The price of purchasing this basket is then tracked over time and if we express it relative to a base year, we get the consumer price index or CPI, while the percentage change in the CPI over a certain period of time is called consumer price inflation. An example of expressing inflation through CPI would be: The base year CPI is 100 and the current CPI is 110, therefore inflation is 10 percent over the period (Ahlgrim & D'Arcy, 2012).

### 5.1 The effect of inflation on the insurance industry

As mentioned before, inflation impacts the price tag of pretty much everything on your monthly spending plan. Your insurance is of course not an exception. But while prices of most things remain fairly correlated with the general inflation rate, the effect on insurer claim payments may be dramatically different. Increases in retail prices are separated into pure price effects and additional manufacturing costs that appear because of technological advances. When inflation is measured, the reported CPI does not consider these additional costs. If the automobile price increases by 25%, the component of the CPI related to automobiles may indicate a much lower increase, for example 10%, ignoring the costs of a more advanced technology that is used. Payments from insurers ignore these “hedonic” corrections. Auto insurers do not reduce payments for car repairs and parts to adjust for differences in quality. Medical insurance claims are not larger because the old and outdated procedures are more expensive because of inflation, but because of constant advancements in medical technology. For example, a new generation of prosthetics would have their costs fully reflected in insurance claims, yet only a part of them would be reflected in CPI. In addition, insurers are exposed only to certain components of the CPI and in some cases, they are exposed to components missing from CPI. An example would be the selling price of a residence. Inflation impacts different insurers differently. Property-liability, automotive, medical, life and other insurers are all impacted in a different way (Ahlgrim & D'Arcy, 2012).

### 5.1.1 High inflation & claim payments

The life insurance is wary that even anticipations of increases in the price level can cause decreases in the sales of term and permanent life insurance. High inflation can reduce the real value, as opposed to the money value, of the cash benefits which are paid to its policyholders and beneficiaries. It can also increase the premium and benefit costs, as well as strain the insurer's investment returns and reserve levels. Life insurance companies usually respond with raising premiums or adjusting policy features, all while policyholders realize that their claim benefits buy less than originally anticipated (Hofflander, Jr. & Duvall, 1967).

An instance of such high inflation environment is the aforementioned Volcker's period, or rather a period before the Volcker's appointment. High inflation was the very reason that Paul Volcker was chosen as the chairman of the Fed and used drastic measures in the form of extremely high interest rates to combat the situation. The seventies were tainted by oil supply shocks due to embargos and ongoing wage-price spirals. The inflation hit the peak in 1981 with 14.7% rate. Way over the 2-3% target, putting significant economic pressure on households and businesses. Volcker then deployed his high-interest rate tactic, which massively affected the US economic system, resulting in two recessions, unemployment increases and the general suffering of the industries, including life insurance companies. Volcker managed to tame the high inflation, although at a great cost. The inflation had to be stopped somehow, since the industry was already deteriorating due to the loss in the value of money. Insurance companies were therefore suffering even before the Volcker's high interest rates, although the effects were slightly different (Matthews, 2022).

Even before the inflation starts to show itself, the anticipation of it already starts to affect the pattern of insurance purchases. The general public gradually starts to change their purchasing behaviour, with more term insurance and less permanent insurance being purchased. The consequence is a smaller volume of premium to the industry. In theory, the policyholder should invest the remaining funds that does not go into the premium, into a common stock portfolio, in order to hedge against the inflation. This hedge technique is also commonly deployed by insurance companies. In a high inflation environment, they invest a larger proportion of their assets in common stocks and have part of the benefits depend upon the results obtained from these investments. Certain sectors such as energy and commodities, tend to perform well during inflationary periods. The attained investment profits help substitute the lost income from the lack of permanent insurance sales. A study done by David B. Houston has shown that as the Consumer Price Index (CPI) increases, the proportion of premiums devoted to savings decreases. Approximately 1 percentage point decrease in CPI decreases the ratio of reserves to premiums for a half percentage point (Hofflander, Jr. & Duvall, 1967).

Despite the listed problems, life insurers are still the less affected by claims inflation in comparison to property-liability insurers, since many of their products are fixed in amount.

They also try to push inflation-indexed products and variable products, which include both life insurance and annuities that are even more popular. The latter tie values of stock market performance for policyholders, who worry about the erosion of value, caused by inflation. The correlation between stock market returns and inflation should allow these variable products to provide an adequate hedge against price increases (Ahlgrim & D'Arcy, 2012).

Inflation also has a more indirect way to affect life insurance companies. It erodes the current value of fixed future payments, which creates disincentive for life insurance purchases and increases the number of policy lapses. It is indeed hard to justify current expenditures on future fixed payments that are rapidly decreasing in value. The guaranteed rate of return that was offered under older policies, is eventually inadequate during continuous inflationary environments. All this causes an increase in lapses and loan activity as policyholders try to take advantage of the higher rates of return of competing products. What we see here is a typical example of the disintermediation risk, which is very likely to reduce the profitability and increase liquidity requirements of life insurers. Their biggest "weakness" here is their long-term nature, since they generally sell significant amounts of long-term care insurance and disability insurance (Ahlgrim & D'Arcy, 2012).

### 5.1.2 Deflation & claim payments

The risks also lie on the other side of inflation. Falling prices can lead to insufficient investment returns and inflation-indexed protections that insurers have set up, could do more harm than good in a deflationary environment. A notable example would be Japan, where the historical inflation rate remained below zero for most of the last 30 years, with at least seven Japanese insurers going bankrupt in the process. Life insurers are especially vulnerable to embedded options in their products, for example inflation-indexed annuities that often provide additional protection that increases the paid amount in the case of positive inflation but does not reduce the amount in the case of deflation (Bégin, 2016).

The most notable deflation period in recent history, which is also one of the causes for the aforementioned Japan situation, is of course the post-2008 crisis period, where the financial crisis led to a severe global recession. The consequences were disinflationary and later deflationary pressures, as asset values and consumer prices fell during the period's lowest times. Between late 2008 and early 2009, the U.S. saw deflation in housing and commodity prices (Boyle, 2023).

The consequences were less consumer spending, as consumers were delaying purchases, anticipating even lower prices in the future. This behaviour additionally slows down the already slow economy. Businesses sell less goods and for lower prices, which leads to lower profits and higher unemployment. Companies also have less funds to re-invest in themselves, putting off innovation and development. The debt also gets more expensive, because if the monthly mortgage or car loan stays unchanged, but your income is lower, then you are spending a larger portion of your income on your debt. It also does not help that the asset you are paying off is continuously dropping in value (The Currency, 2024).

Deflation may cause a significant challenge to insurers that have products with embedded minimum rate of return guarantees. Sustained deflation or low inflation periods may pose a problem for them to earn that promised guarantee, since investment returns are lower, due to lowering interest rates that remain low for extended periods. Low interest rates mean reduced yields on new bonds that lead to possible insufficient return and inability to cover the guarantees. This may force the insurers to raise the premiums or reduce benefits on newer policies, which most likely impacts sales. Deflation also increases the real value of liabilities, causing the purchasing power of claim payments to rise. This means that it is now more expensive for insurers to fulfil future liabilities, since the fixed payouts now have a higher true value. In addition to that, deflation generally signals economic contractions, which encourages people to reduce disposable income. For many, life insurance becomes less affordable and viewed as unnecessary (Ahlgrim & D'Arcy, 2012).

## 5.2 Insurer's risk mitigation strategies for high inflation and deflation

The inflation rate after the Volcker period remained fairly moderate, with the exception of a deflation blip in 2009 and another larger increase in the post-pandemic era (with its peak being 9.1% in June of 2022). This moderate rate has produced an entire generation of employees that have not yet faced a major inflation adversity, since contingency planning for deflation or high inflation was mostly unnecessary. In the fear of risk management becoming complacent, the first risk mitigation strategy for insurers should be staff preparation to be ready to deal with deflation or high inflation. The first step is effective contingency planning, which will allow companies to quickly respond when economic conditions inevitably change. The following mitigation steps can be divided into three different groups: actuarial, operational and investments:

### 5.2.1 Actuarial aspects of risk mitigation

In high inflation environments, insurers tend to reduce policy terms, making coverages for a shorter period of time and adjust rates frequently to keep up with the increasing costs. Usually, the maximum rate level increase is set that could be made without causing a significant lapse rate. This maximum rate is not to be crossed and to achieve this, semi-annual rate adjustments need to be exercised. To keep this area covered, frequent analyses and filings need to be performed and that requires substantially more staff than is currently allocated to pricing areas. There should also be frequent studies of the relationship between rate increases and policy retention, to allow companies to optimize profits in an inflationary environment. Additionally, the chance for arbitrage opportunities in products are lessened by features incorporated in the policy forms. Rather than providing policy loans at fixed rates, whole life policies usually link loan rates to a floating index, which should be

correlated with inflation. This reduces disintermediation risk. Policyholders usually do not like the fact that commonly embedded guaranteed rates of return are eliminated, but triggers that are linked to deflation risk need to be alleviated, since investment returns might not be adequate to sustain such guarantees (Ahlgrim & D'Arcy, 2012).

Compared to USA, Mexico had a rougher inflation period between 1980s – 2010s, with its peak in 1988, reaching a jaw dropping 179.73%. (Trading Economies, 2024) Their experience led to several policy redesign recommendations for life insurance industry. Rather than using nominal rates for guarantees and investments, insurers should be using real interest rates. Premiums, face value and expenses should all be indexed to inflation or wages, so that loss of the policy value is prevented. Inflation adjusted annuities that index benefits for inflation, should have a cap in order to avoid significant unexpected exposure in the case of high inflation. In the case of hyperinflation, a properly priced policy that fully indexes inflation could be cost prohibitive, essentially unaffordable by the majority of people. This is why policy design need to be addressed right away and not only after inflation begins to take form (Ahlgrim & D'Arcy, 2012).

### 5.2.2 Operational aspects of risk mitigation

For life insurers reducing the policy term to be able to implement premium increases quickly is crucial during high inflation environments. Certain lines of business already have partially inflation sensitive exposure bases which helps them slightly mitigate the impact on premium adequacy. Nevertheless, monitoring these exposure bases by auditing payroll or sales for commercial policies and adjusting replacement costs for homeowners becomes critical tasks under high inflation period. It is also possible that some exposure bases will not reflect overall inflation, if unemployment persists at high levels during a high inflation regime. Companies need to be flexible during high inflation times, and they must be willing to extend the staffing budget in order to maintain adequate rates (Ahlgrim & D'Arcy, 2012).

The Mexican inflation example led to the recommendation to determine a maximum level of coverage based on the original face value of a policy and a maximum inflation adjustment. Variable deductibles were recommended to keep the policyholder’s share of a loss proportional to the total value and not a fixed level. Before the Volcker’s period in 1970s, reinsurers were writing excess policies indexed retentions to the CPI, so that they could limit the inflation effect on their costs. Inflations pushed claims that were originally below the retention, over the level, together with increasing claims already hitting retention levels. Consequently, reinsurers experienced a much higher level of claim cost inflation in comparison to primary insurers. One mitigation technique would be indexing those retentions, as well as indexing coverage levels and deductibles (Ahlgrim & D'Arcy, 2012).

There is also deflation, which creates its own set of rules for insurers. It is usually accompanied by an increase in unemployment rate, which is correlated with an increase in

policy lapses. There is an increased risk of unpaid balances on existing policies, either from instalment payments or premium adjustments. This is not relevant only for policyholder's balances, but also for agents and reinsurers. We combine this with the fact that bonds and other debt instruments will have higher default rates. Determining the term of the policy is of crucial importance in deflationary environment. Longer premiums will slow the premium level decline, but they will be harder to sell or collect the premiums when the hard times hit. Shorter policy terms may be the better choice in this case. Rate adjustments lead to lower rates, but they may be necessary for competitive reasons to retain sales (Ahlgrim & D'Arcy, 2012).

### 5.2.3 Investments to mitigate risk

As baby boomers retire, they begin to worry about the inevitable erosion of purchasing power during retirement, so the demand for inflation-indexed products increases. Life insurers usually hedge this exposure with inflation-indexed bonds or over-the-counter derivatives, such as inflation swaps or caps & floors. Index of the insurer's liability must correspond with the index in the acquired asset, in order that the basis risk can be negligible. But if the demand for inflation-indexed products increases and leads to more life insurers scrambling to hedge their risks, then the limited availability of inflation linked securities in the market can make direct hedges more expensive. This can increase costs for policyholders. In addition to that, the use of imperfect hedges, such as equities, real estate and commodities, increases basis risk (Ahlgrim & D'Arcy, 2012).

When interest rates increase, long term fixed income bonds significantly decline in value. The relationship between inflation rates and interest rates tells us that a spike in inflation is usually accompanied by an equally sharp increase in interest rates. Insurers now cannot sell these bonds without recognizing great losses. Financial challenges continue in the case of hyperinflation environment, where stocks usually perform poorly. Short term bonds are a better option, since they allow insurers to reinvest the proceeds more quickly and reducing the impact of an interest rate increase on asset value and earnings. This will on average reduce the investment earnings, because short term bonds normally have lower interest rates compared to longer term bonds, but it will reduce the impact of inflation on earnings. Another valid mitigation strategy is to invest in commodities which are considered to be good inflation hedges. A good example of that would be gold. In May of 2009, the Northwestern Mutual invested $400 million in gold and even though inflation has not increased drastically, concerns over inflation and economic stability boosted the price of gold up for almost 60% in two years.

# 6 CONCLUSION

The thesis comprehensively examines the impact of fluctuating interest rates and inflation on life insurance companies, highlighting three key historical periods: The Volcker's high-interest rate period, the post-2008 low interest rate period and finally the post-COVID period characterized by rising interest rates and inflation. The findings highlight the significant influence of macroeconomic factors on the life insurance industry, emphasizing the critical need for effective risk mitigation strategies.

During the Volcker's period, the rapid rise in interest rates led to policyholder behaviour changes, which placed a lot of pressure on the cash flows of the insurers. High-interest rates increase policy surrenders and require insurers to execute frequent rate resets to retain policyholders. On the other hand, the post-2008 period's prolonged low interest rates created trouble for insurers in maintaining profitability, since investment returns declined and minimum guarantee policies started to cut into the insurer's capital, since they are obligated to cover the difference. The post-COVID presented a mixed landscape, with rising interest rates presenting various potential investment advantages while also increasing the financial strain due to inflation and heightened mortality risks.

Risk mitigation strategies play a crucial role in ensuring the stability of life insurance firms. Short-term strategies include asset-liability matching and hedging using derivatives like Interest Rate Swaps and Options. They also involve adjusting interest rate guarantees. Long-term strategies on the other hand include portfolio diversification, operational efficiency and regulatory adjustment to minimize exposure to extreme economic shifts. Insurers must also adapt their actuarial operational frameworks to counter inflationary effects, which increase claim payments, creating a challenge in pricing policies accurately.

The future outlook for life insurers must include innovation in financial risk management and constant adaptation to volatile economic conditions. It is likely that regulatory bodies will impose stricter solvency requirements to safeguard the industry against financial shocks. Advances in actuarial sciences and data analytics will be essential in forecasting and mitigating emerging risks. Understanding historical trends will be more important than ever for implementing proactive risk management strategies. With that in mind, life insurance companies will be able to navigate financial uncertainties and sustain long-term profitability. It is an incredibly useful and fascinating field that is very much still open for future research.

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# APPENDICES

## Appendix 1: Povzetek vsebine (Summary in Slovene language)

Magistrsko delo celovito preučuje vpliv, ki ga imajo nihajoče obrestne mere in inflacija na življenjske zavarovalnice. Pri tem se osredotoča na tri ključna zgodovinska obdobja: Volckerjevo obdobje rekordno visokih obrestnih mer, obdobje nizkih obrestnih mer, ki je sledilo finančni krizi v letu 2008 ter obdobje, ki je sledilo COVID krizi, ki je bilo zaznamovano z rastjo obrestnih mer ter inflacijo. Ugotovitve jasno kažejo, da imajo makroekonomski dejavniki močan vpliv na panogo življenjskih zavarovanj, kar poudarja pomembnost učinkovitih strategij za obvladovanje tveganj.

V času Volckerjevega obdobja je hitra rast obrestnih mer povzročila spremembe vedenja zavarovancev, kar je občutno obremenilo denarne tokove zavarovalnic. Visoke obrestne mere so množično spodbudile predčasne prekinitve polic, kar je posledično zahtevalo pogoste prilagoditve obrestnih mer z namenom, da bi obdržali svoje stranke. Nasprotno pa so dolgotrajno nizke obrestne mere, ki so sledile finančni krizi v letu 2008, povzročale težave pri ohranjanju dobičkonosnosti, saj so se donosi naložb zmanjševali. Sočasno so police z zajamčenimi minimalnimi donosi začele negativno vplivati na kapital zavarovalnic, saj so slednje bile primorane pokrivati nastale razlike. Obdobje po COVID krizi je prineslo mešano sliko – po eni strani so višje obrestne mere ponujale nove priložnosti za naložbe, po drugi strani pa so rast inflacije in povečana smrtnost povzročali dodatne finančne pritiske.

Strategije za obvladovanje tveganj imajo ključno vlogo pri zagotavljanju stabilnosti zavarovalnic. Na kratki rok to dosegajo z usklajevanjem sredstev in obveznosti ter zavarovanjem tveganj prek izvedenih finančnih instrumentov, kot so zamenjave obrestnih mer in opcije. Prav tako so ključna tudi prilagajanja obrestnih jamstev. Dolgoročne strategije vključujejo diverzifikacijo naložbenega portfelja, izboljšanje operativne učinkovitosti ter prilagajanje regulatornim zahtevam z namenom zmanjšanja izpostavljenosti ekstremnim gospodarskim nihanjem. Zavarovalnice morajo tudi prilagoditi svoje aktuarske modele, saj inflacija zvišuje višino škodnih izplačil, kar otežuje ustrezno določanje premij.

Prihodnost življenjskih zavarovalnic bo močno odvisna od inovacij na področju finančnega obvladovanja tveganj ter nenehnega prilagajanja nepredvidljivim gospodarskim razmeram. Velika verjetnost je, da bodo regulatorni organi uvedli strožje kapitalske zahteve, z namenom zaščite panoge pred finančnimi pretresi. Napredek na področju aktuarskih znanosti in analitike podatkov bo imel ključno vlogo pri napovedovanju in obvladovanju novih tveganj. Razumevanje zgodovinskih trendov bo postalo ključnega pomena, saj bo omogočalo pravočasno in proaktivno upravljanje tveganj. S takim pristopom bodo zavarovalnice lahko uspešno krmarile gospodarske negotovosti ter zagotavljale dolgoročno stabilnost in dobičkonosnost. Gre za zelo pomembno in dinamično področje, ki ponuja številne priložnosti za nadaljnje raziskave.