An illustration to assess the risk profile of investment strategies

Executive summary

This document illustrates how the stochastic methodology that is the backbone of the *OECD Roadmap for the Good Design of Defined Contribution Pension Plans*, in particular on the recommendations referring to default investment strategies, can be used to assess the risk profile of any long-term investment strategy for retirement. This methodology allows calculating, for any investment strategy, the probability for an individual saving for retirement to get back the accumulated nominal value of their contributions. It also provides measures of the potential expected returns and potential losses associated with different investment strategies.

The outcomes of the model, probabilities and potential gains and losses, can serve as a basis for communicating potential risks and rewards to individuals contributing to a personal pension plan such as the pan-European personal pension product (PEPP).

The illustration of the methodology presented in this document suggests that the assumptions made regarding key parameters, such as returns, are of vital importance to determine the probability of an investment strategy to be able to give back to people saving for retirement their accumulated contributions. It also highlights the need to use appropriate communication tools to convey complex information such as risk, returns, and probabilities to individual participants.

The analysis contained in this document chooses the value of several parameters with the only objective of illustrating the use of the methodology. It does not intend to make recommendations on the different parameters used (e.g. the gliding path of the life-cycle investment strategies), but only to illustrate that the methodology can be applied to any investment strategy, and that the choice of parameters will have an impact on the probability of a given investment strategy to give back the accumulated nominal contributions.

Regulators and stakeholders will need to agree on some of these parameters. They need to agree on parameters like the starting age for saving and the retirement age, the asset classes in the portfolios, the indexes representing the different asset classes, the period to determine their statistical properties (e.g. averages and standard deviations), and the contribution rate time profile, among others.

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1. Rationale of the study

The OECD is currently revisiting the *OECD Roadmap for the Good Design of Defined Contribution Pension Plans*. The Working Party on Private Pensions approved and endorsed the OECD Roadmap in June 2012. The OECD Secretariat has used the Roadmap to provide guidance on how to improve defined contribution (DC) pension arrangements. It has been a key instrument in the *OECD Pension Reviews* of Ireland (2014), Mexico (2016), Latvia (2018), Portugal (2019) and Peru (2019). However, the OECD has conducted a lot of work since 2012 that shows the need to update and improve the OECD Roadmap. In addition, new areas of work could be undertaken to provide further evidence to back up some of the recommendations.

The OECD Roadmap comprises two recommendations with respect to investment strategies. It first recommends the establishment of appropriate default investment strategies, while also providing choice between investment options with different risk profiles and investment horizons. The default option addresses the problem of choosing an investment strategy for people unwilling or unable to make choices. Meanwhile, members should be allowed to choose the investment strategy best suited for them according to their risk profile and level of risk tolerance. In addition, the OECD Roadmap suggests establishing life-cycle investment strategies as a default option. Life-cycle investment strategies reduce the impact of financial market risks on account balances as members age, and therefore protect people close to retirement against extreme negative outcomes.

The new pan-European personal pension product (PEPP) is in line with these recommendations contained in the OECD Roadmap. The European Parliament and the Council recently adopted the PEPP Regulation (Regulation 2019/1238).[1] The PEPP is a voluntary personal funded pension scheme that will complement existing national pension arrangements, whether public, occupational or personal. A broad range of private financial providers will be able to offer this new type of product across the European Union. According to Article 42 of the PEPP Regulation, PEPP providers may offer up to six investment options to PEPP savers, including the Basic PEPP.

The Basic PEPP, according to Article 45, shall be a safe product representing the default investment option. It shall be designed by PEPP providers on the basis of a guarantee on the capital, or a risk-mitigation technique consistent with the objective to allow the PEPP saver to recoup the capital. The risk-mitigation technique's objective of recouping the capital is equivalent to the idea of people getting back the nominal value of their accumulated contributions. Article 46 establishes that the applicable risk-mitigation techniques may include provisions i) for gradually reducing the overall risk exposure over time (life-cycle strategy); ii) establishing reserves to mitigate investment losses; or iii) for using appropriate guarantees to protect against investment losses. The PEPP Regulation is

[1] The PEPP Regulation establishes the legal foundation for a pan-European personal pension market by ensuring standardisation of the core product features, such as transparency requirements, investment rules, switching right and type of investment options.

therefore in line with the OECD Roadmap, providing investment choice with a default investment option, for which life-cycle strategies can qualify.

The development of additional measures for the PEPP Regulation, level 2 measures, is an opportunity to undertake new work on investment strategies, which may eventually help update and improve the OECD Roadmap. EIOPA and the European Commission are currently working on a number of delegated and implementing acts for the effective implementation of the PEPP Regulation. In particular, there is a need to identify which investment strategies based on risk-mitigation techniques are actually consistent with the objective to allow PEPP savers to get back the accumulated nominal value of their contributions. In this context, the OECD work and its methodology underpinning the OECD Roadmap could be useful to assist in the development of regulatory standards for the PEPP. This work could also serve as input to update and improve the OECD Roadmap.

The main objective of this document is to present a methodology to assess how likely people are to get back the accumulated nominal value of their contributions, when participating in a PEPP which does not offer an explicit guarantee of the capital.[2] Given that the risk-mitigation techniques in the Basic PEPP have to be consistent with the objective to allow PEPP participants to get back their accumulated contributions, regulators could develop the corresponding regulatory standards by establishing a methodology that PEPP providers could apply to show to regulators, in a consistent and robust manner, that their investment strategies are consistent with this objective. The methodology proposed here allows the calculation of the probability that individuals will get back their accumulated contributions with a given investment strategy. It relies on the use of a stochastic model based on the probability distribution of investment returns for different asset classes and of inflation.

Under this framework, PEPP providers could design the risk-mitigation technique with certain flexibility. PEPP providers could propose any investment strategy to PEPP savers, as long as the risk level of that strategy is consistent with allowing the saver to get back their nominal contributions at the level of certainty required by regulators, and following a set of assumptions. In this context, there may not be a need to set up quantitative investment restrictions in the regulatory framework, with limits on certain asset classes.

The methodology could also be useful to communicate essential information to PEPP savers. Article 28 of the PEPP Regulation specifies that the PEPP Key Information Document (KID) should contain a section titled "What are the risks and what could I get in return?" including a summary risk indicator, the possible maximum loss of invested capital, and appropriate performance scenarios together with the assumptions on which they are based. The stochastic model developed to calculate the probability to get back nominal contributions can also provide information about the expected loss in the cases, or realisations of the world, when the investment strategy fails to give back the accumulated nominal value of their contributions to people, and about the potential return that savers could expect from the investment strategy in different scenarios or realisations of the world. Although the outcomes of the model may be far from ideal for communicating information to participants, they can serve as background information to communicate risk and reward.[3]

[2] The OECD gratefully acknowledges the financial support of EFAMA.

[3] How to communicate risks and rewards is a challenging subject that requires further work, which is beyond the scope of this document.

The rest of the document is structured as follows. Section 2 describes the methodology for the calculation of the probability that individuals will get back the accumulated nominal value of their contributions. Section 3 applies the methodology, for illustration purposes, to selected investment strategies. It also describes which parameters need to be defined by regulators for PEPP providers to apply the methodology in a consistent manner. Section 4 addresses issues related to communication with participants and illustrates how the methodology can also provide background material to communicate investment risk and reward to savers. Section 5 finally presents a potential extension of the methodology.

2. Methodology for the calculation of the probability of getting back the accumulated nominal value of contributions

Approach: stochastic modelling

Retirement income derived from DC pension plans, including PEPPs, depends on several factors, some of which are uncertain. The factors affecting retirement income include the amount saved during the career; the length of the contribution period; the investment strategy; the returns on different asset classes; inflation; wages; periods of employment; and life expectancy. Individuals, regulators and policy makers have some control over certain factors, such as the amount saved periodically during the working life (i.e., the contribution rate), or the ages at which people can start and stop saving for retirement. However, other factors are inherently beyond policy makers' control, such as the returns on different asset classes; returns and yields on government bonds; and the rate of inflation. Similarly, career wage-growth paths vary for individual workers, as well as whether they will suffer unemployment spells during their careers. Additionally, how long people may expect to live is also undetermined. One of the main implications of these labour, financial, and demographic risks is that pension benefits derived from DC pension plans are uncertain.

The OECD approach consists in computing the probability that individuals will get back the accumulated nominal value of their contributions, for different investment strategies using stochastic simulations, in order to factor in the impact of financial risks. As the probability of getting back nominal contributions is determined by the amount of assets accumulated at retirement, the model does not need to incorporate the demographic risk, as the uncertainty about life expectancy does not affect the total amount of pension assets accumulated at retirement. In addition, although labour market risks (spells of unemployment and career real wage profiles) affect the outcome under review, this model leaves these risks aside to focus on financial risks. Labour market risks could be incorporated at a later stage (see Section 5).

The stochastic model derives uncertainty about returns on investment, discount rate and inflation by assuming random-generating processes for each of the variables (or risks) in question.[4] The model produces 10,000 Monte Carlo simulations for savings accumulated at retirement based on stochastic simulations of investment returns in different asset classes, and of inflation. The model also assumes correlations between the different variables when necessary. Each Monte Carlo simulation represents one possible realisation of the world.

[4] Antolin and Payet (2010[3]), and Antolin, Payet and Yermo (2010[4]) describe the stochastic model and the methodology to introduce uncertainty in several retirement parameters in detail.

The model produces, for each simulation, the information on whether the investment strategy allows the individual to get back their accumulated contributions. The model provides the amount of accumulated assets that individuals may get in each of the realisations of the world. It also allows comparing this amount of accumulated assets with the sum of all nominal contributions. This permits to calculate whether individuals would get back their nominal accumulated contributions in each of the realisations for the world. The value of assets accumulated at retirement is the result of an individual joining a Basic PEPP at a certain age and contributing a constant proportion of wages into it each year until retirement at age 65. The wage index starting at 100 at age 25 grows in line with inflation and 1.25% constant productivity growth. Contributions to the Basic PEPP are invested in a portfolio according to the different investment strategies examined. The resulting value of assets accumulated at retirement takes into account an annual fee of 1% of assets, and is compared to the nominal sum of all contributions paid.

Asset classes

Contributions are invested in various portfolios containing different allocations of assets. Therefore, the methodology requires defining the asset classes that make up the different portfolio investment strategies, the indexes representing these asset classes, and the periods to determine the statistical properties of each asset class in order to be imputed into the stochastic simulation.

This document, for illustrative purposes, assumes that contributions to the Basic PEPP are invested in various portfolios containing different allocations to four asset classes, international equities, European equities, corporate bonds, and government bonds. The indexes detailed in Table 1 represent the different asset classes chosen for illustrative purposes.

Table 1. Moments of the distribution of different asset classes' nominal returns and rate of inflation (annual basis)

		1969-2018 (1)		1999-2018	
	Index used	Mean	Standard deviation	Mean	Standard deviation
International equities	MSCI World	8.21%	16.93%	4.45%	17.72%
European equities	MSCI Europe	8.31%	20.60%	3.53%	20.62%
Corporate bonds (2)	ICE BofAML US Corporate Index	0.27%	7.37%	0.20%	5.76%
Government bonds	FTSE World Government Bond Index	6.07%	4.91%	3.84%	3.19%
Inflation	EU countries of the OECD	6.51%	3.96%	2.70%	1.34%

Notes: For simplicity purposes, currency effects were ignored in this analysis, hence moments were computed on the raw data, irrespective of currency denomination, and assuming no hedging. (1) The start date for the different indexes is based on first available data: 31/12/1969 for MSCI World and MSCI Europe, 31/01/1971 for EU Inflation, 31/10/1976 for ICE BofAML US Corporate Index and 31/12/1985 for FTSE World Government Bond Index. (2) The average return on corporate bonds for the entire period seems low. Looking at different periods one may get different average returns. This highlights the importance of the choice of the index.
Source: OECD calculations based on daily data from Thomson Reuters, monthly data for inflation.

The analysis, for illustrative purposes, considers two different scenarios to generate the moments of the returns of the different asset classes and of the rate of inflation. The model generates 10,000 returns for each of these asset classes and rates of inflation by drawing random numbers from a normal distribution with mean and standard deviation provided by historical values. Although past performance may not be indicative of future results, historical data is the only available information to project expected returns together with their variability. The analysis uses, for illustrative purposes, first the longest time series available for each asset class. It uses data for the period 1969-2018 ("historical returns"). Secondly, the analysis also uses data for the period 1999-2018 ("low returns"). This second scenario is added to reflect the fact that the economic and financial landscape of low returns appears to be here for decades to come. The year 1999 is when the euro replaced the former European Currency Unit as an accounting currency. Table 1 therefore presents the basic statistical properties of the asset classes' annual nominal returns and rate of inflation (mean and standard deviation) for both scenarios, together with the indexes used.

The analysis, for illustrative purposes, assumes that global and European equity returns are correlated, as well as yields on government bonds, corporate bonds and inflation. The correlation coefficients ensure that the value of the different risk variables in each simulation are likely to materialise together and form a plausible realisation of the world (Table 2).

Table 2. Correlation coefficients (Pearson coefficient, annual basis)

	1969-2018			1999-2018		
	International equities	European equities		International equities	European equities	
International equities	100%			100%		
European equities	88%	100%		96%	100%	
	Corporate bonds	Government bonds	Inflation	Corporate bonds	Government bonds	Inflation
Corporate bonds	100%			100%		
Government bonds	62%	100%		42%	100%	
Inflation	-14%	56%	100%	-15%	23%	100%

Source: OECD calculations based on daily data from Thomson Reuters, monthly data for inflation.

Investment strategies

The model could accommodate any investment strategy. As this document only aspires to illustrate the methodology, it only considers four types of investment strategies.

- Fixed-weights multi-asset portfolio: The allocation to the four asset classes remains constant over the accumulation period.
- Life-cycle strategy with linear decrease: Using the Poterba approach (Poterba et al., 2006[1]), the allocation to equities is equal to 100% minus the saver's age.
- Life-cycle strategy with piece-wise linear decline: The initial equity exposure is kept constant up to 20 years before retirement and decreases linearly afterwards.
- Life-cycle strategy with steep linear decline: The initial equity exposure is kept constant up to 10 years before retirement and decreases linearly afterwards.

The model keeps constant the relative importance of European equities in the total equity portfolio, as well as the relative importance of government bonds in the total bond portfolio. The analysis assumes that European equities represent 70% of the total equity portfolio. Looking at data from the OECD Global Pension Statistics database (GPS), total foreign currency investment in 14 EU Member States represented 19% of total investment on average in 2018. Unfortunately, GPS data does not provide the split between euro and foreign currency exposure within the equity portfolio. One would assume that the proportion of global equities may be higher within the equity portfolio. In addition, the analysis assumes that government bonds represent 70% of the total bond portfolio. The GPS database shows that on average among 19 EU Member States, bills and bonds issued by a public administration represented 69% of total the bills and bonds portfolio in 2018.

For a given overall equity exposure, the model can assess whether the path of the investment strategy has an impact on the outcome, i.e. the probability of getting back contributions. The analysis therefore builds the four investment strategies so that they all have an overall equity exposure equal to the one of the Poterba strategy, i.e. 52.5%. Box 1 presents the different approaches to determining the overall equity exposure of different investment strategies and justifies the use of the age-weighted average equity exposure in this analysis.

Box 1. How to calculate the overall equity exposure

There are three different approaches to assessing the overall equity exposure of different investment strategies over time.

One straightforward approach is to calculate the simple average of the percentage of equities in the portfolio over the accumulation period -- the time-weighted average. However, as this measure gives the same weight for each year during the accumulation period, it fails to take into account the portfolio-size effect. As the size of the portfolio increases over the accumulation period, later years should be given a higher weight than earlier years, as the amount of assets at risk is rising.

One way of accounting for this portfolio-size effect is to take the amount of assets accumulated in each period and weigh the equity exposure by the amount of assets accumulated (portfolio-weighted average). Unfortunately, this can only be done a posteriori, once the entire accumulation process has run its course and the returns to the different assets comprising the portfolio at each point in time are known. However, to compare the performance of investment strategies with a similar overall risk exposure, the measure of risk exposure to equities needs to be defined a priori.

The analysis here considers investment strategies with the same age-weighted average exposure to equities. This approach takes into account the portfolio-size effect but does not require advance knowledge of the actual amount of assets accumulated in each period, as it consists in weighting the exposure to equities in each year by the age of the individual. In this way, equity exposures at later ages get a higher weight, replicating the effect of higher assets accumulated as individuals near retirement.

The different investment strategies are therefore defined as follows in terms of their equity exposure:

- Fixed-weights multi-asset portfolio: The allocation to equities remains constant at 52.5%.
- Life-cycle strategy with linear decrease: The allocation to equities is equal to 100% minus the saver’s age.
- Life-cycle strategy with piece-wise linear decline: The initial equity exposure is kept constant at 64.1% up to 20 years before retirement and decreases linearly

afterwards. At the end of the saving period, the allocation to equities is equal to 30%.[5]

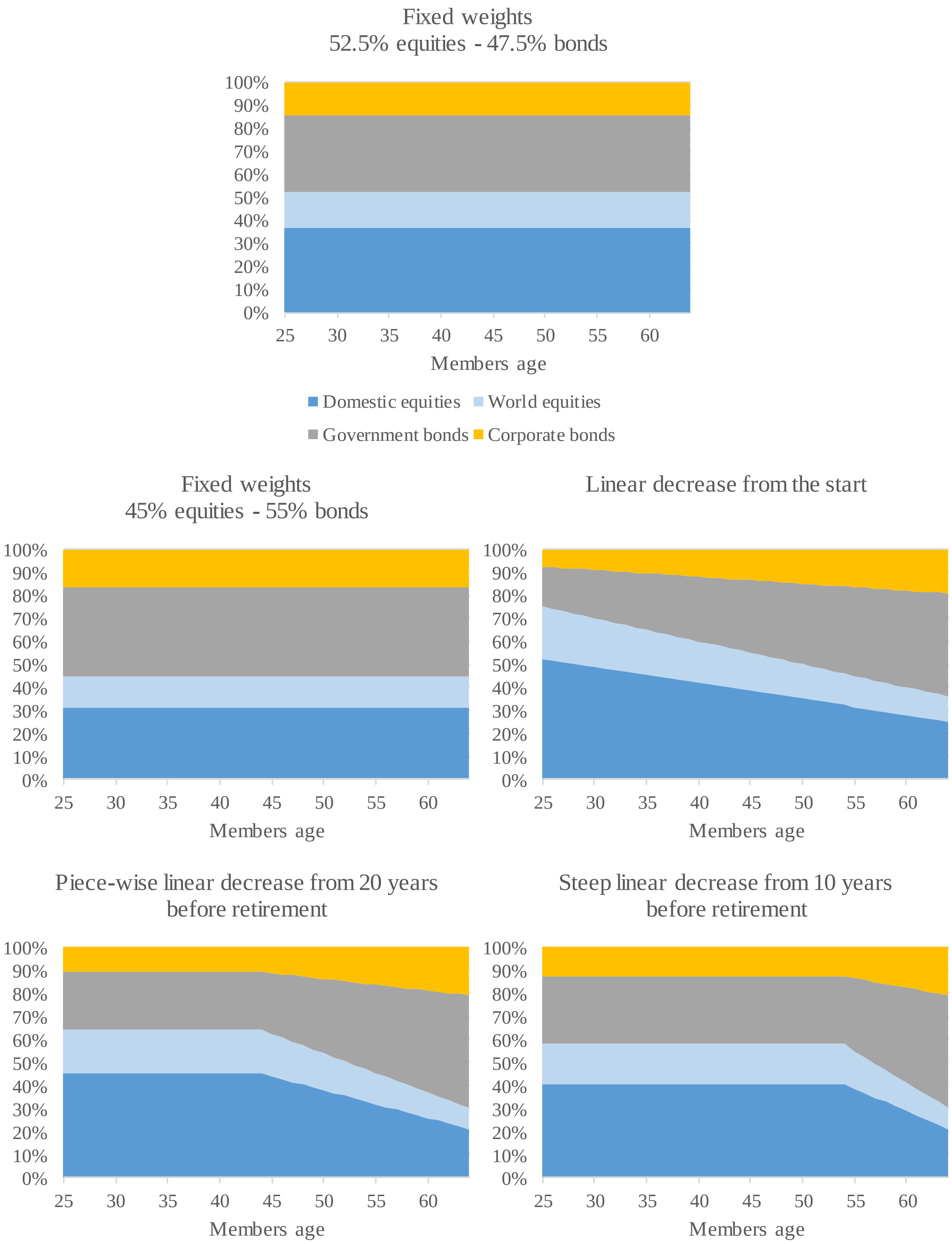
- Life-cycle strategy with steep linear decline: The initial equity exposure is kept constant at 57.7% up to 10 years before retirement and decreases linearly afterwards. At the end of the saving period, the allocation to equities is equal to 30%.

Finally, to check the impact of the overall equity exposure on the probability of getting back the accumulated nominal value of all the contributions saved for retirement, the analysis also considers a fixed-weights multi-asset portfolio with a 45% allocation to equities.

Figure 1 represents the evolution of the asset allocation over the 40-year investment horizon for the five different investment strategies used.

[5] The final allocation to equities is one of the parameters chosen to illustrate this methodology, as are, among others, the glide paths, starting ages for saving, de-risking, and retirement ages. This document does not intend to make recommendations on these parameters but only to illustrate that the methodology can be applied to any investment strategy, and that the choice of parameters will have an impact on the probability of a given investment strategy to give back the accumulated nominal contributions.

Figure 1. Evolution of asset allocation over the 40-year period for the considered investment strategies



Output

For each investment strategy, the output of the model is the probability distribution of the binary indicator of whether the value of assets accumulated at retirement is higher than the nominal sum of contributions paid. Combining the results of all the simulations gives, for each investment strategy, the probability that individuals will get back the accumulated nominal value of their contributions.

The analysis illustrates the impact of the length of the contribution period and of the contribution rate on the outcome. The model runs assuming different ages at which the individual joins the Basic PEPP, so that the distance to retirement is 5, 10, 20, 30 and 40 years. Similarly, the model runs for a fixed contribution rate over the saving period of 3% and 5%, and for a step-wise increasing contribution rate of 5% on average over the contribution period.

Finally, the model runs for a different threshold to which the value of assets accumulated at retirement is compared. The PEPP Regulation mentions that guarantees provided under the default investment option should at least cover the contributions during the accumulation phase after deduction of all fees and charges. The analysis therefore calculates the probability that individuals will get back their contributions when the threshold for the guarantee is calculated as the nominal sum of contributions net of fees (1% of assets annually in the Basic PEPP), instead of the nominal sum of gross contributions.

3. Application of the methodology

Baseline scenario

The assumptions for the baseline scenario are the following:

- Historical data: 1969-2018 (“historical returns” scenario);
- Contribution rate: fixed at 5%;
- Contribution period: 40 years, from age 25 to age 65;
- No cash: all assets are invested in either bond indices or equity indices;
- Threshold for individuals to get their contributions back: sum of all gross nominal contributions made over the saving period.

The analysis shows that over such a long horizon, all five investment strategies have a probability over 99% of returning the capital saved. Table 3 shows the probabilities that individuals will get back their nominal contributions, for the five different investment strategies considered, resulting from the 10,000 Monte Carlo simulations. The fixed-weights strategy with 52.5% allocation to equities is the only strategy with a probability below 99.5% over 40 years of saving.

Table 3. Baseline scenario simulation results

Strategy type	Weight rebalancing	Age-weighted average equity exposure	Probability of getting back contributions
Fixed-weights	None	52.5%	99.43%
Fixed-weights	None	45%	99.68%
Life-cycle	Linear decrease from the start	52.5%	99.80%
Life-cycle	Piece-wise linear decrease from 20 years	52.5%	99.81%
Life-cycle	Steep linear decrease from 10 years	52.5%	99.68%

Source: OECD calculations.

Impact of the length of the contribution period

The analysis uses several starting ages for contributions to assess the impact of the length of the contribution period on the probability that individuals will get their contributions back. For a retirement age of 65, investing from age 25 is compared to investing from age 35, 45, 55 and 60. This analysis therefore assumes different lengths of the contribution period. All other assumptions remain equal, in particular the same asset allocation profiles are kept irrespective of the age at which contributions start. Hence for each investment strategy, the weight in each of the four asset classes is kept equal for any given saving age, and is not affected by the age at which saving has started.

Shortening the contribution period reduces the probability that individuals will get back the accumulated nominal value of their contributions. Table 4 shows the impact of investing in each of the considered investment strategies for 30 years, 20 years, 10 years and 5 years prior to retirement, compared to investing for 40 years. For all investment strategies tested, the probability of returning nominal pension contributions remains above or close to 95% if investment starts 30, 20 or even 10 years before retirement, and above 87% for contribution periods of five years. Both fixed-weights strategies tested show lower probabilities of returning contributions to individuals than the life-cycle strategies, whatever the investment horizon. The estimated likelihood of a loss of nominal contributions is higher for the fixed-weights portfolio with the highest proportion of equities (52.5% versus 45%) across all investment horizons.

Table 4. Probability of getting back nominal contributions for different lengths of contribution

Investment strategy	Length of contribution in years	Probability of getting back contributions
Fixed-weights 52.5% equities - 47.5% bonds	40	99.43%
	30	98.75%
	20	97.28%
	10	91.83%
	5	83.87%
Fixed-weights 45% equities - 55% bonds	40	99.68%
	30	99.28%
	20	98.04%
	10	93.26%
	5	85.66%
Linear decrease from the start	40	99.80%
	30	99.48%
	20	98.53%
	10	94.79%

Investment strategy	Length of contribution in years	Probability of getting back contributions
	5	87.64%
Piece-wise linear decrease from 20 years before retirement	40	99.81%
	30	99.57%
	20	98.80%
	10	95.71%
	5	89.22%
Steep linear decrease from 10 years before retirement	40	99.68%
	30	99.39%
	20	98.53%
	10	95.35%
	5	89.06%

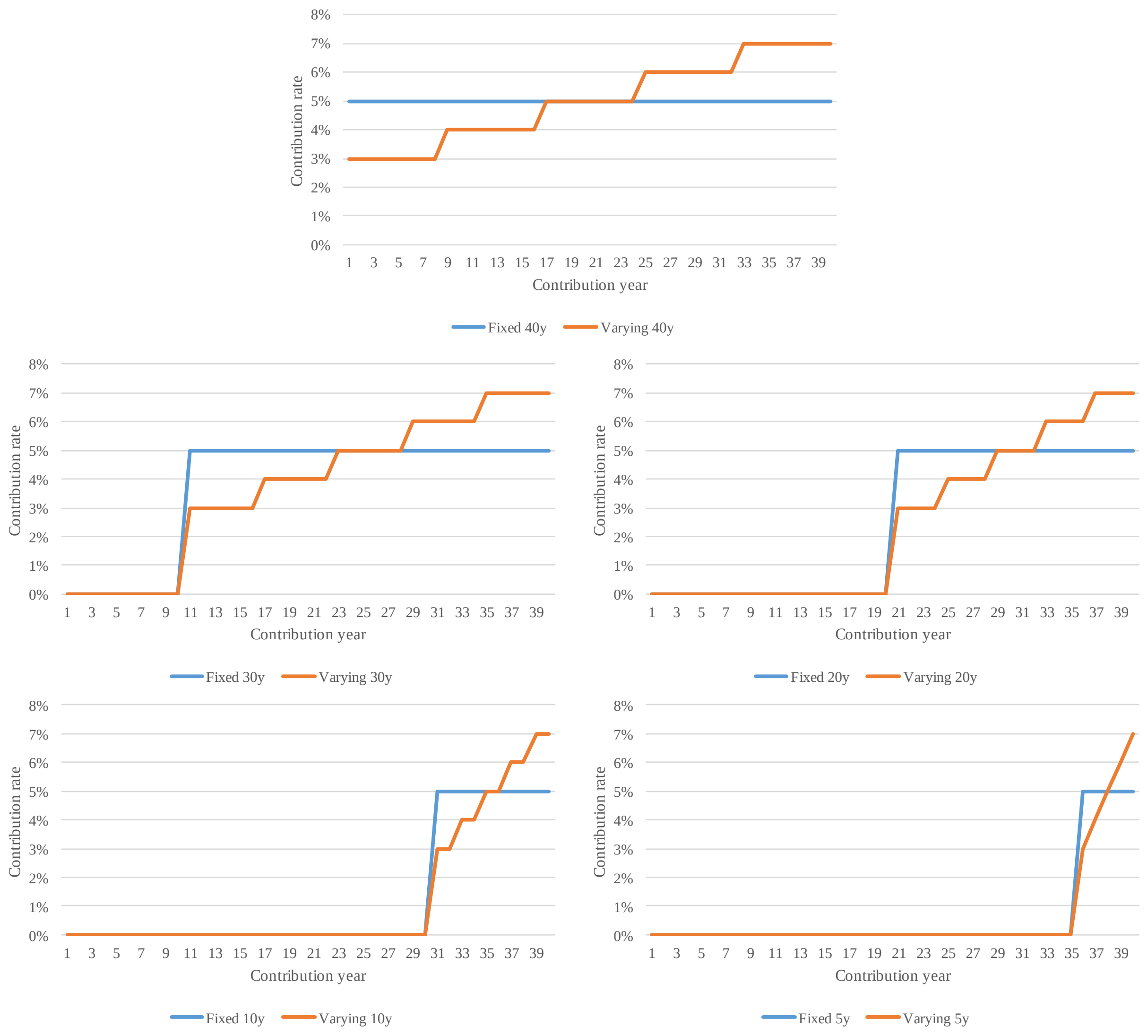
Source: OECD calculations.

Impact of the contribution rate

The level of the contribution rate does not have an effect on the probability of getting back the accumulated nominal contributions. As long as the rate of contribution is fixed over the entire saving period, for instance at 3% instead of 5%, there is no impact of the contribution rate on the probability of an investment strategy to return the saved capital.

Differently, for contribution rates that are low at the beginning and increase as the individual ages, the probability of getting back the accumulated nominal contributions falls. To evaluate the impact of a change in contribution rates over the accumulation period on the probability of getting contributions back, a fixed 5% contribution rate for 40 years is compared to an increasing contribution rate with an average of 5% over the whole period, starting at 3% for the first 8 years of saving and reaching 7% for the final 8 years of saving. A similar approach is followed for the different contribution periods, with increases every 6, 4, 2 and 1 year(s) for 30, 20, 10 and 5-year contribution periods respectively. Figure 2 shows the different contribution rates considered for the various contribution periods.

Figure 2. Contribution rate profiles considered for the five contribution periods



Over a 40-year contribution period, an increasing contribution rate profile marginally decreases the probability of getting back contributions for all investment strategies, as shown in Table 5.

Table 5. Probability of getting back nominal contributions according to different contribution rate profiles over a 40-year contribution period

Investment strategy	Fixed contribution rate (5%)	Increasing contribution rate (average 5%)
Fixed-weights 52.5% equities - 47.5% bonds	99.43%	99.06%
Fixed-weights 45% equities - 55% bonds	99.68%	99.46%
Linear decrease from the start	99.80%	99.68%
Piece-wise linear decrease from 20 years before retirement	99.81%	99.74%
Steep linear decrease from 10 years before retirement	99.68%	99.57%

Source: OECD calculations.

For shorter contribution periods, probabilities of getting contributions back remain slightly higher in the fixed contribution rate scenarios. Table 6 shows that across various contribution periods, the impact of an increasing contribution rate on the probability of returning capital varies across the different investment strategies. However, when sorting investment strategies by their probability of returning nominal contributions, the order is not altered by the change in the contribution rate profile.

Table 6. Probability of getting back nominal contributions according to different contribution rate profiles over several contribution periods

Length of contribution	Investment strategy	Fixed contribution rate (5%)	Increasing contribution rate (average 5%)
30 years	Fixed-weights 52.5% equities - 47.5% bonds	98.75%	98.28%
	Fixed-weights 45% equities - 55% bonds	99.28%	98.82%
	Linear decrease from the start	99.48%	99.20%
	Piece-wise linear decrease from 20 years before retirement	99.57%	99.33%
	Steep linear decrease from 10 years before retirement	99.39%	99.12%
20 years	Fixed-weights 52.5% equities - 47.5% bonds	97.28%	96.44%
	Fixed-weights 45% equities - 55% bonds	98.04%	97.28%
	Linear decrease from the start	98.53%	98.10%
	Piece-wise linear decrease from 20 years before retirement	98.80%	98.40%
	Steep linear decrease from 10 years before retirement	98.53%	98.17%
10 years	Fixed-weights 52.5% equities - 47.5% bonds	91.83%	90.41%
	Fixed-weights 45% equities - 55% bonds	93.26%	92.09%
	Linear decrease from the start	94.79%	93.67%
	Piece-wise linear decrease from 20 years before retirement	95.71%	94.62%
	Steep linear decrease from 10 years before retirement	95.35%	94.45%
5 years	Fixed-weights 52.5% equities - 47.5% bonds	83.87%	82.36%
	Fixed-weights 45% equities - 55% bonds	85.66%	84.00%
	Linear decrease from the start	87.64%	86.16%
	Piece-wise linear decrease from 20 years before retirement	89.22%	87.51%
	Steep linear decrease from 10 years before retirement	89.06%	87.44%

Source: OECD calculations.

Impact of the macro-economic scenario

This section assesses the influence of macro-economic conditions on the probability of getting contributions back by comparing the results of the 10,000 simulations using historical data from the 1969-2018 period (the "historical returns" period), to results of 10,000 new simulations using data from the 1999-2018 period (the "low returns" period). Under the "low returns" scenario, inflation and returns on government bonds and equities are lower, to reflect the recent economic trends. Table 7 and Table 8 illustrate the impact of such a change in the macro-economic environment for contribution periods of 40 years (i.e. against the baseline scenario) and shorter periods respectively.

The probability of getting back the accumulated nominal value of contributions decreases for all the investment strategies in the "low returns" scenario compared to the "historical returns". Table 7 shows this probability for 40 years of contribution. In the "low returns" scenario, the probability of getting contributions back remains highest for the piece-wise linear decrease from 20 years before retirement, as was the case in the "historical returns" scenario. The investment strategy with the steep decrease in equity allocation from 10 years before retirement has a lower probability of returning capital than the fixed-weights strategy with 45% equities under the "low returns" scenario for a contribution period of 40 years (93.55% vs 94.61% respectively), whereas they both enjoyed similar probabilities (99.68%) in the “historical returns” scenario.

Table 7. Probability of getting back nominal contributions for different macro-economic scenarios, for a contribution period of 40 years

Investment strategy	“Historical returns” scenario	“Low returns” scenario
Fixed-weights 52.5% equities - 47.5% bonds	99.43%	91.65%
Fixed-weights 45% equities - 55% bonds	99.68%	94.61%
Linear decrease from the start	99.80%	94.76%
Piece-wise linear decrease from 20 years before retirement	99.81%	94.67%
Steep linear decrease from 10 years before retirement	99.68%	93.55%

Source: OECD calculations.

Over a shorter contribution period, this is no longer the case and all three life-cycle investment strategies display higher probabilities of returning nominal contributions than the two fixed-weights strategies considered for all other contribution periods analysed, as shown in Table 8. However in the “low returns” scenario and for a 20-year savings period, there is a shift in the ranking of investment strategies according to their probability of returning capital when compared to the “historical returns” scenario, as the investment strategy with a steep decrease from 10 years before retirement ranks lower than the strategy with a linear decrease from the start (89.13% probability vs 89.84% respectively), whereas both strategies had a similar probability of returning the saved capital (98.53%) in the “historical returns” scenario.

Table 8. Probability of getting back nominal contributions for different macro-economic scenarios, for several contribution periods

Length of contribution	Investment strategy	“Historical returns” scenario	“Low returns” scenario
30 years	Fixed-weights 52.5% equities - 47.5% bonds	98.75%	88.68%
	Fixed-weights 45% equities - 55% bonds	99.28%	91.93%
	Linear decrease from the start	99.48%	93.29%
	Piece-wise linear decrease from 20 years before retirement	99.57%	93.64%
	Steep linear decrease from 10 years before retirement	99.39%	92.04%
20 years	Fixed-weights 52.5% equities - 47.5% bonds	97.28%	84.02%
	Fixed-weights 45% equities - 55% bonds	98.04%	87.72%
	Linear decrease from the start	98.53%	89.84%
	Piece-wise linear decrease from 20 years before retirement	98.80%	91.34%
	Steep linear decrease from 10 years before retirement	98.53%	89.13%
10 years	Fixed-weights 52.5% equities - 47.5% bonds	91.83%	76.06%
	Fixed-weights 45% equities - 55% bonds	93.26%	79.32%
	Linear decrease from the start	94.79%	82.67%
	Piece-wise linear decrease from 20 years before retirement	95.71%	85.09%
	Steep linear decrease from 10 years before retirement	95.35%	83.81%
5 years	Fixed-weights 52.5% equities - 47.5% bonds	83.87%	68.76%
	Fixed-weights 45% equities - 55% bonds	85.66%	71.27%
	Linear decrease from the start	87.64%	74.59%
	Piece-wise linear decrease from 20 years before retirement	89.22%	77.26%
	Steep linear decrease from 10 years before retirement	89.06%	76.79%

Source: OECD calculations.

Impact of the definition of the guarantee

The probability of getting back the accumulated contributions increases when the analysis is performed on the guarantee to get back the nominal value of all the accumulated contributions, net of fees, instead of the accumulated gross contributions. Assuming net instead of gross contributions implies lowering the threshold for investment strategies to be deemed to give back the saved capital and therefore increases the probabilities across all investment strategies over a 40-year saving horizon, to the point where only very few simulations experience a loss of saved capital, as shown by the little number of loss occurrences presented in Table 9.

Table 9. Probability of getting back nominal, net of fees, contributions over a 40-year contribution period

Investment strategy	Probability of getting back net contributions	Number of loss occurrences over 10,000 simulations
Fixed-weights 52.5% equities - 47.5% bonds	99.88%	12
Fixed-weights 45% equities - 55% bonds	99.97%	3
Linear decrease from the start	99.97%	3
Piece-wise linear decrease from 20 years before retirement	99.98%	2
Steep linear decrease from 10 years before retirement	99.95%	5

Source: OECD calculations.

Table 10 shows that all investment strategies have a probability of returning saved capital greater than 99% for contribution periods of 40, 30 and 20 years and greater than 95% for a contribution period of 10 years, when using contributions net of fees paid.

Table 10. Probability of getting back nominal, net of fees, contributions over various contribution periods

Investment strategy	Length of contribution in years	Probability of getting back net contributions
Fixed-weights 52.5% equities - 47.5% bonds	40	99.88%
	30	99.71%
	20	98.86%
	10	95.01%
	5	87.88%
Fixed-weights 45% equities - 55% bonds	40	99.97%
	30	99.78%
	20	99.31%
	10	96.31%
	5	89.75%
Linear decrease from the start	40	99.97%
	30	99.88%
	20	99.54%
	10	97.46%
	5	91.90%
Piece-wise linear decrease from 20 years before retirement	40	99.98%
	30	99.92%
	20	99.65%
	10	97.99%
	5	92.86%

Investment strategy	Length of contribution in years	Probability of getting back net contributions
Steep linear decrease from 10 years before retirement	40	99.95%
	30	99.84%
	20	99.53%
	10	97.74%
	5	92.75%

Source: OECD calculations.

Parameters that regulators may need to define for providers to apply the proposed methodology

Regulators willing to use this methodology may need to first define the minimum probability threshold of getting back the nominal accumulated contributions (the probability of recouping capital) to qualify as a Basic PEPP. For investment strategies different than the Basic PEPP, regulators may also require reporting this probability with potential gains and losses.

Regulators need to make sure that, when applying the methodology to their investment strategies, PEPP providers will use comparable and consistent assumptions for all the parameters. Previous sections have shown that the length of contribution period, the time profile of the contribution rate, the macro-economic scenario and the definition of the guarantee affect the probability that individuals will get back their contributions for the different investment strategies.

Regulators may need to define different contribution periods over which to assess the probability of getting back the nominal accumulated contributions. Individuals may join the PEPP at different ages and thereby save for different periods. PEPP providers will have to demonstrate that their investment strategies will be suitable for different lengths of the contribution period. This implies that regulation may require PEPP providers to apply the methodology and calculate the probability to get back contributions for a pre-defined set of saving periods. The saving periods considered in this analysis (5, 10, 20, 30 and 40 years) are standard and could be used by regulators. The 5-year contribution period (people saving between 60 and 65 years old) may seem too short given that the PEPP is supposed to be a long-term savings product. However, there is no maximum age for joining the PEPP in the PEPP Regulation, and advisors may still encourage people to participate in a plan for tax purposes. It is therefore important to also cover short contribution periods when applying the methodology.[6]

Regulators may need to define whether the probability of getting back contributions should be calculated for fixed or varying contribution rates. Although the level of contribution rate does not affect the probability of getting back contributions when it is fixed during the entire saving period, it does have an impact when it varies over time.

Regulators may also need to define the macro-economic scenario underlying the calculations. The analysis shows that the probability of getting back the accumulated nominal value of contributions is lower when returns are lower. Basing the simulations of

[6] Advisors may need to inform savers that the risk of starting saving five years before retirement is higher. However, this risk could be reduced if savers keep their retirement savings invested for more than five years, after retirement.

the different asset classes on data from more recent years, which exhibit lower returns and similar volatilities when compared to longer historical data, leads to a lower probability of getting back accumulated contributions.[7] Regulators may additionally need to define the framework for PEPP providers to select appropriate indexes for the different asset classes that compose their investment strategies. They should fix the period over which the returns, volatilities and correlations of the different asset classes are calculated. This would avoid that some providers pick and choose the indexes and the periods with the aim of maximising the probability of getting back contributions, which would break comparability across providers. Regulators may also need to continue monitoring to re-adjust the macro-economic scenario when necessary.

Finally, regulators may need to adjust the probability threshold in accordance with the chosen definition of the guarantee. The analysis shows that the probability that individuals will get back the nominal sum of their contributions net of fees is very high for all investment strategies, in particular for the 40/30/20-year saving periods. This definition of the guarantee matches that of the guarantee provided by Basic PEPP products offering capital protection. Given the relatively lower target of this guarantee, when compared with a guarantee on the sum of gross nominal contributions as in the baseline scenario presented in this document, a higher probability threshold should be associated to it. In addition, a different probability threshold may need to be defined for different lengths of the contribution period. This would reflect the fact that investment risk increases for shorter durations, as people have less time to recover following investment losses.

4. Communicating investment risk and reward to savers

This section discusses issues related to communication with participants, in particular with respect to investment risks and rewards. This discussion focuses first on what information could be communicated using the results provided by the proposed methodology. Secondly, it focuses on how to communicate this information so that individuals readily understand it and act accordingly.

What information to communicate

Communication with PEPP participants is of primary importance. In particular, a section of the PEPP KID should explain the risks and rewards that individuals can expect with the selected investment strategy. This section of the PEPP KID could include:

- A summary risk indicator, with a narrative explanation of that indicator, its main limitations, and a narrative explanation of any risks that are not adequately captured by the indicator;
- The possible maximum loss of invested capital; and
- Appropriate performance scenarios together with the assumptions on which they are based.

The stochastic model described in this document can easily provide background information to communicate about the expected loss when the investment strategy fails to give back the contributions, and about the potential return that savers can expect from the investment strategy. Although the outcomes of the model may not directly form

[7] See Table 1 for more detail on the differences in returns and volatilities between the two periods considered in this document.

comprehensible information for participants, they can serve as background information to develop communication programs that will inform individuals of the risks and rewards involved.

Expected return

The methodology allows to draw the probability distribution of the value of assets accumulated at retirement, for any given investment strategy. It provides the different values of assets accumulated at retirement generated by the 10,000 simulations, with their associated frequency. This probability distribution can be used as a base to derive an indicator of the expected reward or return for individuals from selecting a given investment strategy. For example, using the same assumptions as in the baseline scenario of Section 3, Table 11 shows the expected return, both the average and the median value of assets accumulated at retirement expressed as a share of the sum of nominal contributions, for the different investment strategies considered over a 40-year contribution period.

Table 11. Expected return over a 40-year contribution period, by investment strategy

Share of assets accumulated over total nominal contributions

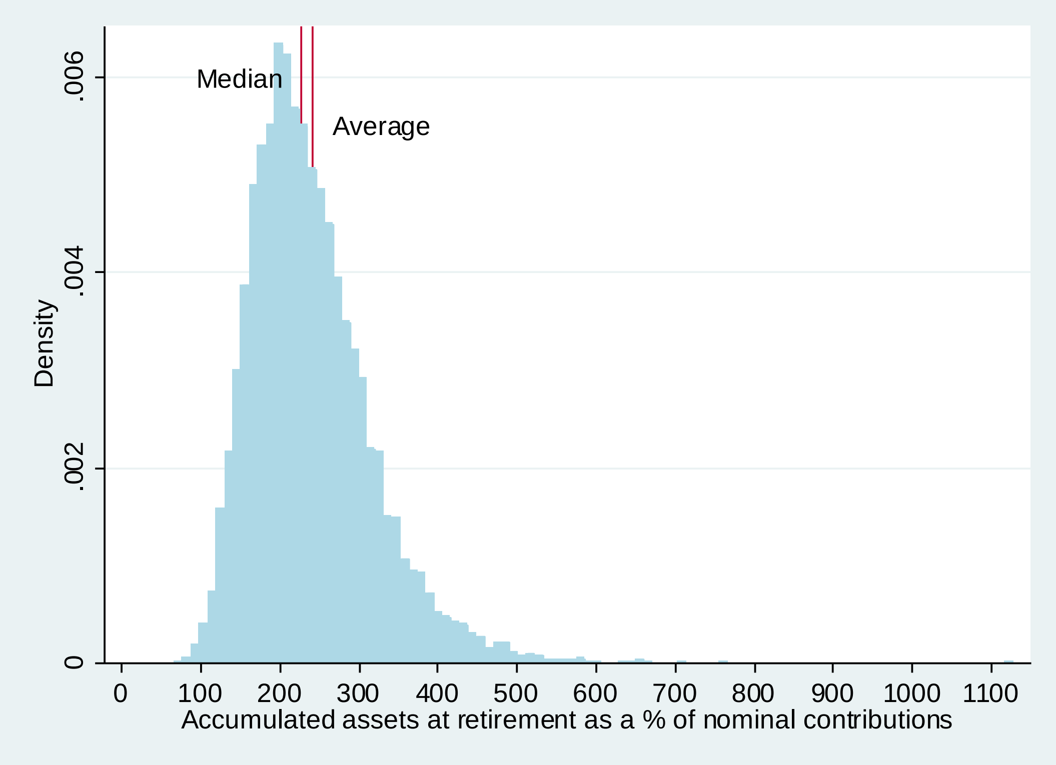
Investment strategy	Average expected return	Median expected return
Fixed-weights 52.5% equities - 47.5% bonds	244%	230%
Fixed-weights 45% equities - 55% bonds	233%	223%
Linear decrease from the start	237%	226%
Piece-wise linear decrease from 20 years before retirement	237%	226%
Steep linear decrease from 10 years before retirement	240%	227%

Source: OECD calculations.

The median value of assets accumulated at retirement represents a useful indicator of the expected return. Figure 3 shows the probability distribution of the return, i.e. the different outcomes of this return generated in the 10,000 simulations for the life-cycle strategy with a steep linear decrease in equity allocation from 10 years before retirement. All the scenarios where the individual would not get back their accumulated contributions have a value below 100%. Figure 3 shows that the distribution is skewed towards the right, with the maximum value at 1128% of nominal contributions, so that the average is higher than the median (240% vs 227% of nominal contributions respectively). The median is therefore a more robust indicator of the expected return or reward for the individual, as it avoids an overweighting of extreme outcomes. The median return participants can expect to receive from choosing the life-cycle strategy with a steep linear decrease in equity allocation from 10 years before retirement is 227% of their nominal contributions. This means that 50% of individuals electing this investment strategy and contributing a fixed rate of their salary over a 40-year period can expect to receive at least 227% of their nominal contributions.

Figure 3. Probability distribution of the return at retirement for the life-cycle strategy with a steep linear decrease in equity allocation from 10 years before retirement, for a contribution period of 40 years

Return expressed as the share of assets accumulated over total nominal contributions



Source: OECD calculations.

Expected loss

Negative outcomes, the cases where individuals may not get back their accumulated nominal contributions at the end of the saving period, are rare. These cases are rare over a 40-year saving horizon, as illustrated by the 99.68% probability of getting back nominal contributions with the life-cycle investment strategy with a steep linear decrease in equity allocation from 10 years before retirement for example. However, the probability does not provide information with respect to the potential severity of the loss, which is of interest to regulators and participants in the PEPP.

The stochastic model can derive the probability distribution of losses for different investment strategies, conditional on each strategy not returning the contributions saved. The main outcome of the model is, for each of the 10,000 Monte Carlo simulations and for each investment strategy, the value of assets accumulated at retirement. When this value is lower than the nominal sum of contributions, the difference represents the loss suffered by the individual. The model can therefore produce the probability distribution of the amount of loss suffered, conditional on not getting back the contributions. Different percentiles of that distribution can be of interest. In the illustration below, which follows the baseline scenario assumptions described in Section 3, the analysis looks at the median loss, i.e. the amount of loss such that 50% of the loss simulations have a loss at or below that threshold. The loss, as the return in the previous section, is expressed as a share of the sum of nominal contributions paid to avoid monetary values. Table 12 illustrates the median expected loss in case of a negative outcome, together with the expected number of occurrences of such outcome for the five investment strategies considered in this document, under the assumptions of the baseline scenario. Out of the 32 occurrences when nominal contributions were not given back to participants with the life-cycle strategy with a steep linear decrease in equities from 10 years before retirement, the median expected loss indicates that 50% of those savers who will not get their nominal contributions back, will have lost 5.50% of their nominal contributions or less.

Table 12. Probability of getting back nominal contributions and expected loss in case of a negative outcome for a 40-year contribution period, by investment strategy

Strategy type	Weight rebalancing	Age-weighted average equity exposure	Probability of getting back contributions	Number of occurrences when contributions are not given back	Median expected loss if contributions are not given back
Fixed-weights	None	52.50%	99.43%	57	7.16%
Fixed-weights	None	45%	99.68%	32	6.67%
Life-cycle	Linear decrease from the start	52.50%	99.80%	20	6.63%
Life-cycle	Piece-wise linear decrease from 20 years	52.50%	99.81%	19	7.04%
Life-cycle	Steep linear decrease from 10 years	52.50%	99.68%	32	5.50%

Source: OECD calculations.

Comparing investment strategies

Finally, the stochastic model can also be used to compare investment strategies on selected risk and return measures simultaneously. Given the three metrics computed with the model, i.e. the probability of getting back contributions, the median expected return, and the median expected loss conditional on not getting back accumulated nominal contributions, a comparison between different investment strategies can be made. This comparison should be based on as many investment strategies as possible.

How to communicate the information

Previous work by the OECD

The OECD has previously examined and evaluated the content and design of annual pension statements in various OECD and non-OECD countries (Antolín and Harrison, 2012[2]). Forward-looking information, such as pension projections or risk measures, is regularly presented in annual pension statements. In theory, projections can act as a powerful call to action for members to increase their contributions, to change their asset allocation, or to postpone retirement for instance. However forward-looking data is also generally the most complex feature of a pension statement, and therefore the most likely to increase member confusion.

The OECD also concluded that while introducing stochastic modelling could be very useful, it could also lead to misunderstanding from members who often confuse probabilities with blind chance or lottery results.

Any communication comprising probabilities should therefore be very carefully designed in order to make sure it can be understood and used by individuals in their pension-related decisions. While it is important to make sure individuals understand the risks linked to long-term investment for retirement purposes, communication should not focus only on those risks but in all instances be balanced so as to adequately express the potential benefits of saving for retirement.

Example of communication on probabilities

This section presents ideas of how to communicate probabilities based on categorisations or risk levels instead of percentages. The ideas presented are meant to provide a flavour for the type of discussions that further work may need to address.

Communication of probabilities can be done in several ways. For example regulators could set up a pre-defined risk classification of investment strategies based on the frequency of bad outcomes over a given period. This replaces the equivalent measure expressed as a percentage or probability. The regulator may need to define those bad outcomes (e.g. number of years with negative returns). This measure could assist individuals in comparing different investment strategies, by assessing the expected frequency of bad outcomes in a simple and clear manner. It does not provide information as to the severity of any potential bad outcome, but it rather allows individuals to understand that bad outcomes are to be expected over a long-term horizon such as when saving for retirement. In this context, Australian members of any of the registered superannuation entities can rely on the Standard Risk Measure.[8] This measure was elaborated conjointly by the Australian Prudential Risk Authority (APRA), the Financial Services Council (FSC) and the Association of Superannuation Funds of Australia (ASFA). The Standard Risk Measure is made of seven risk bands representing the estimated frequency of negative returns over a 20-year period, as presented in Table 13.

Table 13 Standard Risk Measure categorisation

Risk level	Number of negative annual returns over any 20 year period	Risk band
Very Low	Less than 0.5 year out of 20	1
Low	0.5 to less than 1 year out of 20	2
Low to Medium	1 to less than 2 years out of 20	3
Medium	2 to less than 3 years out of 20	4
Medium to High	3 to less than 4 years out of 20	5
High	4 to less than 6 years out of 20	6
Very High	6 or more years out of 20	7

Source: APRA, FSA and AFSA Standard Risk Measure Guidance Paper for Trustees – July 2011
https://www.superannuation.asn.au/ArticleDocuments/359/FSC-ASFA_StandardRiskMeasures_July2011.pdf.aspx?Embed=Y

Additionally, regulators could define categories based on the probability of a given investment strategy to reach a set goal, and provide this information to individuals. AustralianSuper, one of the main pension funds in Australia, communicates the risk level that a given investment strategy would fail to reach at least inflation as a return. Each risk

[8] Registered superannuation entities manage the assets of the mandatory and voluntary defined contribution pension arrangements in Australia.

level corresponds to a range of probabilities. Table 14 presents six risk bands in order to convey this additional measure of risk, it follows that defined by AustralianSuper.

Table 14. AustralianSuper's inflation risk level classification

Risk level	Probability of underperforming inflation
Low	Less than 10%
Low to Medium	10% to 20%
Medium	20% to 30%
Medium to High	30% to 40%
High	40% to 60%

Source: AustralianSuper website

Communication challenges

Any risk measure should be designed keeping in mind the objective of the pension arrangement. The choice of the objective is therefore key to any risk analysis and measure. In the AustralianSuper illustration for example, the long-term objective of the DC pension arrangement is defined as keeping up with inflation and the measure of risk is designed to reflect this objective, with risk categories representing outcomes or situations which are sufficiently different from one another, i.e. based on probability ranges wide enough, for individuals to be able to understand the difference between them.

In the case of the Basic PEPP, the objective is to allow savers to get back their contributions when using a risk-mitigation technique. The threshold for accumulated contributions would need to be defined if the methodology proposed in this report would be adopted. In order to be comparable with the Basic PEPPs providing a capital guarantee, the threshold may be the nominal sum of contributions, net of all fees and charges. Alternatively, a slightly more ambitious target and one that individuals would probably value more is the nominal sum of gross contributions.

Using risk buckets or other similar approaches such as traffic lights, smiley faces or other visual elements can be useful for supervisors to assist individuals in understanding the risk categorisation of several pension investment strategies, if the buckets or differentiating factors between the categories are meaningful and clearly defined. Attention must also be paid to the communication strategy of regulators on financial products in general, so as to avoid any confusion between products. Using seven risk bands for instance as in the example of the Australian Standard Risk Measure, could prove confusing for individuals who might be familiar with the Synthetic Risk Indicator (SRI) in use to categorise market and credit risks for Packaged Retail Investment and Insurance-based Products (PRIIPs) and Undertakings for Collective Investments in Transferable Securities (UCITS). In order for individuals to understand the specificities of long-term retirement products and their associated risks and benefits, it is therefore important that any measure of risk and return is defined according to their particular objectives and requirements.

5. Possible extension of the methodology

The OECD stochastic model proposed in this document could be adjusted to include additional risks. Labour market risks and demographic risks could be added to reflect all the risks, not just financial, that individuals face when saving for retirement. The OECD has already included labour market risks in the stochastic model (Antolin and Payet, 2010[3]).

Labour market risk originates from the possibility of spells of unemployment or inactivity during people's careers. During such episodes of unemployment or inactivity, contributions set aside to finance retirement may be discontinued. Consequently, the amount of assets accumulated to finance retirement at the end of one's career would tend to be lower than in the absence of such episodes. Additionally, spells of unemployment or inactivity may also affect wages. People suffering spells of unemployment may re-enter the labour market at lower wages than they enjoyed at their previous job. This would tend, other things being equal, to reduce their total amount of contributions and the amount of assets accumulated relative to an uninterrupted career path.

Labour market risk may also originate from the uncertainty surrounding the trajectory of real wages during one's career. Real-wage gains during a career vary across individuals, according to their socio-economic situation (e.g. occupation, educational level and income). Labour market studies document that there are three main career paths for real wages. In general, real wages experience the largest gains during the early part of a person's career, with lower gains, even negative gains, in the latter part. This pattern results in real-wage paths that for some people reach a plateau at the end of their careers (high real-wage gains), while for others, real wages plateau earlier, around ages 45 to 55 (medium real-wage gains) and fall thereafter. A minority experience flat real wages throughout their working lives. The different real-wage gains experiences affect the amount saved by individuals at different ages and thereby the amount of assets accumulated at the end of the career.

The model could also account for the pay-out phase. The proposed methodology looks at the probability for people to get back their accumulated contributions at the age of retirement and does not account for the pay-out phase. Article 46 of the PEPP Regulation specifies that the use of risk-mitigation techniques shall ensure that the investment strategy is designed in order to build up a stable and adequate future retirement income. This implies looking at the pay-out phase and the interaction between different pay-out and investment strategies. This document does not deal with this issue of the pay-out phase. However, past OECD work assessed the performance of different investment strategies for different structures of the pay-out phase (Antolin, Payet and Yermo, 2010[4]).

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