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THE ROLE OF GUARANTEES IN DEFINED CONTRIBUTION PENSIONS

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EXECUTIVE SUMMARY

The paper examined the role of guarantees in DC pension plans, in particular minimum return guarantees. The main goal is to assess how costly different minimum returns guarantees (MRG) in DC pension plans are. Policy recommendations about whether it is a good idea to introduce MRG in DC pension plans take into account the overall pension arrangements and whether there are already strong guarantees embedded in public PAYG pensions and defined benefit pensions making the introduction of MRG in DC plans unnecessary. However, even if there are guarantees embedded in public pensions, it may be a good idea to introduce certain guarantees in DC pension plans to encourage coverage and improve people's appreciation of funded pension arrangements.

In this context, the report recommends to include capital guarantees that DC pension plans. They do not seem to be costly and address one of the main concerns about DC plans people are deterred to save in DC plans because they can loose even part of the money the put in. Implementing capital guarantees means that the money people contribute to DC pension plans is guaranteed and they will always receive at retirement at least the money they put in.

The main recommendations distilled form the analysis, are as follows

- Guarantees in DC pension plans are not necessary in countries where the PAYG-financed public pension already provides a high degree of retirement income guarantees

- Yet, regulators and policy makers may find worth considering the possibility of introducing capital guarantees in DC pension plans. This capital guarantee is not that costly and it may help to a large extend in motivating people to save for retirement in DC pension plans as they will appreciate the fact that the money they contribute is safe. They will never loose their contributions or capital.

- Additionally, it seems interesting to pursue further the idea of financing guarantees using haircuts on capital gains instead of fees as the full contribution will accumulate over time and fees are paid mostly at the end of the accumulation period. However, they suffer an important drawback. Haircuts may require providers to set higher capital buffers than when guarantees are paid through annual fees as the risk of not getting paid may be higher. Taking into account this higher potential cost may reduce the attractiveness of using haircuts to finance guarantees.

1. Introduction

1. The financial and economic crisis has highlighted the uncertainty of retirement income derived from defined contribution pension plans. Indeed, people with defined contribution (DC) pension plans saw their accumulated pension saving disappear as they were heavily exposed to risky assets. Unfortunately, even people very close to retirement had exposures to equities. Moreover, these plans are becoming more prevalent in OECD countries as a means to finance retirement. They are already the main source to finance retirement in many OECD countries (e.g. Australia, Chile, Hungary, Poland), and they may become in the near future the main source in some other OECD countries (e.g. Canada, the UK and the US). As a result, several ideas are being put forward to alleviate the impact of market risk on DC pension plans. For example, the setting up of default life cycle investment strategies and the introduction of minimum return guarantees.

2. Introducing minimum return guarantees could alleviate the impact of market risk on DC pension plans by setting a ceiling on retirement income looses from these plans. The WPPP already discussed setting up default investment strategies and recommended to have them organised around life cycle strategies as one of the approaches to alleviate the impact of market risk on retirement income derived from DC pension plans.[1] This paper focuses on another approach highlighted as a strategy to alleviate the impact of market risk on retirement income: introducing investment return guarantees, in particular minimum return guarantees (MRG). These guarantees by granting a minimum return would be in fact setting a floor to retirement income and thus making sure that retirees will not end up with retirement income lower that the corresponding guarantee in case of negative market conditions.

3. The assessment on whether to introduce investment return guarantees need to be done in the context of the overall pension system. Indeed, if public pensions provide already some guarantees that retirement income would be always above a certain threshold, investment return guarantees in DC pension plans may loose their purpose: provide a floor to retirement income, as the public sector guarantee already does it and guarantees in DC plans have a cost – the fee to be paid for the guarantee. Section 2 discusses first the guarantees embedded in public systems that provide a floor to retirement income. For example, low income workers rely more on state pension for retirement, which generally includes a minimum pension; and, state pension provision itself has built-in automatic stabilisers and old-age safety nets.

4. However, there is still the need of investment return guarantees in DC pension plans. Indeed, one of the main criticisms of funded DC pension plans is that people fear to loose even their contributions. Therefore, if guaranteeing at least that people would not loose their contribution makes saving for retirement in DC pension plans more attractive and increases coverage, this may be worth considering. Section 2 then discusses the type of guarantees in DC plans that exist in several OECD countries and provides a useful classification of theses guarantees.

5. Section 3 provides an assessment of the cost of providing minimum return guarantees in DC plans. It also evaluates different approaches to finance the cost of these guarantees. This section first describes the main characteristics of the minimum return guarantees analysed. It also explains the approach taken to determine the cost of different types of guarantees and to assess their impact on retirement income. Secondly, it compares the price of the different types of guarantees, as measured by the fee that the individual has to pay for them, and assesses the sensitivity of the cost to changes in different parameters. Thirdly, section 3 assesses the impact of the different types of guarantees on different retirement income outcomes. It looks at the lump sum accumulated at retirement and at the distribution of replacement rates. A sensitivity analysis also assesses the impact of model parameters and specific scenarios on the results.

[1] DAF/AS/PEN/WD(2009)3, DAF/AS/PEN/WD(2009)14and DAF/AS/PEN/WD(2010)5.

6. Section 4 concludes with several recommendations. First, guarantees in DC pension plans are not necessary in countries where the PAYG-financed public pension already provides a high degree of retirement income guarantees. Yet, the capital guarantee in DC pension plans is not that costly and it may help to a large extend in motivating people to save for retirement in DC pension plans as they can always be told that the money they will contribute to these plans is guaranteed. They will never loose their contributions or capital. Additionally, financing guarantees using haircuts on capital gains instead of fees looks interesting as the full of contributions will accumulate over time and fees are paid mostly at the end of the accumulation period. However, haircuts may require providers to set higher capital buffers than when guarantees are paid through annual fees as the risk of not getting paid may be higher. Taking into account this higher potential cost may reduce the attractiveness of using haircuts to finance guarantees

7. In the light of the issues examined in this report delegates are cordially invited to address the following questions:

1. Do delegates find useful to recommend capital guarantees in DC pension plans? Or is it better to reinforce state pension guarantees and leave retirement income from DC pension plans expose to market risk?

2. Do delegates find interesting the idea of financing guarantees by haircuts on potential surpluses instead of by using a fee?

3. Do delegates would like to add to the discussion on who should provide these guarantees in DC pension plans?

2. Guarantees in pension systems

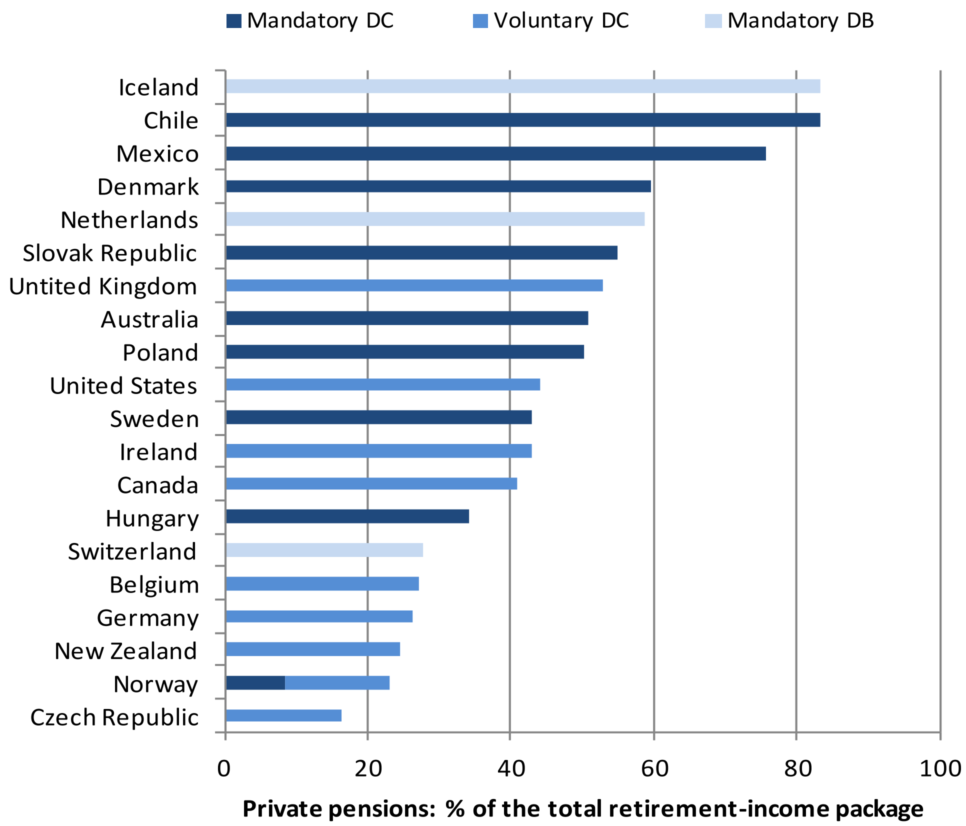
8. Privately managed, funded pension plans are an increasingly part of retirement income systems. As shown in Figure 1, private pensions will account for over 50% of total pension benefits of workers that start their careers today in countries such as Australia, Chile, Mexico, Poland, Slovak Republic, and the United Kingdom. In these countries, private pensions for new entrants to the labour force are provided predominantly in the form of defined contribution arrangements, where members bear all investment risk during the accumulation stage. As a result, pension benefits are likely to exhibit a great degree of variability both within and across generations, even for workers with similar wage, contribution and longevity profiles [DAF/AS/PEN/WD(2009)3].[2]

9. In general, lower income workers tend to be less affected by investment risk in defined contribution arrangement because, firstly, they rely more on state pensions for retirement income provision, and secondly, because state pension provision itself often has built-in automatic stabilisers and old-age safety nets that partly compensate for investment losses on individual retirement accounts. On the contrary, middle and higher income workers are generally fully exposed to investment risk in defined contribution plans.

10. One way to reduce the impact of investment risk equally across workers, without differentiating by income levels, is to introduce investment performance guarantees, in particular minimum return guarantees. Such guarantees can come in different forms but their main objective is to provide a floor to the value of savings that an individual will accumulate at retirement for a given contribution record. This in turn ensures that replacement rates (the ratio of pension benefits to wages) will not fall below a certain value or threshold.

[2] Final version published in http://www.oecd.org/dataoecd/37/14/44628862.pdf

Figure 1. The role of private pensions in the overall retirement income package by type of provision



Source*:* Pensions at a Glance (2009).

2.1. Public pension automatic stabilisers and old-age safety nets

11. The overall impact of investment risk on retirement income depends on the automatic stabilisers and anti-poverty safety nets built into countries' pension systems. Most countries have provisions that help prevent retirees from falling into poverty in their old age, which may buffer the impact of investment losses on retirement income for some people. Most public retirement-income programmes – basic pensions and earnings-related schemes – will pay the same benefit regardless of the outcome for private pensions.

12. However, many resource-tested schemes interact with the value of private pensions. In Australia, Chile and Denmark, for example, most current retirees receive resource-tested benefits. The value of these entitlements increases as private pensions deliver lower returns, protecting much of the incomes of low- and middle-earners. The withdrawal rate of the benefit against other income sources is currently 40% in Australia and 30% in Chile and Denmark. In Australia, for example, each extra dollar of private pensions results in a 40 cent reduction in public pension. Conversely, a dollar less in private pensions results in 60 cents more from the public pension. More than 75% of older people in Australia and around 65% in Denmark receive at least some benefit from resource-tested schemes. In Chile, the scheme introduced in 2008 is being rolled gradually and is expected to cover 60% of older people by 2012. The proportion of older people receiving such resource-tested schemes is also relatively high in Canada, Ireland and the United Kingdom (20-35%). Low earners will have their overall pensions protected by resource-tested programmes. In all these cases, the public retirement-income programmes act as "automatic stabilisers",

meaning that some or most retirees do not bear the full brunt of the effect of the financial crisis on their income in old age.

13. However, not all resource-tested schemes use incomes from private pensions in calculating entitlements. The value of the guarantee pension in Sweden, for example, currently received by more than half of retirees, depends only on the value of the public, earnings-related scheme (which has a notional-accounts formula). Losses in private pension savings are thus not compensated for Swedish pensioners.

14. A second automatic stabiliser of net retirement incomes, faced with investment risk, comes through the personal income tax.[3] In most OECD countries, pensions in payment are taxable. An average earner could expect to pay about 30% of his or her pension in tax in Denmark and Sweden. In Belgium, Germany and Norway, the average earner would pay about 20% of retirement income in taxes and this figure is around 15% in Hungary and Poland. If investment returns turn out to be poor, then governments will collect less in taxes on pensions. The result is that individuals' net retirement incomes will fall by less than the decline in pension funds' asset values.[4] In contrast, pensions are not taxable in Hungary and the Slovak Republic and so there is no automatic stabiliser of retirement incomes. The compensating effect of the tax system is also very limited in countries such as Australia, Canada, Ireland, the United Kingdom and the United States where the effect of special credits, allowances and reliefs for pension income or for older people mean that only retirees with very large incomes from voluntary pensions would pay much in income tax.

15. Putting these two effects – taxes and resource-tested benefits – together, automatic stabilisers have much the largest effect in Denmark, which is arguably the country where investment risk is lowest anyway, because of the minimum investment returns and guaranteed annuity conversion rates offered in such plans. The dampening effect on net retirement incomes is also substantial in Belgium, Poland and Sweden and is large in the United Kingdom and the United States.

16. The impact of these automatic stabilisers in reducing the variability of retirement income can be evaluated by calculating the pension benefits from the different sources for workers with different wages.[5] Figure 2 shows the projected replacement rates by different percentiles of the distribution of investment returns for workers with a full career, a portfolio of 50% domestic equities and 50% domestic government bonds, and OECD average mortality rates. In Australia, the defined-contribution pension is 2.3 times higher in the best rather than worst scenario for returns. Overall income, including means-tested benefit, varies by a factor of just 1.4. In Denmark, the ratio of total pension in the best and worst cases before taxes is 1.8 compared with 1.5 after taxes are taken into account. It is important to highlight that this difference decreases when considering after tax pensions. The tax system seems to smooth out the impact of market returns on retirement income.

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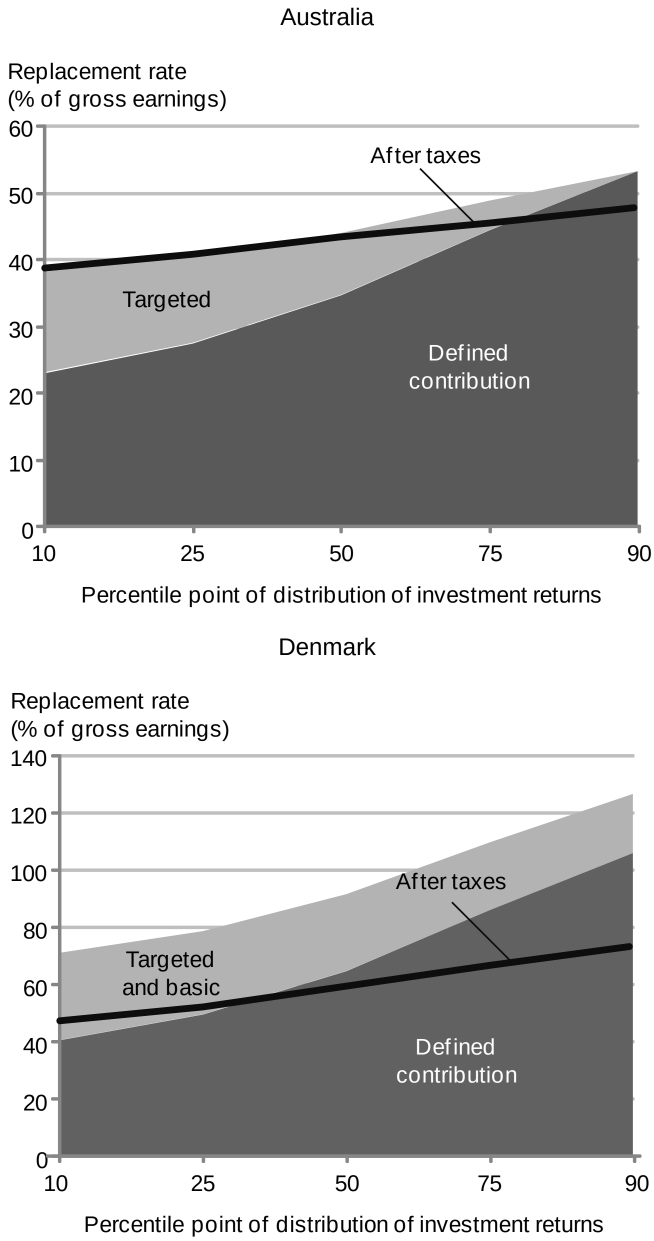
[3] See Keenay and Whitehouse (2003a and b) for analysis of the role of the tax system in old-age support.

[4] Whitehouse *et al.* (2009), Table 4, provides detailed data. This paper also analyses the impact of taxes on net retirement incomes with different investment returns.

[5] For the calculation method, see Whitehouse, E.R., A.C. D'Addio and A.P. Reilly (2009), "Investment Risk and Pensions: Impact on Individual Retirement Incomes and Government Budgets", Social, Employment and Migration Working Paper No. 87, OECD

Figure 2. Gross pension replacement rate and taxes and contributions paid on pensions with different rates of investment return



Source: Pensions at a Glance (2010).

2.2. Investment return guarantees

17. Investment return guarantees establish either a floor to the rate of return on pension contributions or a minimum that must be obtained beyond which an additional return may be offered. Guaranteed returns used to be common features in savings products sold by life insurance companies, but are less so in defined contribution pension plans. The main characteristic of return guarantees are the following:

- Whether it is a fixed or a minimum return.

- Their level, and whether it is set on nominal or real terms
- The period over which they apply
- The extent to which they may be reset during the application period

18. The level of return guarantees is clearly one of its most important features, as it determines the minimum value of the accumulated savings at retirement. In this regard, one may distinguish between absolute return guarantees – which are set against a pre-specified return (e.g. 2 percent annually), and relative return guarantees – which are set in relation to a market benchmark, a synthetic investment portfolio or the average performance of pension funds in the industry. Only absolute return guarantees pre-determine the minimum value of the accumulated savings. The minimum value of accumulated savings under a relative guarantee will vary with market performance.

19. Some OECD countries require DC pension plan providers to offer an absolute rate of return guarantees:

- In the **Czech Republic**, pension fund managers must guarantee the nominal value of contributions made by plan members every year. Contributions cannot receive a negative rate of return in a single year.
- In **Switzerland**, pension funds (which operate that operate the mandatory system - law BVG/LPP) must currently meet a minimum return threshold of 2 percent. The minimum return has been lowered over the past decade to reflect market conditions. It is applied when calculating a workers' accumulated fund when they switch plans and at retirement. The minimum return can be (and usually is) the actual return credited to members' accounts. The annuity conversion rate is also fixed by law and was lowered recently to 6.4%.

20. Absolute return guarantees also apply by law in Belgium and Germany but as they are the responsibility of sponsoring employers, the plans are treated as DB under both the law and international accounting standards (IAS19):

- Occupational pension plans in **Belgium** must since January 2004 (as a result of the Vandenbroucke Law) provide an annual minimum return of 3.75 percent on employees' contributions and 3.25 percent on their own contributions. This minimum return must be used when calculating the entitlements of workers that change plans. The actual market return must be applied if this is higher than the minimum guaranteed return. The employers that sponsor the plan are by law responsible for this engagement.
- The new **German** pension plans introduced under the Riester reform must guarantee a minimum rate of return of 0 per cent in nominal terms, hence ensuring the protection of the nominal capital invested. In Germany also, the minimum return must be met only when switching plans and at retirement. Employers are by law responsible for meeting this guarantee.

21. There are also some OECD countries where pension funds must meet a relative return guarantee:

- In **Chile**, pension fund managers must ensure that returns fall within a band that is defined differently depending on the type of fund chosen by the member. For the funds with the lower equity exposure (C, D and E) the band is defined as the greater of 2 percentage points below the weighted-average real rate of return over the previous thirty-six months and 50% of the weighted-average return. For the funds with the higher equity exposure (A and B), it is defined as the greater of 2 percentage points below the weighted-average real rate of return over the previous thirty-six months and 50% of the weighted-average return. The rate of return regulation has changed various times since the establishment of the system.

- In **Denmark**, ATP, the operator of a nationwide, mandatory DC plan, must provide a minimum return guarantee of member's contributions. However, ATP itself fixes the level of the guarantee. It used to be set in absolute terms, but in 2009 they changed to a relative return guarantee, where the minimum is reset regularly in line with long-term interest rates.

- In **Hungary**, mandatory pension funds must ensure that the investment return is not less than 15 percent less than the yield on Hungarian government bonds.

- In **Poland**, pension fund managers must ensure that returns fall within a band that is defined as the greatest of 4 percentage points below the weighted-average real rate of return over the previous twelve months and 50% of the weighted-average return.

- In **Slovenia**, DC plan providers must meet a minimum return that is defined as 40% of the average annual interest on Slovenian government bonds.

3. Minimum return guarantees in DC pension plans

22. Considering the growing role that minimum return guarantees will play in the future to protect retirement income from DC pension plans, the objective of this part of the report is to compare structurally different guarantees and to assess which ones would best suit for DC plans based on the analysis of their cost-benefit profile. The analysis first examines the cost of different types of minimum return guarantees for DC pension plans, depending on the guaranteed level (0%, 2% or 4%), the design of the guarantee (floating or fixed minimum return, valid at retirement only or in every period) and the structure of the fees (paid annually or at the end of the accumulation period). In addition to the price a guarantee provider would charge the individuals for each guarantee, two measures of cost are also considered to assess the total amount paid by the individual throughout the accumulation period and the cost corresponding to the compound loss on contributions when paying annual fees avoid to invest all contributions. The analysis then looks at the impact of different types of guarantees on retirement income outcomes. The report assesses the probability that each guarantee would be exercised, the probability that the individual would have been better off with a guaranteed portfolio than with a portfolio not guaranteed, and at the distribution of replacement rates. Sensitivity analyses are also conducted by changing some of the parameters of the model and looking at specific market scenarios.

3.1. Types of guarantees considered

23. This section discusses the characteristics of minimum return guarantees in the context of retirement income protection from DC pension plans. It first describes the different types of guarantees analysed, which can be found in different countries or are currently discussed for DC plans. The report distinguishes six kinds of guarantees for which the structure of the fees is identical, i.e. fees are paid and calculated annually, as a percentage of the accumulated net assets value[6] or as a percentage of every contribution paid. They differ according to the guaranteed level (0% nominal, 0% real, 2% nominal or 4% nominal) and the design of the guarantee (floating or fixed minimum return, valid at retirement only or in every period). For one of the guarantees, 2 additional structures of fees are analysed. Fees can be calculated as a haircut on the potential surplus, calculated annually or at the end of the accumulation

[6] The accumulated net asset value corresponds to the value of assets accumulated, net of the fees paid in previous periods.

period. The potential surplus in one period is defined as the difference between the amount of assets accumulated in the portfolio until that period and the amount of assets that would have been accumulated for the same period in a portfolio with a return equal to the guaranteed level (if the difference is negative, the surplus is null). Secondly, this section explains the approach used to determine the cost of different guarantees and to assess their impact on retirement income.

24. Table 1 summarises the characteristics of the minimum return guarantees analysed.[7] The first column describes the characteristics of a capital guarantee as proposed by German pension funds, in which the lump sum at retirement equals at least the nominal sum of contributions made. The minimum return guarantee of 0% nominal is valid at retirement only. If the lump sum at the end of the accumulation period is above the guaranteed lump sum (in this case, the nominal sum of contributions), the surplus (i.e. the difference between the two lump sums) is fully transferred to the individual. Each year, the individual is charged an annual fee paid out of contributions or of accumulated net assets (the analysis calculates the fee in both cases).

25. The second guarantee provides a minimum return of 2% nominal. Except for the guaranteed level, this 2% guarantee is comparable in every respect to the capital guarantee: the guarantee is only valid at retirement, the minimum return is fixed throughout the accumulation period, the surplus is fully transferred to the individual and the fee is paid annually. It is similar to what can be found in Switzerland, where the minimum rate of return for mandatory occupational pensions equals 2%.

26. The third guarantee examined protects the capital from inflation. The lump sum at retirement equals at least the sum of contributions in real terms. This inflation-indexed capital guarantee provides a minimum return of 0% in real terms.

27. The report also examines a capital guarantee that holds during the whole savings phase and not only at retirement. This ongoing capital guarantee is similar to the capital guarantee above, but requires that at each point of time (i.e. on an annual basis) the accumulated assets equal at least the nominal sum of contributions made until then. This kind of guarantee exists in the Czech Republic.

28. For the fifth guarantee examined, the guaranteed rate of return is not fixed along the savings phase. This floating guarantee depends on the development of the 1-year interest rate until retirement. The current 1-year interest rate is assigned to each annual contribution made and is valid until retirement so that, at each point of time, there is a different minimum return. This is similar to the ATP system in Denmark, where most of the contributions (80%) are guaranteed based on the rates the ATP can obtain in the market when contributions are paid.

29. Finally, the report compares three guarantees that provide the same minimum return of 4% nominal, but differ in respect to the structure of the fees. The 4% guarantee with annual fees is comparable to the previous types of guarantees: the individuals are charged an annual fee paid out of contributions or of accumulated net assets. For the two others, the individuals are charged a fee only if the portfolio provides a surplus, i.e. only if the amount of assets accumulated in the portfolio is above the amount of assets that would have been accumulated in a portfolio with a 4% nominal return. For the 4% guarantee with ongoing haircut, the fee is calculated as a haircut on the annual potential surplus, while for the 4% guarantee with final haircut, the fee is only paid at the end of the accumulation period and corresponds to a haircut on the final potential surplus. For these two guarantees therefore, the surplus is not fully transferred to the individual; instead a haircut is applied to the surplus to calculate the fee.

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[7] A formal description of the guarantees analysed is provided in the annex. More details can be found in the accompanying technical paper.

Table 1. Description of the minimum return guarantees analysed

	Capital guarantee	2% guarantee	Inflation-indexed capital guarantee	Ongoing capital guarantee	Floating guarantee	4% guarantee		
						With annual fees	With ongoing haircut	With final haircut
Guaranteed level	Nominal 0%	Nominal 2%	Real 0%	Nominal 0%	1-year interest rate	Nominal 4%	Nominal 4%	Nominal 4%
Guarantee applies	At retirement	At retirement	At retirement	Ongoing	At retirement	At retirement	At retirement	At retirement
Fixed vs. floating	Fixed	Fixed	Fixed	Fixed	Floating	Fixed	Fixed	Fixed
Surplus	All	All	All	All	All	All	Haircut	Haircut
Charge	Annual fee	Annual fee	Annual fee	Annual fee	Annual fee	Annual fee	Annual haircut	Final haircut

30. The guarantees in which the fee is charged as a haircut on the potential surplus are not implemented yet in any DC pension plan around the world. However, insurance companies and mutual funds already use this approach to charge fees. It may create a strong incentive for the guarantee provider to achieve high returns as he is paid only if the actual return on the portfolio is higher than the guaranteed level, only if the provider and the asset manager coincide in a same entity and they do not hedge that risk.[8] The approach using the final haircut may be difficult to implement in the context of pension plans as the guarantee provider has to wait until the end of the accumulation period before receiving a payment. Furthermore, solvency capital issues arise with this approach. These issues are however out of the scope of this study, which focuses on the impact of such types of guarantees on retirement income outcomes.

31. The report first set a price for each type of guarantee using a stochastic financial market model. In this model, the guarantee provider is neutral, meaning that the present value of the expected future guarantee fees equals the present value of the expected future guarantee claims. The guarantee claims are calculated by valuing the guarantee as a financial derivative in a financial market framework (like e.g. the valuation of a put option). This can be achieved assuming that the guarantee provider hedges himself using a synthetic portfolio.[9] Market-consistent scenarios of a 40 years horizon are generated by an appropriate stochastic financial market model using 10,000 Monte-Carlo simulations of different asset returns and inflation. The model is consistent with market prices of derivatives like equity futures, equity options, or swaptions. The value of the guarantee is the average of the present value of guarantee fees, or claims, over all scenarios. This pricing model abstracts from administrative costs as well as solvency rules and related regulations. In real life, fees would therefore be higher than the ones calculated in this model.

32. The price of each type of guarantee determined in the financial market model is then used to assess the impact of the different types of guarantees on retirement income. The model assumes that the guarantee provider applies this price to every single individual whatever the realisation of the world. [10] If the price is determined so that the guarantee provider is neutral, different realisations of the world and different structures of fees may imply different retirement income outcomes for the individuals. The model therefore produces 10,000 new stochastic simulations of the savings accumulated at retirement given stochastic simulations of investment returns for different asset classes and inflation. The model assumes a

[8] When the guarantee provider is not the same than the asset manager, there may not be any incentive for the asset manager to create higher return. Moreover, it may the case that the guarantee provider hedges capital market fluctuations. In this case, the provider would not have any incentive as higher returns would not translate into higher benefits, they are hedged against losses and gains.

[9] A simple numerical example is provided in the Annex. More details can be found in the accompanying technical paper.

[10] The model assumes a representative individual of a cohort entering the model at age 25 under generic conditions regarding equity returns, interest rates term structure and inflation (e.g. the initial 1-year interest rate equals 3.9%). This means that the initial point at age 25 is identical for every Monte-Carlo simulation. Thereafter, between age 26 and 65, each of the 10,000 simulations has a different realisation of equity returns, interest rates term structure and inflation. The identical starting point may constrain the scenarios and limit the variability of the outcomes. This issue is partly addressed in the sensitivity analysis.

generic capital market, described in detail in the technical paper. In particular, the interest rate term structure is upward sloping ranging from 3.5% to 5.5%, inflation term structure is about 2% and volatilities range from 20 to 22%, and the risk premium is set at 3%. The lump sum accumulated at retirement is the result of people contributing 10% of wages each year to their DC plan for forty years, with wages growing from an initial wage of 10,000 currency units by 3.782% on average annually, according to a stochastic inflation rate with median 2% and a career-productivity factor depending on the age of the employee. Contributions to DC plans are invested in a life-cycle investment strategy with a constant exposure to equities of 80% between age 25 and 55 that decreases linearly during the last 10 years to 20%. The model calculates the lump sum obtained in case of a guarantee and in case of no guarantee. The guarantee implies the payment of a fee, which can be deducted, depending on the structure of the fee, either annually from the accumulated net asset value,[11] annually from the potential surplus, or at the end of the accumulation period from the final potential surplus, using the price determined in the financial market model. At retirement, set at age 65, the assets accumulated are used to buy a fixed life annuity.

3.2. What is the cost of different guarantees?

33. This section discusses the cost of the different types of guarantees. Table 2 first shows the price of the guarantee fee according to the kind of guarantee and to the structure of the fees.

34. The price of the guarantee increases when the guaranteed level increases. When the individual is charged an annual fee, the higher is the guaranteed level, the higher is the price. It applies both when the fee is calculated as a percentage of the accumulated net asset value or as a percentage of every contribution paid. Thus, it is cheaper to guarantee the capital than any other level. To buy this guarantee, the individual has only to pay, each year, 0.06% of the accumulated net asset value or 1.24% of the contributions made. If the individual wants also to protect the capital from inflation, the annual fee increases significantly, from 6 to 24 basis points of the accumulated net asset value. The more expensive guarantees are the 4% guarantee and the floating guarantee. For instance, as much as 26% of the contributions needs to be paid each year for the floating guarantee. The price is higher for higher guaranteed level as the guarantee provider has to compensate for higher guarantee claims.

35. Table 2 also shows that the price of the guarantee also depends on the design of the guarantee. Indeed, the capital guarantee is more expensive when it holds over the whole accumulation phase than when it is only valid at retirement. The price of the fee increases by 33 basis points (as a percentage of the accumulated net asset value) with the ongoing guarantee. Additionally, the floating guarantee is more expensive than the fixed 4% guarantee: [12] there is a difference in the fee of 33 basis points between the two if the fee is deducted from the accumulated net asset value. This is due to the fact that the interest rate term structure has a positive slope in most of the Monte-Carlo simulations of the financial market model and starts at the rate of 3.9% for a 1 year maturity for all simulations. Therefore, the floating guarantee eventually guarantees more than 4% on average over the whole accumulation period in most of the simulations, leading to a higher price as compared to a fixed 4% guarantee. The sensitivity analysis below shows that the results change if the interest rate term structure is shifted downwards.

[11] The financial market model analyses two different types of annual fees: an annual payment calculated as a percentage of the accumulated net asset value of all contributions and an annual payment calculated as a percentage of every contribution paid (see the annex). To assess the impact of different types of guarantees, only the first type of payment is used.

[12] The floating guarantee is compared to the 4% guarantee as the initial return under the floating guarantee is equal to 3.9%, which is similar to the fixed 4% return.

Table 2. Price of guarantees by type of guarantee and by approach considered to pay the guarantee fee

	Capital guarantee	2% guarantee	Inflation-indexed capital guarantee	Ongoing capital guarantee	4% guarantee with annual fees	Floating guarantee	4% guarantee with ongoing haircut	4% guarantee with final haircut
% of net asset value	0.06%	0.22%	0.24%	0.39%	0.89%	1.22%	-	-
% of contributions	1.24%	4.94%	5.58%	18.36%	18.71%	26.09%	-	-
% of surplus	-	-	-	-	-	-	1.60%	-
% of final surplus	-	-	-	-	-	-	-	24.06%

36. In order to compare the different structures of fees, two standard cost measures are calculated. The first one corresponds to the sum of all guarantee fees paid (indexed to inflation) expressed as a percentage of the lump sum accumulated at 65 obtained in case of no guarantee. The second cost measure corresponds to the percentage loss in the lump sum accumulated at 65 obtained in case of a guarantee as compared to obtained in case of no guarantee.[13] For both cost measures, Table 3 shows the median value of all scenarios.

Table 3. Median cost of the guarantee by type

	Capital guarantee	2% guarantee	Inflation-indexed capital guarantee	Ongoing capital guarantee	4% guarantee with annual fees	Floating guarantee	4% guarantee with ongoing haircut	4% guarantee with final haircut
Sum of fees paid as a % of the lump sum at 65 in case of no guarantee	0.86%	3.33%	3.67%	6.08%	12.20%	15.96%	5.74%	7.67%
% loss in the lump sum at 65 in case of a guarantee as compared to no guarantee	1.28%	4.98%	5.49%	7.14%	18.30%	23.81%	6.99%	7.67%

37. Using the first measure of cost, the cheapest guarantee remains the capital guarantee. The discounted sum of fees paid represents 0.9% of the lump sum at 65 obtained in case of no guarantee. The more expensive guarantee is the floating guarantee: the discounted sum of fees paid represents 16% of the assets accumulated at 65 obtained in case of no guarantee.

38. For the same level of guarantee, the median total cost depends on the structure of fees. Indeed, when the fee of the 4% guarantee is paid annually, the median total cost is significantly higher and represents 12% of the lump sum obtained in case of no guarantee, as compared to 6% when the fee is paid as a haircut on the potential annual surplus and 8% when the fee is paid as a haircut on the potential final surplus. The guarantee is less expensive on average when the fee is paid in the form of a haircut on the potential surplus because in case the surplus is null, the individual is not charged any fee, and because of the opportunity cost as fees are mostly paid towards the end.[14] However, the dispersion is higher when considering guarantees using a haircut: for instance, the cost at the 95th percentile is the same when fees are paid annually and when fees are paid at the end of the accumulation period (17.5% of the lump sum obtained in case of no guarantee).

[13] It corresponds therefore to the difference between the lump sum accumulated at 65 obtained in case of no guarantee and the lump sum accumulated at 65 obtained in case of a guarantee, expressed as a percentage of the lump sum accumulated at 65 obtained in case of no guarantee.

[14] This would not have been necessarily the case if the two additional structures of fees (as a haircut on annual or final surplus) had been applied to a lower guaranteed level. For instance, the number of cases in which the surplus is null would be much lower if only the capital were to be guaranteed, leading to higher costs for guarantees using a haircut.

39. Both guarantees using a haircut share the same weakness regarding solvency capital issues. The main weakness of the 4% guarantee with final haircut is that the guarantee provider has to wait until the end of the accumulation period before receiving any payment from the pension plan member. He therefore needs to do reserves (the related cost is not included in this study). Charging fees on the potential annual surplus (instead of final surplus) only partially solves this issue, as in more than 25% of the cases the individual does not pay any fee during the first 36 years of the contribution period. The more significant part of the payments is done at the end of the accumulation period, when the surplus is potentially high. This is the reason why the costs associated with both guarantees using a haircut are close to each other, as compared to the cost of the guarantee with annual fees.

40. When the compound loss on contributions resulting from the annual fee payment is taken into account, the total cost of the guarantees can increase significantly. The second cost measure includes another component, which is the compound loss on contributions as a result of annual fee payments. Indeed, when annual fee payments are required, the part of the contributions that is used to pay the annual fee is not invested and does not produce any return. This implied cost does not exist when the fee is paid at the end of the accumulation period, as a haircut on the potential final surplus. In that case, the full contributions are invested, which allows a higher lump sum at 65 (before the payment of the fee). This is the reason why the 4% guarantee with final haircut has the same median total cost with both measures of cost (7.67% of the lump sum at 65 obtained in case of no guarantee). For the other types of guarantees, in which fees are paid annually, the total cost is higher with the second measure. While the difference between the two costs measures varies between 0.4 and 1.8 percentage points for most guarantees, it is much more important for the 4% guarantee with annual fees (+ 6.1 percentage points) and the floating guarantee (+ 7.8 percentage points). This is because the fees paid represent a higher share of the accumulated net asset value each year for these two guarantees. Therefore, the part of the cost represented by the compound loss on contributions is more important.

Sensitivity analysis

41. The sensitivity of the price of the guarantees is assessed by changing model assumptions at the starting point (i.e. at age 25) regarding the volatility term structure, the interest rate term structure and the inflation term structure. [15] In particular, Table 4 shows that a shift of -1% of the interest rate term structure increases significantly the price of all guarantees, except the floating guarantee. Under such assumptions, the price of the floating guarantee is lower than the one of the 4% guarantee with annual fees: the individual is charged 1.24% of the accumulated net asset value each year for the floating guarantee and 1.80% for the 4% guarantee. In addition, Table 4 also shows that a shift of +10% of the volatility term structure makes the capital guarantee even more appealing, as the gap between its price and the price of the other guarantees increases. For instance, the difference between the price of the 2% guarantee and the capital guarantee represents 16 basis points for the baseline model and 24 basis points when the volatility term structure is shifted by +10%.

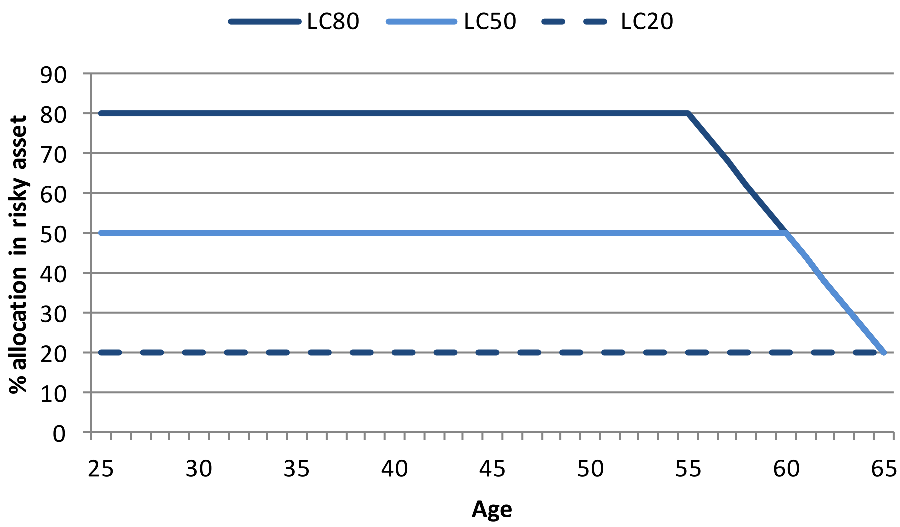
[15] The full results of the sensitivity analysis can be found in the accompanying technical paper.

Table 4. Impact of a shift of the term structures of interest rate and volatility on the price of guarantees

	% of accumulated net asset value						% of annual surplus	% of final surplus
	Capital guarantee	2% guarantee	Inflation-indexed capital guarantee	Ongoing capital guarantee	4% guarantee with annual fees	Floating guarantee	4% guarantee with ongoing haircut	4% guarantee with final haircut
Baseline	0.06%	0.22%	0.24%	0.39%	0.89%	1.22%	1.60%	24.06%
Parallel shift of -1% of interest rate term structure	0.11%	0.42%	0.47%	0.54%	1.80%	1.24%	3.78%	45.38%
Parallel shift of +10% of volatility term structure	0.11%	0.35%	0.38%	0.54%	1.15%	1.70%	1.77%	28.04%

42. The analysis also shows that the life cycle investment strategy in which assets are invested during the accumulation phase has an impact on the price of guarantees. Three different life cycle investment strategies are analysed, in which the exposure to equities starts with 80%, 50% or 20% respectively (see Figure 1). As shown in Table 5, if the guaranteed portfolio is invested in a strategy with a lower starting exposure to equities, the price of all guarantees is lower, except for the 4% guarantee with ongoing haircut. Additionally, it shows that the ongoing guarantee becomes less expensive than the 2% guarantee and the inflation-indexed capital guarantee when the investment strategy is less exposed to equities.

Figure 3. Shapes of the different life cycle investment strategies analysed (LC80, LC50, LC20)



Note: "LC80" represents the life cycle investment strategy that keeps a constant exposure in equities of 80% from age 25 to 55 and decreases thereafter linearly this exposure to 20%. "LC50" represents the life cycle strategy that keeps a constant exposure in equities of 50% from age 25 to 60 and decreases thereafter linearly this exposure to 20%. "LC20" represents an investment strategy with a fixed exposure in equities of 20%.

43. Finally, when the contribution period is shortened from 40 to 20 years, the price of all guarantees increases significantly. The lower is the contribution period the higher are the fees because the individual has less time to recover from potential market crashes in a 20 year period and therefore the probability that the guarantee would be exercised is much higher.

Table 5. Impact of investment strategies and the length of the contribution period on the price of guarantees

	% of accumulated net asset value						% of annual surplus	% of final surplus
	Capital guarantee	2% guarantee	Inflation-indexed capital guarantee	Ongoing capital guarantee	4% guarantee with annual fees	Floating guarantee	4% guarantee with ongoing haircut	4% guarantee with final haircut
Contribution period: 40 years								
LC 80	0.06%	0.22%	0.24%	0.39%	0.89%	1.22%	1.60%	24.06%
LC 50	0.03%	0.14%	0.15%	0.15%	0.71%	0.90%	1.63%	22.02%
LC 20	0.01%	0.06%	0.07%	0.02%	0.49%	0.44%	1.57%	18.87%
Contribution period: 20 years								
LC 80	0.24%	0.89%	0.84%	0.91%	4.04%	3.32%	18.95%	83.27%

Note: "LC80" represents the life cycle investment strategy that keeps a constant exposure in equities of 80% from age 25 to 55 and decreases thereafter linearly this exposure to 20%. "LC50" represents the life cycle strategy that keeps a constant exposure in equities of 50% from age 25 to 60 and decreases thereafter linearly this exposure to 20%. "LC20" represents an investment strategy with a fixed exposure in equities of 20%.

44. The analysis so far has examined the cost of different types of minimum return guarantees for DC pension plans, depending on the guaranteed level (0%, 2% or 4%), the design of the guarantee (floating or fixed minimum return, valid at retirement only or in every period) and the structure of the fees (paid annually or at the end of the accumulation period). The remaining important question to address is to what point these guarantees are useful to protect retirement income from DC pension plans in a world of uncertainty about rates of return on investment and inflation. This issue is taken up in the next section.

3.3. What is the impact of different guarantees on retirement income outcomes?

45. This section looks at the impact of the type of guarantee on retirement income outcomes. Three different outcomes are considered: the probability that a guarantee would be exercised (i.e. the probability that the guarantee provider needs to pay the guaranteed benefit to the individual), the probability that the lump sum accumulated at 65 obtained in case of a guarantee is higher than the one obtained in case of no guarantee, and the replacement rate an individual would get after buying a fixed life annuity with the accumulated assets. The section ends with sensitivity analyses to assess the impact of different volatility, interest rate, and inflation term structures, different investment strategies and different contribution periods on replacement rates.

46. Individuals paying for a minimum return guarantee are buying an insurance that may be exercised in very few cases. As shown in Table 6, the capital guarantee would be exercised in only 0.5% of the cases, and would provide a higher lump sum accumulated at 65 than in case of no guarantee in only 0.5% of the cases also. Individuals paying for a capital guarantee therefore buy an insurance to protect themselves against extreme negative cases that are rare in which they would lose what they put in their DC pension plans. This applies also for the other guarantees, where the probability that the guarantee would be exercised is higher when the guaranteed level is higher (except for the ongoing capital guarantee that would be exercised in 83% of the cases at least once during the accumulation period). Additionally, the 4% guarantee is less often exercised when the fee is paid as a haircut on the potential surplus (either annual or final) because the cost associated with such structures of fees is lower.

Table 6. Exercising of the guarantee and cases in which the guarantee provides a higher lump sum

	% cases the guarantee is exercised	% cases better off with the guarantee
Capital guarantee	0.49	0.48
2% guarantee	5.75	4.78
Inflation-indexed capital guarantee	6.48	5.22
Ongoing capital guarantee	83.45	18.20
4% guarantee with annual fees	35.32	21.26
Floating guarantee	40.33	21.72
4% guarantee with ongoing haircut	23.09	21.26
4% guarantee with final haircut	21.26	21.26

47. The capital guarantee makes attractive for people to save in private pension systems. Indeed, the distribution of replacement rates by type of guarantee (see Table 7) shows that the median replacement rate and the replacement rate at the 95th percentile are higher for the capital guarantee as compared to other types of guarantees. Replacement rates provided by the capital guarantee are however lower than the ones obtained in case of no guarantee in most of the cases, as individuals buy an insurance to protect themselves against extreme negative cases. Only the replacement rates at the 0.5th percentile are higher in case of a capital guarantee as compared to no guarantee. In those cases, the capital guarantee allows individuals not to lose what they put in their pension plan.

48. The analysis also shows that paying the fees as a haircut on the potential surplus allows protecting individuals from very low replacement rates without losing too much of the upside potential. These guarantees provide the best replacement rates at the 0.5th and 5th percentiles. In addition, they provide also quit high replacement rates at the median and at the 95th percentile, which are lower than those observed for low guaranteed level (capital guarantee and 2% guarantee for instance), but higher than those observed for similarly high guaranteed level (4% guarantee with annual fees and floating guarantee).

Table 7. Probability distribution of replacement rates by type of guarantee

	0.5th percentile	5th percentile	Median	95th percentile
No guarantee	20.5	30.0	68.4	184.2
Capital guarantee	20.8	29.7	67.5	181.5
2% guarantee	25.5	30.8	65.0	173.5
Inflation-indexed capital guarantee	27.0	30.9	64.6	172.4
Ongoing capital guarantee	22.9	30.8	64.7	169.4
4% guarantee with annual fees	34.2	39.0	56.8	145.0
Floating guarantee	28.5	33.5	56.6	140.3
4% guarantee with ongoing haircut	34.8	40.1	63.2	150.7
4% guarantee with final haircut	34.8	40.3	63.2	152.4

Sensitivity analysis

49. The report analyses the impact of the different types of guarantees on replacement rates under specific market stress scenarios. Each scenario analysed has a different real rate term structure and inflation level, but for all of them the equity return index is declining (these are therefore cases in which the guarantees may need to be exercised).[16] High inflation favours the guarantee that protects capital from inflation, as in scenarios where inflation is high, the inflation-indexed capital guarantee provides a higher

[16] For more details on the market stress scenarios, please refer to the accompanying technical paper.

replacement rate than the one provided by the 2% guarantee. Additionally, if the real rate term structure increases or is high during the whole accumulation period, the floating guarantee is the one providing the highest replacement rate.

50. The analysis also looks at the impact of the life cycle investment strategy in which assets are invested and of the length of the contribution period on retirement income outcomes. Table 8 shows that lower equity allocations decrease the number of cases in which the guarantee would be exercised, for all types of guarantees. Consequently, the number of cases in which the lump sum is higher with a guarantee than without is also lower for all types of guarantees. When the contribution period declines (e.g. from 40 to 20 years), the reverse situation is observed: the number cases in which the guarantee would be exercised increases and there are also more cases in which the individuals are better off with a guarantee than without. Moreover, the comparative advantage of the guarantees using a haircut on replacement rate is less important when the portfolio is less exposed to equities and when the contribution period is shortened. These guarantees still provide a higher protection for worst case scenarios in both situations, but the gap in the replacement rate at the 5th percentile with other types of guarantees is lower. For instance, lower equity allocations increase the replacement rates for worst case scenarios for all guarantees, except when the guaranteed level is 4%, because with such high guaranteed level, in all worst case scenarios (5th percentile) the guarantee would be exercised, whatever the equity allocation.

Table 8. Impact of the investment strategy and of the length of the contribution period on the probability that the guarantee would be exercised and on the replacement rate at the 5th percentile

	Contribution period: 40 years				Contribution period: 20 years	
	LC80		LC50		LC80	
	% cases the guarantee is exercised	Replacement rate at the 5th percentile	% cases the guarantee is exercised	Replacement rate at the 5th percentile	% cases the guarantee is exercised	Replacement rate at the 5th percentile
No guarantee	-	30.0	-	34.0	-	10.6
Capital guarantee	0.49	29.7	0.06	33.8	0.99	10.4
2% guarantee	5.75	30.8	2.12	33.3	13.81	10.6
Inflation-indexed capital guarantee	6.48	30.9	2.56	33.1	14.35	10.7
Ongoing guarantee	83.45	30.8	66.25	33.6	82.85	10.5
4% guarantee with annual fees	35.32	39.0	30.41	39.0	86.49	11.7
Floating guarantee	40.33	33.5	33.27	34.1	76.98	11.0
4% guarantee with ongoing haircut	23.09	40.1	19.15	40.2	39.93	12.0
4% guarantee with final haircut	21.26	40.3	17.21	40.3	26.95	12.0

Note: "LC80" represents the life cycle investment strategy that keeps a constant exposure in equities of 80% from age 25 to 55 and decreases thereafter linearly this exposure to 20%. "LC50" represents the life cycle strategy that keeps a constant exposure in equities of 50% from age 25 to 60 and decreases thereafter linearly this exposure to 20%.

3.4. Conclusions

51. This section has examined the cost of different minimum return guarantees and the impact of these guarantees on retirement income outcomes. The main conclusions from this section are the following:

- *The capital guarantee can make attractive for people to save in private pension systems*. Individuals willing to avoid losing the money they put in their DC pension plans during the whole accumulation period would only need to pay a fee equivalent to 6 basis points annually of the accumulated net asset value of the portfolio. As the guaranteed level is low, the probability that the guarantee would be exercised is also low, but in the 0.5% worse case scenarios, it would prevent the individuals to lose the money they put in.

- *The compound loss on contributions can increase significantly the cost of a guarantee*. To guarantee a minimum rate of return on pension assets has a cost for the individual, who is actually buying an insurance against extreme negative scenarios. Traditionally, individuals have to pay an annual fee. These annual payments introduce however an additional cost, corresponding to the compound loss on contributions, as not all contributions are invested and produce returns. This cost can be high, especially for high guaranteed level for which fees are more important. Changing the structure of the fees, by charging the individuals on the potential surplus at the end of the accumulation period is a way to eliminate this additional cost.

- *Changing the structure of the fees may be appropriate for high guaranteed level, but solvency capital issues still need to be addressed before implementing them.* When comparing three structures of fees for a 4% guarantee, the analysis shows that charging fees as a haircut on the potential surplus above the guaranteed level as compared to annually implies lower costs and higher replacement rates. However, using a haircut as design in this study on the potential annual or final haircut also implies that the guarantee provider receives most or all of the payments at the end of the accumulation period. Related reserving costs have not been taken into account in this analysis and would need to be considered.

4. Conclusion and policy recommendations

52. The purpose of having guarantees is to provide a floor or minimum income at retirement to prevent people from having inadequate pensions. However, section II shows that in many OECD countries public pensions' automatic stabilisers and old-age safety nets already provide for this floor. Therefore, some people may argue that there may not be a need to have guarantees in DC pension plans. Yet, this floor does not alleviate the impact of market risk for medium to high income individuals. Moreover, in countries where retirement income from DC plans is the main source to finance retirement, there may be a need for some type of investment guarantees, as retirement is fully expose to market risk. In countries with safety nets and defined benefit public pensions, market risk affect to a lower share of retirement income than in countries with most benefits coming from DC plans.

53. Additionally, the negative reputation that saving for retirement in DC pension plans have may also call for the introduction of some minimum return guarantees, in particular the capital guarantee. Surveys highlight that people's negative feelings about saving in DC pension plans esteem from the fear of the possibility of even loosing their contributions. Therefore, it may be a good idea to introduce capital guarantees -- guarantee the contributions -- to increase the attractiveness of saving for retirement in DC accounts and promote coverage in these plans. Section 3 shows that the cost of guaranteeing that people will get back at least their contributions is quite affordable.

54. It is important to highlight that stronger guarantees than just the capital guarantee are much more expensive. People may want stronger guarantees such as an inflation guarantee or even a minimum real return of 2%. The analysis in section 3 shows that these stronger guarantees may be too costly. More so for individuals that already have a guaranteed retirement income floor through state pensions (e.g. lower income people).

55. The analysis shows that changing the structure of how the cost of these guarantees is paid, may increase the amount of assets accumulated at retirement. The cost of providing minimum return guarantees can be cover through charging a fee on contributions or on assets accumulated independently of how the portfolio performs. They can also be covered by charging a hair-cut on investment surpluses when the portfolio outperforms. Therefore, haircuts may introduce incentives for providers -- only if the provider and the asset manager coincide in a same entity and they do not hedge that risk -- to perform well as they only get paid when the actual portfolio balance is higher than the value of the portfolio determined by the guarantee (*e.g.* the portfolio balance that would result from assuming a minimum return of 2%). Additionally, a haircut have the advantage that contributions are fully invested (the fee is not deducted

from the contribution) and accumulated, and therefore the full contribution earns returns reducing therefore the cost in terms of assets accumulated at retirement.

56. Unfortunately, the haircut has also a severe drawback. Providers hold a future promise to be paid depending of investment surpluses, which it may not materialise. Therefore, a haircut requires providers to set aside capital buffers that may be higher than those required in the case of regular annual fees. This would increase the cost of providing the guarantees, cost that is not considered in the analysis throughout this paper. If such costs were to be included in the assessment of payment structures based on the haircut, they would diminish the attractiveness of haircuts.

57. The main recommendation of the report is regulators and policy makers may consider assessing the potential advantages of introducing capital guarantees. They may increase the attractiveness of saving for retirement in DC pension plans as people will always get back at least what they contributed. Hence, the next step in the discussion is on who should provide these guarantees.

58. Two recent papers argue that the government would be the more realistic guarantee provider. To support that argument, both Munnel (2009) and Grande (2010)[17] first highlight the existence of the counterparty risk over long-term horizons linked to the private provision of minimum return guarantees. Bankruptcies, like the ones observed during the recent financial crisis, severely hamper individuals' confidence that the firm providing the guarantee would still be there for the payoff in 40 years time.

59. Another argument for direct government involvement is its ability to access hedging products to insure against the possibility of having to cover the guarantee in situations of sharp economic downturns. Credit-worthy governments may indeed issue long-term bonds at advantageous prices, while private insurers do not have access to such products.

60. Additionally, the pooling of all guarantee claims in a single public fund would allow to enjoy better risk-sharing opportunities. This in turn would imply that the fees charged to the individuals to manage the guaranteed portfolios would be lower than the ones a private sector provider would set.

61. However, public minimum return guarantees may also raise some issues. First, public pension systems already have serious sustainability issues in some countries. If the government guarantee minimum returns in DC pension plans, it will increase again its liabilities, which may not be opportune. Second, a public guarantee would play the role of a safety net against stock market collapse for DC pension plan members. This may favour the risk of opportunistic behaviour by the insured, who may be encouraged to over-expose themselves to financial risks. This risk could be mitigated by imposing a ceiling on the share of risky assets in the pension fund's portfolio. However, this would put aside from the public minimum guarantee less risk adverse individuals, while private sector providers could provide different guarantee levels at different prices depending on the individual's risk aversion.

62. This discussion of who should provide the guarantee must also be considered in the context of the pension system as a whole. If the public pension system already provides high replacement rates, the need for an additional public guarantee for private DC pension plans may not be that important. In cases however where most of the individuals' retirement income comes from DC pension plans, guaranteeing portfolio returns becomes more important and the government may have more facility to step in to finance for such guarantees.

[17] Munnel, A.H., Golub-Sass, A., Kopcke, R.A., Webb, A., What does it cost to guarantee returns?, Number 9-4, February 2009, Center for Retirement Research and Grande, G., Visco, I., A public guarantee of a minimum return to defined contribution pension scheme members, Temi di discussion, Number 762, June 2010, Banca d'Italia.

ANNEX: FORMAL DESCRIPTION OF THE DIFFERENT TYPES OF GUARANTEES ANALYSED

In order to price each guarantee so that the guarantee provider is neutral, it is necessary to find, for each type of guarantee, the guarantee fee such that the present value of the expected future guarantee fees equals the present value of the expected guarantee claims. For the capital guarantee for instance, the lump sum (LS) at retirement (T) equals at least the nominal sum of contributions made. This can be written as:

$$LS^{Capital}(T) = \max\left[NAV(T), \sum_{t=1}^{T} Contributions(t)\right],$$

where NAV(T) is the net asset value of all contributions invested into the life cycle strategy.

This can be decomposed into the net asset value of all contributions invested into the life cycle strategy and an additional optional component corresponding to an option contract which pays off if the lump sum at retirement is lower than the sum of all contributions made (the guarantee):

$$LS^{Capital}(T) = NAV(T) + \max\left[0, \sum_{t=1}^{T} Contributions(t) - NAV(T)\right]$$

Depending on how the guarantee fee is paid, the calculation of the net asset value differs. This report analyses four different approaches to pay the guarantee fee.

1. An annual payment calculated as a percentage of the accumulated net asset value of all contributions invested into the life cycle investment strategy

This approach applies to all guarantees except the ones using a haircut. Each year, the net asset value is reduced by the guarantee fee following this formula:

$$\forall t \in [2;T],\ NAV(t) = [NAV(t-1) \times (1 + Return(t-1,t)) + Contributions(t)] \times (1 - GPrice_1\%)$$

2. An annual payment calculated as a percentage of every contribution paid

This approach applies to the same guarantees as above. Each year, the net asset value is reduced by the guarantee fee following this formula:

$$\forall t \in [2;T],\ NAV(t) = NAV(t-1) \times (1 + Return(t-1,t)) + Contributions(t) \times (1 - GPrice_2\%)$$

3. An annual payment calculated as a percentage of the potential surplus above the guaranteed benefit

This approach only applies to the 4% guarantee with ongoing haircut. Each year, the net asset value is reduced by the guarantee fee following this formula:

$$\forall t \in [2;T],\ NAV(t) = NAV_{BH}(t) - Surplus(t) \times GPrice_3\%,$$

where $NAV_{BH}(t) = NAV(t-1) \times (1 + Return(t-1,t)) + Contributions(t)$ is the net asset value before the haircut and $Surplus(t) = \max\left[0, NAV_{BH}(t) - \sum_{i=1}^{t} Contributions(i) \times (1 + 4\%)^{t-i}\right]$ is the potential surplus.

4. A single payment calculated as a percentage of the potential surplus above the guaranteed benefit at the end of the accumulation period

This approach only applies to the 4% guarantee with final haircut. The guarantee fee is directly deducted from the lump sum at retirement following this formula:

$\forall t \in [2;T]$, $NAV(t) = NAV_{BH}(t) = NAV(t-1) \times (1 + Return(t-1,t)) + Contributions(t)$,

and $LS^{Final\ haircut}(T) = NAV(T) - Surplus(T) \times GPrice_{4}\%$

Basic example of the idea behind how the fair price of a guarantee is calculated

In order to determine the price of the capital guarantee for instance, it is necessary to find $GPrice_1\%$ (or $GPrice_2\%$) such that the present value of the expected future guarantee fees equals the present value of the expected future guarantee claims, where:

Includes guarantee fees

$$LS^{Capital}(T) = NAV(T) + \underbrace{\max\left[0, \sum_{t=1}^{T} Contributions(t) - NAV(T)\right]}_{\text{Guarantee claim}}$$

To value a guarantee at a fair price means valuing the guarantee as a financial derivative in a capital market framework (like e.g. the valuation of a put option). This is illustrated in the simple numerical example below – the accompanying technical paper has a detailed description of the mathematical modelling.

Let assume that the holder of a stock (valued at 100 units: S_0) wants to protect his investment and does not want to lose more than 5% of his investment. The objective is to determine the cost of such a protection (i.e. determine the fee). The holder is assumed to pay the fee first and then to invest 100. Additionally it is assumed that, after one year, the stock can take two values with the same probability (120 or 90) and that the investor wants a guaranteed level of 95. This can be achieved by buying an appropriate option:

Stock			Option			Stock + option = guaranteed portfolio
	$S_{up} = 120$			$G_{up} = 0$		$S_{up} + G_{up} = 120$
$S_0 = 100$		+	$G_0 = ?$		=	
	$S_{down} = 90$			$G_{down} = 5$		$S_{down} + G_{down} = 95$

The payoff of the option G_0 can be achieved with a replicating portfolio: a fraction Δ of the stock is sold to buy a zero-bond B.

– If the stock is worth 120 after one year: $G_{up} = B - \Delta S_{up} = B - 120 \times \Delta = 0$ (1)

– If the stock is worth 90 after one year: $G_{down} = B - \Delta S_{down} = B - 90 \times \Delta = 5$ (2)

– The value of the option is the present value of the replicating portfolio. Assuming a discount rate of 3%, this gives: $fee = G_0 = B/(1 + 3\%) - \Delta S_0 = B/(1 + 3\%) - 100 \times \Delta$ (3)

This is a system of 3 equations with 3 unknown variables (B, Δ and fee) with a unique solution: B = 20, Δ = 1/6 and fee = 2.75. The same kind of method (use of a replicating portfolio) can be used for more complex guarantees and more realistic assumptions regarding the fluctuations of the underlying asset classes.