# Comparison of risk sharing approaches in hybrid occupational pension schemes

## 1. Introduction

Aim of occupational pension schemes is to allow members (employees of a sponsoring employer) to provide extra means for retirement. The actual cost of benefit provision is unknown (it will only be known after all the benefits have been paid out or bought out with an insurance company), so there is a risk that the funds accumulated for payment of benefits could be inadequate. While there are several types of risk affecting retirement benefit provision [Blake 2006, p. 174, Turner 2014 p. 5-6, Cooper 2005, p. 6-7], this article focuses on two types of risk which have a big impact on the funding of a pension scheme: investment risk and longevity risk.

Investment risk is a risk that rate of returns which the scheme earns on its investments is higher or lower than expected. Longevity risk is a risk that future lifetime in retirement of a member (which determines how long the benefits will be paid for) is shorter or longer than assumed. As a result, funds accumulated for the payment of benefits can be lower or higher than required.

Defined contribution (DC) and defined benefit (DB) schemes are the two main forms of occupational pension schemes [Pugh, Yermo 2008, p. 6]. In a DC scheme, benefit amount is unknown and depends on contributions paid and rate of scheme's investment returns . The member bears the investment and longevity risk, although they can protect themselves against the latter by purchasing a life annuity from an insurance company. In a DB scheme, the benefit amount is set in advance and employer has the responsibility to fund the scheme in such a way that the promised benefits can be paid. As such, it is the employer who bears the risk in this scheme. DB schemes have been recently in decline, with some employers choosing to close their DB scheme in favour of a DC scheme in order to decrease the level of risk they are exposed to [Petelczyc 2016, p. 62]. This however leads to members bearing all the risk, despite often not having adequate means or knowledge to manage and protect themselves against risk [Clark, Monk 2006 p. 43-44, Davis 2013 p.685, Sweeting 2007 p. 2].

Hybrid pension schemes are schemes that are neither fully DB or DC, but are a mixture of features of both. They allow for the risk to be shared between employer and member.

Aim of this article is to firstly illustrate risk sharing within selected forms of hybrid pension schemes, and then to propose a new scheme which takes a different approach to risk sharing between employer and member. To achieve this, variability of employer's and member's contribution required to achieve a target level of benefit is investigated.

## 2. Risk measures in pension schemes

Risk in a pension scheme can be measured in several ways. From the member's point of view, an important measure is the variability in benefit amount which can be received from the scheme [Blommestein et al. 2009, Cooper 2005, Davis 2013, Davis, Madland 2013]. In a DB scheme, the member is guaranteed to receive pension with an amount equal to a fraction of salary, hence there is no variability of benefit amount. In contrast, in a DC scheme the benefit amount is not known until retirement, as it depends on the amount of contributions paid, rate of investment returns which the scheme has earned net of costs, and annuity conversion rates.

Another measure used to illustrate risk in pension schemes is the variability of funding level, i.e. the ratio of scheme's assets to its liabilities [Blommestein et al. 2009]. This measure applies to DB schemes and schemes with some benefit guarantee. Depending on the financial performance of its assets, such a scheme may be under or over funded. In contrast, a DC scheme is always fully funded. This is an important measure for the employer, as any changes in the funding level will need to be rectified, typically via an increase in employer's contributions. From the member's point of view, this measure shows the security of benefits as very low funding level can indicate financial difficulty and possibility of benefits not being paid.

Third measure, and one that will be used in this article, is the variability of contributions needed to provide a fixed level of benefit. Contributions of employer and member will be considered separately, to illustrate risk sharing within a scheme. In a DB scheme, member's contributions are fixed, whereas employer's contributions are adjusted in order to ensure funding level stays at required level. In a DC scheme the situation is the opposite: employer's contributions are fixed and member's contributions may need to be adjusted in order to provide the required level of benefit. In a hybrid scheme, either employer's or member's contributions can change depending on who bears the given type of risk.

## 3. Hybrid schemes considered

For the purpose of this article, two forms of hybrid schemes have been chosen due to their risk sharing characteristics: cash balance scheme and self-annuitizing scheme.

In a cash balance scheme, a member's account is credited every year with a certain fixed percentage of the member's salary (a so called salary or pay credit). Every year, the amount accumulated within the account is increased by some fixed interest rate guaranteed by the employer (interest credit). At the point of retirement, the member is entitled to the amount accumulated within the account, which can be used to purchase a life annuity from an insurance company [Mackenzie 2010, p.4-5, Szczepański, Brzęczek 2016, p. 114, Takayama 2013, p. 11]. This scheme resembles a DB scheme during the pre-retirement phase, as the interest rate used to accumulate funds is guaranteed by the employer and independent of the actual scheme's investment returns, hence the employer bears the investment risk. However, post retirement the risk is passed to the member, who has to bear the longevity risk or purchase an annuity from an insurer.

Second hybrid scheme considered is a self-annuitizing scheme. Pre-retirement this scheme resembles a DC scheme – contributions are fixed and accumulated with the actual rate of scheme's investment returns. However, at the point of retirement the amount accumulated within the member's account is used to "buy" a life benefit within the scheme, according to some fixed, pre-determined annuity conversion rates [Wesbroom, Reay 2005, p. 13-14]. Hence the member bears the investment risk, and employer bears the longevity risk.

## 4. Modelling assumptions

All schemes under consideration (a DB, DC, cash balance and self-annuitising schemes) provide or aim to provide same level of benefit. A replacement rate of 60% of final salary was chosen to be that target. Within each scheme there is only one member, who joins the scheme aged 25 and remains an active member of the scheme until retirement at age 65. Assumptions about rate of scheme's investment returns, salary increases, interest rate and survival probabilities used to calculate annuity conversion rates were made, and an annual contribution rate required to achieve 60% replacement rate was calculated (this is referred to as the base contribution rate). Next, investment and longevity risks were introduced by varying rate of investment returns and survival

probabilities in the life table. A corresponding increase or decrease in contribution rate required to maintain target replacement rate was calculated.

**Base contribution rate**

All calculations were made in relation to real values and amounts. Real rate of scheme's investment return was set to be 4% p.a. In reality this assumption will vary from scheme to scheme and possibly member to member, depending on chosen investment strategy, risk attitudes and time to retirement, but for the purpose of this article it was assumed that all schemes follow the same investment strategy. Real rate of salary increases was chosen to be 1.5% p.a. In order to calculate annuity conversion rate, real interest rate was set at 0.5% p.a., and survival probabilities from unisex life tables 2017 published by Central Statistical Office of Poland [GUS 2018] were used.

The benefit, with an amount equal to 60% of final salary, takes form of life annuity payable yearly in arrears. Using interest rate of 0.5% p.a. and GUS 2017 unisex life tables, an annuity conversion rate of 16.67 was derived, thus for every monetary unit of the required pension amount, 16.67 monetary units have to be accumulated at retirement aged 65. It is assumed that this conversion rate is used by an insurer to price annuities. For the chosen financial assumptions this means an amount equal to about 10 times the final salary needs to be accumulated at retirement within the scheme in order to purchase target benefit.

Base contribution rate, assuming rate of investment returns of 4% p.a. and salary increases of 1.5% p.a., was calculated to be 15% of salary. It was divided equally between a member and employer, meaning each party contributes 7.5% of salary into the scheme every year. It is assumed that the contribution is paid annually at the end of the year.

**Scheme specific assumptions**

In a DC scheme, the target benefit of 60% of final salary is set and annual contribution rates of 7.5% of salary for both the employer and member are agreed. If the assumptions are borne out, an annuity of desired amount will be purchased at retirement. If the actual experience differs from assumed, member contributions will need to change in order to achieve desired level of benefit (employer contributions are fixed at 7.5% of salary). If the investment returns are lower than expected, or increases in longevity cause insurer to increase price of annuity, member's contribution rate will need to increase, if

investment returns are higher or longevity lower than expected member contribution rate will decrease. This means that while bearing the investment risk and longevity risk (via the risk of change in annuity prices), the member bears the upside as well as the downside of risk. In practice, it is more common for members to pay fixed contribution rate and bear the risk through variability of benefits, but for the purpose of this article it is assumed that member chooses (and is allowed) to vary their contribution rate.

In DB scheme, employer promises member a benefit of the target amount. The employer bears the investment risk and the longevity risk, just as the member does in the DC scheme described above. For comparison purpose, it is assumed the employer will buy out the liability when the member retires, i.e. will purchase an annuity similarly to member in a DC scheme, rather than pay out the pension from the scheme. The contribution rate of the employer is calculated in the same way in which member contribution is calculated in a DC scheme[1]. Any impact of regulation, which could require sponsor of a DB scheme to use more pessimistic or prudent assumptions to fund the scheme is not considered.

In a cash balance scheme, 15% of salary is credited to member's account at the end of every year. An interest credit is calculated using a real rate of 4% p.a. This means that a lump sum equal to 10 times the final salary is promised at retirement. If the investment returns differ from assumed, employer contribution rate will need to be adjusted. However, it is the member who bears the longevity risk in this scheme. If the annuity prices change (due to changes in longevity), a lump sum of 10 times the final salary may not be enough to purchase the desired benefit amount. Hence the member's contribution will need to change. As member's contribution rate in this scheme is fixed at 7.5% of salary, the extra members contributions made due to changes in longevity can be considered to be paid as additional voluntary contributions.

In the self-annuitising scheme, annuity conversion rates are fixed at 16.67. It is assumed that the employer will buy out the liability with the insurance company, hence any changes in the annuity prices will cause the employer to adjust their contribution rate

[1] Often in a DB scheme contribution rate is set every year (or every couple of years) based on benefits accruing over the next year (couple of years) of service [GCAE 2001]. In this article, in order to compare DB and hybrid schemes with DC scheme, it is assumed that in all schemes contributions are calculated every year as constant rates of salary over the time remaining to retirement, taking into account projected value of contributions already accumulated.

accordingly. Member bears the investment risk, hence changes in investment returns will need to be rectified by variation in member's contribution rate.

Finally, a new type of hybrid pension scheme is proposed. In this scheme, each member has an individual account, into which contributions made by employer and member are paid. At retirement, an annuity providing desired benefit level for life is purchased. A target benefit level (60% of final salary) is chosen, and base contribution rate required to achieve that benefit is calculated. Using assumptions described above this will be contribution rate of 7.5% for the member and 7.5% for the employer. Every year, a change to the contribution rate, required to achieve the target benefit in case of changes in investment returns or longevity, is calculated and divided between member and employer as follows: a change of up to 5 percentage points (p.p.) is paid by the employer, anything required above 5 p.p. by the member.

Next, four different scenarios in which investment returns or survival probabilities change causing a change in the required contribution rate are considered.

## 5. Calculation results

### Scenario 1

A following model of future investment returns is considered: rate of return every year is a random variable following normal distribution with set mean and variance. In scenario 1 this mean is equal to 4% and standard deviation is equal to 2%. A random sample of 40 rates of return was drawn (one for each year of service in the scheme), and year by year a contribution rate required to achieve target benefit in each of the considered schemes was calculated. Figure 1 illustrates contribution rates payable in each of the considered schemes.

Figure 1a. Contribution rates under scenario 1 in DC, DB, cash balance and self-annuitising scheme

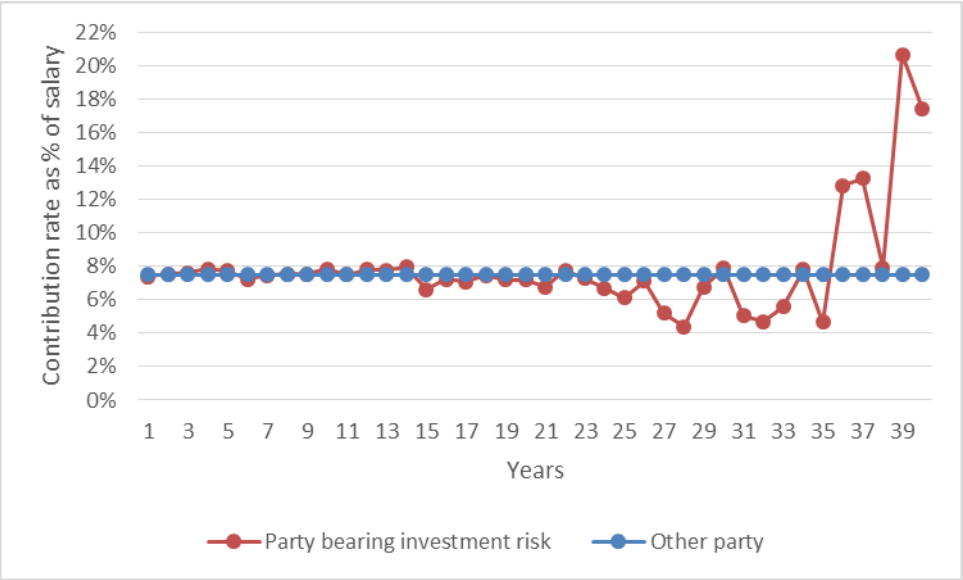
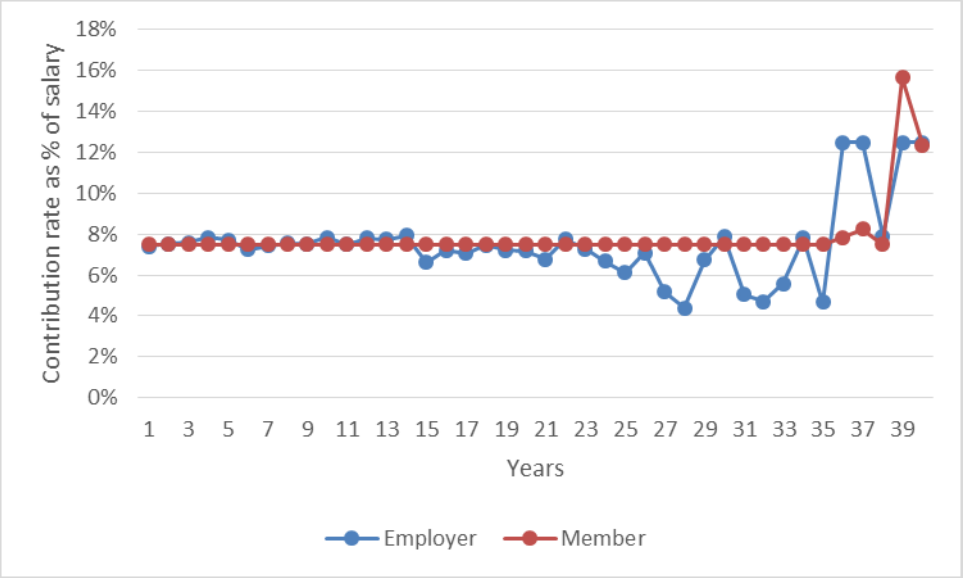



Figure 1b. Contribution rates under scenario 1 in proposed scheme




Source: own work.

As shown by Figure 1a, a change in investment return rates according to scenario 1 causes a fluctuation in the contribution rate of a party bearing the investment risk (member in DC and self-annuitising scheme, employer in DB and cash balance scheme). On average, they pay a contribution rate which differs by 1.5 p.p. from base contribution rate. If the member chose not to adjust their contribution rate in a DC or self-annuitising scheme, the benefit at retirement would decrease slightly to 59% of final salary.

In the proposed hybrid scheme, as shown in figure 1b, the extra contribution is shared between employer and member. Employer's contribution rate is different from base rate

by 1.1 p.p. on average, member's contribution rate by 0.4 p.p. Member needs to adjust their contribution in 10% of all years.

**Scenario 2**

In this scenario a decrease in real rate of scheme investment returns is considered. Rate of investment returns follows normal distribution with mean 2% and standard deviation of 2%. Figure 2 illustrates contribution rates payable in each of the considered schemes.

Figure 2a. Contribution rates under scenario 2 in DC, DB, cash balance and self-annuitising scheme

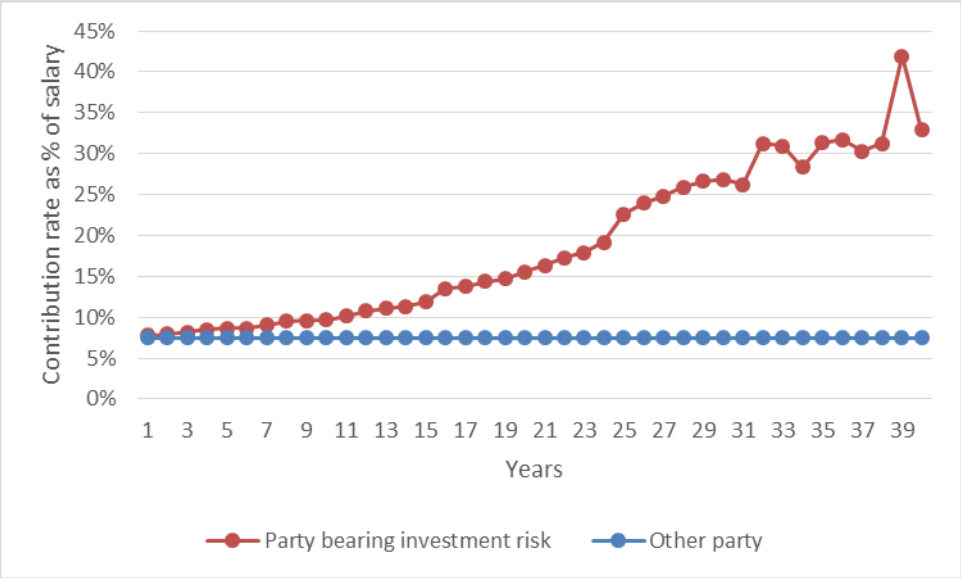
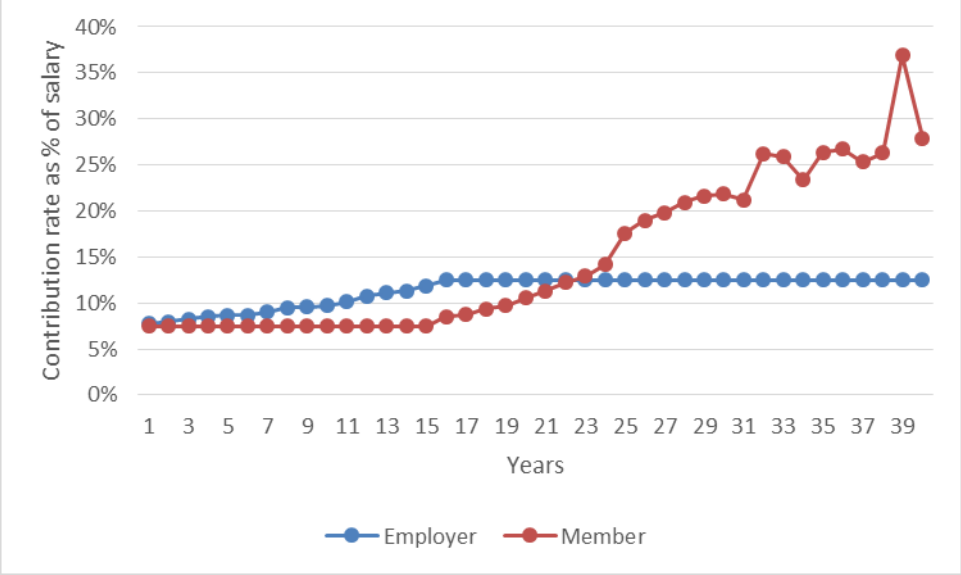



Figure 2b. Contribution rates under scenario 2 in proposed scheme




Source: own work.

As shown by Figure 2a, a change in investment return rates according to scenario 2 causes an increase in the contribution rate of a party bearing the investment risk. In case of DC and self-annuitising scheme it is the member, in case of DB and cash balance scheme it is the employer. They pay a contribution rate which on average differs by 11.3 p.p. from base contribution rate. If the member chose not to adjust their contribution rate in a DC or self-annuitising scheme, the benefit at retirement would decrease to 34% of final salary.

In the proposed hybrid scheme, as shown in figure 2b, the extra contribution is shared between employer and member. Employer's contribution rate is different from base rate by 3.9 p.p. on average, member's contribution rate by 7.4 p.p. Member needs to adjust their contribution in 63% of all years.

**Scenario 3**

In this scenario an increase in real rate of scheme investment returns is considered. Rate of investment returns follows normal distribution with mean 5% and standard deviation of 2%. Figure 3 illustrates contribution rates payable in each of the considered schemes.

Figure 3a. Contribution rates under scenario 3 in DC, DB, cash balance and self-annuitising scheme

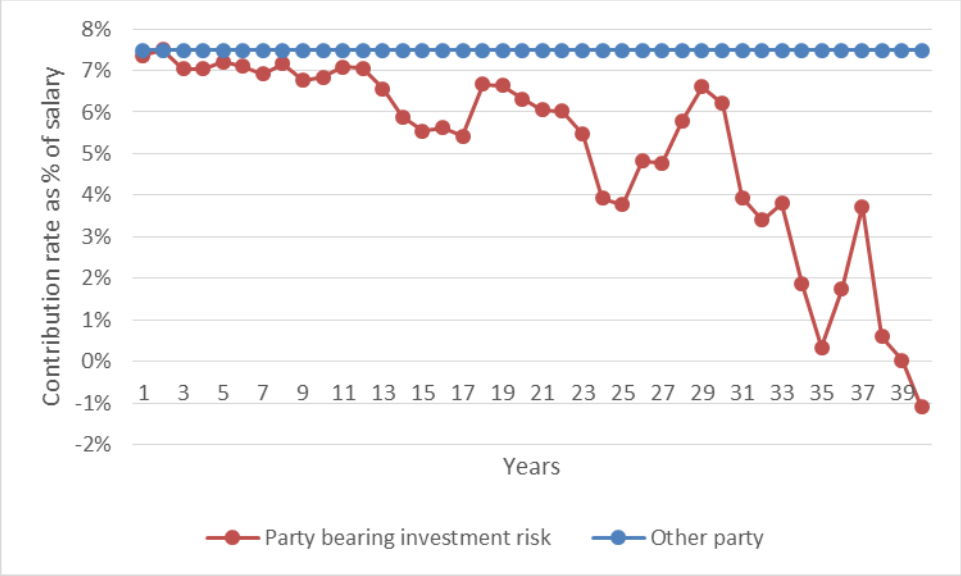
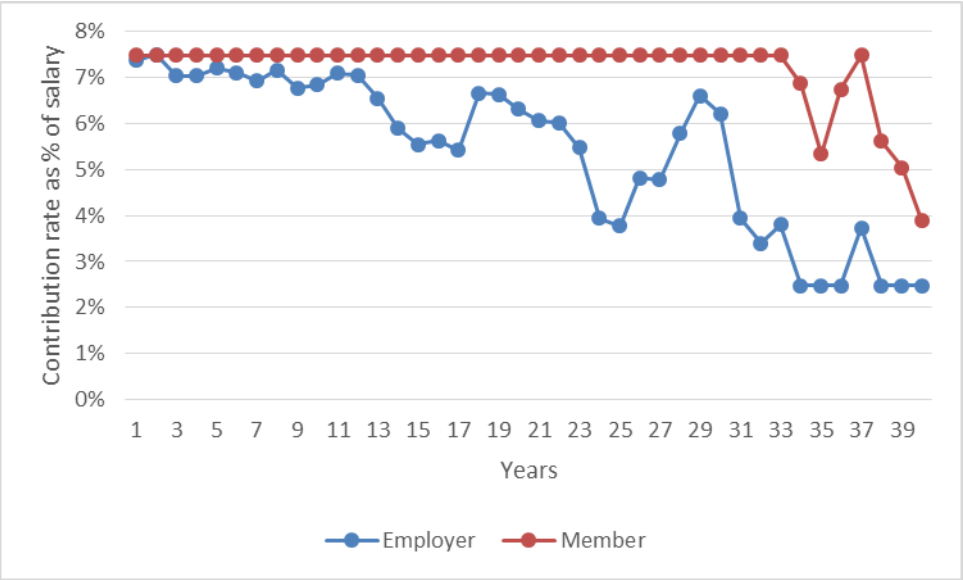



Figure 3b. Contribution rates under scenario 3 in proposed scheme

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As shown by Figure 3a, a change in investment return rates according to scenario 3 causes a decrease in the contribution rate of a party bearing the investment risk. In case of DC and self-annuitising scheme it is the member, in case of DB and cash balance scheme it is the employer. On average, they pay a contribution rate by 2.3 p.p. different from base contribution rate. If the member chose not to adjust their contribution rate in a DC or self-annuitising scheme, the benefit at retirement would increase to 68% of final salary.

In the proposed hybrid scheme, as shown in figure 3b, the extra contribution is shared between employer and member. Employer's contribution rate is different from base rate by 2.1 p.p. on average, member's contribution rate by 0.3 p.p. Member needs to adjust their contribution in 15% of all years.

**Scenario 4**

In addition to changes in rates of return (according to Scenario 1), an increase in the future longevity is considered. Survival rates change in a way which corresponds to rating the life table down by 5 years, i.e. the survival probabilities which applied to a person aged 60 say in the original table now apply to a person aged 65. This means lower mortality rates, and an increase in annuity conversion rates (due to increased longevity) from 16.67 to 19.86. This increase happens once, at the start of year 21. Figure 4 illustrates contribution rates payable in each of the considered schemes.

Figure 4a. Contribution rates under scenario 4 in DC and DB scheme

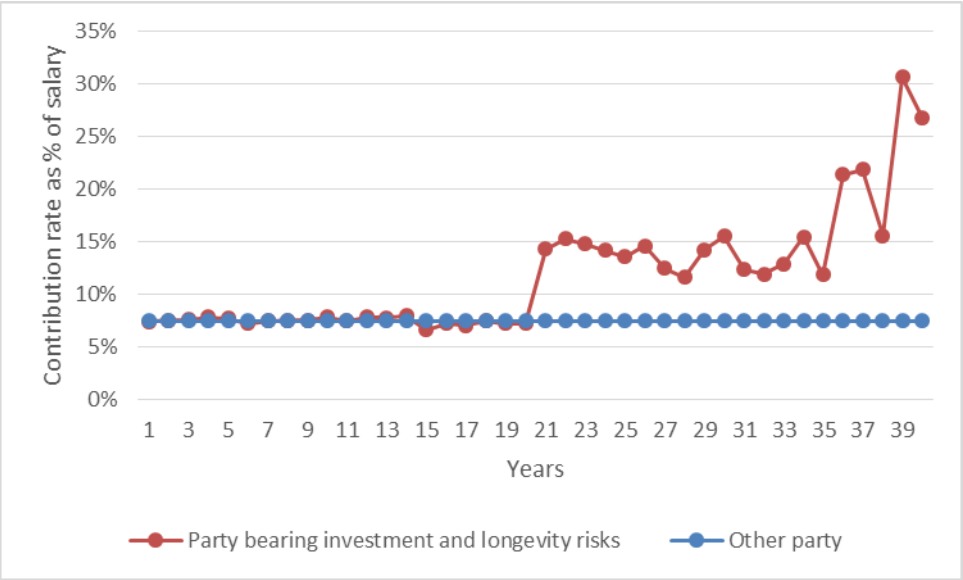



Figure 4b. Contribution rates under scenario 4 in cash balance and self-annuitising scheme

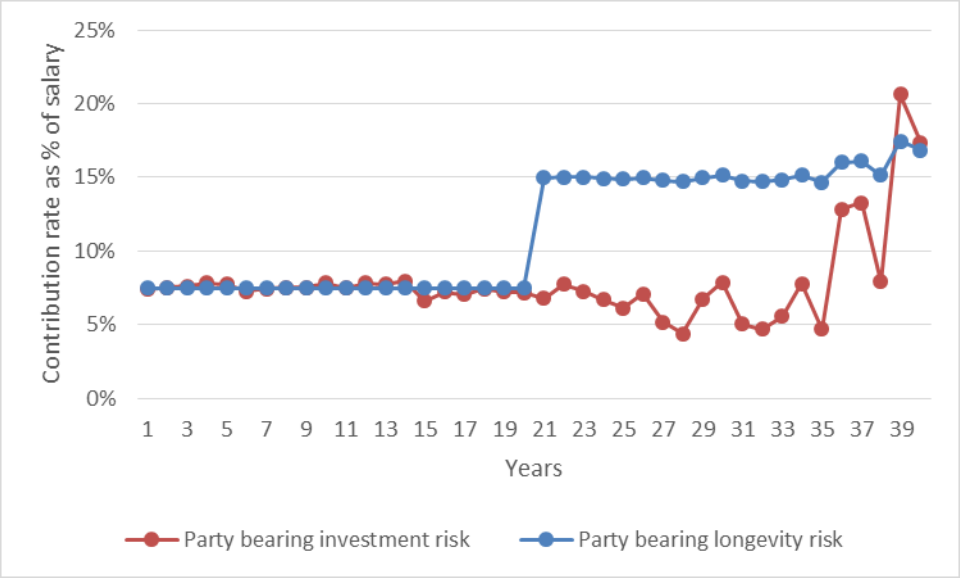
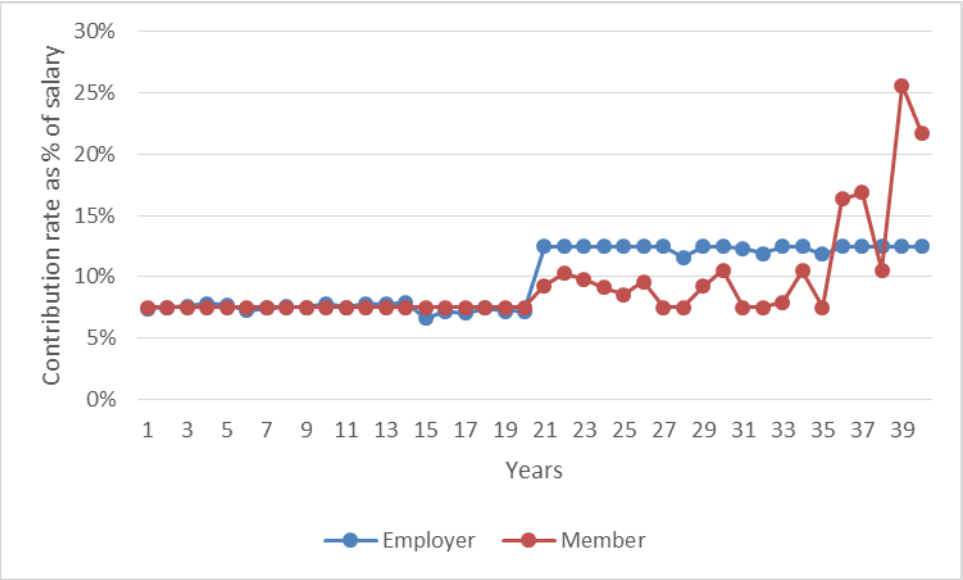



Figure 4c. Contribution rates under scenario 4 in proposed scheme




Source: own work.

As shown by Figure 4a, a change in conditions according to scenario 4 causes a fluctuation in the contribution rate of a party bearing the investment and longevity risk. In case of DC scheme it is the member, in case of DB scheme it is the employer. On average, they pay a contribution rate by 4.4 p.p. different from base contribution rate. If the member chose not to adjust their contribution rate in a DC scheme, the benefit at retirement would decrease to 50% of final salary.

Figure 4b shows that in case of cash balance and self-annuitising schemes, contribution of a party bearing investment risk (employer in cash balance, member in self-annuitising scheme) fluctuates. Party bearing longevity risk (member in cash balance, employer in self-annuitising scheme) has the contribution rate increased at the end of year 21, the rate than fluctuates slightly due to changes in investment return rate (thus even though this party is said to bear just the longevity risk, the need to provide extra fund due to change in longevity while investment conditions change means they also bear some investment risk). On average, party bearing investment risk pays a contribution rate by 1.5 p.p. different from base contribution rate, party bearing the longevity risk pays contribution rate different by 3.9 p.p. on average. If the member chose not to adjust their contribution rate in a cash balance scheme, the benefit at retirement would decrease to 50% of final salary. If the member chose not to adjust their contribution rate in a self-annuitising scheme, the benefit at retirement would decrease to 59% of final salary.

In the proposed hybrid scheme, as shown in figure 4c, the extra contribution is shared between employer and member. Employer's contribution rate is different from base rate by 2.6 p.p. on average, member's contribution rate by 1.8 p.p. Member needs to adjust their contribution in 40% of all years.

## 6. Practical considerations

There are several issues that need to be considered if such a theoretical concept for a scheme was to be implemented in practice. Firstly, members of a pension scheme tend to appreciate fixed, known level of benefits, but may be unwilling to increase their contribution rates. In many countries participation in occupational pension schemes is voluntary, hence the members cannot be forced to adjust their contributions. In such a case the scheme setup can be adjusted so that whilst employer needs to adjust their contribution rate as described above, the member is not required to do so. As a result, the benefit amount achieved in the scheme will be variable, although to a lesser extent than in a DC scheme due to adjustments in employer contribution.

Communication with members in such a scheme would be crucial. Members may not understand or be willing to accept the fact that employer contribution rate can decrease. In practice it is more likely that instead of decreasing their contribution rate, an employer will allow for the surplus to accumulate as a buffer for when the experience is adverse.

In the proposed scheme contribution rate is recalculated annually. It should be done by an independent party (e.g. an actuary) so that there is no moral hazard of employer attempting to influence the contribution rate. However, if the actuarial fees are covered by the employer, this can in turn lead to moral hazard for the actuary. A regulator may need to be involved to provide guidance and oversee the process of setting the contribution rate. Annual recalculation of contribution rate can be costly, especially if there are many members in the scheme. It can be changed to bi- or triannual recalculation, however as a result the variability of contribution rate will increase.

Under considered model for proposed pension scheme it is possible for contribution rates to be negative. In practice this would mean return of funds to employer and/or member. Such payments may be forbidden or subject to unfavourable tax treatment. It is therefore possible that instead of return of funds member will opt for the funds to remain in the scheme and increase benefit amount. Issue of return of surplus to

employer is a very complicated one and depending on laws of a given country may not be possible or heavily restricted.

## 7. Conclusions

In a DB scheme, both investment risk and longevity risk is borne by the employer. Modest investment returns and low interest rates caused costs and risk of such schemes to increase, leading some employers to close their DB schemes [Clark, Monk 2006 p. 44]. They often choose to offer their employees a DC scheme instead. However, in such a scheme the risk is borne by the member, who often does not have adequate means to manage the risk. Hybrid schemes provide a mixture of features of both traditional forms, allowing for the risk to be shared between employer and member. Exact approach to risk sharing depends on the form of the hybrid scheme. In the two forms considered in this article, it is achieved by allocating given type of risk to a certain party. In a cash balance scheme, employer bears investment risk and member longevity risk, in self-annuitising scheme it is the opposite case.

In the proposed scheme the risk is shared between member and employer irrespective of its type. An upper and lower limits for extra contribution for employer is set. If an increase in the required contribution means the extra contribution is over the upper limit, the member is called upon to pay the remainder of extra contribution, and analogously in case of a decrease in contributions. In this way, the risk is shared between both parties. Employer will always need to adjust their contribution when such adjustment is required, but only up to a certain limit, so is sure the extra contribution (and so the variability in contributions) will be no greater than a known value. Member's contribution will only need to be adjusted in a certain number of instances, if the actual experience is much different from expected. These features allow for better financial planning for the two parties involved. However, there are several practical issues that should be considered if such a theoretical concept for a pension scheme was to be implemented in practice.

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