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Packaged Retail and Insurance-based Investment Products (PRIIP)

PRIIP regulation unwrapped: Essential aspects and practical implications

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BNP PARIBAS
ASSET MANAGEMENT

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EXECUTIVE SUMMARY

The new requirements under the European Union's Packaged Retail and Insurance-based Investment Products (PRIIP) regulation, designed to provide more transparency for retail investors, came into effect in January 2023. In this paper, we examine the key aspects of the regulation, particularly the methodologies for the calculation of risk, and the performance scenarios required for the new Key Information Document (KID).

We compare the risk calculated under the PRIIP regulation (SRI) and the risk calculated under the UCITS (Undertakings for Collective Investment in Transferable Securities) regulation (SRRI). Our results show that most funds managed by BNP Paribas Asset Management (BNPP AM) will be classified between 1 and 5 under PRIIP, whereas with UCITS, funds were classified between 1 and 7, with many funds classified 6 and some even 7. This comparison shows that the new classification tends to shrink the risk scale for asset managers' typical fund range.

We also present examples of performance scenarios for funds managed by BNPP AM. We observe that the returns in the performance scenarios tend to be higher following good performances of the underlying fund and lower following poor performances. We also highlight that the calculation of returns for the four performance scenarios not only relies on three different approaches, which can create confusion, but can also produce a large dispersion of possible outcomes, which may limit their usefulness.

In conclusion, we believe that the PRIIP regulation has brought about much-needed transparency and consistency for retail investors across products from asset managers, investment banks and insurers, but there are still challenges that could be addressed. This paper provides a useful starting point for further discussions on the PRIIP regulation and its impact on retail investors.

1. INTRODUCTION

Packaged Retail and Insurance-based Investment Products, or PRIIPs, are financial products designed to be sold to retail investors in the European Union (EU). PRIIPs include a wide range of financial products typically composed of multiple underlying assets, such as stocks, bonds or derivatives. They include:

- **Investment funds:** These are collective investment schemes that pool the assets of many investors and are invested in a diversified portfolio of securities, such as stocks, bonds or other assets
- **Exchange-traded funds (ETFs):** These are pooled investment securities that operate much like a mutual fund. Typically, ETFs will track a particular index, sector, commodity or other assets. However, unlike mutual funds, ETFs can be purchased or sold on a stock exchange in the same way as a regular stock
- **Structured products:** These are financial products that are based on the performance of underlying assets, such as stocks, bonds or commodities. They may be structured in a variety of ways, such as through the use of derivatives or other financial instruments
- **Insurance-based investment products:** These are investment products that are linked to insurance contracts. They may provide investors with a combination of investment and insurance benefits.

PRIIPs also include other financial products designed to be sold to retail investors, such as certain types of debt securities, warrants and certificates.

2. PRIIPS REGULATION

The PRIIP Regulation is an EU legal framework that sets out the rules for the production, approval and distribution of PRIIPs. It is designed to improve information disclosure and the protection of retail investors by introducing the requirement to provide a key information document (KID) prior to the subscription of a PRIIP.

The KID is a standardised document intended to provide retail investors with key information about the product, including the risks and costs associated with investing in it. It is expected to improve the transparency and comparability of PRIIPs, making it easier for retail investors to understand the risks and potential returns associated with these products and compare the different options available to them.

The KID must be provided to retail investors before they purchase a PRIIP and must be presented in a clear and concise manner.

The PRIIP regulation has evolved over the following timeline:

- **November 2014:** Publication of regulation (EU) No 1286/2014 of the European Parliament and of the Council of 26 Nov-14 ('PRIIPs Regulation') concerning key information documents for PRIIPs
- **March 2017:** Publication of KID (Level 2) technical standards for PRIIPs, detailing the regulatory technical standards (RTS) with regards the presentation, content, review and revision of key information documents and the conditions for fulfilling the requirement to provide such documents
- **January 2018:** Entry in application of PRIIPs regulation and exemption for UCITS (Undertakings for Collective Investment in Transferable Securities)
- **November 2021:** The European Parliament voted to extend the UCITS exemption and postponed the new PRIIP RTS. The go-live date of the new RTS and the end of the UCITS exemption was postponed from 1 July 2022 to 1 January 2023
- **September 2021:** Publication of amendments to the KID (Level 2) technical standards with release by the EU Commission of the RTS and draft annexes
- **December 2021:** Publication of the final version of the RTS in the Official Journal of the EU
- **January 2023:** Go-live date for the PRIIP KID document for all UCITS and non-UCITS PRIIPs distributed to retail investors.

3. PRIIP CATEGORIES AND REPRESENTATIVE SHARE CLASS

In this section, we present the four different categories of PRIIPs as defined by the regulation. The regulation allows for a representative share class to be chosen for each PRIIP. Here we also describe how BNPP AM selected the representative share classes.

3.1. PRIIP CATEGORIES

PRIIPs are classified into four different categories, as follows:

- **Category 1** covers riskier PRIIPs and those typically invested in more illiquid assets. These PRIIPs can either lose more than the amount invested or invest in securities priced on a less regular basis than monthly. PRIIPs with no appropriate benchmark or proxy, or whose appropriate benchmark or proxy is priced on a less regular basis than monthly are also included in this category. This category includes most options, futures, swaps, forward rate agreements and other derivative contracts relating to securities, currencies, interest rates or yields, financial indices, financial measures, commodities, emission allowances, climatic variables, freight rates, inflation rates or other official economic statistics, which may be settled physically or in cash. Derivative instruments for the transfer of credit risk and financial contracts for differences are also included.
- **Category 2** covers the most standard investment funds and ETFs. These are PRIIPs that give a linear exposure to the prices of underlying investments. This exposure can be offered either directly or on a synthetic basis and can be either non-leveraged or leveraged by paying a constant multiple of the prices of the underlying investments. The regulation requires that at least two years of historical daily prices, four years of historical weekly prices, or five years of monthly prices be available for the PRIIP, or that existing appropriate benchmarks or proxies be available, provided that such benchmarks or proxies fulfil the same criteria for the length and frequency of the price history.
- **Category 3** covers PRIIPs whose values reflect the prices of underlying investments, but not as a constant multiple of the prices of those underlying investments. It is required that at least two years of historical daily prices, four years of historical weekly prices or five years of monthly prices are available for the PRIIP, or that existing appropriate benchmarks or proxies be available, provided that such benchmarks or proxies fulfil the same criteria for the length and frequency of the price history.
- **Category 4** covers PRIIPs whose values depend in part on factors not observed in the market. These include insurance-based PRIIPs which distribute a portion of the PRIIP manufacturer's profits to retail investors.

3.2. PRIIPS REPRESENTATIVE SHARE CLASS

For costs, risk class and performance scenario, which are described in the next few sections, the PRIIP regulation allow the producer to choose a single share class per PRIIP, identified as the representative share class. This is a simplification which allows producers to use only one share class per PRIIP, e.g., the one with the longest track record, thus reducing considerably the number of shares classes used for calculations. All calculations of costs, risk class or performance scenarios for a given PRIIP will be based on the selected representative share class.

At BNPP AM, we have defined a number of criteria to help identify the representative share class for each PRIIP. The representative share class should, as much as possible:

- **Be a share in the PRIIP's reference currency**
- **Not be a hedged share class**
- **Have the longest track record**
- **Have the lowest ongoing charge (OCR)**
- **Have the largest assets under management (AUM)**

4. PRIIP RISK

In the context of PRIIPs, risk is defined as the possibility of an investor losing money as a result of investing in the PRIIP.

4.1. SUMMARY RISK INDICATOR (SRI)

The risk of a PRIIP is given by the summary risk indicator, or SRI, which ranges from the lowest risk class of PRIIPs, 1, to the riskiest class, 7.

		MRM class						
		MR1	MR2	MR3	MR4	MR5	MR6	MR7
CRM class	CR1	1	2	3	4	5	6	7
	CR2	1	2	3	4	5	6	7
	CR3	3	3	3	4	5	6	7
	CR4	5	5	5	5	5	6	7
	CR5	5	5	5	5	5	6	7
	CR6	6	6	6	6	6	6	7

Exhibit 1: Summary risk indicator (SRI) class as a function of market risk measure (MRM) and credit risk measure (CRM) classes.

The SRI is calculated from the market risk measure for the PRIIP, or MRM, which ranges from 1 for the least risky class to 7 for the riskiest class, and from the credit risk measure, or CRM, on a scale ranging from 1 for the least risky class to 6 for the riskiest class. More details about the calculation of the MRM and CRM classes are given below in sections 4.2 and 4.3.

The SRI is assigned according to the combination of the MRM and CRM classes as shown in exhibit 1.

4.2. MARKET RISK MEASURE (MRM)

The MRM calculation depends on the PRIIP category. For Category 1, the MRM is either 6 for PRIIPs or underlying investments of PRIIPs which are priced on a less regular basis than monthly, or which do not have an appropriate benchmark or proxy, or whose appropriate benchmark or proxy is priced on a less regular basis than monthly. The MRM is 7 for all other category 1 PRIIPs.

For Category 2, the MRM is a function of the annualised volatility corresponding to the value-at-risk (VaR) at a confidence level of 97.5% over the recommended holding period, unless stated otherwise. The VaR is the percentage of the amount invested that is returned to the retail investor. The MRM class is determined from this VaR as below.

MRM class	VaR-equivalent volatility (VEV)
1	<0.5%
2	>= 0.5% and < 5.0%
3	>=5.0% and < 12%
4	>= 12% and < 20%
5	>= 20% and < 30%
6	>= 30% and < 80%
7	>= 80%

Exhibit 2: MRM as a function of the VaR-equivalent volatility (VEV).

The methodology for the calculation of this VaR-equivalent volatility (VEV) measure is detailed in the regulation. It is based on the Cornish-Fisher expansion[1], which takes into account the skewness[2] and excess kurtosis[3] measured from the observed distribution of returns of the PRIIP, or its benchmark, or its proxy's price during the preceding five years. A summary of the details of the calculation of this VEV measure is given in the appendix.

The highest frequency of available price data must be used: Daily prices, weekly prices, bi-weekly prices or monthly prices. The minimum frequency that can be used is monthly. A shorter period may be used where daily or weekly prices covering the 5-year period are not available, but never shorter than two years for daily prices or four years for weekly prices.

The PRIIP is assigned to an MRM class, as shown in Exhibit 2, as a function of the VEV. For PRIIPs with monthly price data, the MRM class is increased by one additional class.

For Category 3, the calculation is based on a VaR in price space[4] calculated from a distribution of bootstrap[5] simulated PRIIP values at the end of the recommended holding period. The distribution must be obtained by simulating the price or prices, which determine the value of the PRIIP, at the end of the recommended holding period. The VaR is the value of the PRIIP at a confidence level of 97.5 % at the end of the recommended holding period, discounted to the present date using the expected risk-free discount factor from the present date to the end of the recommended holding period.

The simulation of prices is based on bootstrapping the expected distribution of prices or price levels for the PRIIP's underlying contracts from the observed distribution of returns for those contracts with replacement. The minimum number of simulations is 10 000. The regulation provides details of how to construct the simulations. We provide more details in the appendix.

Like for Category 2 PRIIPs, the Category 3 PRIIP is assigned to an MRM class, as shown in Exhibit 2, as a function of the VEV (see appendix). For PRIIPs with monthly price data, the MRM class is increased by one additional class.

Finally, for Category 4, the different components of PRIIP that contribute to its performance must be identified. The component of the PRIIP that depends wholly or partly on a factor or factors that is/are unobserved in the market must follow robust and well recognised industry and regulatory standards for determining relevant expectations as to the future contribution of those factors, and any uncertainty that may exist in respect of that contribution. Where the component is not wholly dependent on a factor that is unobserved in the market, a bootstrap methodology must be used to account for the market factors, as set out for Category 3 PRIIPs.

4.3. CREDIT RISK MEASURE (CRM)

[1] Cornish, E. A.; Fisher, Ronald A. (1938). "Moments and Cumulants in the Specification of Distributions" (PDF). Revue de l'Institut International de Statistique / Review of the International Statistical Institute. 5 (4): 307–320. doi:10.2307/1400905

[2] Skewness is a measurement of the distortion of symmetrical distribution or asymmetry in a data set. Skewness can be quantified as a representation of the extent to which a given distribution varies from a normal distribution. A normal distribution has a zero skew. Negative skew refers to a longer or fatter tail on the left side of the distribution.

[3] Kurtosis is a statistical measure used to characterise the distribution of a dataset. When normally distributed data is plotted on a graph, it generally takes the form of an upside-down bell. This is called the bell curve. The plotted data that are furthest from the mean of the data usually form the tails on each side of the curve. Kurtosis indicates how much data resides in the tails. Distributions with a large kurtosis have more tail data than normally distributed data, which appears to bring the tails in toward the mean. The kurtosis of a normal distribution is 3.

[4] The PRIIP Regulation refers to "VaR in price space" explicitly for Category 3 PRIIPs. The difference between the Value-at-Risk (VaR) 'in return space' and 'in price space' is that the first is based on returns over the period while the second is based on prices over the period.

[5] This term is used explicitly in the regulation and refers to a simulation technique that samples from historical data to construct hypothetical performance scenarios.

If the returns of a PRIIP or its underlying investments or exposures depend on the creditworthiness of a manufacturer or party that is obliged to make, directly or indirectly, relevant payments to the investor, then the PRIIP entails credit risk. The CRM classifies PRIIPs based on their credit risk.

Where an entity engages directly to make a payment to a retail investor for a PRIIP, credit risk shall be assessed for the entity that is the direct obligor. However, if all payment obligations of an obligor or one or more indirect obligors are unconditionally and irrevocably guaranteed by another entity (the guarantor), then the credit risk assessment of the guarantor can be used if it is more favourable than the credit risk assessment of the respective obligor or obligors.

Where available, a PRIIP manufacturer shall define, ex-ante, one or more external credit assessment institutions (ECAI) certified or registered with the European Securities and Markets Authority (ESMA), whose credit assessments will consistently be referred to for the purpose of the credit risk assessment.

Where multiple credit assessments are available according to that policy, the median rating shall be used, defaulting to the lower of the two middle values in case of an even number of assessments. The level of credit risk of the PRIIP and each relevant obligor shall be assessed on the basis of, as applicable, the credit assessment assigned to the PRIIP by an ECAI, the credit assessment assigned to the relevant obligor by an ECAI, or, in the absence of a credit assessment, a default credit assessment as set out in the regulation.

The detail behind the exact calculation of the CRM class for a PRIIP is described in the regulation and falls out of the scope of this paper. For BNPP AM's funds, the credit risk class is 1 and thus, as shown in exhibit 2, the SRI is just equal to the MRM.

4.4. SRI (PRIIP) VERSUS SRRI (UCITS)

As mentioned, the SRI is the classification system used to assess the risks associated with investing in a given PRIIP under this new regulation. The SRRI (Synthetic Risk and Reward Indicator) from UCITS is the rating system that is used to assess the risks associated with investing in a given UCITS product.

Both SRI and SRRI are defined on a scale ranging from 1 to 7. However, the two scales are not equivalent, which may create confusion. As a step up from the UCITS' SRRI, the SRI calculation methodology: i) introduces the credit risk dimension via the CRM defined in section 4.3; and ii) assesses market risk using the MRM, based on a Cornish Fisher methodology defined in section 4.2, which is more complex than the volatility measure used in the SRRI. Other differences include the period of calculation, which for the SRRI is always five years of historical data, and the frequency of data, which for the SRRI of daily valued funds is weekly.

SRRI	Annualised volatility	SRI for CR1 and CR2	VaR-equivalent volatility (VEV)
1	<0.5%	1	<0.5%
2	>= 0.5% and < 2.0%	2	>= 0.5% and < 5.0%
3	>=2.0% and < 5.0%	3	>=5.0% and < 12%
4	>= 5.0% and < 10%	4	>= 12% and < 20%
5	>= 10% and < 15%	5	>= 20% and < 30%
6	>= 15% and < 25%	6	>= 30% and < 80%
7	>= 25%	7	>= 80%

Exhibit 3: Risk scale used for the SRRI of UCITS and the SRI of PRIIPs for credit risk CR1 and CR2.

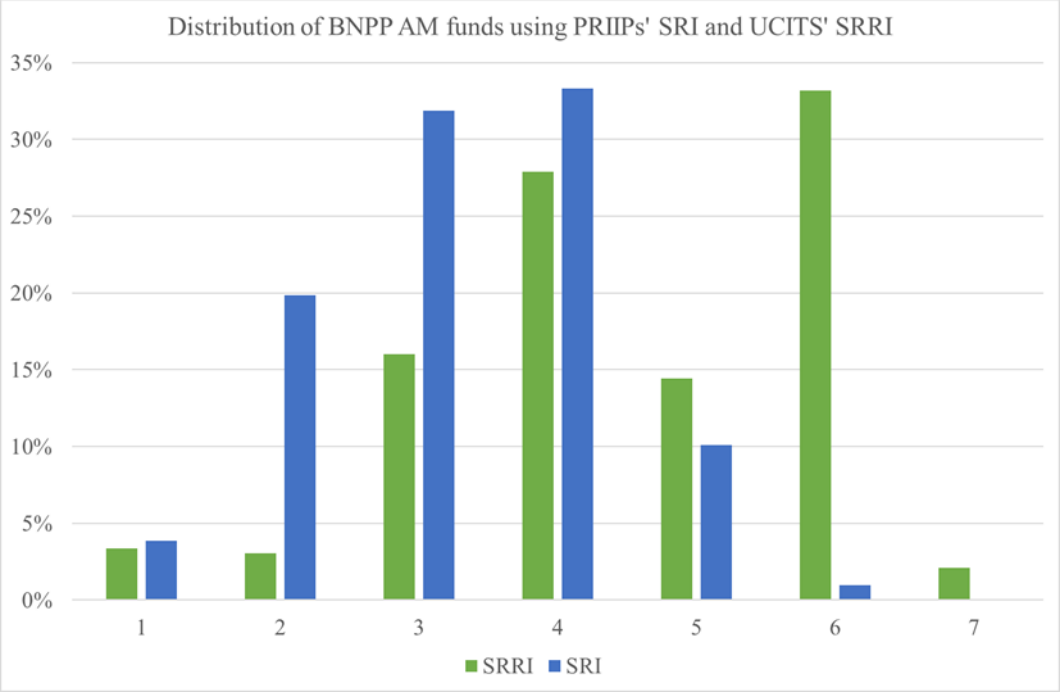

Exhibit 4: Distribution of BNPP AM funds based on the SRRI risk scale of UCITS and the SRI risk scale of PRIIPs. Source: BNPP AM, 31 December 2022.

In exhibit 4, we show the impact of the changes in methodology on the BNPP AM fund range on 31 December 2022 using the selected representative share classes. As is clear from exhibit 3, the tendency is for the risk of funds to be lower. In particular, there is no fund with risk 7 and hardly any with risk 6 under the SRI, whereas this was not at all the case with the SRRI. In turn, the number of funds with an SRI equal to 2 increased significantly when compared to the number of funds with an SRRI equal to 2.

For PRIIPs with the lowest credit risk, e.g., CR1 and CR2, which is the case for BNPP AM funds, the SRI equals the MRM, and the differences between the SRI and the SRRI are essentially due to the differences in the scale of volatility under the two regulations, as show in exhibit 3.

In exhibit 5, we show how the funds have migrated towards lower risk classes under PRIIP. We can see that most funds with an SRRI equal to 6 have an SRI of 4 and 5. In turn, most funds with an SRRI equal to 4 have an SRI equal to 3, and similarly, most funds with SRRI equal to 3 have an SRI of 2. The funds with an SRRI equal to 1 are essentially the same that have an SRI equal to 1, i.e., hardly any funds migrated from an SRRI equal to 2 towards an SRI equal to 1.

In conclusion, while the PRIIP regulation introduces the benefit of allowing for products from asset managers, investment banks and insurers to be assessed using the same risk scale, for BNPP AM's fund range, and for asset managers in general, the regulation appears somewhat less discriminant than the UCITS when it comes to risk assessment. There is a tendency for many funds with SRRI higher than 2 to fall into the lower risk class when moving to SRI. There is also a significant increase in the number of funds with SRI equal to 2, when compared to SRRI equal to 2, and hardly any funds with an SRI equal to 6 or 7. Finally, as show in exhibit 1, similar funds from different asset managers may now have significantly different SRI for as long as their respective associated credit risk is sufficiently different.

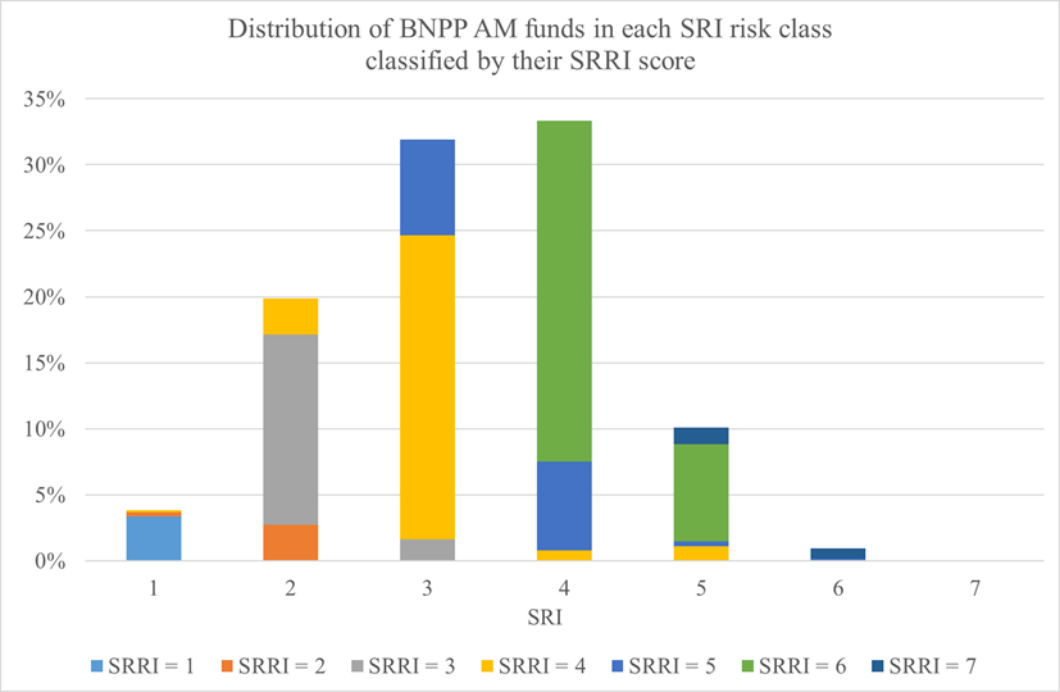

Exhibit 5: Distribution of BNPP AM funds in each risk scale based on the PRIIPs' SRI, classified by their UCITS' SRRI risk score. Source: BNPP AM. 31 December 2022.

5. COSTS

The PRIIP regulation provides full information about how costs should be considered and shown in the KID. Here, we provide a short summary of some of the key points. The reader should refer to the regulation for more detail about costs.

Typical costs that need to be shown and taken into account in calculations of risk and performance scenarios include:

- **One-off costs upon entry and exit including:**
  - Distribution fee (maximum of all possible known distribution costs used when exact amount is not known)
  - Constitution costs (up-front part)
  - Marketing costs (up-front part)
  - Subscription fee including taxes.
- **Ongoing costs deducted each year from the assets, including:**
  - Management fees and other administrative or operating costs
  - Transaction costs

- **Incidental costs incurred under specific conditions, including:**
  - Performance fees (and carried interest).

Transaction costs must be calculated on an annualised basis, based on an average of the transaction costs incurred by the PRIIP over the previous three years, the average being calculated from all transactions. Where the PRIIP has been operating for less than three years, transaction costs must be calculated using the methodology set out by the regulation. In such cases, these are calculated either by multiplying an estimate of portfolio turnover in each asset class with costs based on an given approach for each asset class, or as an average of the actual transaction costs incurred during the period of operation and a standardised estimation for the reminder of the three year period.

A summary cost indicator will be required for the KID. This should be calculated as the difference between two percentages, i and r. Here, r is the annual internal rate of return in relation to gross payments by the retail investor and estimated benefit payments to the retail investor during the recommended holding period based on the moderate scenario (see next section) under the assumption that all costs included in the total costs are deducted. In turn, i is the annual internal rate of return for the respective cost-free scenario, except for the PRIIPs referred to in point 17 of Annex IV. This methodology applies to all PRIIPs, except those in Category 1, which are futures, call options and put options traded on a regulated market or on a third-country market considered to be equivalent to a regulated market.

For PRIIPs with a recommended holding period of less than one year, instead of calculating an annual cost impact, the impact of costs is calculated over a holding period of less than one year. Cost impact figures for such PRIIPs cannot be directly compared with those for other PRIIPs.

6. PERFORMANCE SCENARIOS

The PRIIPs regulation requires the KID to include performance scenarios presented in a way that is accurate, fair, clear and not misleading, and that is likely to be understood by the average retail investor. The regulation specifies objectively how those scenarios should be calculated and how they should be presented in the KID.

For all PRIIPs, except Category 1 PRIIPs that are futures, call options and put options traded on a regulated market, a table with the following four performance scenarios showing the expected range of performance of the PRIIP should be included:

- **A favourable scenario**
- **A moderate scenario**
- **An unfavourable scenario**
- **A stress scenario**

The stress scenario sets out significant unfavourable impacts not covered in the unfavourable scenario.

An additional scenario must be included for insurance-based investment products based on the moderate scenario above, where the performance is relevant in respect of the return of the investment. The minimum investment return must also be shown without taking into account the situation where the PRIIP manufacturer or party obliged to make, directly or indirectly, relevant payments to the retail investor, is not able to pay.

Different methodologies for the calculation of performance scenarios apply to the different categories of PRIIPs. The methodology used for the favourable and moderate scenarios is similar and based on a same set of historical performance data for a number of overlapping sub-periods. The methodology used for the unfavourable scenario is similar to the first two, but is based on a different set of historical performance data, which includes more sub-periods. Finally, while the favourable, moderate and unfavourable scenario are based on sets of historical performance data, the stress scenario is based on a different methodology using a specific Cornish-Fisher VaR calculation[6].

6.1. PERFORMANCE SCENARIOS FOR CATEGORY 2 PRIIPS

For Category 2 PRIIPs, the calculation of the favourable, moderate and unfavourable scenarios depends on the length of historical data for the PRIIP. For recommended holding periods shorter than five years, the calculation requires 10 years of historical consecutive values. For recommended holding periods longer than five years, the calculation requires five years more of historical consecutive values than the recommended holding period.

The performance has to be presented in monetary units and percentage terms. The costs figures presented in the KID should reflect in the same way the projected costs over the recommended holding period. The average annual return required under the performance scenarios tables of the KID is meant to represent the actual projected return per year over one year, half of the recommended holding period and the recommended holding period, i.e., the implicit assumption is that the recommended holding period is more than one year.

Where the recommended holding period of the PRIIP is less than one year, it should be assumed that the performance scenarios should reflect the projected return over the recommended holding periods. In this case, there is no obligation to calculate the performance scenarios over one year and half of the recommended holding period.

6.1.1. FAVOURABLE AND MODERATE PERFORMANCE SCENARIOS

If the required data is available, then the calculation over the selected historical values requires several steps. The first is to identify all the overlapping sub-intervals of length equal to the duration of the recommended holding period contained in this sample of historical values, starting and ending at each of the months or at each valuation date for the PRIIP, with a monthly valuation frequency. In exhibit 6, we give an example for a recommended holding period of five years.

[6] The Value at Risk measures the potential loss in value of a risky asset or portfolio over a defined period for a given confidence interval. The Cornish-Fisher modification is an elegant and simple adjustment by taking into account the skewness and kurtosis of the distribution.

The performance of the PRIIP during the exact duration of each of those sub-intervals is calculated net of all applicable costs and on the basis that any distributable income of the PRIIP has been reinvested. The value of the favourable scenario is the best performance calculated in this way that can be found in all those sub-intervals. The value of the moderate scenario is the median performance that can be found in all those sub-intervals.

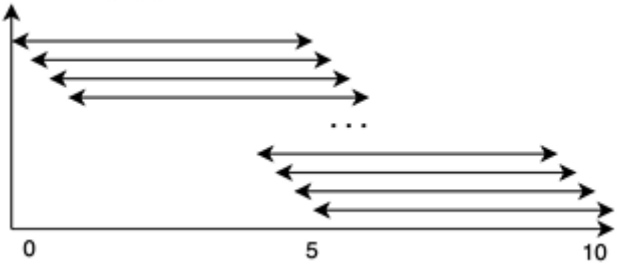

Exhibit 6: Overlapping sub-intervals of length equal to the duration of the recommended holding period, five years in this example, contained in this sample of historical values.

6.1.2. UNFAVOURABLE PERFORMANCE SCENARIOS

The calculation of the value of the unfavourable scenario requires an additional step. For PRIIPs with a recommended holding period longer than one year, the set of sub-intervals is augmented with all additional overlapping sub-intervals equal to or shorter than the duration of the recommended holding period, but equal to or longer than one year, and which end at the end of the time period being used for the scenario calculation. In exhibit 7, we give an example of those additional sub-periods for a recommended holding period of five years.

The regulation requires a *linear transformation*[7] to be used to obtain the performance in all sub-intervals shorter than the recommended holding period, in order to render all sub-intervals of comparable length. This was clarified in a Q&A document published in November 2022: The *linear transformation* means that the performance over a shorter period (e.g. an outcome of EUR 8 000 over two years) is also taken to be the performance over the recommended holding period (e.g. an outcome of EUR 8 000 over the recommended holding period).

The value of the unfavourable scenario is the worst performance that can be found in the new augmented set of sub-intervals.

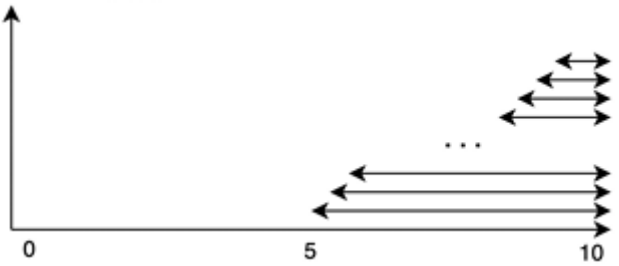

Exhibit 7: Additional overlapping sub-intervals equal to or shorter than the duration of the recommended holding period, five years in this case, but equal to or longer than one year, ending at the end of the time period.

6.1.3. STRESS PERFORMANCE SCENARIOS

The calculation of the stress scenario also starts with the definition of overlapping sub-intervals. However, the sub-intervals are not the same as those used in the other scenarios and depend on the frequency of the underlying data. For one year holding periods, sub-intervals of about one month, two months and six months should be used if the underlying returns are daily, weekly or monthly, respectively. For holding periods of longer than one year, about three months, four months and 12 months should be used for daily, weekly and monthly data, respectively. Exact details are provided in the annex.

Once the overlapping sub-intervals have been identified, the volatility of historical lognormal returns is calculated over each sub-period. From the distribution of volatilities, the value of volatility that corresponds to the 99th percentile for one-year holding periods and to the 95th percentile for other holding periods is taken and used in a Cornish Fisher expansion, net of all applicable costs. Details of the calculation are given in the appendix.

The regulation requires that if the value of the stress scenario calculated in this way is more favourable than that the value of the unfavourable scenario, then the stress scenario should take the value of the unfavourable scenario.

6.1.4. WHERE THERE IS AN ABSENCE OF HISTORICAL DATA FOR THE PRIIP

In cases where there is insufficient historical data but it is possible to use a benchmark that has enough historical data, then the steps described above should use the historical values of the benchmark instead of the values of the PRIIP. For example, this would be the case when the information on the objectives of the PRIIP makes reference to a benchmark.

If neither the PRIIP nor the benchmark have sufficient historical data, or if there is no obvious benchmark, then the unfavourable, moderate and favourable scenarios should still use this methodology by using benchmarks regulated by Regulation (EU) 2016/1011 of the European Parliament and of the Council (1). These benchmarks represent the asset classes in which the PRIIP invests or the underlying investments to which the PRIIP is exposed, to supplement the values for the PRIIP or the

[7] This is the exact term used in the regulation

benchmark. All asset classes in which the PRIIP could invest more than 25% of its assets or underlying investments that represent more than 25% of the exposure should be considered. Where such benchmarks do not exist, an appropriate proxy should be used. The regulation specifies the criteria those proxies should meet; this falls out of the scope if this paper.

6.2. PERFORMANCE SCENARIOS FOR CATEGORY 3

For these PRIIPs, the regulation requires the running of simulations of possible outcome scenarios over the recommended holding period. The scenario values are taken from the distribution of simulated values, net of all applicable costs. The value of the:

- Favourable scenario is the value of the PRIIP at the 90th percentile
- Moderate scenario is the value of the PRIIP at the 50th percentile
- Unfavourable scenario is the value of the PRIIP at the 10th percentile

For Category 3 PRIIPs, the method for deriving the estimated distribution of the PRIIP´s outcomes over the recommended holding period relies on the same simulation approach used for the MRM of Category 3 PRIIPs. This is described in the appendix. However, the expected return of each asset shall be the return observed over the period calculated without discounting the expected performance using the expected risk-free discount factor.

The calculation of the stress scenario for Category 3 PRIIPs follows a similar approach to that required for Category 2 PRIIPs while taking into account the simulated outcomes instead of using the historical values of the PRIIPs.

To generate the distribution of outcomes for the stress scenario, the stress volatility is first inferred from the historical returns using the same approach as that used for Category 2 PRIIPs. The historical returns are then scaled by multiplying them by the ratio of stress volatility to historical volatility. The bootstrapping simulation is conducted using these rescaled returns.

The outcome from each simulation is calculated by summing the returns from the periods selected. The returns must be adjusted so that the expected return measured from the simulated distribution of returns is equal to -0.5 multiplied by the square of the stress volatility, multiplied by the number of trading periods.

For Category 3 PRIIPs, the stress scenario is the value of the PRIIP calculated using the same methodology as for Category 2 detailed in the appendix, but using the simulated distribution created as described above instead of using historical returns.

6.3. PERFORMANCE SCENARIOS FOR CATEGORIES 1 AND 4

For Category 4 PRIIPs, the methods used for the MRM, combined as necessary with the method for Category 3 PRIIPs, are used. The relevant methods for Category 2 PRIIPs and the relevant methods set out for Category 3 PRIIPs should be used for the relevant components of the PRIIP where the PRIIP combines different components. The performance scenarios shall be a weighted average of the relevant components. Product features and capital guarantees shall be taken into consideration in the performance calculations.

For Category 1 PRIIPs that are not futures, call options or put options traded on a regulated market or on a third-country market considered to be equivalent to a regulated market, performance scenarios shall be calculated using the same methodology as for Category 3 PRIIPs.

For Category 1 PRIIPs that are futures, call options or put options traded on a regulated market or on a third-country market considered to be equivalent to a regulated market, performance scenarios shall be shown in the form of pay-off structure graphs using the methodology described in the regulation.

6.4. PERFORMANCE SCENARIOS FOR CATEGORIES 1 AND 4

We shall now investigate several examples of performance scenarios for category 2 PRIIPs. The values of PRIIPs for each scenario can be calculated in two steps: i) the returns for the scenario are calculated according to the methodology in section 6.1 and then ii) these returns are used to calculate the value of the PRIIPs for each scenario based on its present net asset value. Here, we focus on how the returns for each scenario would have changed over time for different funds. All returns are annualised to simplify the comparison. The calculations are gross of fees, also for simplification.

6.4.1. SCENARIOS OVER THE RECOMMENDED HOLDING PERIOD FOR AN EQUITY FUND

In exhibit 8, we show as an example what could have been expected for an equity fund, the BNP Paribas Actions Monde ISR fund, a category 2 PRIIP. The calculation is repeated every month from December 2000 to December 2022. The calculation for December 2000 used the preceding 10 years of data (not shown). The returns shown in the exhibit were calculated using the recommended holding period for this fund, i.e., five years.

Exhibit 8 shows a large dispersion in the returns for each performance scenario of this equity fund, in particular during periods of strong equity market volatility. The return for the favourable scenario tends to change less over time than the returns for the other scenarios, and it remains constant for long periods. We can expect a constant return for as long as the 5-year sub-interval with the highest return remains fully contained in the preceding 10-year interval and is not superseded by another 5-year sub-interval with an even higher return. This also explains the drop in return in 2005. From 2000 through 2005, the sub-interval with the highest returns is the 5-year strong bull market of the late 90s. From 2005 onwards, this sub-interval is no longer fully contained in the preceding 10-year interval. Similarly, the drop in return in 2012 is due to the fact that the bull market from 2003 through 2007 is no longer fully contained in the preceding 10 years from 2012 onwards. In fact, in 2012, the returns for the favourable performance scenario even fall almost to zero. This is because by mid-2013, almost all the 5-year sub-intervals contained in the preceding 10 years tend to have a negative return.

The moderate scenario, which is calculated using a similar methodology to that used for the favourable scenario, is less stable over time because it is based on the medium return of all possible 5-year sub-intervals contained in the preceding 10 years, which tends to change more often from one month to the next than the maximum return.

It is interesting to observe that the largest return for the moderate scenario is found in 2000, right after the strong bull market of the late 90s, exactly when the equity markets were overvalued and just before a 3-year period of bear markets returns. The return of the moderate scenario remains positive and relatively constant throughout the entire bear market from 2000 through 2003, whereas it would have made more sense to expect lower or negative returns in 2000 and increasingly

higher returns as the markets fell until 2003. Also, while the moderate scenario return increases during the sharp market fall in 2008, throughout the Global Financial Crisis, it fails to turn positive by 2009 at the start of the long bull market that followed and remains negative until mid-2015.

The unfavourable scenario uses a modified methodology that adds the returns of the most recent sub-intervals shorter than 5 years to the distribution of returns. This is why the return of the unfavourable scenario is somewhat more volatile than those of the favourable and moderate scenarios.

The unfavourable scenario for this equity fund was negative for most of the period. The highest returns were at the start of the bear market in 2000 and then from 2018. In turn, the lowest return is found at the start of the bull market in 2003.

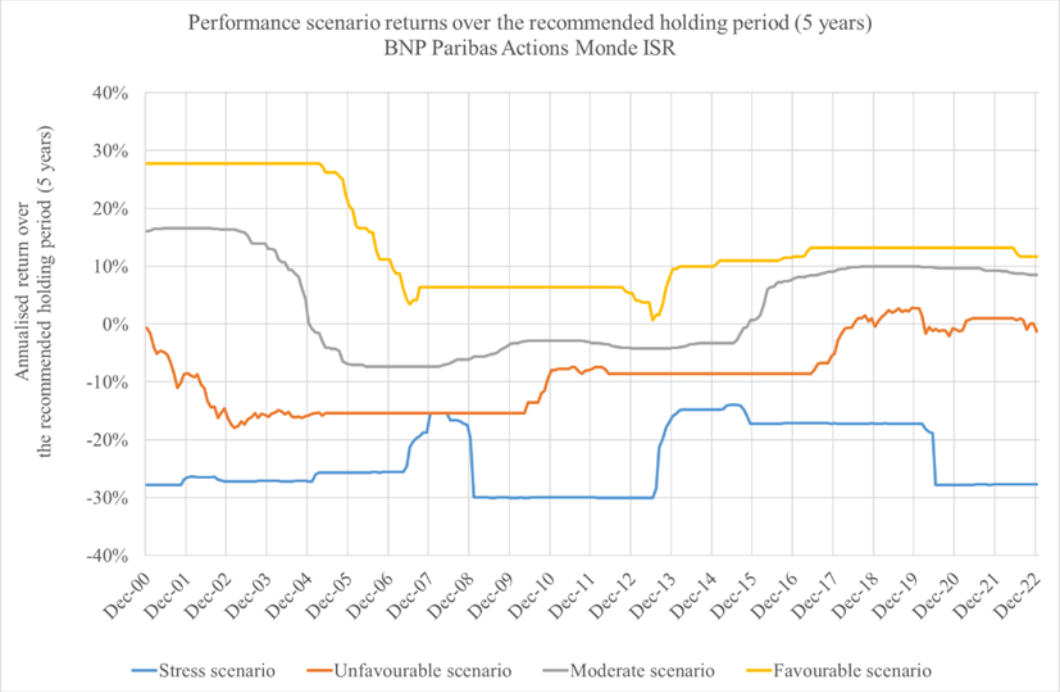

Exhibit 8: Performance scenario annualised returns in euros, calculated for the BNP Paribas Actions Monde ISR fund over its recommended holding period, i.e., five years, using the methodology required by the PRIIP regulation. The calculation was repeated each month from December 2000 to December 2022. For simplification, the simulations are gross of fees. The name of the fund was taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

The stress scenario return is actually more stable than that of the unfavourable scenario. At times, the calculation using the methodology in the regulation base on the Cornish-Fisher formulae in the appendix produces a higher return for the stress scenario than that for the unfavourable scenario. The regulation requires that in such cases the return of the stress scenario is set to the return of the unfavourable scenario. In exhibit 8, this happened briefly in 2008.

Overall, the stress scenario return is always negative by construction. This arises directly from the methodology imposed by the regulation, which is based on a Value-at-Risk Cornish-Fisher formulation that assumes zero average expected return over time. Thus, unlike the unfavourable scenario, the stress scenario return is always negative and becomes more negative in periods of higher market volatility, higher kurtosis and more negative skewness. The stress scenario had the highest returns just before the Global Financial Crisis of 2008 and the bear market that came with it. The stress scenario returns were also at their highest just before the sharp fall in equity markets in March 2020. Currently, the return of the scenario is still reflecting this period which includes this sharp fall.

In exhibit 9, we compare the returns calculated for the moderate performance scenario against the realised returns of the fund over next 5-year recommended holding period. The realised returns were calculated up to December 2017, which corresponds to the return from December 2017 through December 2022.

Exhibit 9 allows us to investigate to what extent the variability of the returns for the moderate scenario can help the retail investor make a more informed investment decision. The results are not encouraging. The worst returns of the fund over the future recommended holding period occur when the moderate scenario return had it highest returns, in 2000. On the other hand, the fund performed best over the future recommended holding period between 2009 and 2015, when the moderate scenario return is negative. Only between 2005 and 2007, and between 2015 and 2017, was the return of the moderate scenario in line with the future performance of the fund. At all other times, the return of the moderate scenario was misleading.

If we compare the realised returns in exhibit 9 with those for the other performance scenarios in exhibit 8, we find that, at least for a typical equity fund such as this one, the variation in the returns of the performance scenarios does not appear to be helpful. Between 2009 and 2015, the realised return is actually higher than that of the favourable scenario. In particular, some of the highest returns are realised in the period that follows June 2013, when the favourable scenario return shows its smallest value, close to zero. We also find that the return of stress scenario was extremely pessimistic compared to the realised returns of the fund over the entire period between 2000 and the latest available realised return at the end of 2017.

These results suggest that the variability of the returns behind the scenarios is not necessarily helpful. In fact, it may actually discourage investment in equity funds, since the stress scenario returns are too pessimistic when compared with the realised returns over the recommended holding period. Moreover, they may encourage investors to invest in the fund at the worst possible time, with the moderate and favourable scenario returns reaching their highest values just before the fund had its worst performances and, conversely, showing the smallest values just before the fund had its best performances.

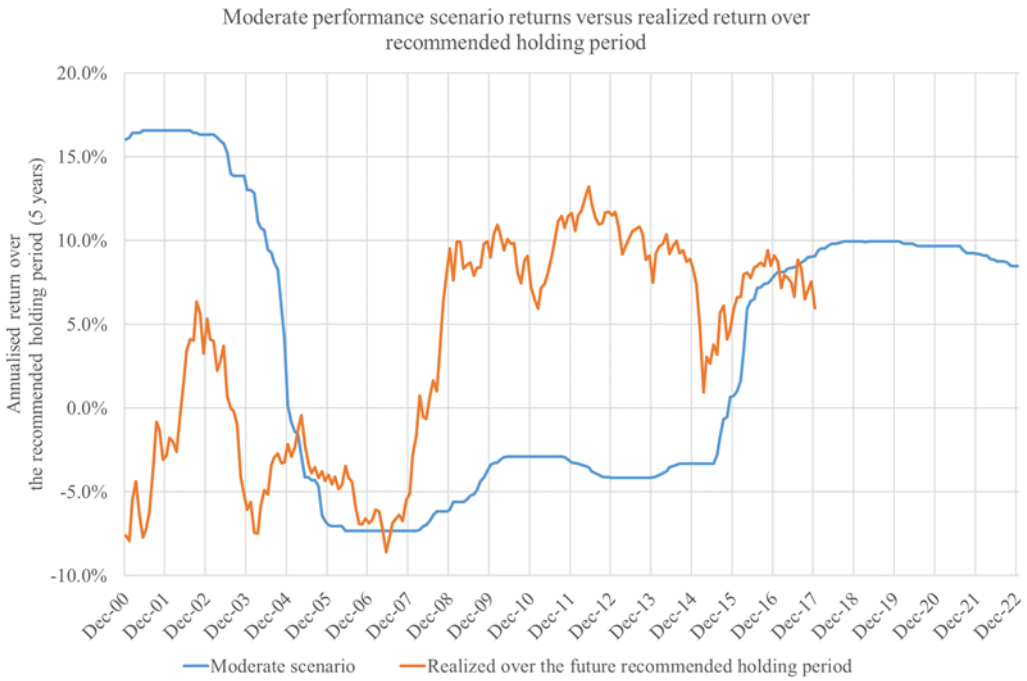

Exhibit 9: Moderate performance scenario annualised returns in euros calculated for the BNP Paribas Actions Monde ISR fund over its recommended holding period, i.e., five years, using the methodology required by the PRIIP regulation compared to the returns of the fund in the following five years. The calculation was repeated each month from December 2000 to December 2022. For simplification, the simulations are gross of fees. The name of the fund was taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

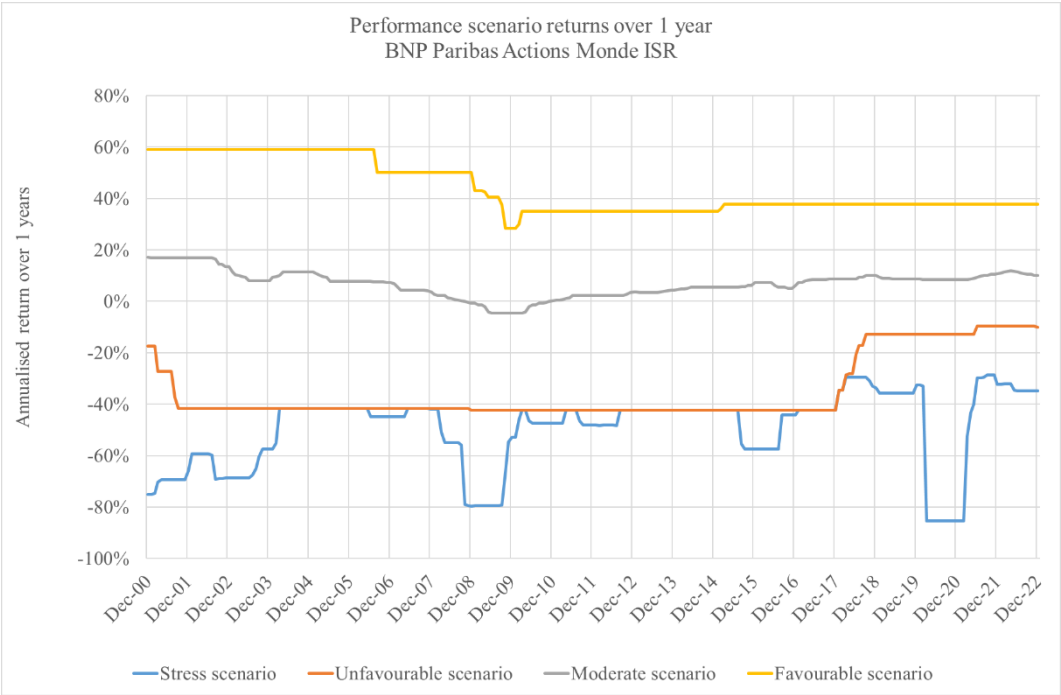

Exhibit 10: Performance scenario annualised returns in euros calculated for the fund BNP Paribas Actions Monde ISR fund over one year using the methodology required by the PRIIP regulation. The calculation was repeated each month from December 2000 until December 2022. For simplification, the simulations are gross of fees. The name of the fund was taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

6.4.2. SCENARIOS OVER ONE YEAR FOR AN EQUITY FUND

In exhibit 10, we show the performance scenario for the same fund as in section 6.4.1. but using a 1-year instead of a 5-year holding period, i.e., considering all 1-year periods in the preceding 10 years. The calculation is repeated each month from December 2000 until December 2022. The calculation of the unfavourable scenario is now based on the same intervals and sub-intervals used for the calculation of the return of the favourable and moderate scenario, because all sub-intervals are now of one year.

Exhibit 10 shows that the dispersion of the returns for the different scenarios is now even larger than in exhibit 8 for the longer holding period. This makes sense, because it is more likely that we find a larger dispersion in returns over sub-intervals of one year than of five years.

The return for the unfavourable scenario is now as stable as that for the favourable scenario. This is because the methodology is now based on the same sub-intervals, which was not the case when scenarios were calculated over the recommended holding period.

The return for the favourable and unfavourable scenarios can stay constant for even longer periods than shown in exhibit 8. This is because once a sub-period of one year with the highest returns is observed, this sub-period can determine the return for the favourable scenario for the next nine years, as long as no other 1-year sub-period is observed with an even more extreme positive return. A sub-period of five years with the highest return can only determine the return of the favourable scenario for the future five years at best.

The return for the moderate scenario has its largest value in 2000, just before the equity bear market started, when the markets were overvalued. In turn, the smallest return is found in 2009.

The stress scenario is now the most volatile. In 2020, we can see that immediately after the equity market crash in March 2020, the return for the stress scenario becomes significantly more negative as a consequence of the sharp increase in volatility accompanied by the sharp decrease in skewness (more negative) and increase in kurtosis. Because 1-year holding periods are used, the return for the stress scenario increases significantly as soon as March 2020 drops out of the interval used in the calculation. Similarly, in 2008, the equity market crash pushes the return for the stress scenario down. One year after the crash, the return for the stressed scenario recovers.

Overall, for 1-year periods of return, the scenarios tend to be more stable, but the huge dispersion may not be helpful for investors.

6.4.3. SCENARIOS OVER THE RECOMMENDED HOLDING PERIOD FOR A BOND FUND

In exhibit 11, we show what could have been expected for a bond fund, the BNP Paribas Obli Revenus fund. The calculation is repeated every month from December 2000 until December 2022. The calculation for December 2000 used the preceding 10 years of data (not shown). The recommended holding period for this fund is three years.

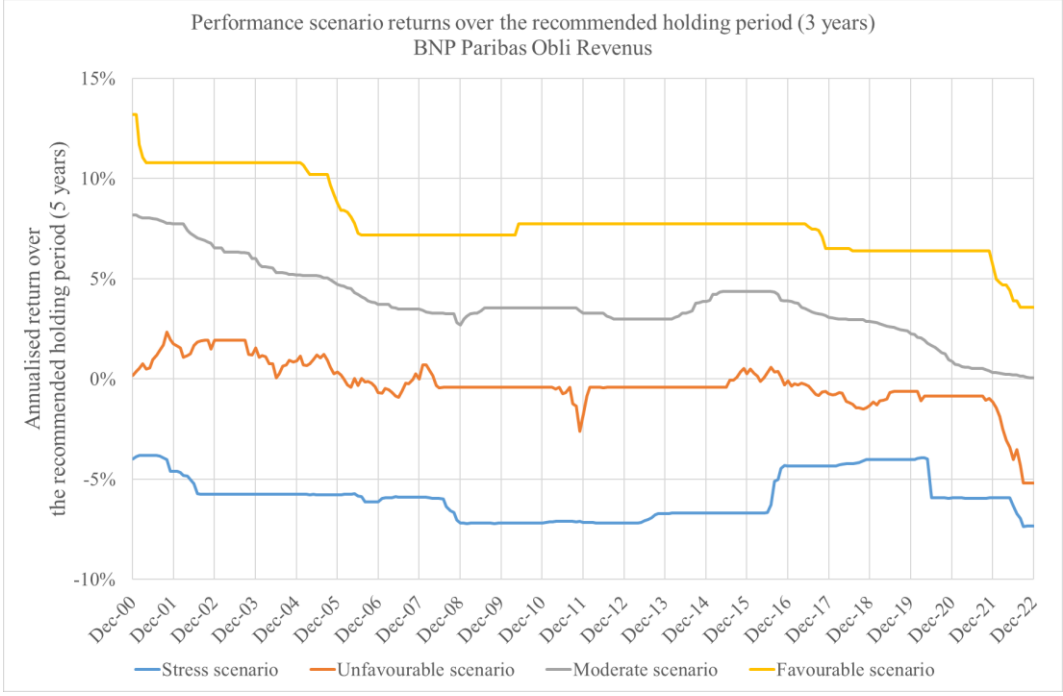

Exhibit 11: Performance scenario annualised returns in euros calculated for the BNP Paribas Obli Revenus fund over its recommended holding period, i.e., three years, using the methodology required by the PRIIP regulation. The calculation was repeated each month from December 2000 until December 2022. For simplification, the simulations are gross of fees. The name of the fund was taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

Much like in the example for an equity fund in exhibit 8, we find that the dispersion in the performance scenario returns is rather large. The favourable scenario has the most stable returns over time and the unfavourable scenario has the most volatile returns. The larger variability of the unfavourable scenario return is due to the return of the unfavourable scenario being based on a distribution of the returns over an augmented set of past sub-intervals which also includes the most recent sub-periods

shorter than the recommended holding period. This additional set of short-term sub-periods is responsible for the sharp fall in the returns for this scenario at the end of 2021.

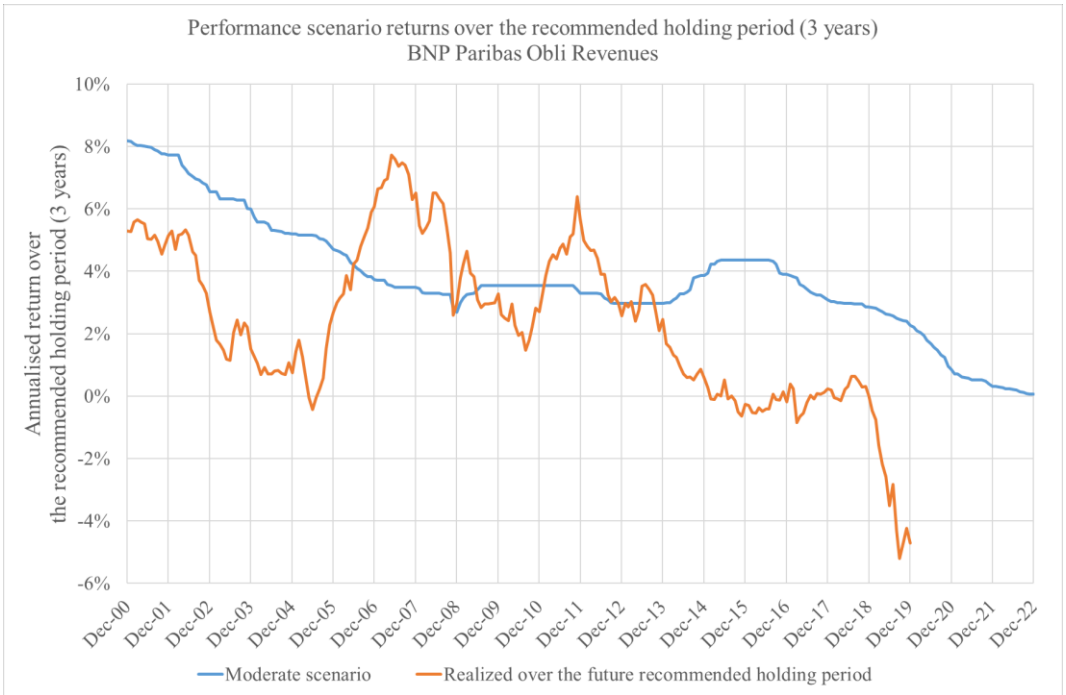

Exhibit 12: Moderate performance scenario annualised returns in euros calculated for the BNP Paribas Obli Revenus fund over its recommended holding period, i.e., three years, using the methodology required by the PRIIP regulation compared to the returns of the fund in the following three years. The calculation was repeated each month from December 2000 until December 2022. For simplification, the simulations are gross of fees. The name of the fund was taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

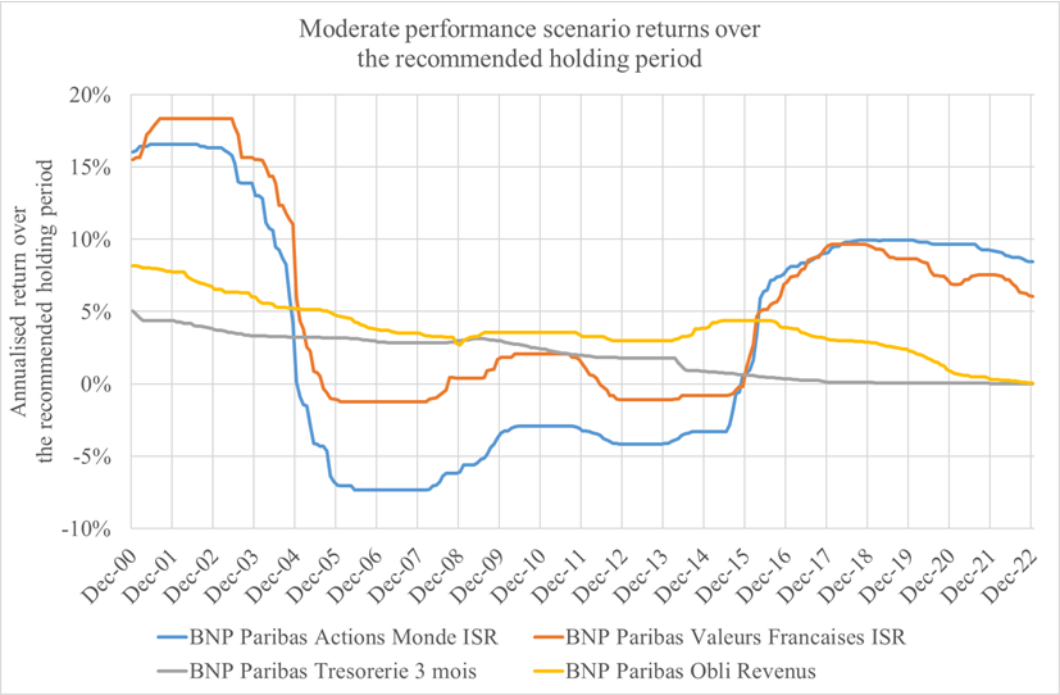

Exhibit 13: Moderate performance scenario annualised returns in euros calculated for two equity funds, one fixed income fund and one money market fund over their respective recommended holding periods using the methodology required by the PRIIP regulation. The calculation was repeated each month from December 2000 until December 2022. For simplification, the simulations are gross of fees. The names of the funds were taken at the end of the period and may have changed over time. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

In exhibit 12, we compare the returns calculated for the moderate performance scenario against the realised returns of the fund over the future 3-year recommended holding period. The realised returns are calculated until the most recent possible date, i.e., December 2019. Much like in the example given for an equity fund in exhibit 9, we find that the moderate scenario is a relatively poor indicator of the future performance of the fund. In particular, until 2005, the moderate scenario returns were significantly higher than the return realised by the fund in the following three years; the same is the case from 2013. The moderate scenario return continues to have over-optimistic returns from 2014 and fails to anticipate the negative performance from 2018.

We can also see from exhibits 11 and 12 that the realised returns over the following years would have exceeded the returns of the favourable scenario on some occasions, in particular at the end of 2007. In turn, the worst realised returns occurred in the three years after September 2019, at about minus 5%, while the stress scenario had some of its less negative returns on this date.

6.4.4. MODERATE PERFORMANCE SCENARIO FOR EQUITY, BOND AND MONEY MARKET FUNDS

In exhibit 13, we compare the moderate scenario annualised returns of two equity funds, BNP Paribas Actions Monde ISR and BNP Paribas Valeurs Françaises ISR, with those for a fixed income and a money market fund, BNP Paribas Obli Revenus and BNP Paribas Trésorerie 3 mois, over their respective recommended holding periods.

The moderate scenario returns of the two equity funds follow a correlated path reflecting their historical performances at each point in time. However, the actual moderate scenario returns can be quite different at any given point in time. In 2010, we can find a positive return for the BNP Paribas Valeurs Françaises ISR fund and a negative return for the BNP Paribas Actions Monde ISR. Scenario returns can be quite different for two funds that invest in the same asset class, e.g., equities, even if they are correlated over time.

The moderate scenario return of the bond fund and the money market fund fall over time; reflecting the smaller returns earned towards the end of the fixed-income bond bull market. These returns reach zero by the end of 2022.

The performance scenarios can indeed result in significantly different values for different funds, even funds invested in the same asset class. However, the differences in scenario values essentially reflect past performance and are poor indicators for the future returns, as seen from exhibits 9 and 12. Thus, the most likely outcome is that the differences will affect the choice of investments but are not necessarily likely to lead to better investment choices and can be misleading.

6.4.5. PERFORMANCE SCENARIOS FOR CATEGORY 3 FUNDS

In this section, we applied the methodology based on bootstrapping simulations to calculate the performance scenarios of two structured funds. These are the:

- **DPI fund Hydrogen Economy Protetto, with a 100% capital protection objective, with protection backed with a hold-to-maturity Italian Treasury Bonds (BTP) portfolio. Early redemption is possible starting at the end of year two:**
  - At each anniversary "i" (i=2 to 4), if the net asset value (NAV) is more than 100% + i*5% during three consecutive business days, then the fund is redeemed early at the NAV, subject to being above 100% + i*5%.
- **Formula Fund BNP Paribas Apollo Global ESG Hydrogen Economy, with three possible scenarios at maturity (six years):**
  - If the index performance is 0% or positive, the investor gets his capital back plus the performance of the index,
  - If the index performance is in the -40%/0% range, investor gets his capital back,
  - If the index performance is below -40%, the investor bears all the loss incurred by the index,
  - The fund does not offer a capital guarantee at maturity.

Given that these funds are closed to subscription after launch and subscribers are advised to hold them until maturity, the performance scenarios were calculated at inception. These are given in exhibit 14.

Recommended Holding Period: Maturity	DPI Hydrogen Economy Protetto	Formula Fund BNP Paribas Apollo Global ESG Hydrogen Economy
Stress Scenario	1.1%	-16.8%
Unfavorable Scenario	1.5%	-11.9%
Moderate Scenario	2.5%	0.6%
Favorable Scenario	4.4%	4.5%

Exhibit 14: Performance scenario annualised returns in euros calculated for two structured funds over their respective recommended holding periods (maturity) using the methodology required by the PRIIP regulation. The calculation was carried out at inception of each fund as they are closed funds. For simplification, the simulations are gross of fees. Past performance is not indicative of future performance. For illustrative purposes only. Source: BNPP AM, 31 December 2022.

It is difficult to compare the performance of category 3 funds' as their payoffs could be different. In this case, we compare a fund with 100% capital protection and no upside cap with a formula fund that has no capital protection and has 15% cap at maturity if the underlying index performance goes above this value. While these features appear to be reflected in the performance scenarios of each fund, the fact that the simulations are based on historical data means that the performance scenarios may not reflect the expected opportunity that was behind the creation of such products. Asset managers create such products opportunistically and often based on their view about future market trends rather than on historical performance data.

7. CONCLUSIONS

The European Parliament, through the Regulation n. 1286 (November 2014), confirmed that the disclosure requirements concerning investment products were necessary for retail investors to understand the risks related to these products when making investment decisions. Indeed, both the manufacturers and the distributors used to provide a prospectus for each product. However, this document, too long and complex, discouraged any careful reading: Retail investors would in turn be inclined to trust the advice and the explanations offered by distributors, which can have conflicts of interests.

The PRIIP regulation, aimed at retail investors, is intended to address this problem by regulating the information disclosure, and consequently, attempt to restore investor confidence. Moreover, the scope of the PRIIP regulation covers the products sold by asset managers, investment banks and insurers, and proposes the same single document for all with one single risk scale and one similar approach to displaying information. In particular, the objective of the KID is to provide general information about the product, to identify and analyse:

- **the level of the risk for each PRIIP, "in the form of a risk class by using a summary risk indicator (SRI) having a numerical scale from 1 to 7"**
- **four different payoffs in three different time periods, known as performance scenarios**
- **all the costs related to the PRIIP.**

The KID was designed to provide a forward-looking analysis of the potential return the investor could expect, considering the initial amount invested (usually 10 000, irrespective of currency, as suggested by the regulation), over three different periods (one year after the initial investment, half of the recommended holding period and the recommended holding period), under different scenarios.

While we believe that the PRIIP regulation is an important step in the right direction in terms of helping retail investors, we see room for improvement. Below, we list some of the issues we identified in the PRIIP regulation which we believe could be addressed in the future to further assist retail investors in making informed decisions.

With regards to the new risk scale:

The change from UCITS' SRRI to the PRIIP SRI is likely to create confusion. For asset managers, the fact that most PRIIPs fall mainly into the 1-to-5 SRI range while before, under UCITS, the SRRI would occupy the full scale from 1 to 7 is a drawback, in our view.

With regards to the performance scenarios:

- **Complexity:** The performance scenarios are complex and not likely to be easily understood by retail investors. First, the assumptions and calculations used to create the performance scenarios may be difficult for retail investors to grasp, leading to confusion and misunderstandings. Second, the fact that three different methodologies are used to calculate the scenario returns (one for the favourable and moderate, one for the unfavourable and one for the stress scenario) makes it difficult to compare the returns from the four different scenarios. In particular, for the unfavourable scenario, the use of shorter-term term sub-intervals introduces more volatility in the scenario returns from one month to the next.
- **Unrealistic assumptions:** The performance scenarios are based on the historical performance of the underlying assets and the investment strategy of the PRIIP. For the funds in our examples, this resulted in the highest returns for the favourable and moderate scenarios just before the worst fund performances. Similarly, we also observed the worst favourable and moderate scenario returns just before the funds' best performances. Thus, the differences in scenario returns for different PRIIPs are not likely to be good guidance for selecting PRIIPs.
- **Limited value:** The use of unrealistic assumptions, both overly optimistic and overly pessimistic, leads to performance scenarios that in the end do not seem to accurately reflect the potential risks and returns of the PRIIP. In particular, the huge dispersion in scenario returns is not helpful and the fact that the returns of the stress scenario are always excessively negative is more likely to discourage investors from investing in riskier PRIIPs such as equity funds at all than to encourage them to invest for the longer-term, which would have been a better outcome.

8. APPENDIX

8.1. MARKET RISK MEASURE CALCULATIONS

The calculation of the VaR measure used for the MRM of Category 2 PRIIPs uses the return over each period defined as the natural logarithm of the ratio of the price at the market close at the end of the current period to the market close at the end of the preceding period. The VaR measure in return space is given by the Cornish-Fisher expansion, as follows:

$$\mathrm{VaR}_{Return\ Space} = \sigma\sqrt{\mathrm{N}} * \left(-1.96 + 0.474 * \frac{\mu_1}{\sqrt{\mathrm{N}}} - 0.0687 * \frac{\mu_2}{\mathrm{N}} + 0.146 * \frac{{\mu_1}^2}{\mathrm{N}}\right) - 0.5 * \sigma^2\mathrm{N}$$

where N is the number of trading periods in the recommended holding period; and σ, μ_1, μ_2 are respectively the volatility, skew and excess kurtosis measured from the return distribution. The volatility, skew and excess kurtosis are calculated from the measured moments of the distribution of returns in accordance with the following:

1. The zero moment, M_0, is the count of the number of observations in the period as defined above
2. The first moment, M_1, is the mean of all the observed returns in the sample
3. The second M_2, third M_3 and fourth M_4 moments are defined in the standard manner:

$$M_2 = \sum_i (r_i - M_1)^2 / M_0$$

$$M_3 = \sum_i (r_i - M_1)^3 / M_0$$

$$M_4 = \sum_i (r_i - M_1)^4 / M_0$$

where r_i is the return measured on the ith period in the history of returns. The volatility, σ, is given by $\sqrt{M_2}$, the skew, μ_1, is given by M_3/σ^3 and the excess kurtosis, μ_2, by $M_4/\sigma^4 - 3$. For PRIIPs of Category 2, the VEV is a function of this VaR in return space given by:

$$VEV = \left[\sqrt{\left(3.842 - 2 * VaR_{Return\ Space}\right)} - 1.96\right] / \sqrt{T}$$

where T is the length of the recommended holding period in years.

For Category 3 PRIIPs, bootstrapping simulations based on the observed distribution of returns for these contracts with replacement are used to generate the expected distribution of prices or price levels for the PRIIP's underlying contracts. There are two types of market observables that may contribute to a PRIIP's value: spot prices (or price levels) and curves. For each simulation of a spot price (or level):

1. Calculate the return for each observed period in the past five years (or minimum of two years when using daily prices or minimum of four years when using weekly prices) by taking the logarithm of the price at the end of each period divided by the price at the end of the previous period
2. Calculate the return for each contract by summing the returns from the selected periods and correcting this return to ensure that the expected return measured from the simulated distribution of returns is the risk neutral expectation of the return over the recommended holding period. The final value of the return is given by
    a. $Return = E[Return_{risk-neutral}] - E[Return_{measured}] - 0.5 * \sigma^2 N - \rho\ \sigma\ \sigma_{ccy}\ N$
    b. where σ is the measured volatility of the asset, σ_{ccy} is the measured volatility of the FX rate; ρ is the correlation between the asset price and the relevant FX rate measured over the recommended holding period; the second term corrects for the impact of the mean of the observed returns; the third term corrects for the impact of the variance of the observed returns; and the last term corrects for the expected impact arising when the strike currency is different from the asset currency.
3. Calculate the price of each underlying contract by taking the exponential of the return.

For curves, a principal component analysis (PCA) must be applied to ensure that the simulation of the movements of each point on the curve over a long period results in a consistent curve. The PCA is performed by:

1. Collecting the historical record of tenor points that define the curve for each trading period over the past five years (or minimum of two years when using daily prices or minimum of four years when using weekly prices)
2. Ensuring that each tenor point is positive. If there is a negative tenor point, then all tenor points should be shifted by the minimum whole number or percentage to ensure positive values for all
3. Calculating the return over each period for each tenor point by taking the natural logarithm of the ratio between the price (or level) at the end of each observed period and the price (or level) at the end of the preceding period
4. Correcting the returns observed at each tenor point so that the resulting set of returns at each tenor point has a zero mean
5. Calculating the covariance matrix between the different tenors by summing over returns
6. Calculating the eigenvectors and eigenvalues of the covariance matrix
7. Selecting the eigenvectors that correspond to the three largest eigenvalues
8. Forming a matrix with three columns, where the first column is the eigenvector with the largest eigenvalue; the middle column is the eigenvector with the second-largest eigenvalue; and the last column is the eigenvector with the third-largest eigenvalue
9. Projecting the returns onto the three principal eigenvectors calculated in the previous step by multiplying the N × M matrix of returns obtained in point 5) by the M × 3 matrix of eigenvectors obtained in point 8)
10. Calculating the matrix of returns to be used in the simulation by multiplying the results in point 9) with the transpose of the matrix of eigenvectors obtained in point 8). This is the set of values to be used in the simulation.

The curve simulation is performed as follows:

1. The time step in the simulation is one period. For each observation period in the recommended holding period, a row is selected at random from the calculated matrix of returns. The return for each tenor point, T, is the sum over the selected rows of the column corresponding to tenor point, T
2. The simulated rate for each tenor point T, is the current rate at tenor point T:
    a. Multiplied by the exponential of the simulated return

b. Adjusted for any shifts used to ensure positive values for all tenor point, and

c. Adjusted so that the expected mean matches current expectations for the rate at tenor point T, at the end of the recommended holding period.

For PRIIPs of Category 3, the VEV is a function of the VaR in price space calculated from the bootstrapping simulations given by

$$\mathrm{VEV} = \left[\sqrt{\left(3.842 - 2 * \ln(\mathrm{VaR}_{Price\ Space})\right)} - 1.96\right] / \sqrt{\mathrm{T}}$$

Here, T is also the length of the recommended holding period in years except in cases where the PRIIP is called or cancelled before the end of the recommended holding period according to the simulation, in which case the period measured is the years until the call or cancellation.

8.2. PERFORMANCE SCENARIO CALCULATIONS

For PRIIPs of Category 2, the calculation of the stressed scenario values involves the steps below. For Category 3 PRIIPs, bootstrapping simulations based on the observed distribution of returns for these contracts with replacement are used to generate the expected distribution of prices or price levels for the PRIIP's underlying contracts. There are two types of market observables that may contribute to a PRIIP's value: spot prices (or price levels) and curves.

1. Identify a sub-interval of length w which is a function of the holding period and the frequency of returns used:

	1 year	> 1 year
Daily prices	21	63
Weekly prices	8	16
Monthly prices	6	12

Exhibit 5: Length of overlapping sub-periods as a function of holding period and data frequency

2. For each sub-interval of length w, identify the historical lognormal returns, r_t, where $t = t_0, t_1, t_2, \ldots, t_{\mathrm{N}}$.
3. Calculate the volatility for each sub-period t_i, from $t_i = t_0$ rolling until $t_i = t_{\mathrm{N}} - w$

$$ {}^{w}_{t_i}\sigma_S = \sqrt{\frac{\sum_{t_i}^{t_i+w}\left(r_{t_i} - {}^{t_i+w}_{t_i}\mathrm{M}_1\right)}{\mathrm{M}_w}} $$

where M_w is the count of number of observations in the sub interval and ${}^{t_i+w}_{t_i}\mathrm{M}_1$ is the mean of all the historical lognormal returns in the corresponding subinterval

4. The stressed volatility, ${}^{w}\sigma_S$, is the value that corresponds to the 99th percentile for one year holding periods and the 95th percentile for longer holding periods
5. With N the number of trading periods in the recommended holding period and with all the variables defined as in the previous section, the expected values at the end of the recommended holding period must be calculated from the Cornish-Fisher expansion:

$$\mathrm{Exp}\left[{}^{w}\sigma_S\sqrt{\mathrm{N}} * \left(z_\alpha + \left[\frac{z_\alpha^2 - 1}{6}\right] * \frac{\mu_1}{\sqrt{\mathrm{N}}} + \left[\frac{z_\alpha^3 - 3z_\alpha}{24}\right] * \frac{\mu_2}{\mathrm{N}} - \left[\frac{2z_\alpha^3 - 5z_\alpha}{36}\right] * \frac{{\mu_1}^2}{\mathrm{N}}\right) - 0.5^{w} * {}^{w}{\sigma_S}^2\,\mathrm{N}\right]$$

Where ${}^{w}\sigma_S$ is the stressed volatility and z_α is the value of the PRIIP at the extreme percentile that corresponds to 1% for one year and to 5% for longer holding periods.each simulation of a spot price (or level):

9. REFERENCES

- "COMMISSION DELEGATED REGULATION (EU) 2017/653" of 8 March 2017, Official Journal of the European Union.
- "COMMISSION DELEGATED REGULATION (EU) 2021/2268" of 6 September 2021, Official Journal of the European Union.
- "COMMISSION DELEGATED REGULATION (EU) 2022/975" of 17 March 2022, Official Journal of the European Union.
- "Questions and answers (Q&A) on the PRIIPs Key Information Document (KID)" of 14 November 2022, Joint Committee of the European Supervisory Authorities - JC 2017 49 - EBA/EIOPA/ESMA.
- "Questions and answers (Q&A) on the PRIIPs Key Information Document (KID)" of 21 December 2022, Joint Committee of the European Supervisory Authorities - JC 2017 49 - EBA/EIOPA/ESMA.

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