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**What is the impact of assumptions on the calculation of an
actuarial valuation in Germany?**

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Project Work

presented as partial requirement for obtaining the Master Degree Program in Statistics and Information Management

NOVA Information Management School
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WHAT IS THE IMPACT OF ASSUMPTIONS ON THE CALCULATION OF AN ACTUARIAL VALUATION IN GERMANY?

By

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Project Work presented as partial requirement for obtaining the Master's degree in Statistics and Information Management, with a specialization in Risk Analysis and Management.

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledge the Rules of Conduct and Code of Honor from the NOVA Information Management School.

[student signature]

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ABSTRACT

The purpose of this project work is to acknowledge and quantify the impact of assumptions on the calculation of an actuarial valuation in Germany, and, simultaneously compare multiple scenarios, in order to identify which ones have the highest impact on normal cost. Regarding the methodology, in collaboration with Mercer, the project utilizes anonymized data from a German enterprise, as well as a software capable of calculating the actuarial valuation. The study includes four actuarial assumptions, which are discount rate, cost of living increase, pay increase and mortality rates, and for the creation of scenarios, variations of 0,5% and 1% are taken for each assumption. The key finding from this research is that, in this particular case, the most decreasing scenario occurred when there was a 1% increase in the discount rate, while the most increasing one was observed when the pension growth rate increased by 1%. In both scenarios, it was visible a variation higher, in absolute terms, than 10% in the normal cost, which leads to the conclusion that assumptions have a major effect on the plan's financial status, funding levels and the adequacy of benefits provided to pensioners. Therefore, plan sponsors must do their selection with great caution, using reliable information and in accordance with the plan's details.

KEYWORDS

Actuarial Valuation; German Pension Plan; Actuarial Assumption; Defined Benefit

Sustainable Development Goals (SGD):



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GLOSSARY

Active	Employed member in a pension plan, contributing towards retirement savings for a secure future income.
Actuary	Financial professional who uses mathematical and statistical methods to assess and manage risks for insurance companies, pension plans, and other businesses.
Actuary Assumptions	Key factors and variables that actuaries use to make predictions and calculations regarding future pension obligations.
Annuity	Financial product that provides a regular stream of income for a specific period or for the lifetime of an individual.
Benefit/Pension	Regular payment provided to individuals, typically retirees or those who meet specific eligibility criteria, as a form of financial support. It is designed to provide income security and help cover living expenses during retirement or in certain circumstances, such as disability or the loss of a loved one.
Book Reserve	Amount of money set aside by a company or organization to cover future liabilities or expenses. It is recorded on the company's financial statements as a contingency or provision for potential future obligations.
Contribution	Monetary payment made by both the employee and employer towards the pension fund.
Contributor	Individual or employer who actively makes financial contributions towards the pension fund.
Deferred	Individual who has accumulated pension benefits but has not yet reached the eligible age for retirement or started receiving the pension payments. They have deferred the receipt of their pension benefits until a later date when they become eligible to claim them.
Dependency Ratio	Demographic indicator that measures the ratio of the non-working population, often people aged under 15 or over 64, to the working-age population, typically defined as those aged between 15 and 64.
Eligibility	Criteria or requirements set by the plan in order to qualify for receiving pension benefits. It typically includes factors such as age, length of service, and employment status.
Liability	Financial obligation or responsibility of the plan sponsor or administrator to provide pension benefits to plan participants in the future. It represents the

	estimated amount of funds that will need to be disbursed from the pension plan to fulfill the promised retirement benefits.
Normal Contribution	Present value of the benefit corresponding to the current year. More precisely, it is the present value of the increase in benefit due to an additional year of service.
Normal Cost	Present value of the future pension benefits that are attributed to a particular year of service. It represents the actuarially determined cost of providing retirement benefits for employees based on their service and salary levels.
Normal Fund	Portion of the pension fund that is designated to cover the expected future pension benefit payments for active plan participants. It represents the accumulated contributions and investment earnings that are specifically earmarked for fulfilling these anticipated retirement obligations.
Normal Retirement Age	Age at which plan participants are eligible to start receiving full retirement benefits without any reductions or penalties. It is defined in the plan document and is usually 65 years old.
Participants/Members	Individuals who are enrolled in the plan and actively contributing towards their retirement savings.
Pensionable Salary	Portion of an employee's salary that is taken into account when calculating their pension benefits. It typically includes the base salary and may also include certain additional components such as bonuses or allowances, as defined by the pension plan's rules and regulations.
Pensioner	Individual who has reached the retirement age or met the eligibility criteria and is receiving regular payments from the pension plan as retirement benefits.
Replacement rate	Percentage of pre-retirement income that is replaced by pension benefits during retirement. It measures the extent to which a retiree's income is maintained or substituted by their pension payments, providing an indication of the level of financial security in retirement.
Withdrawal	Likelihood of a participant leaving the company.

LITERATURE REVIEW

1.1. THEORETICAL CONCEPTS

With the rising of the life expectancy and a shift toward less secure employment, the need for a dependable source of income for retirees who are no longer able to work is more pressing than ever. Individuals are frequently unable to save enough money on their own to fund their retirement. As a result, governments and private companies have established pension funds to facilitate the attainment of a financially stable and comfortable retirement for individuals.

According to its established meaning, a pension fund is a type of investment vehicle that is specifically established for the purpose of providing retirement benefits to its members. It is comprised of a pool of assets that are managed and invested with the goal of generating enough returns to meet a pension plan's future obligations (Crisan, 2016). Members contribute to the fund throughout their working years, and the investment returns generated by the fund are used to provide retirement benefits to the members once they reach retirement age.

Pension funds can be classified as open or closed. Individuals can voluntarily apply to participate in an open pension fund, subject to approval or rejection by the managing investment entity. In other words, the entry requirements are not restricted, and anyone can join the fund if they meet the criteria set by the fund management. On the other hand, a closed pension fund has membership limited to a specific group of individuals who are linked by a common business, professional, or social connection.

A pension plan can be defined as a set of rules that outlines the conditions for someone to receive a pension and its primary goal is to provide income to employees during their retirement (Winklevoss, 1993). Nonetheless, a pension can be more than a monetary support for retirement being also associated to pre-retirement, early retirement, total and permanent disability, vested rights and survivor benefits.

It is noteworthy that a plan can have 3 different categories and guarantees based on the information available. If the benefit to be received from the retirement age is predefined, it is a defined benefit plan. Alternatively, if the contributions that the employer and/or the employee must make over the years of service are known, it is a defined contribution plan. Lastly, it is a hybrid plan if both the benefit and contribution metrics are predetermined.

A pension plan can also be classified as contributory or non-contributory, depending on whether the participants contribute or not to the fund.

1.1.1. Defined Benefit Plan

As previously mentioned, in a defined benefit plan the benefit to be received is established from a certain age or occurrence. It is noteworthy that this is not always a fixed nominal value, but it is based on a formula, which may be a fixed amount, a fixed percentage of salary, a fixed percentage per year of service or other type of formula (Bodie et al., 1985).

In order to accomplish these values, companies have to contribute over the years of service to a pension fund or any other type of funding vehicle. Since the performance of this last concept is uncertain, the contributions the company will make will vary along the years.

One cannot mention defined benefit plan without bringing up actuarial valuations, which are, summarily, the tool that calculates and ensures that the contributions made are enough to cover the promised pensions.

1.1.2. Defined Contribution Plan

When the contributions that the company makes, usually monthly, to an employee's retirement account are known, it is a defined contribution plan (Bodie et al., 1985). The benefits levels will depend on how the contributions and investment earnings accumulate over the years of service. The employee will generally have some degree of choice over how the account is invested and if he/she wants to contribute to the fund. Typically, the benefit is only known at the time of retirement, and it is a straightforward matter of measuring the market value of the assets held in the retirement account. Upon retirement, the employee can receive either a lump sum or an annuity. Although the cost of the company is defined and it is not mandatory to make an actuarial assessment, it is recommended to estimate the value of the pension to be received and, from there, determine whether any adjustments to contributions are necessary.

1.1.3. Hybrid Plan

As a concluding remark, hybrid plans are also an option. These are essentially defined contribution plans with an added benefit. In this type of plan, the final pension is given by the sum of the defined benefit with the normal fund accumulated from the defined contributions.

1.1.4. Types of Benefits

Pension plans offer a variety of benefits to their members, with the purpose of ensuring a secure and comfortable retirement. These benefits can vary greatly depending on the pension plan's specifics, such as the type of plan, the employer or industry that sponsors the plan, and the regulations that govern the plan. The following paragraphs will go over the various types of benefits that pension plans can offer in Germany.

Firstly, there is the retirement benefit. This is the most common source of income during retirement years, replacing the income earned during working years. To be eligible for this benefit, the Employee Retirement Income Security Act of 1974 (ERISA) sets a standard age and service requirement for employees to join a pension plan. As such, an employee is eligible to enroll in a plan after turning 21 and with a minimum working time of 1 year (Winklevooss, 1993). However, some plans may have a more flexible membership policy with no waiting period to join. It is important to keep in mind that the employee only starts to accrue benefits when he/she enters the plan and not when he/she enters the organization.

When a plan provides accrued benefits to a leaver of the plan, it bears vested benefits. These can be defined as a payment to a former employee and member of the plan. The benefit becomes payable at the normal retirement age but can also begin at an early retirement age with a reduction. Concerning eligibility for a vested benefit, the Tax Reform Act of 1986 requires a minimum age of 30 years old

when leaving the company and 5 years of service for full vesting or 3 years of service for graded vesting with an additional 20 percent per year, reaching full vesting at 7 years of service (Winklevoss, 1993). The benefit amount is based on the retirement benefit formula, which uses the final average salary and service at termination, payable for life or in lump sum.

Given that nowadays there is an increased willingness among individuals to change jobs, this will result in several pensions dispersed by various entities as well as devalued vested pensions, since only the salary at departure is used, instead of the career-end salary.

Then, there is the option for pre-retirement that occurs when the employee reduces the number of working hours or volume of work, leading to a reduction in salary. The worker will continue to receive this payment until they retire due to old age, disability, return to full-time work or the end of their employment contract. To be eligible for pre-retirement an employee must be at least 55 years old and have a minimum of 10 years of service.

Furthermore, early retirement pertains to scenarios in which an active participant becomes a retiree before the normal retirement age, facing a reduction in the benefit amount for each early period. As in pre-retirement, a member is eligible for early retirement if he/she is 55 years old and has a minimum of 10 years of service. The most common benefit amount is 1.5 percent of the employee's final 5-year average salary per year of service, payable for life, with the actuarial reduction for early retirement.

When the participant of the plan dies, and the pension is paid to the spouse or to minor children a survivorship pension or death benefits takes place. This benefit is usually a monthly payment equal to 50 or 60% of the promised pension to the original member. To be eligible for death benefits (Winklevoss, 1993), an employee must have at least 5 years of service. It is usually payable for life starting right after the moment of death or given in a lump sum.

Lastly, one can receive disability benefits. By disability, solely total and irreversible disability is considered. To be eligible for disability benefits, an employee must be 40 years old and have a minimum of 10 years of service. In case the participant becomes disabled and fulfills the eligibility requirements, they should start receiving an immediate lifetime pension, with the value of the benefit being usually 60% of the pensionable salary.

1.2. GERMAN PENSION SYSTEM

The German Pension System is a crucial aspect of the social security framework in Germany. It is designed to provide financial support and stability to individuals during their retirement years and it is known for its comprehensive coverage, ensuring that most individuals are entitled to receive a pension upon reaching retirement age.

In this chapter will explore the key features, structure, and functioning of the German Pension System. It will delve into the challenges and debates surrounding the sustainability of the German Pension System in the face of demographic changes, such as an aging population and declining birth rates, highlighting the significant reforms that have taken shape.

Furthermore, the chapter will shed light on the various types of pensions available in Germany, including the state pension, occupational pensions, and private pensions. It will discuss different factors that affect the pension's functioning, such as the occurrence of insolvency and the different types of funding vehicles.

1.2.1. Recent News

Nowadays, a significant obstacle that society faces is the shifting demographics resulting from an aging population (Chen & Rach, 2021). While birth rates have remained low, life expectancy has steadily increased over the past few decades. This has resulted in significant expenses for social security systems. With a declining workforce, the burden of supporting a growing number of retirees through pensions places an unsustainable strain on the statutory pay-as-you-go system, hindering its effectiveness.

This demographic situation in Germany indicates that the number of retirees is expected to exceed the number of contributors in the future. In the recent past, there were approximately three individuals aged 20-64 for every individual aged 65 or older, but this ratio is projected to decrease from two-to-one after 2030.

Besides, we also must consider that the duration for which individuals receive pensions has significantly risen. In the past 40 years, the average length of time for which pension payments are made has gone up by eight years, to nearly 20 years.

The generosity of the German pension insurance system, which provided extremely generous old age, disability and survivor pensions until recently, is no longer sustainable. Projections show that the dependency ratio will more than double in the next four decades, from roughly 30% in 2019 to between 60% and 65% in 2050 (Wilke, 2009).

In the last few years, in response to the actual demographic situation, Germany introduced some new reforms (Federal Ministry of Labour and Social Affairs (BMAS), 2021):

- State pensions now have EET (Exempt, Exempt and Taxed) taxation, meaning that benefits payments are taxed but the employee and employer contributions are deductible and there is tax exemption on returns from pension fund investments;
- Strengthening of private pension regimes by introducing certified individual pension contracts;
- Introduction of pension funds;
- Increase of the legal retirement age from 65 to 67 and reduction of state benefits.

1.2.2. Definition and information

The pensions in Germany are funded by a system that was implemented in the 19th century. Along the decades, it has undergone some modifications, considering the natural evolution of the economy among other factors.

In Germany, the pension system follows the Three Pillars System (or Three Layer System). As the name suggests, this scheme consists of 3 "layers": social security pensions, company-initiated pensions, and private pensions.

The first pillar pension plans tend to be funded by a pay-as-you-go system with mandatory participation, where contributions to the plan are made by active workers who will pay the benefits to the current retirees. The goal is that one day when the active workers retire, the new active workers will pay their retirement, completing the cycle (Fontes, n.d.). Currently, in Germany the social security layer continues to predominate, having more than 80% of the active population covered by this system (Bodie et al., 1996). In the German social security system, it is mandatory to participate in the following:

- Legal pension insurance (retirement, survivorship, and disability pension)
- Unemployment insurance
- Health insurance
- Nursing care insurance

From just one salary, contributions to social security are identical for employees and employers. The percentage is taken from gross salary up to a limit known as the Social Security Contribution Ceiling (SSCC), which was 20% until 2020 (Berkel & Börsch-Supan, 2003) and is, now, 22% until 2030 (Wilke, 2009).

Until a short time ago, the German public pension system recorded comparably high pension levels of 67% of net wages and approximately 48% of gross wages for typical pensioners, that is, someone who has paid into social security for 45 years. However, these levels are slowly decreasing due to demographic transition mentioned previously.

In the second pillar, the plans, commonly called occupational pension plans, tend to be funded by a capitalization system, where contributions are made by the employer and possibly also by the employee. Contributions are accumulated and later when the participant retires, the individual will receive the amount contributed and the earnings generated over time by that amount. In this system, each person finances and is responsible for their own pension. This layer is voluntary in nature and is a company-wide collective scheme, covering only for 10% of old age income to the population covered by this regime (Wilke, 2009).

Regarding this second layer, it is the Germany Company Act (BetrAVG) that contains all the current legal material, such as definitions of company pensions, eligibility, vested rights, adjustment of pensions in payment and protection against insolvency. In this document, it is written that the employer has the duty to pay benefits to the employee in the case of retirement, early retirement, disability or death. These pensions can be paid directly or indirectly, as will be shown in next pages.

Lastly, the third layer refers to individual savings, including retirement savings plans, life insurance policies and pension funds, being also voluntary in nature.

1.2.3. Insolvency

When dealing with occupation pension plans, there is the risk that the company becomes insolvent and, therefore, cannot provide the pension benefits. To protect employees, the BetrAVG provided mandatory insolvency insurance for all company pension plans except for those that are funded through pension funds and direct insurance with irrevocable rights (Bodie et al., 1996).

The Act on the Improvement of Occupational Pensions provides insolvency protection of pension entitlements for all benefits from direct pension promises, support funds, and direct insurance

contracts with a revocable claim. The insolvency protection is provided by the Pensions-Sicherungs-Verein (PSVaG), a mutual insurance corporation that has the powers of an institution of public administration. The PSVaG does not pay the guaranteed occupational pensions itself; it uses a consortium.

Section 7 of the BetrAVG specifies the obligations of the PSVaG in cases of bankruptcy or similar situations, which include the rejection of bankruptcy petitions due to lack of assets, the initiation of composition proceedings to avoid bankruptcy, the settlement out of court with the formal consent of the PSVaG, the suspension of operations under the Act on the Improvement of Occupational Pensions, and serious economic difficulties similar to bankruptcy with restrictions or suspensions of entitlements by labor courts or the PSVaG (Bodie et al., 1996). The PSVaG is obligated to provide coverage regardless of the cause of the insolvency, and employees are entitled to benefits even if their employer did not pay contributions to the PSVaG as required by law. This is to ensure that employees' pension entitlements are not dependent on whether the employer followed the law.

The insolvency insurance covers pensions in course of payment and vested pension entitlements at the time of bankruptcy, with coverage starting from the moment of bankruptcy for pensions in course of payment and after the pensionable incident for vested entitlements. The PSVaG pays a pension equal to what the employer would have paid according to the original pension plan but will not adjust pensions based on section 16 of the BetrAVG. Instead, any indexation clauses contractually agreed upon in the pension plan will be applied. The PSVaG is not obliged to pay a monthly pension exceeding three times the Social Security Contribution Ceiling. If there is evidence of abuse, such as excessive improvements made to the pension plan in the year before insolvency, the PSVaG may not provide coverage.

If the PSVaG becomes unable to continue its activities, its assets and liabilities will be transferred to the Deutsche Ausgleichsbank (German government-owned financial institution) by statutory order. In Germany, most occupational pensions are financed internally through book reserve accrual, so no external assets are accrued or available if the company becomes insolvent. Despite this, the PSVaG provides effective protection for current pensions and vested entitlements against company insolvency.

1.2.4. Funding Vehicles

Funding vehicle is the way in which the money used to pay the promised benefits is collected by the company. As mentioned earlier, occupational pensions in Germany can be financed directly by the company through book reserves or indirectly through a legally independent institution (Fontes, n.d.). Four financing methods are available to employers, including direct pension promises, support funds, direct insurance, and pension funds. The accumulated funds for pension purposes in 1991 showed that book reserves (direct pension promises) accounted for 58%, pension funds for 22%, direct insurance for 11%, and support funds for 9% (Bodie et al., 1996).

Their differences consist in the restrictions on investing and tax treatment. Regardless of the type of funding vehicle, the employer is obligated to fulfill the payment of the benefits.

In this work project, direct pension promise will be the only funding vehicle explained since it will be the one used for the calculation of the actuarial valuation. As so, direct pension promises are the most

common financing arrangement in Germany (Bodie et al., 1996), being a type of internal financing with the employer having a direct liability to pay benefits out of the company's assets.

According to the Income Tax Act (Einkommensteuergesetz, EStG), financing a direct pension promise involves accruing a book reserve and disclosing it in the tax and trade balance sheet. The company is required to disclose a liability in the trade balance sheet for pension promises effective after December 31, 1986, while disclosure for promises given before this date is optional.

The accrual of book reserves reduces the taxable profit of the company, resulting in a reduction of its income tax burden. The pension promises and the allocations to the book reserves do not represent taxable income for the employer. Once the benefits are being paid, they are like wages, subject to income tax with several tax-exempt allowances.

Since this method recognizes the costs of the pension plan on the company's balance sheet, it brings the advantage of giving a more real reading of the company's financial situation and performance, as recognizing the pension liabilities as a liability of the company is visibly recognizing the future retirees' rights over part of the company's gross assets.

With this taken in mind and adding the presence of a regulator that oversees an organizations' actions and reliability, the book reserve method may be considered a secure method as it acts as a backstop for the pension plan, helping to ensure that there are sufficient resources to meet benefit obligations even in the event of a downturn in the financial markets or other unexpected events.

1.3. ACTUARIAL VALUATION ASPECTS

As mentioned before, in a defined benefit plan, actuarial valuations are essential and mandatory. By definition (Crisan, 2016), an actuarial valuation is a comprehensive financial evaluation of a pension plan that aims to calculate the current value of the plan's liabilities and determine the necessary contributions to meet these obligations.

This analysis considers various factors, including the financing methods utilized, economic and demographic assumptions and the design of the plan. Apart from these, there are other variables that can affect these calculations such as the labor market, the economy, and the company where the plan belongs to. All referred factors make such a valuation highly uncertain. The ultimate goal of an actuarial valuation is to ensure the financial stability of the pension plan.

Other essential objectives of an actuarial valuation are:

- Define the level that the fund must reach in order to finance the plan;
- Discover the reason for deviations of liabilities and the total value of the fund compared to previous valuations;
- Readjust parameters and verify their effects on future liabilities and contributions;
- Understand and study the effects of changing benefits or introduction of new risks;
- Prepare descriptive and detailed reports.

It is noteworthy that for companies to make provisions in advance for the payment of pensions, they need an actuary to calculate the current value of the future obligation. To perform an actuarial

valuation, various information about the population involved in the pension plan is required. To cite a few, it is essential to be acquainted with (Crisan, 2016):

- Type of participant (active, vested, pensioner, widow, orphan)
- Gender
- Birth date
- Date of entry in the company
- Pensionable salary

Actuarial valuations are usually done annually or every three years, depending on the country. In the case of Germany, they are done annually.

1.3.1. Funding Methods

A funding method is essentially a model or formula that calculates the responsibilities and contributions of a plan. For this reason, funding methods are only required when dealing with defined benefit plans. Although there are several methods, choosing one will not affect the final cost of the plan, but it will affect the annual distribution of costs over time (Trowbridge, n.d.). Thereby, the method is used for calculating the necessary contributions, which are then passed on to the funding vehicle, which will accumulate the annual contributions until retirement.

A good method allows one to know at any time the existing responsibilities, the value of the advisable contributions, and to ensure the participant's security and the interests and financial capacity of the plan promoters. The most commonly used method is the PUC, projected unit credit, which is an individual cost method, that is, calculates the cost of each participant separately.

In this report, the PUC method and the entry age normal method will be the only funding methods approached since they will be the ones used for the calculations of the actuarial valuation.

1.3.1.1. Projected Unit Credit (PUC)

Since the pension value at retirement is already known and the years of service, from entering the organization to retiring, can be assumed, it can also be calculated how much benefit must be accumulated for each year of service. Considering this information, the value of each annual contribution to pay is calculated. To reach the normal cost and normal contribution of the year, it is just necessary to sum up these values for the whole population of the plan. Lastly, to know the normal fund, one just adds the normal contribution of the year to the responsibilities added to the fund in previous years.

In this method, the benefit makes use of the final salary. However, since the final salary can only be known when the member retires, it is made a hypothetical projection, where the current salary is estimated to the retirement date using a salary growth scale.

One thing to consider is that, over time, each pension unit has a growing cost as the payment period of each contribution decreases and the probability of reaching retirement increases.

1.3.1.2. Entry Age Normal (EAN)

The Entry Age Normal funding method bases its calculations on the age at each employee enters the plan and on its average salary, while assuming their future retirement age. By using these factors, it

calculates the present value of the pension benefits. Through the cumulative summation of these elements, the total plan liability is quantified. Then, to determine the contribution rate, it must be divided the total plan liability by the sum of all employees estimated future salaries. Finally, when multiplying the contribution rate with each employee estimated future salary it is figured the employer's annual contribution for each employee and by summing these, we get the total annual contribution of the plan.

Under the EAN method, younger workers will have a lower present value of benefits, which implies lower yearly contributions from the employer. On the other hand, the present value of benefits for older employees will be higher, and, therefore, their yearly payments will also be higher. Using the expected working lives and retirement ages of each employee, this strategy seeks to distribute the expense of the pension plan evenly among all employees.

1.3.2. Actuarial Methods

The actuarial methods refer to the already referenced funding methods, but with a purpose attached to it and there are three: Tax, Trade and IFRS.

Tax is the calculation for tax purposes. The German tax code indicates that the method to be used in the calculation of benefits is the entry age normal. The restrictions given by the German tax code on the economic assumptions are as follow:

- Minimum age of entry of 28 years (or 30 for plans before 01/01/2001);
- Discount rate of 6%;
- No existence of future benefit increases, unless specified in the plan rules. Thus, there is no assumption of long-term salary or pension increase to be considered.

As for the restrictions on the demographic assumptions, these need to be approved by the competent authorities. The standard tables are the Heubeck-Richttafeln (GLOBACS, 2021). There are different mortality tables for active members, pensioners, and disabled pensioners, as the probability of deaths of the various groups differ significantly.

Trade is the calculation for commercial purposes. German companies work to comply with the new accounting standards BilMoG, in force since 2010 (Crisan, 2016). These standards mainly address the accounting of pension promises for retirement that are paid directly by the employer, therefore, direct promise plans. Usually, in this type of calculation the method to be used is the projected unit credit, although entry age is also allowed. Trade was created to have a method based on expected market flows, taking into account various economic assumptions.

For Trade, there are the following demographic assumptions:

- Assumptions must be based on observed data and mathematical techniques;
- Withdrawal assumptions are allowed;
- The retirement age must be the retirement age agreed in the rules;
- The tables used are usually the *Richttafeln 2005*, but there are clients who use these with some changes.

IFRS (International Financial Reporting Standards) is the calculation for international purposes. Like Trade, IFRS also works with expected market flows and uses, most commonly, the PUC method.

However, in many cases, there is only a difference between Trade and IFRS, which is the discount rate to be applied. While Trade uses the averages obtained over the last seven years (data calculated and disclosed by Deutsche Bundesbank), in IFRS it is determined by reference to market yields on the balance sheet date (Crisan, 2016).

Within IFRS, it is relevant to point out the IAS19, an accounting standard set by the International Accounting Standards Board (IASB) that relates to the accounting and reporting of employee benefits, including pension plans. The standard provides guidance on how to measure the cost of providing employee benefits, how to recognize this cost in the financial statements, and how to present and disclose information about employee benefits in the notes to the financial statements.

In the context of German pension plans, IAS19 is relevant for companies that provide defined benefit pension plans. The standard requires companies to estimate the future costs of providing the benefits promised to their employees, and to recognize these costs in their financial statements. This helps to ensure that the financial statements provide a true and fair representation of the company's financial position, and that investors and other stakeholders have accurate and transparent information about the company's obligations with respect to employee benefits.

It is pertinent to mention that while IAS19 provides a comprehensive framework for the accounting and reporting of employee benefits, the standard is not mandatory in Germany. Nonetheless, many German companies choose to adopt the standard voluntarily, as it provides a widely recognized and accepted framework for the accounting and reporting of employee benefits. By adopting IAS19, these companies can improve the comparability and consistency of their financial statements with those of other companies, both in Germany and internationally.

1.3.3. Actuarial Assumptions

As it has been shown, the purpose of an actuarial valuation is, among many, to assess future liabilities, calculate how they will be achieved and stabilize financially the pension plan. To achieve these objectives, it is highly necessary the determination of contribution rates, which is where the relevance of actuarial assumptions surges. These can be divided into 2 categories:

- Economic or financial
- Demographic

While the economic assumptions are used to project the amount of benefit to be paid, the demographic are necessary to project the timing at which the benefits must be paid, as well as the development of the population of the respective pension plan.

The following assumptions will be viewed in more detail as they will be used to create various calculation scenarios:

- Discount rate
- Salary growth rate
- Inflation rate
- Mortality rate

Discount rate, to put it simply, is a ratio that is used to "discount" or bring future pension payments closer to their present value. Money has a time value, meaning that a dollar earned today is worth more than a dollar received in the future since it may be invested and grow in value over time. Taken this into account, pension liabilities will have a lower present value when the discount rate is higher, and a higher present value when the discount rate is lower. As a result, the stated financial health of a pension plan is significantly impacted by the discount rate selection. Some businesses may employ numerous discount rates to consider various kinds of pension liabilities.

The assumption of salary growth rate is used to estimate the future growth of salaries of plan participants. This is crucial because it helps determining the future level of benefits that will be provided to plan members. Future benefits will increase with a greater salary growth rate and decrease with a lower rate. Typically, projections of future economic conditions are combined with historical data, such as past rates of inflation and wage growth, to determine the salary growth rate. Additionally, it is affected by things like the participants' age and demographics, the sector or industry they work in, and the general state of the economy.

The inflation rate is the percentage increase in an economy's overall level of prices for goods and services over a given time period, often a year. Since it has an impact on the future purchasing power of benefits provided to plan participants, it is one of the fundamental economic assumptions used in actuarial valuations of pension plans. Given that the cost of delivering benefits rises with inflation, a higher inflation rate could make future benefits more expensive to provide. Due to the rising cost of benefits, the plan sponsor may need to make additional contributions to the plan. A lower inflation rate, on the other hand, might have the reverse effect and reduce the cost of paying future payments. In this situation, the plan sponsor might be able to make less plan contributions. The Consumer Price Index (CPI) or another comparable indicator of the general level of prices in an economy is typically used to assess the inflation rate.

Lastly, the mortality rate is the likelihood of a person dying at a specific age. It is a key demographic presumption in the actuarial valuation process since it aids in estimating the participants' life expectancies. Mortality rates can be determined using a variety of data sources, including previous plan experience, national mortality tables, or a mix of the two. It is customary to regularly evaluate mortality assumptions to ensure that they remain accurate in light of demographic changes and medical advances. The plan's liabilities would fall with a greater death rate while rising with a lower one.

2. DATA AND PENSION PLAN DESCRIPTION

In this chapter, the data and the pension plan used for the valuation will be described. Due to the fact that this is a project work in collaboration with Mercer Portugal, it is noteworthy that the company provided all data, anonymized and belonging to a real client, and the tool to perform and obtain the actuarial valuation results.

The following visualizations present statistics of the data by type of participant, gender, age and time of service. Upon observation, it becomes apparent that the predominant category of participants in the plan is the "Active" group, constituting 43% of the total, while the number of deferreds and pensioners remains relatively similar. In terms of gender distribution, males account for 70% of the population, whereas females make up the remaining 30%.

Furthermore, the majority of the plan participants are aged 50 and above, with a notable scarcity of members below the age of 30. As for distribution, it is notable that almost 10% of the population are women with more than 85 years old, while men have a more normal distribution. Lastly, a significant portion of the members has been affiliated with the company for at least 11 years.

Table 2.1 – Type of Participant Statistics

Type of Participant		
Type of Participant	Nº of Participants	% of Participants by Type
Active	250	43%
Deferred	125	22%
Pensioner	127	23%
Widow(er)	70	12%
Total	575	100%

Table 2.2 – Gender Statistics

Gender		
Gender	Nº of Participants	% of Participants by Gender
Feminine	173	30%
Masculine	402	70%
Total	575	100%

Table 2.3 – Age Statistics

Age		
Age Group	Nº of Participants	% of Participants by Age Group
< 30	41	7,13%
30 - 39	76	13,22%
40 - 49	83	14,43%
50 - 59	120	20,87%
59 >	255	44,35%
Total	575	100%

Figure 2.1 – Population Pyramid

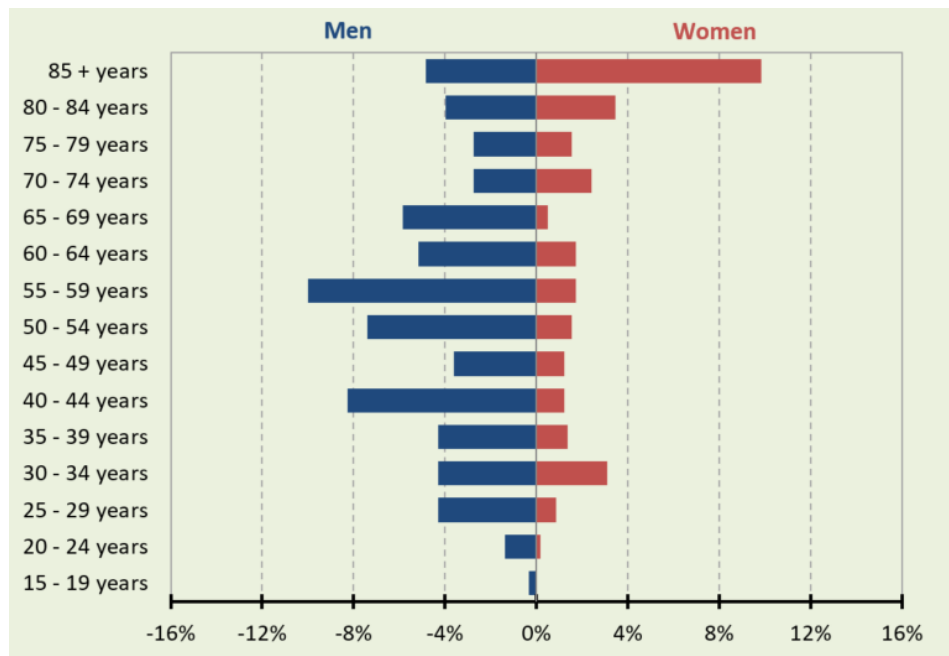


Table 2.4 – Time of Service Statistics

Time of Service		
Time of Service	Nº of Participants	% of Participants by Time of Service
< 6	74	12,87%
6 – 10	131	22,78%
11 - 20	180	31,31%
20 >	190	33,04%
Total	575	100%

Concerning the pension plan taken for this project, the main attributes to consider are that it is a defined pension plan, non-contributory, supplying benefits for retirement, disability, survivorship and vested rights, provided that the participant meets the eligibility requirements. Furthermore, the assumption pertaining to Withdrawal was not applied in this valuation and should be disregarded. The table below presents other relevant characteristics of the pension plan.

Table 2.5 – Pension Plan Description

Plan Aspects	Individual Pension Promise
Eligibility	Worker has to have more than 3 years of service for the organization
Nº of Payments per year	12
Normal Retirement Age	Variable age according to the German Pension Insurance (<i>Deutsche Rentenversicherung</i>)
Pensionable Salary	Actual salary updated every year
Pensionable Service	All service after fulfilling eligibility requirements
Retirement Benefit	Formula uses pensionable salary and pensionable service
Form of Payment	Life annuity
Disability Rate	<i>Invaliditäts-Richttafeln 2018</i>

Considering that German pension plans must be analyzed annually, it was assumed that the calculations were done with a valuation date of December 31, 2021.

The results that will be presented and analyzed correspond to values obtained through calculations for trade purposes (Trade) using the same methodology as the calculations for international purposes (IAS), despite the fact that the tax calculations (Tax) are somewhat conservative as a result of the limitations imposed by the German Tax Code. The two applied approaches are identical aside from the discount rate. The funding method is the Projected Unit Credit strategy and the funding vehicle is the Direct Promise, as was mentioned in a previous chapter.

3. RESULTS AND DISCUSSION

The outcomes of the actuarial valuation will be provided in this chapter along with some key findings. The purpose of this experiment was to study the impact of various actuarial assumptions and determining the most impacting scenarios. The following tables shows the starting point of this experiment:

Table 3.1 – Initial Actuarial Assumptions

Actuarial Assumptions		Trade	IFRS
Economic	Discount Rate (<i>DR</i>)	1,78%	3,76%
	Salary Growth Rate (<i>SGR</i>)	2,25%	2,25%
	Pension Growth Rate (<i>PGR</i>)	1,75%	1,75%
Demographic	Mortality Decrement (<i>MD</i>)	Heubeck 2018G	Heubeck 2018G

Table 3.2 – Initial Valuation Results

Scenario	Trade Normal Fund	Trade Normal Cost	IFRS Normal Fund	IFRS Normal Cost
Baseline	102.075.541 €	5.936.469 €	59.928.882 €	3.265.064 €

The sum accumulated from the participant's enrollment in the plan to the valuation date is represented by the value of the Normal Fund, in the table above. This value, which is derived from the total of the accrued obligations of all plan participants, in turn secures the payment of future benefits based on the period already passed.

The Normal Cost, on the other hand, is computed exclusively for participants with service in the next year, specifically for active participants, and it is the cost of predicted benefits or the cost of future services. Given that the Projected Unit Credit approach is being applied, this is the value that the corporation will be required to reserve for an additional year of service. Once the starting point was defined, increases of 0,5% and 1% were made to each assumption individually, creating 8 scenarios in total. Their results in variation comparing to baseline are shown below.

Table 3.3 – Comparison of Baseline to other Scenarios in %

Scenario	Trade Normal Fund	Trade Normal Cost	IFRS Normal Fund	IFRS Normal Cost
DR +0,5%	-13,24%	-14,77%	-11,46%	-12,80%
DR +1,0%	-24,34%	-26,91%	-21,29%	-23,56%
SGR +0,5%	6,88%	8,17%	6,09%	7,25%
SGR +1,0%	12,27%	14,55%	10,88%	12,94%
PGR +0,5%	7,48%	7,63%	6,50%	6,59%
PGR +1,0%	15,74%	16,11%	13,61%	13,85%
MD +0,5%	-7,98%	-8,91%	-6,54%	-7,25%
MD +1,0%	-15,41%	-17,12%	-12,74%	-14,06%

The results above support a previous chapter's assertion that a greater mortality or discount rate reduces the current value of liabilities while a higher rate of wage growth or pension growth increases future benefits. Naturally, the effects of the second scenario will be roughly twice as large as those of the first when an assumption is changed by 0,5% and subsequently by 1%.

According to the results, the scenario where the discount rate was raised by 1% is the one with the highest decrease in normal cost, -26,91% in Trade and -23,56% in IFRS. As a result, providing the promised pensions will cost less. On the other hand, the biggest increase scenario is when the pension growth rate grew by 1%, leading to a normal cost increase of 16.11% in Trade and 13.85% in IFRS. Thus, there will be higher costs associated with providing the plan's promised benefits.

These outcomes may have a few reasons behind them. For example, future pension payouts are expected to grow more quickly if the pension growth rate rises. The expected liabilities of the pension plan consequently rise as a result. The regular cost rises together with the estimated liabilities to reflect the extra money required to pay for the greater expected benefits. In addition, the effect of a higher pension growth rate may be enhanced if the pension plan includes a sizable number of active participants or retirees with longer life expectancies. The extra benefits will have to be covered by the plan over a longer period of time, which will raise the normal cost.

About the discount rate scenario, this might have been the one with highest decrease, if we consider how mature the pension plan is. A mature plan often has a higher percentage of participants who have retired or are close to retirement, meaning their benefits are about to be paid out. In these circumstances, a larger discount rate may have a greater effect on lowering the present value of these near-term liabilities, which may result in a reduction in the normal cost. However, it is fundamental to bear in mind that the choice of the discount rate that best serves the fund cannot be freely made.

Nonetheless, it is crucial to remember that actuarial results depend on the pension plan's unique characteristics and the actuarial valuation assumptions utilized. Different results may result from various plan characteristics and assumptions. Ultimately, the actuarial valuations purpose is to obtain a medium and long-term cost scheme, determine the contributions for each year, evaluate the company, prepare reports for the plan sponsors, define funding levels and, lastly, adjust assumptions and redefine contributions.

4. CONCLUSIONS

An urgent concern stems from the status of social security pension plans today. Due to an aging population and rising life expectancy, these schemes struggle to offer sufficient and sustainable retirement benefits to an expanding number of retirees. The issue is made worse by insufficient funding, changing demographics, and shifting economic conditions, endangering the long-term sustainability of social security systems. In order to overpass this concern, many companies are working to create pension initiatives, such as giving employees the opportunity to supplement their social security payments with private pension plans, ensuring more financial stability in retirement.

For the plans where the benefit is defined, actuarial valuations surge as a crucial instrument for determining the viability and stability of these pension plans, by offering a thorough evaluation of the plan's financial status. As so, the assumptions used during the valuation process have a significant impact on the accuracy of the computation of liabilities, assets and funding requirements.

To confirm the statement above, Mercer made available anonymous data that was tested by the creation of different scenarios, each one modifying 0,5% or 1% of one of the following actuarial assumptions: discount rate; salary growth rate; pension growth rate; mortality decrement. The results showed that increases of 1% can provoke variations higher than 10% in the normal cost, verifying the importance of assumptions in an actuarial valuation.

Thus, plan sponsors must exercise extraordinary caution in using the most correct assumptions given the intricate and diverse nature of actuarial valuations. The selection of assumptions should be supported by trustworthy information, wise judgment, and a complete comprehension of the particular plan's details. The financial stability of the plan, funding levels, and the sufficiency of benefits offered to retirees can all be adversely affected by the results of incorrect or improper assumptions.

It is significant to note that the findings and conclusions of this study cannot be extrapolated to the general majority of cases. Each valuation is distinct and is influenced by the unique features and circumstances of the pension plan being evaluated. Different plans could have different economic situations, investment philosophies, and demographic profiles. As a result, even though this project work provides information about how assumptions affect actuarial assessments in a particular pension scheme and population in Germany, it is crucial for plan sponsors to do their own careful research that is suited to their particular situation.

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