EIOPA-CP-16/03
6 April 2016

Consultation Paper

on

the methodology to derive the UFR and its implementation

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Responding to this paper

EIOPA welcomes comments on the Consultation Paper on the methodology to derive the UFR and its implementation.

Comments are most helpful if they:

- respond to the question stated, where applicable;
- contain a clear rationale; and
- describe any alternatives EIOPA should consider.

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1. Introduction

On this consultation paper

1. This consultation paper seeks feedback on the methodology to derive the ultimate forward rate (UFR) referred to in Article 77a of the Solvency II Directive[2]. The public consultation is part of EIOPA's review of the UFR methodology started in May 2015. The review included a workshop with stakeholders in July 2015 based on an issue paper on the UFR methodology. This consultation paper takes account of the input received during and after the workshop. EIOPA intends to decide on the outcome of the review in September 2016.

2. This consultation paper includes a proposal for the UFR methodology and its implementation (section 2). The proposal and the underlying rationale are explained in section 3. Section 4 sets out analysis of the impact of changing the UFR on the risk-free interest rates, the time value of money and on the present value of insurance cash-flows.

What is the ultimate forward rate?

3. Under Solvency II, the assessment of the financial situation of insurance and reinsurance undertakings is based on harmonised principles and methodologies for the valuation of their assets and liabilities. In particular, the risk-free interest rates to be used for the discounting of insurance and reinsurance liabilities are set out in implementing acts. For that purpose, EIOPA is required to derive and publish risk-free interest rates on a regular basis.[3] Accordingly, EIOPA has been publishing on a monthly basis risk-free interest rates for 33 currencies since February 2015.[4]

4. The risk-free interest rates are derived from prices of financial instruments that are traded in deep, liquid and transparent markets. The financial instruments are interest rate swaps and, where swaps are not available, government bonds.

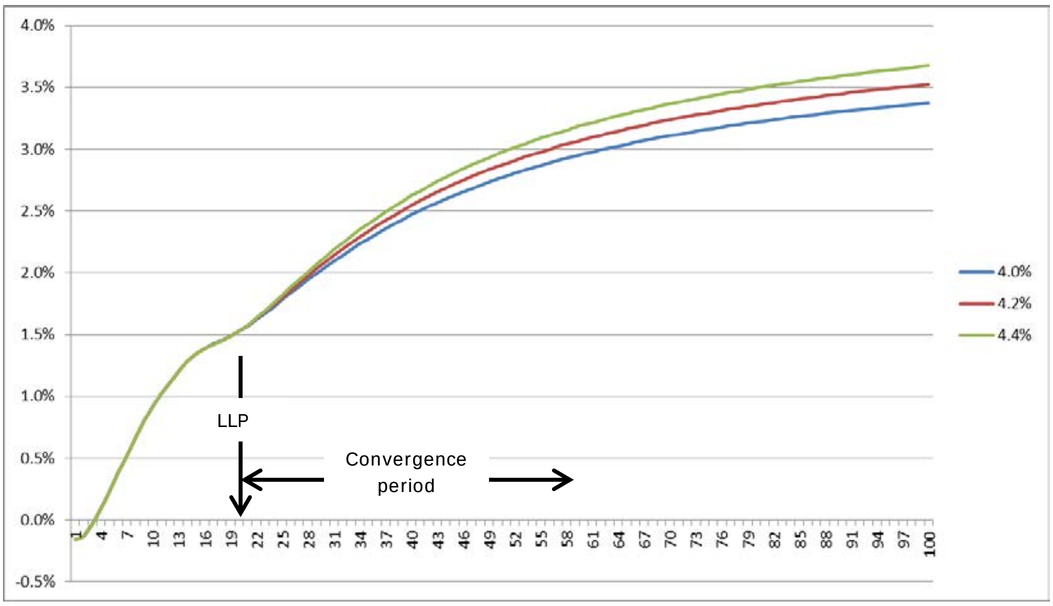
5. As insurance liabilities can have durations of several decades, in particular in life and health insurance, risk-free interest rates for long durations are required. The durations of financial instruments traded in deep, liquid and transparent markets are limited. Depending on the currency, the highest

[2] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II) (OJ L 335, 17.12.2009, p. 1)
[3] See Article 77e of the Solvency II Directive.
[4] See EIOPA's website: https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii-technical-information/risk-free-interest-rate-term-structures

duration (last liquid point) is between 10 and 50 years, for the euro for example it is 20 years.[5] The risk-free interest rates for maturities beyond the last liquid point are derived by means of extrapolation.[6] According to Article 77a of the Solvency II Directive, the risk-free interest rates should be extrapolated towards an ultimate forward rate (UFR). EIOPA is currently applying a UFR of 4.2% for most currencies, including for the euro. For the Swiss franc and the Japanese yen a UFR of 3.2% and for the Brazilian real, the Indian rupee, the Mexican peso, the Turkish lira and the South African rand a UFR of 5.2% is used.

6. The extrapolated risk-free interest rates are based both on the risk-free interest rates risk-free interest rates up to the last liquid point and the UFR. The influence of the UFR on the extrapolated rates increases with the maturity of those rates. How fast the influence of the UFR increases depends on the convergence period. The convergence period varies, depending on the currency, between 10 and 50 years. For the euro, for example the convergence period is 40 years.

7. The following diagram shows the euro term structure calculated with the current UFR of 4.2% and for comparison also with the UFRs of 4.4% and 4.0%. Up to the last liquid point (LLP) of 20 years the three term structures basically coincide. For higher maturities the term structures differ. The convergence period for the euro is 40 years; it includes the maturities from 20 to 60 years.



[5] Recital 30 of the Omnibus II Directive states that under market conditions similar to those at the date of entry into force of that Directive, the starting point for the extrapolation of risk- free interest rates, in particular for the euro, should be at a maturity of 20 years.
[6] See Article 77a of the Solvency II Directive.

8. It should be noted that the risk-free interest rates at the end of the convergence period are not equal to the UFR. Even at the end of the depicted term structures at 100 years the risk-free interest rates are significantly lower than the UFR. The reason is that the UFR is a forward rate, while the risk-free interest rates in the diagram are spot rates. At the end of the convergence period, the forward rate by which two successive spot rates are related has (approximately) converged to the UFR.[7] With increasing maturity also the spot rates will converge to the UFR. But they usually come close to the UFR only at maturities that are too long to be economically relevant.

9. The extrapolated risk-free interest rates are not only determined by the UFR, but also by the choice of the last liquid point, the convergence period and the extrapolation method. This consultation paper only deals with the methodology to derive the UFR, but not the other elements of the extrapolation.

Legal framework for the derivation of the UFR

10. The Delegated Regulation on Solvency II[8] includes provisions on the calculation of the UFR. According to Article 47 of that Regulation the UFR should have the following properties:

- The UFR is stable and only changes as a result of changes in long-term expectations.
- The methodology to derive the UFR is clearly specified in order to ensure the performance of scenario calculations by insurance and reinsurance undertakings.
- The UFR is determined in a transparent, prudent, reliable, objective manner that is consistent over time.
- The UFR takes account of expectations of long-term real interest rates and expectations of inflation, provided they can be determined in a reliable manner.
- The UFR does not include a term premium to reflect the additional risk of holding long-term investments.

11. As a general requirement Article 43 of the Delegated Regulation states that insurance and reinsurance undertakings should be able to earn the rates of the term structure in a risk-free manner in practice.

[7] The mathematical relation between spot rates and forward rates is as follows: $(1+s_{n+1})^{n+1}=(1+f_n)\cdot(1+s_n)^n$ where s_n and s_{n+1} are spot rates for maturities n and $n+1$ respectively and f_n is the forward rate at maturity n.

[8] Commission Delegated Regulation (EU) No 2015/35 of 10 October 2014 supplementing Directive 2009/138/EC of the European Parliament and of the Council on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II) (OJ L 12, 17.01.2015, p. 1)

Reasons for reviewing the UFR methodology

12. The main objective of Solvency II is the protection of policyholders. To achieve that objective, the UFR needs to be chosen appropriately. Where that is not the case, insurance undertakings may set up provisions for their long-term obligations towards policyholders that are too low and may turn out to be insufficient to meet those obligations.

13. The UFR is not a constant. According to the legal framework the UFR should change in line with long-term expectations. That change should be based on a clearly specified methodology that allows insurance and reinsurance undertakings to make scenario calculations. On that basis undertakings would in particular be able to anticipate possible future changes of the UFR and prepare for them.

14. The UFRs that EIOPA currently use were initially derived in 2010 for the purpose of the fifth Quantitative Impact Study for Solvency II (QIS5). The derivation of the UFRs was described in a background paper on QIS5.[9] That description does not constitute a specified methodology because it is not fully clear on how the derivation approach will be applied on an ongoing basis. The review of the UFR methodology aims at filling these gaps.

15. Furthermore, the current UFRs in 2010 were determined before the UFR derivation was specified in the Delegated Regulation. The review should, where necessary, align the methodology to the legal provisions.

16. EIOPA is aware of the concern of some stakeholders that the currently used UFRs are too high. These concerns are usually based on comparing the UFRs with the market rates observable under the low interest rate environment of some economies. While those market conditions determine the rates that insurers can currently earn on new investments, it needs to be taken into account that the UFR is a long-term forward rate. For the euro, for example, only the forward rates for maturities of 60 years and longer are fully determined by the UFR. The UFR should therefore be based on long-term expectations of interest rates as required in Article 47 of the Delegated Regulation.

17. At the same time other stakeholders seem to favour keeping the UFR constant in the foreseeable future. But where the expectations on long-term interest rates change, this approach is not in line with the description of the UFR in the Delegated Regulation. It should also be considered that delaying any change of the UFR due to current changes in long-term expectations my result in even more drastic changes of the UFR in the

[9] QIS5 – Risk-free interest rate – Extrapolation method, see EIOPA's website: http://archive.eiopa.europa.eu/fileadmin/tx_dam/files/consultations/QIS/QIS5/ceiops-paper-extrapolation-risk-free-rates_en-20100802.pdf

future, in case the long-term expectations have then moved further away from the current UFRs.

18. Since a change of the UFR affects the valuation of payments with a maturity after the last liquid point, the impact of changing the UFR on the technical provisions is expected to be material for insurance and reinsurance undertakings with significant long-term liabilities. It may therefore be unnecessarily disruptive to immediately apply the new UFR methodology without, for example phasing it in. This consultation paper also sets out a proposal to implement the methodology and seeks feedback on it.

2. Proposal for the UFR methodology and its implementation

2.1 Methodology to derive the UFR

Update of the UFRs

19. EIOPA will annually calculate the UFRs and where they are different from the UFRs of the previous year update them. The calculated UFRs will be announced every year by the end of March. Three months after the announcement of the calculated UFRs, EIOPA will use them to calculate the risk-free interest rate term structures.

Calculation of the UFRs

20. In order to ensure that the UFRs do not change by more than 20 bps per year, they will be derived as follows:

$$UFR_t^L = \max(UFR_{t-1}^L - 20\ bps; \min(UFR_t;\ UFR_{t-1}^L + 20\ bps))$$

where:

- UFR_t^L denotes the UFR of the current year after limitation of the annual change,
- UFR_{t-1}^L denotes the UFR of the previous year, after limitation of the annual change,
- UFR_t denotes the UFR of the current year before limitation of the annual change.

21. For each currency the UFR before limitation of the annual change is the sum of an expected real rate and an expected inflation rate. The expected real rate is the same for each currency. The expected inflation rate is currency-specific.

Calculation of the expected real rate

22. The expected real rate is the weighted geometric mean of annual real rates from 1960 to the year before the update of the UFRs according to the following formula:

$$R = \exp\left(\frac{\sum_{i=0}^{n} w_i \cdot \ln(1 + r_i)}{\sum_{i=0}^{n} w_i}\right) - 1$$

where:

- *R* is the expected real rate,
- *n* is the number of years since 1960,
- r_i the annual real rate for the i^{th} year after 1960,
- w_i is the weight for the i^{th} year after 1960 being defined as $w_i = \beta^{n-i}$ with β=0.99.

23. For each of the years since 1960 the annual real rate is derived as the simple arithmetic mean of the annual real rates of Belgium, Germany, France, Italy, the Netherlands, the United Kingdom and the United States.[10]

24. For each of those years and each country the annual real rate is calculated as follows:

real rate = (*short-term nominal rate* – *inflation rate*)/(1 + *inflation rate*).

25. The short-term nominal rates are taken from the annual macro-economic database of the European Commission (AMECO database).[11] The inflation rates are taken from the Main Economic Indicators database of the OECD.[12]

26. The expected real rate is rounded to full five basis points as follows:

- When the unrounded rate is lower than the rounded rate of the previous year, the rate is rounded upwards.
- When the unrounded rate is higher than the rounded rate of the previous year, the rate is rounded downwards.

[10] For 1960 the annual real rate is based only on real rates from Germany, Italy and the Netherlands.

[11] Short-term nominal rates used for deriving the expected real rate can be found in the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs, "AMECO". On AMECO online, select 13-Monetary variables, select Interest Rates and then tick the box Short-term nominal (ISN). (http://ec.europa.eu/economy_finance/ameco/user/serie/ResultSerie.cfm)

[12] Inflation rates used for deriving the expected real rate can be found on the website of the Organisation for Economic Co-operation and Development (OECD): go to the OECD Main Economic Indicators (MEI) and select consumer price indices. When accessing the database, choose consumer prices – all items for the subject, percentage change on the same period of the previous year for the measure and percentage for the unit. (http://stats.oecd.org/Index.aspx?DataSetCode=MEI_PRICES). OECD data used in this document were accessed in March 2016.

Calculation of the expected inflation rate

27. For currencies where the central bank has announced an inflation target, the expected inflation is based on that inflation target according to the following rules:

    - The expected inflation rate is:
        - 1%, where the inflation target is lower than or equal to 1%,
        - 2%, where the inflation target is higher than 1% and lower than 3%,
        - 3%, where the inflation target is higher or equal to 3% and lower than 4%,
        - 4%, where the inflation target is 4% or higher.

    - Where a central bank is not targeting a specific inflation figure but tries to keep the inflation in a specified corridor, the midpoint of that corridor is relevant for the allocation to the four inflation rate buckets.

28. For currencies where the central bank has not announced an inflation target[13], the expected inflation rate is 2% by default. However, where past inflation experience and projection of inflations both clearly indicate that the inflation of a currency is expected in the long-term to be at least 1 percentage point higher or lower than 2%, the expected inflation rate will be chosen in accordance with those indications. The expected inflation rate will be rounded downwards to full percentage points.

29. The past inflation experience will be assessed against the average of 10 years annual inflation rates. The projection of inflation rates will be derived on the basis of an autoregressive–moving-average model.

2.2 Implementation of the methodology

30. The methodology to derive the UFR should be implemented in 2017. The first UFRs calculated according to the methodology should be announced by end of March 2017. Those UFRs should be applied for the first time to calculate the risk-free interest rate term structures for end-June 2017.

31. The initial application of the methodology in 2017 should be based on the following additional specification:

    - The UFR of the previous year, denoted UFR_{t-1}^{L} in paragraph 20, is:
        - 3.2% for the Swiss franc and the Japanese yen,

[13] The currencies currently concerned are: the kuna, the Hong Kong dollar, the ringgit, the Singapore dollar and the new Taiwan dollar.

  - 5.2% for the Brazilian real, the Indian rupee, the Mexican peso, the Turkish lira and the South African rand,
  - 4.2% for all other relevant currencies.
- The rounded expected real rate of the previous year referred to in paragraph 26 is equal to 2.2%.

3. Reasoned explanation of the proposal

3.1 Introduction

32. This section sets out explanations on the main areas of the methodological review and the findings that the proposal for the methodology to derive the UFR is based on. These areas are:

- the general approach to derive the UFR,
- the instruments used for estimating the expected real rate,
- the database to compute the expected real rate,
- the number of expected real rates,
- the determination of the expected real rate,
- the way to exclude the term premium from the UFR,
- the time span for averaging the real rates,
- the determination of the expected inflation rate,
- implementing changes of the UFR over time,
- the initial implementation of the revised methodology.

33. The baseline of the review is the approach that was used to calculate the current UFRs which are 4.2% for most currencies, including for the euro. For the Swiss franc and the Japanese yen a UFR of 3.2% and for the Brazilian real, the Indian rupee, the Mexican peso, the Turkish lira and the South African rand a UFR of 5.2% is used.

34. These UFRs that were derived 2010 for the purpose of the fifth Quantitative Impact Study (QIS5). The QIS5 calibration approach is based on the following key features:

- <u>UFR = expected real rate + expected inflation rate</u>
- <u>The expected real rate</u>:
    - o is a single real interest rate for all currencies of 2.2%,
    - o is based on an arithmetic average of historical data covering 12 countries and stemming from a research publication.
- <u>The expected inflation rates</u>:
    - o are based on a 3 buckets approach,
    - o are allocated, by default, to the central bucket of 2%,
    - o may be allocated to a low inflation bucket of 1% or to a high inflation bucket of 3%.

3.2 Review of the general approach

3.2.1 Current approach

35. According to the current approach, the UFR is derived as the sum of two components: the expected real rate and the expected inflation rate.

3.2.2 Pros and cons of the current approach

36. The current approach is based on Article 47 of the Delegated Regulation according to which the UFR shall take account of expectations of the long-term real interest rate and of expected inflation but shall exclude the term premium.

37. Moreover, this approach is supported by academic analysis of bond yields according to which the nominal yield at any maturity is the sum of three components[14]: a component reflecting the expected inflation over the term of the security; another component capturing the expected path of real interest rates; and a residual component, the term premium.[15]

3.2.3 Assessment of alternatives

38. The current approach has been reviewed against four existing methods to derive a UFR. A summary table is provided below. See Annex I for the details of the comparison.

Table 1. Comparison of the current approach against 4 existing models of UFR

Model	Components	UFR value for the EUR (last value known)
Current approach	Historical real rates +inflation targets	4.2% (2010 based on 2009 data)
Barrie & Hibbert	Historical real rates + weighted average of inflation targets and	5.7%, or 4.2% without term premium and convexity effect (2010 based on 2009 data)

[14] See, for example:
Stefania D'Amico, Don H. Kim, and Min Wei, 2010, Tips from TIPS: the informational content of Treasury Inflation-Protected Security prices, *Finance and Economics Discussion Series* (Divisions of Research & Statistics and Monetary Affairs of the Federal Reserve Board, Washington, D.C.),
A. Ang, G. Bekaert and M. Wei, 2008, The Term Structure of Real Rates and Expected Inflation, *Journal of Finance* 60 (2), 797-849,
Haubrich, Pennacchi and Ritchken, 2012, Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps, *Rev. Financ. Stud.* 25 (5), 1588-1629,
Ben S. Bernanke, 2013, Remarks on Long-Term Interest Rates, speech available at http://www.federalreserve.gov/newsevents/speech/bernanke20130301a.htm.
[15] The term premium is also known as "maturity premium" or "inflation risk premium".

	historical inflation rates + long-term nominal term premium + long-term nominal convexity effect.	
Dutch UFR	10-year average of euro 20-years forward rates	3.3% (July 2015)
IAIS	Forecast of growth rates + inflation targets	3.5% (IAIS Field Test 2015)
Swiss SST	Current Solvency II UFR minus 0.3%	3.9% (2015)

	Pros	Cons
Barrie & Hibbert	• Without taking account of the term premium and the convexity effect, the method arrived at result consistent with current UFR for the euro.	• The average real rate estimate is based on underlying data which are not publicly available. • The method is not fully disclosed and therefore not replicable. • Historical inflation rates may not reflect the current and future momentary policy. • The UFR includes a term premium.
Dutch UFR	• The UFR is based on observable market data. • The method is replicable. • The approach is prospective because forward rates reflect market expectations about future rates.	• The method does not allow excluding the term premium included in long-term forward rates. • The method may not be sufficiently stable. • Not for all currencies consistent data to apply the method are available.
IAIS	• By using the assumed equality between real interest rates and potential growth rates in the long-term, it is possible to base real rates on macro-economic forecasts rather than relying on past real rates.	• The underlying model of the OECD is not fully known and therefore its output is not verifiable by EIOPA. • The use of the OECD model impairs the predictability of the method. • There may be a low correlation between future

	• The output of the method is public and issued by a public institution (OECD).	growth rates and future real rates.[16]
Swiss SST	• The adjustment factor is easy to implement.	• The adjustment factor cannot be clearly justified by reference to Article 47 of the Delegated Regulation.

39. It is noted that there are similarities between the current approach for deriving the UFR and the Barrie & Hibbert method (use of historical real rates, use of inflation targets) and the IAIS method (use of inflation targets).

3.2.4 Stakeholders feedback from the July 2015 consultation

40. Methodological continuity as to the general approach to derive the UFR is sought by stakeholders. See Annex II for a summary of the stakeholders' feedback.

3.2.5 Findings

41. After scrutinizing the pros and cons of each model as well as their compliance with the Delegated Regulation, the alternative approaches have been discarded based on the following arguments:

- The Barrie & Hibbert method is not fully disclosed and therefore not fully replicable. It is based on data series not publicly available. The historical inflation rates used in the method may not reflect the current and future momentary policy.
- The Dutch UFR method produces a UFR that includes the term premium and is therefore not in line with the Delegated Regulation.
- The IAIS method relies on an OECD study which may not be fully replicable and therefore cannot be clearly specified and determined in a transparent manner by EIOPA. The approach is not in line with the Delegated Regulation when expectation on real rate and growth differ.
- The Swiss SST method consists of an adjustment of 0.3% of the current approach which cannot be justified by reference to Article 47 of the Delegated Regulation.

[16] See for example Hansen, Bruce E. and Ananth Seshadri, 2013, Uncovering the Relationship between Real Interest Rates and Economic Growth, *Ann Arbor MI: University of Michigan Retirement Research Center (MRRC) Working Paper*, WP 2013-303. http://www.mrrc.isr.umich.edu/publications/papers/pdf/wp303.pdf.

42. The current approach should therefore be kept. However, it needs to be further reviewed for the following reasons:

- The calibration itself was not sufficiently clearly specified.
- It is unclear whether the UFR derived with the current approach includes a term premium.
- The real rates were derived for all currencies on the basis of the US dollar inflation rates.
- The real rates were based on a private source of data whose underlying data are not available.
- As it was a one-off calibration, it was not specified how the UFR could change over time.

<u>Conclusion of the review</u>: EIOPA intends to maintain the current approach. The UFR should be derived as the sum of the expected real rate and the expected inflation rate.

3.3 Review of the determination of the expected real rate

3.3.1 Review of the instruments used for estimating the expected real rate

Current approach

43. In the current approach, the expected real interest rate is based on an arithmetic average of historical real rates.

Pros and cons of the current approach

	Pros	Cons
Historical rates	• Real rates based on a long-term average of historical data are stable. • Removing the term premium from past real rates can be done easily and in a transparent manner.	• It needs to be assumed that the real rates fluctuate around a stationary average. • Past data may include information which may not be in line with expectations because it relates to outdated market structures or policy making.

Assessment of alternatives

44. Two alternatives have been assessed: firstly to rely on market forward rates instead of historical rates and the secondly to use a weighted average of historical rates with weights giving less influence to the oldest data.

Alternative 1: Using forward rates instead of historical rates

45. According to the Delegated Regulation the UFR should take account of expectations of the long-term real interest rate and of expected inflation. However, the Delegated Regulation does not rule out to derive the sum of expected real interest rate and the expected inflation as one amount rather than two separate rates.

46. Hence a long-term expected nominal rate may be estimated from forward rates observable on the market. This is, for instance, the approach recommended by the Dutch UFR committee in 2013 for the pension regulation in the Netherlands.[17] (See Annex 1 for further details on this approach.)

	Pros	Cons
Forward rates	• The approach is prospective because forward rates reflect market expectations about future rates.	• The longest forward rates are only reliably observable up to maturities which are significantly lower than the time horizon of the ultimate forward rate (e.g. 20 years for the euro for an UFR to be reached in 60 years). For some currencies there are no appropriate forward rates. • The output of this approach is less stable than the output of the approach based on historical data. • There seems to be no reliable method to remove the term premium from the forward rate.

[17] For example, long-term forward rates as recommended by the Dutch Ultimate Forward Rate Committee, see http://www.government.nl/documents-and-publications/publications/2013/10/06/advisory-report-of-the-ufr-committee.html.

47. In order to assess the alternative, the stability of an average of historical real rates[18] was compared with an average of euro forward rates[19]. The comparison showed that the UFR based on forward rates would be significantly more volatile. For example, from July 2011 to December 2015, the UFR based on forward rates would have decreased by about 1 percentage point. Based on historical data the UFR only changes by 0.2 percentage points. On the other hand the use of forward rates would capture changes in market expectations earlier than the use of historical real rates.

Alternative 2: Weighted average of historical rates giving more weight to recent data

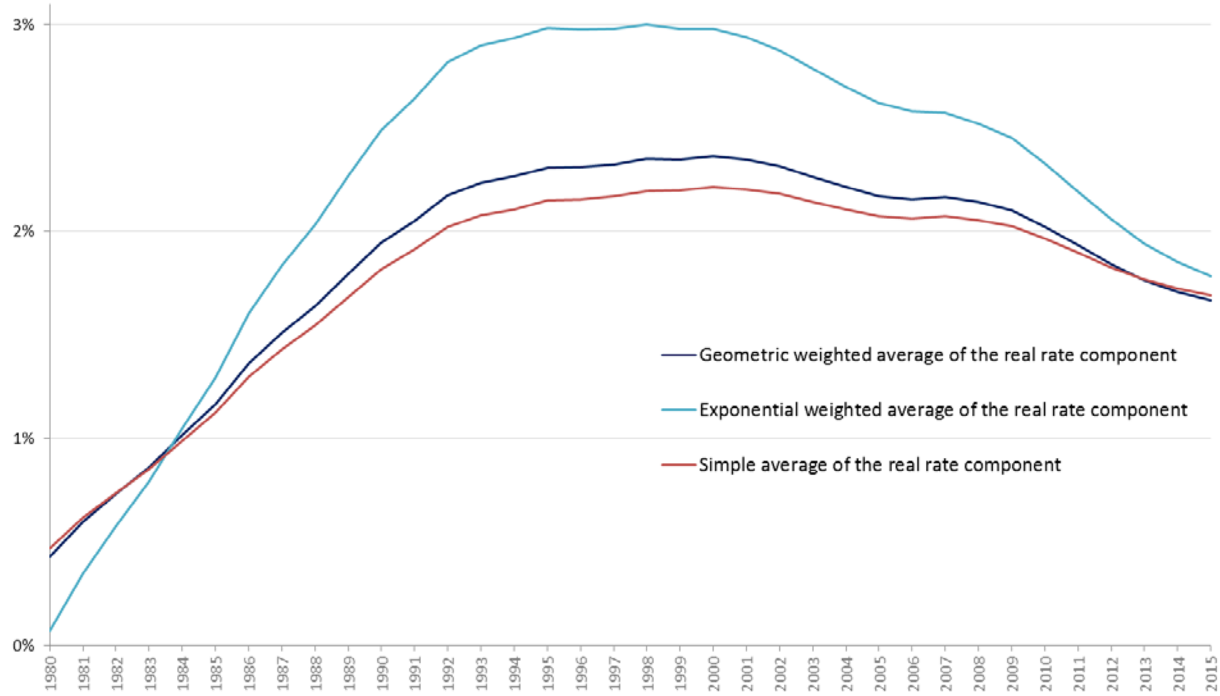
48. It is possible to mitigate the disadvantages of using historical data by giving less influence to the oldest data using a weighted average instead of a simple arithmetic average.

	Pros	Cons
Weighted average of historical data	• Same pros as those of the current approach. • Recent trends of the real rates that are likely to influence the expectation about the level of future real rates are better reflected in the average.	• The real rate component becomes less stable if the last observations differ significantly from the mean. • However, this drawback can be mitigated by using a control parameter (see Figure 3).

49. Two methods have been scrutinized: weights based on the geometric series[20] and exponential weights[21]. Figure 1 shows that the exponentially weighted average proved too much volatile. Conversely, the use of geometric weighted average with a control parameter very close to 1 (e.g. 0.99) proved efficient in providing more weights to the last 30 years data without jeopardizing the general goal of stability of the output.

[18] This arithmetic average includes real rates back to 1960. They are derived on the basis of long-term nominal rates provided by the AMECO database minus the corresponding inflation rates and term premia.
[19] This arithmetic average is based on 10 years of monthly EUR forward rates at maturity 20 years with a tenor of 1 year (see Annex 1 – Dutch UFR for further details).
[20] Where the weights are expressed as: $\Omega_y = \frac{\omega_y}{\sum_i \omega_i}$ and $\omega_y = \beta^{year_{max}-y}$
[21] Where the weights are expressed as: $\Omega'_y = \frac{\omega'_y}{\sum_i \omega'_i}$ and $\omega'_y = 1 - e^{\frac{y-(year_{min}-1)}{y-(year_{max}+1)}}$

Figure 1. Using a weighting average of historical data: average real rate with different weights



The graph starts in 1980 but the UFR levels depicted include data going back to 1960 (see 2.4 for further details). This means that the real rate component of the UFR is an average of 56 annual real rates in 2015, 55 in 2014 … and 20 in 1980. The smoothness of the curve increases with the number of constituents of the average.

50. The main advantage of using a geometric weights with a control parameter of 0.99 is that it provides smooth and nearly linear weights over the time series. It is shown that exponential weights range between 0.1% and 3% from the first observed real rate (1960) to the last (2015), that geometric weights range between 1.3% to 2.3% and that under the current approach (arithmetic average) weights are equally distributed at a level of 1.8%.

51. Figure 2 shows the weights for control parameters 0.91, 0.93, 0.95, 0.97 and 0.99 and for comparison the weights that correspond to the simple average. For a control parameter of 0.91, for example, the weights for the last 10 to 15 years are high and they would strongly influence the average. The real rates from 1960 to 1980 would receive very low weights and would have only marginal impact on the average. In contrast, a weighted average with a control parameter of 0.99 would be close to a simple average. It would assign a relevant weight to each real rate. If the average is taken from 1960 to 2015, then 2015 would get the highest weight of 2.3% and 1960 the lowest weight of 1.3%.

52. Figure 3 depicts the impact of the different control parameters on the average real rate. It shows that the proposed level of the control parameter of 0.99 strikes the balance between the aim of giving less influence to the oldest data and the necessity to keep the average stable over time.

Figure 2. Weights for different control parameters

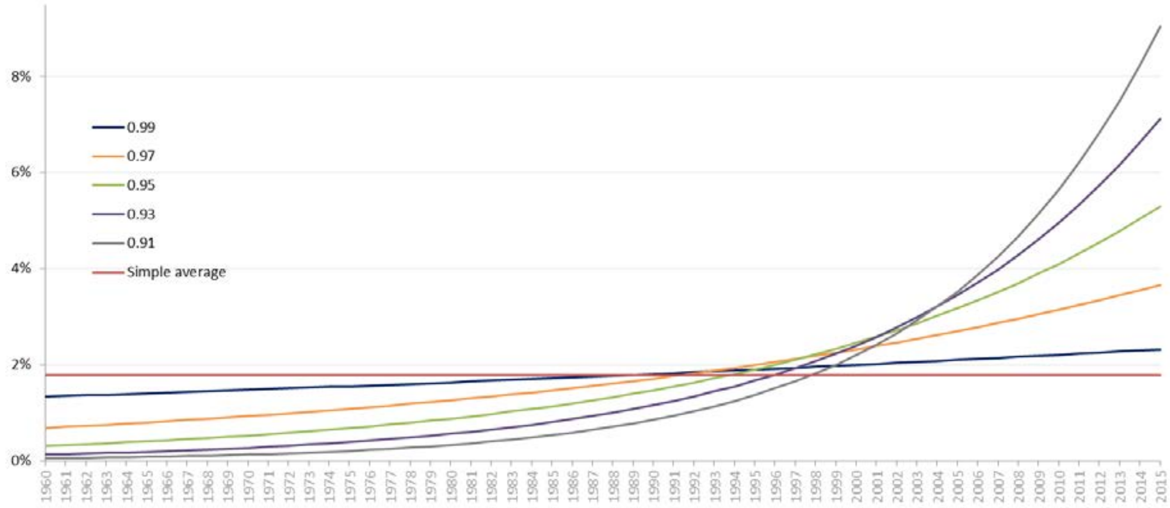
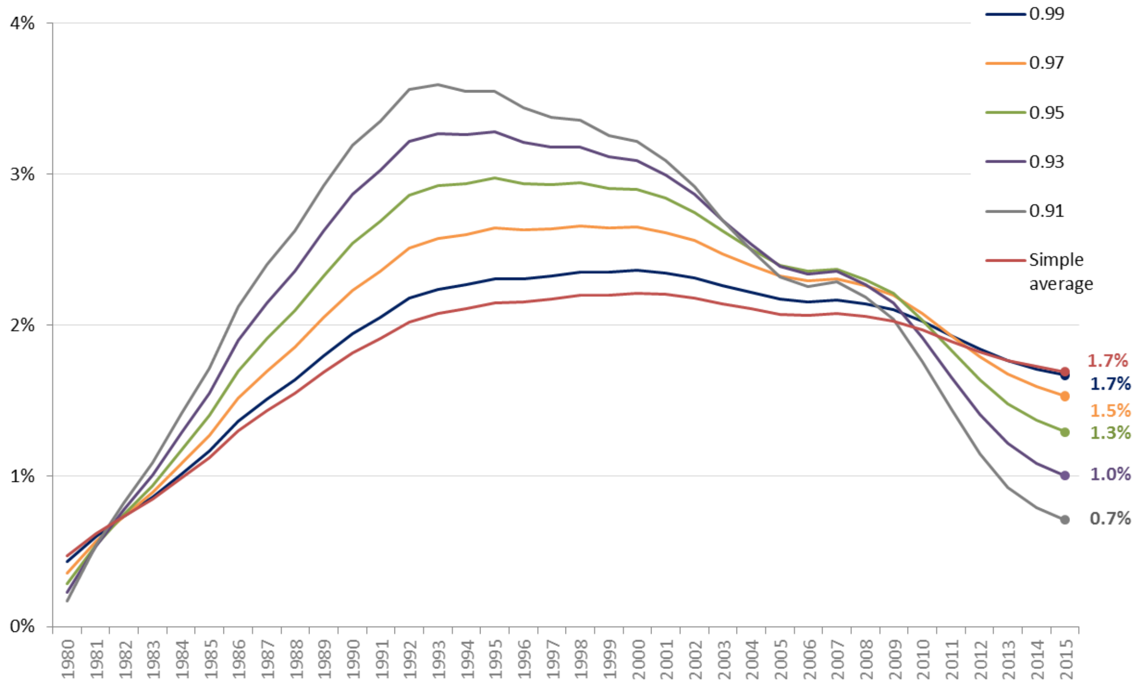


Figure 3. Impact of different control parameters on the average real rate



53. EIOPA also analysed the time series of real interest rates by means of autoregressive–moving-average (ARMA) models. For the time series from 1960 to 2015 the AR(1) model was found to be most appropriate. On that basis the long-term average real rate was estimated as 1.59%. The result confirms the appropriateness of the weighted average to derive the expected real rate. Details of the analysis can be found in Annex III.

Stakeholders feedback from the July 2015 consultation

54. Stakeholders were in favour of maintaining an approach where the real rate component of the UFR is based on historical data.

Findings

55. The compelling argument to maintain the current approach according to which the real rate component is derived on the basis on historical data is that it provides a stable output, in line with the requirement of the Delegated Regulation.

56. However, the current approach should be improved to not overly rely on data relating to the distant past. The balance between the need for a stable output and the need to capture trends of the real rates can be achieved by using a weighted average of historical real rates with geometric weights. The control parameter, when set at 0.99, ensures that recent data are given a higher, but not excessive, weight. Moreover, the use of a fixed control parameter ensures the transparency and predictability of the methodology and hence its replicability by insurance and reinsurance undertakings for their scenario calculations.

Conclusion of the review: EIOPA intends to maintain the use of historical real rates to derive the real rate component of the UFR. Instead of the arithmetic average used under the current approach, a geometrically weighted average with a fixed control parameter of 0.99 should be used.

3.3.2 Review of the database to compute the expected real rate

Current approach

57. The current approach was developed by CEIOPS for the QIS5 calibration. CEIOPS used the outputs provided by a study performed by Dimson, Marsh and Staunton on real returns of bonds over the period from 1950 to 2000[22] (see Annex 1 for further details).

Pros and cons of the current approach

	Pros	Cons
Dimson et al. study (2000)	• Annual updates of the data are available from a	• Real returns examined in this study do not correspond to

[22] Elroy Dimson, Paul Marsh and Mike Staunton, 2000, Risk and return in the 20th and 21th centuries, *Business Strategy Review* 11 (2), 1-18. See Figure 4 on page 5 of that publication.

	private entity.	real interest rates referred to in the Delegated Regulation. • The methodology used to derive those real returns is unknown. • It is unclear whether the term premium was removed from the long-term real bond returns. • The data series underlying the average real returns are not available.

Assessment of alternatives

58. Databases that allow computing a long-term average of real rates are rare and in most cases subject to licence.

- Dimson-Marsh-Staunton Global returns: The database provides real returns for 20 countries since end-1899. Morningstar EnCorr is the exclusive software distributor of the Dimson-Marsh-Staunton Global Returns data. Dimson-Marsh-Staunton Global Returns data is not included in the standard EnCorr data package and must be licensed separately.
- GFDatabase: The database operated by Global Financial Data Inc. provides historical data on short-term and long-term yields for 200 countries since 1520. It also provides inflation rates over the past 800 years.
- AMECO database: This is the macro-economic database of the European Commission. It is based on Eurostat data and serves for the macro-economic monitoring of for example the convergence criteria of Member States. The database provides short-term and long-term rates, both in nominal and real terms, from 1960.
- OECD MEI database: This database provides inflation rates for OECD countries and some non-OECD countries. For most countries, data start in the mid-1950s.
- Eurostat database: The statistical database of the European Union provides short-term and long-term interest rates as well as inflation rates for all countries belonging to the EEA and some non-EEA countries since 1997. This database is consistent with the AMECO database but it provides more granular data over a shorter period of time.

	Pros	Cons
Dimson-Marsh-Staunton Global returns	• The data are likely similar to those underlying the calibration and the current UFRs	• This database provides real returns, which are not equivalent to real interest rates sought by the Delegated Regulation. • This is a private source of data subject to licence and hence the appropriateness of the data for deriving real rate averages could not be checked.
GFDatabase	• This database provides the longest times series of nominal yields and inflation rates.	• This is a private source of data subject to licence and hence the appropriateness of the data could not be checked.
AMECO database	• This database provides the necessary data over more than 50 years. • The database is provided and maintained by a public institution.	
OECD MEI database	• This database provides the necessary data over more than 50 years. • The database is provided and maintained by a public institution. • This database was used to allocate currencies to bucket of inflation for the QIS5 calibration.	
Eurostat database	• The database is provided and maintained by a public institution.	• The database provides the necessary data, but only from 1997 on.

Stakeholders feedback from the July 2015 consultation

59. Not applicable (no question was asked on this particular point).

Findings

60. The compelling argument not to maintain the current approach is that the data series and the methodology to derive those data are unknown and hence the appropriateness of the data is not verifiable by EIOPA. Moreover, it is unclear whether those data are not fully in line with the requirements set out in Article 47 of the Delegated Regulation.

61. In turn, there is a compelling argument to use databases provided freely and maintained transparently by public institutions. Among the databases available, the AMECO database and the OECD MEI database have the advantage to cover a sufficiently long period of time to allow computing a long-term average real rate.

Conclusions of the review: EIOPA intends to change the source of data to derive the UFR and to use the EU AMECO database to obtain nominal rates and the OECD MEI database to obtain inflation rates.

3.3.3 Review of the number of expected real rates

Current approach

62. The current approach is based on a single real rate for all currencies.

Pros and cons of the current approach

	Pros	Cons
Single real rate component for all currencies	• This approach is prospective insofar as it is based on the expectations that economies will converge in the distant future. • This approach allows a consistent treatment across currencies. • Averaging real rates from several economies makes the real rate component more stable.	• Currency specificities are not taken into account.

Assessment of alternatives

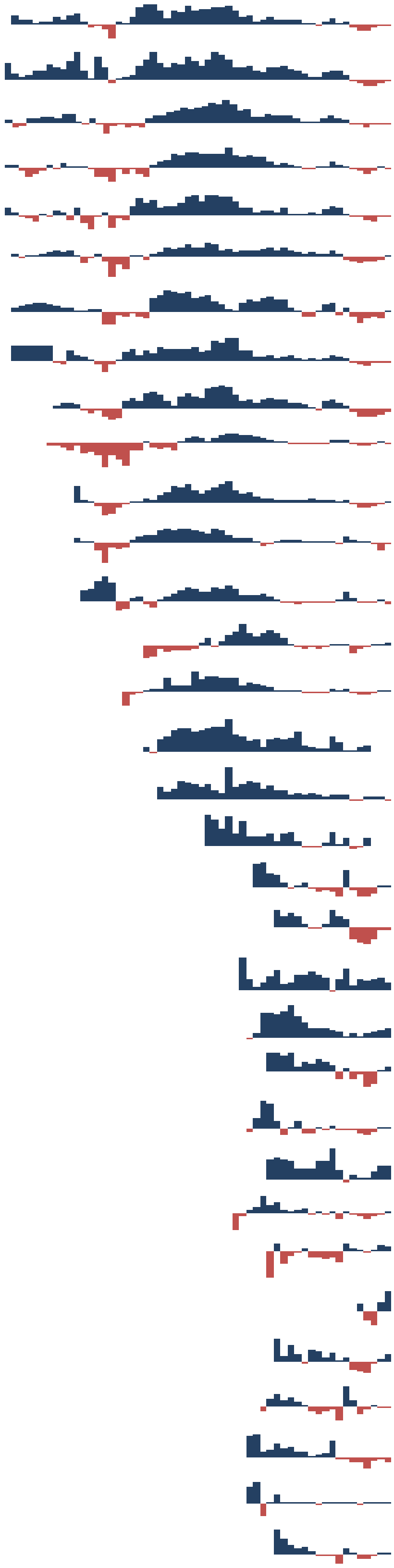
63. As opposed to a single real rate component for all currencies, it has been assessed whether the real rate component could be differentiated by currency.

	Pros	Cons
As many real rate components as currency	• Currency specificities are taken into account.	• This approach looks backward as it relies only on past experience of real rates in the economy concerned without regard to possible future convergence. • The possibility to derive as many real rate components as currency implies that consistent data across all currencies are available: this is not the case (see Table 2). • A currency-specific real rate component would lead to materially different real rate component across currencies (see Figure 4). • At least for some currencies the real rate component would be more volatile.

64. Table 2 shows that there is no consistent time series for all countries and currencies included in the database.

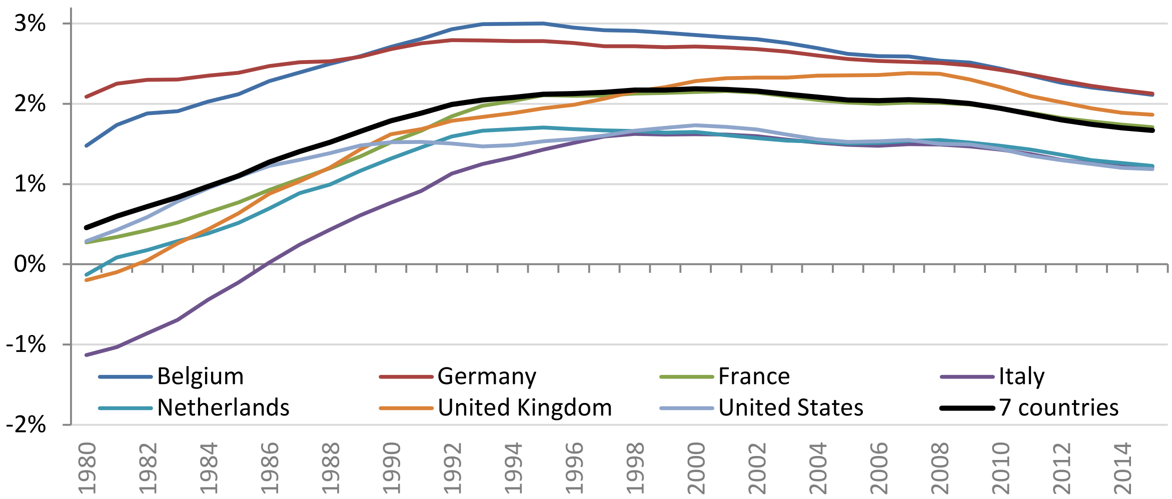
Table 2. Availability of time series of real rates provided by a public source of data

Country	Start year	End year	Time span	Evolution of real rates
Belgium	1961	2015	55	
Germany	1960	2015	56	
France	1961	2015	55	
Italy	1960	2015	56	
Netherlands	1960	2015	56	
United Kingdom	1961	2015	55	
United States	1961	2015	55	
Denmark	1961	2015	55	
Austria	1967	2015	49	
Portugal	1966	2015	50	
Finland	1970	2015	46	
Japan	1970	2015	46	
Ireland	1971	2015	45	
Greece	1980	2015	36	
Spain	1977	2015	39	
Norway	1980	2013	34	
Sweden	1982	2015	34	
Switzerland	1989	2013	25	
Estonia	1996	2015	20	
Luxembourg	1999	2015	17	
Hungary	1994	2015	22	
Poland	1995	2015	21	
Slovenia	1998	2015	18	
Slovakia	1995	2015	21	
Iceland	1998	2015	18	
Czech Republic	1993	2015	23	
Bulgaria	1998	2015	18	
Croatia	2011	2015	5	
Cyprus	1999	2015	17	
Latvia	1997	2015	19	
Malta	1995	2015	21	
Romania	1995	2015	21	
Lithuania	1999	2015	17	



65. Figure 4 shows that real rates vary across economies. However, it can be observed that overall they follow the same trends and that the differences between the currencies become smaller over time.

Figure 4. Determining a real rate component by currency/country



The graph starts in 1980 but the UFR levels depicted include data going back to 1960 (see 2.4 for further details). This means that the real rate component of the UFR is an average of 56 annual real rates in 2015, 55 in 2014 … and 20 in 1980. The smoothness of the curve increases with the number of constituents of the average.

Stakeholders feedback from the July 2015 consultation

66. The use of one single real rate for all currencies is in line with the stakeholder feedback during the consultation in July 2015.

Findings

67. The compelling argument to reject the possibility to differentiate the real rate component is that consistent data across all currencies and countries are not available. The use of a single average real interest rate for all currencies is then warranted for practical reasons given the lack of publicly available data.

<u>Conclusion of the review</u>: EIOPA intends to maintain the current approach according to which the real rate component is based on a single average real rate.

3.3.4 Review of the determination of the expected real rate

Current approach

68. The single real rate component is an arithmetic average of the real rates of 12 countries: Australia, Canada, Denmark, France, Italy, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

Pros and cons of the current approach

	Pros	Cons
Set of 12 countries: AU, CA, DK, FR, IT, DE, JP, NL, SE, CH, UK, US	• Use of all data available from the source used to derive the current UFRs	• Since the simple average over the real rates of the 12 economies gives strong weight to certain economies (e.g. Australia, Canada) that are underrepresented in the asset portfolios of European insurers and reinsurers.

Assessment of alternatives

69. It was considered whether this set of 12 countries should be retained. Table 3 shows that the weights of investments denominated in currencies other than the euro, pound sterling, US dollar and Swedish krona are not significant at the level of the European Economic Area. Thus there is an argument to limit the subset of real rates included in the average.

Table 3.Weights of currencies included in the current approach in the European portfolio of insurers' investments[23]

Currency	Currency weight
EUR	66,32%
GBP	23,69%
USD	4,70%
SEK	2,39%
JPY	0,44%
CHF	0,33%
AUD	0,23%

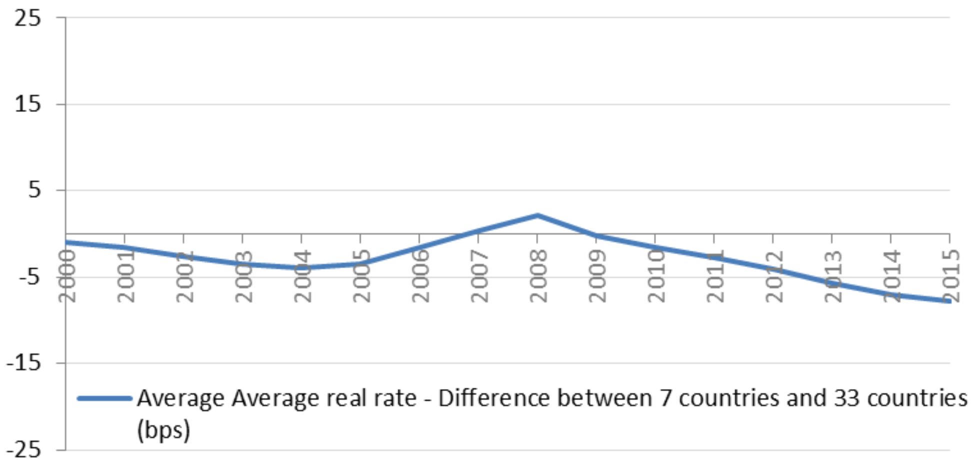
[23] The weights were derived from the preparatory reporting of insurance and reinsurance undertakings for Solvency II for end of 2014. Please note that the weight for DKK is low because the Danish market did not participate in the preparatory reporting.

CAD	0,23%
DKK	0,12%

70. In addition, looking at the availability of publicly available time series of real rates (see Table 2), the following 7 countries are the best candidates for composing the average single real rate with consistent time series: Belgium, France, Germany, Italy, the Netherlands, the United Kingdom and the United States.

71. For the purpose of testing the degree of approximation introduced by limiting the average single real rate to 7 countries, the impact of including all of the 30 countries of the EEA plus the United-States, Switzerland and Japan[24] was estimated. Figure 5 shows that this impact is low in average (absolute difference of 3 basis points from 2000 to 2015) and is not deemed material.

Figure 5. Impact of limiting the average of the single real rate to 7 countries (vs. using the data from 33 countries)



The graph starts in 2000 to include most of 33 countries in the comparison (only Croatia is reflected at a later stage – i.e. as of 2011 – see Table 2 for further details).

72. Conceptually, attaching geographical weights to the 7 countries according to the proportion of investments in euro, pound sterling and US dollar in the European insurers' representative asset portfolio should improve the representativeness of the real rate component. It was therefore assessed whether this would lead to results materially different to those obtained without attaching geographical weights.

73. For this purpose, currency weights representative of the European insurers and reinsurers' portfolio as at end 2014 were used. For the members of the

[24] For the purpose of this comparison, real rates composing the 7 countries average and the 33 countries average have been weighted according to the currency weights displayed in Table 4. For the Member States of the euro area, the currency weight has been re-scaled according to their GDP weights.

euro area, the euro currency weight has been re-scaled according to their GDP weights from 1960 to 2015.

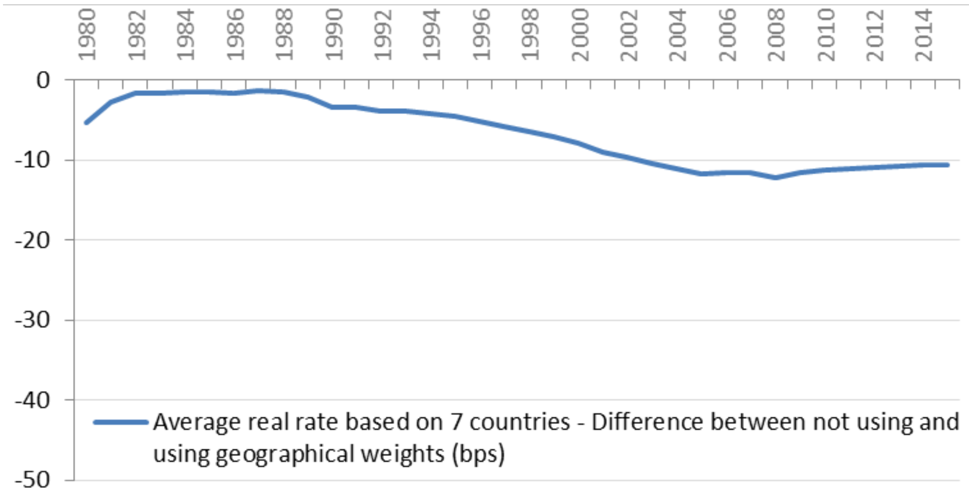
Table 4. Geographical weights used to test a more representative average for the real rate component

Currency	Currency weights
EUR	70%
GBP	25%
USD	5%

GDP weights for members of the euro area							
	Belgium	**Germany**	**France**	**Italy**	**Netherlands**	**United Kingdom**	**United States**
	EUR	EUR	EUR	EUR	EUR	GBP	USD
2000	3,3%	26,7%	18,7%	15,6%	5,7%	25,0%	5,0%
2001	3,2%	26,5%	18,8%	15,8%	5,8%	25,0%	5,0%
2002	3,3%	26,1%	18,9%	15,9%	5,9%	25,0%	5,0%
2003	3,3%	25,7%	19,0%	16,1%	5,9%	25,0%	5,0%
2004	3,3%	25,4%	19,2%	16,2%	5,9%	25,0%	5,0%
2005	3,4%	25,1%	19,3%	16,3%	6,0%	25,0%	5,0%
2006	3,4%	25,0%	19,4%	16,2%	6,1%	25,0%	5,0%
2007	3,4%	25,0%	19,4%	16,0%	6,1%	25,0%	5,0%
2008	3,5%	25,0%	19,5%	15,9%	6,2%	25,0%	5,0%
2009	3,5%	24,8%	19,6%	15,9%	6,2%	25,0%	5,0%
2010	3,6%	25,2%	19,5%	15,7%	6,2%	25,0%	5,0%
2011	3,6%	25,5%	19,4%	15,5%	6,1%	25,0%	5,0%
2012	3,6%	25,8%	19,5%	15,1%	6,0%	25,0%	5,0%
2013	3,6%	26,0%	19,5%	14,8%	6,0%	25,0%	5,0%
2014	3,6%	26,4%	19,3%	14,6%	6,0%	25,0%	5,0%
2015	3,6%	26,7%	19,2%	14,5%	6,0%	25,0%	5,0%

74. In terms of results, Figure 6 shows that the difference between the two approaches was around 7 basis points in average from 1980 to 2015 and above 10 basis points from 2000 to 2015.

Figure 6. Difference between the real rate component calculated with and without geographical weights



	Pros	Cons
Real rate component based on an average of 7 countries	• Allow using consistent time series of data (from 1960). • Easiest approach to replicate and simulate since no geographical weights are attached to the countries.	• Not fully representative since the average does not account for the fact that European insurers and reinsurers are not invested in each currency to the same degree.
Real rate component based on an average of 33 countries including geographical weights	• This approach makes use of all data available for the most representative countries and currencies.	• This approach is based on averaging time series of inconsistent length (see Table 2). • This approach is less replicable insofar as it implied to make use of further parameters (geographical weights) that are not observable by insurers
Real rate component based on an average of 7 countries including geographical weights	• Allow using consistent time series of data (from 1960). • This approach is more representative since the average accounts for the fact that European insurers and reinsurers are not invested in each currency to the same degree.	• This approach is less replicable insofar as it implied to make use of further parameters (geographical weights) that are not observable by insurers

Stakeholders feedback from July 2015 consultation

75. Not applicable (no question was asked on these particular points).

Findings

76. The compelling argument to retain a subset of 7 countries real rates in the average is the availability of consistent time series covering more than 50 years data. In terms of results, the exclusion of other time series is not material.

77. Both the use of 7 countries with and without geographical weights are appropriate approaches to derive the real rate component. Because the application of geographical weights does not affect materially the results and the calculation without geographical weights is simpler and easier to replicate a calculation without geographical weights is preferable.

Conclusion of the review: EIOPA intends to base the real rate component on historical real rates of the following 7 countries: Belgium, France, Germany, Italy, the Netherlands, the United Kingdom and the United States. No geographical weights are attached to the country real rates in the average.

3.3.5 Review of the way to exclude the term premium from the UFR

Current approach

78. It is unclear whether the current UFRs exclude the term premium because the source data for their calibration were long-term bonds. The current UFRs exclude the convexity effect which affects long-term yields[25].

Pros and cons of the current approach

79. The Delegated Regulation defines the term premium as the premium required by investors for the additional risk of holding long-term investments. The term premium also reflects the convexity effect which constrains long-term interest rates.

[25] The convexity effect arises from the fact that the relation between bond prices and bond yields is not linear. More precisely, the yield computed from the average bond price is less than the average yield. This is why the convexity effect is always a negative adjustment to the yield curve. The convexity of the yield curve explains why it is common to see that the yield on a 30-year zero-coupon bond is lower that the yield on a 20-year zero-coupon bond.

80. Using historical realised rates makes it simple to remove the term premium embedded in long-term interest rates. The term premium is usually measured as:

$$term\ premium = \frac{1 + long\ bond\ rate\ of\ return}{1 + short\ bond\ rate\ of\ return} - 1$$

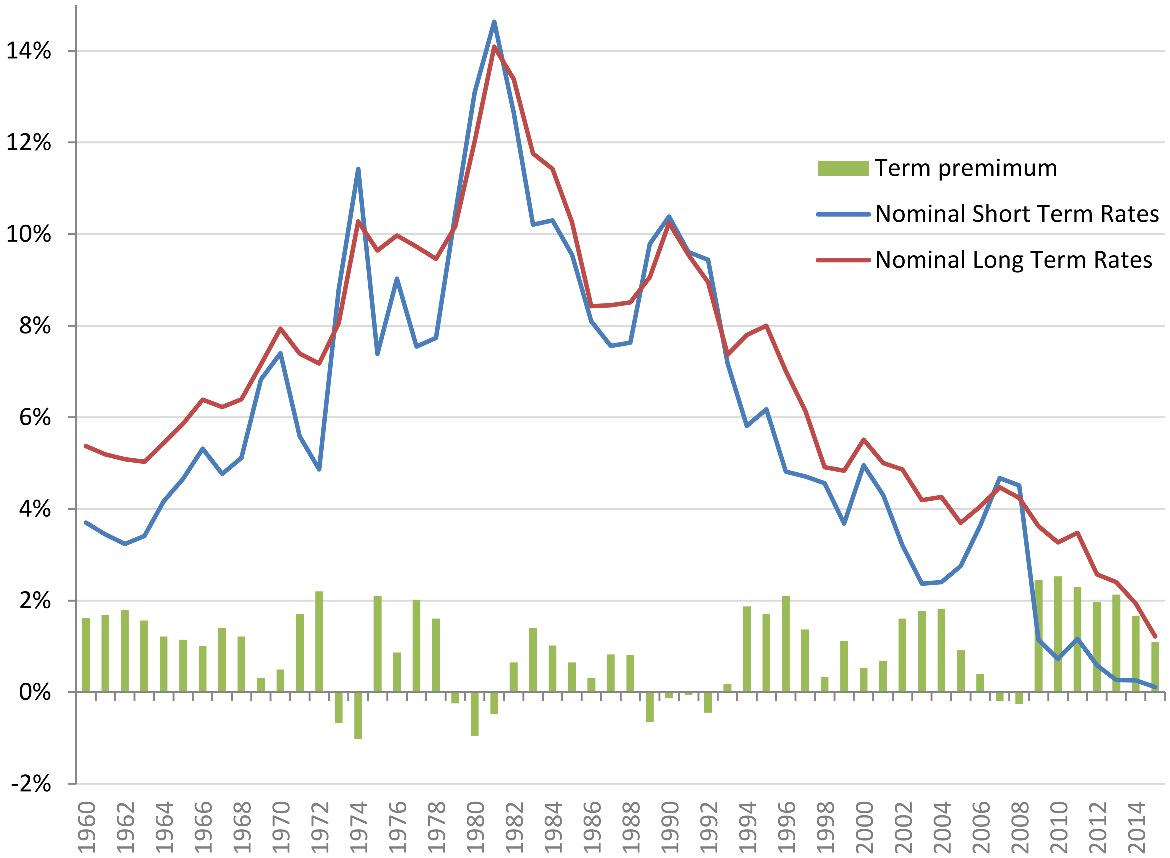
81. Therefore, approximately:

long-term interest rates – term premium = short-term interest rates.

Assessment of alternatives

82. Although the use of short-term interest rates in the current approach is technically justified, the removal of the term premium should be done explicitly and transparently. This can be achieved by using the AMECO database which provides both long-term and short-term interest rates.

Figure 7. Evolution of the term premium computed from the AMECO database



Stakeholders feedback from the July 2015 consultation

83. Stakeholders were in favour of not including the convexity effect in the methodology. Stakeholders were not asked about how to remove to term premium.

Findings

84. The use of short-term interest rates is the easiest way to exclude the term premium and the convexity effect from the real rate component of the UFR.

85. The use of the AMECO database allows for an explicit and transparent removal of the term premium because it provides both long-term interest rates and short-term interest rates.

Conclusion of the review: EIOPA intends to exclude the term premium (and the convexity effect embedded in the term premium) by using short-term interest rates from the AMECO database.

3.3.6 Review of the time span for the averaging the real rates

Current approach

86. The current approach is based on a 51 years window starting in 1950 and ending in 2000.[26]

Pros and cons of the current approach

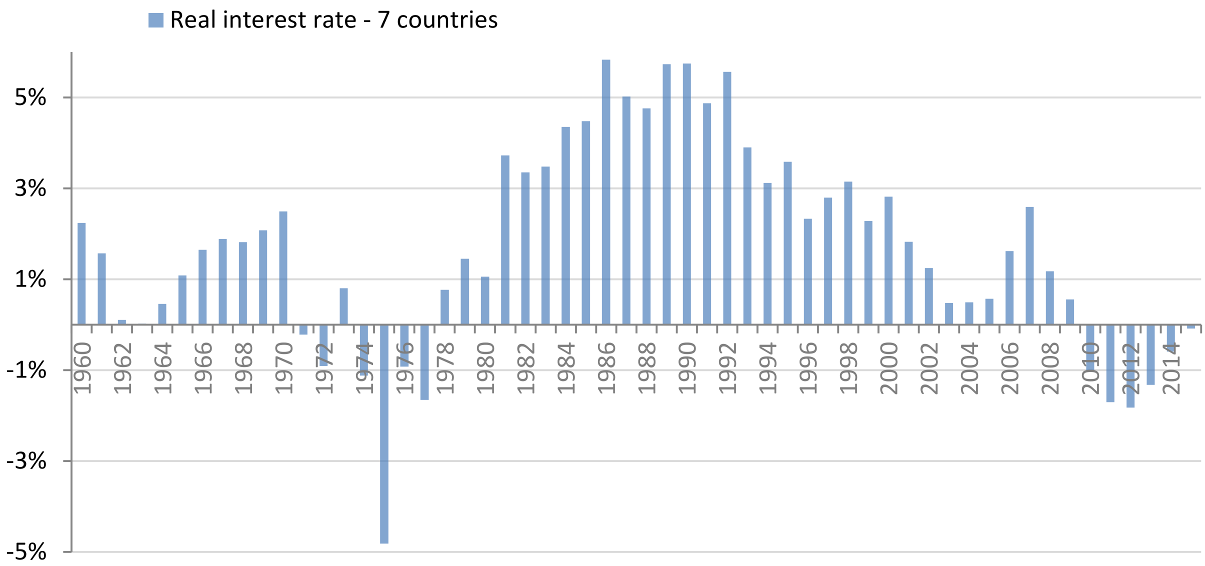
87. Not applicable because the time window is outdated. There is no reason to close the time window in 2000 while there are data for the following years. Furthermore, since the calibration of the current UFRs was a one-off exercise, it was not specified whether this time window should be conceived as a rolling window or a widening window.

Assessment of alternatives

88. By using the AMECO database and the OECD MEI database, it is possible to derive real interest rates for a subset of countries back to 1960.

[26] CEIOPS also considered the 2010 Credit Suisse Global Investment Return Yearbook (Dimson, Marsh, Staunton) in which real bond returns are provided for a period going from 1900 to 2009. Over this period the average real bond return was 1.7% against 2.3% for the period going from 1950 to 2000. CEIOPS chose a real rate component of 2.2%, indicating that the returns before 1950 had a very little influence in the final choice.

Figure 8. Annual short-term real interest rate for the period 1960-2015[27]



89. The average of real rates depends on the time period for the average. The longer the time period is the more stable the average will be. Two type of windows were tested:

Widening window starting in 1960

90. The average includes all real rates from 1960. Then the start date is fixed (1960) but not the end date, which changes every year (2015 in 2016, 2016 in 2017, etc.).

Rolling window starting later than 1960

91. The average encompasses only a specified number of recent rates. The time space is fixed (e.g. 10 years) but not the start date and the end date, which change every year (e.g. from 2006 to 2015 in 2016, from 2007 to 2016 in 2017, etc.).

	Pros	Cons
Widening window	• This approach provides the most stable UFR, as the average will includes the maximum number of rates. • This approach allows	• This approach attaches decreasing weight to new data28 and may therefore not capture changes in the level of real rates only with delay. This

[27] For the subset of 7 countries: BE, DE, FR, IT, NL, UK, US.
[28] A widening window means that the average will include a growing number of rates: year after year, the weight of each new value will decrease. At infinite, the average will converge to a constant value.

	including in the average all past economic cycles since 1960, thus providing an output more reflective of the long economic trends.	disadvantage is however mitigated by the use of a weighted average which attaches a higher weight to more recent data.
Rolling window	• This approach allows the UFR to react faster to changes in the level of real rates.	• The results of this approach may prove counter-intuitive because the yearly change of the real rate component does not depend of the trend of recent observation but on the difference of the oldest observation leaving the window and the new observation entering the window.

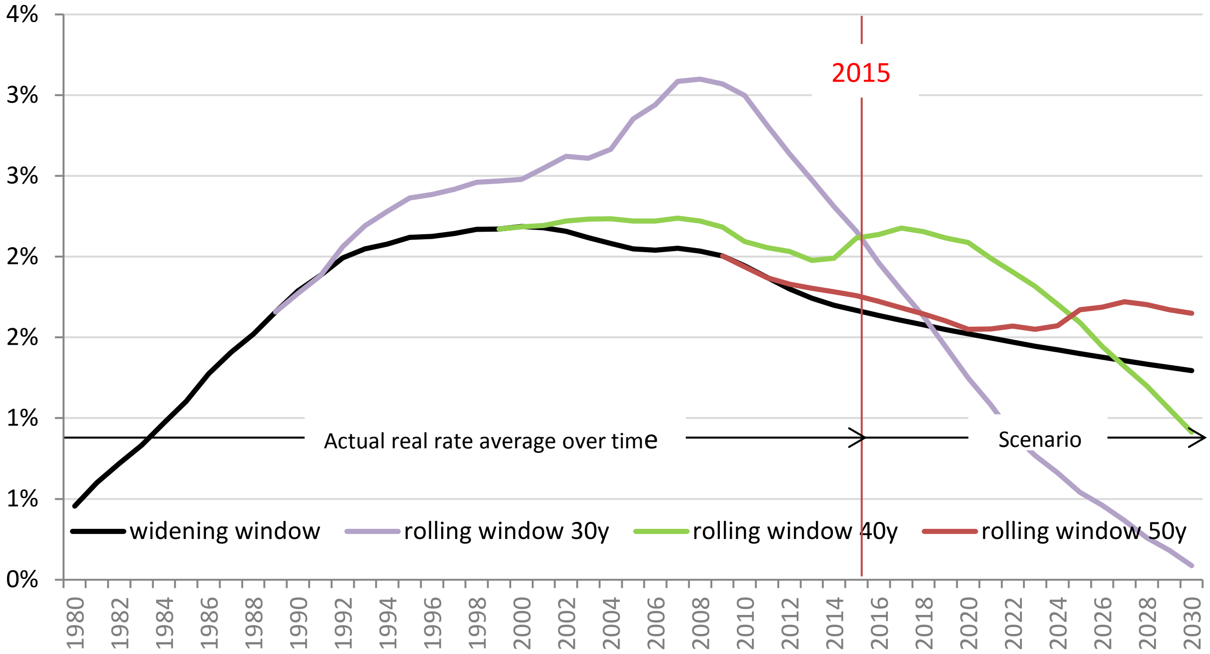
92. In addition, for the rolling window, three different time periods were studied:

- 50 years
- 40 years
- 30 years

93. The advantage of a longer time period is that the resulting average is more stable. The disadvantage of a longer time period is that the old data that enter the average may not be representative anymore for current and future market conditions.

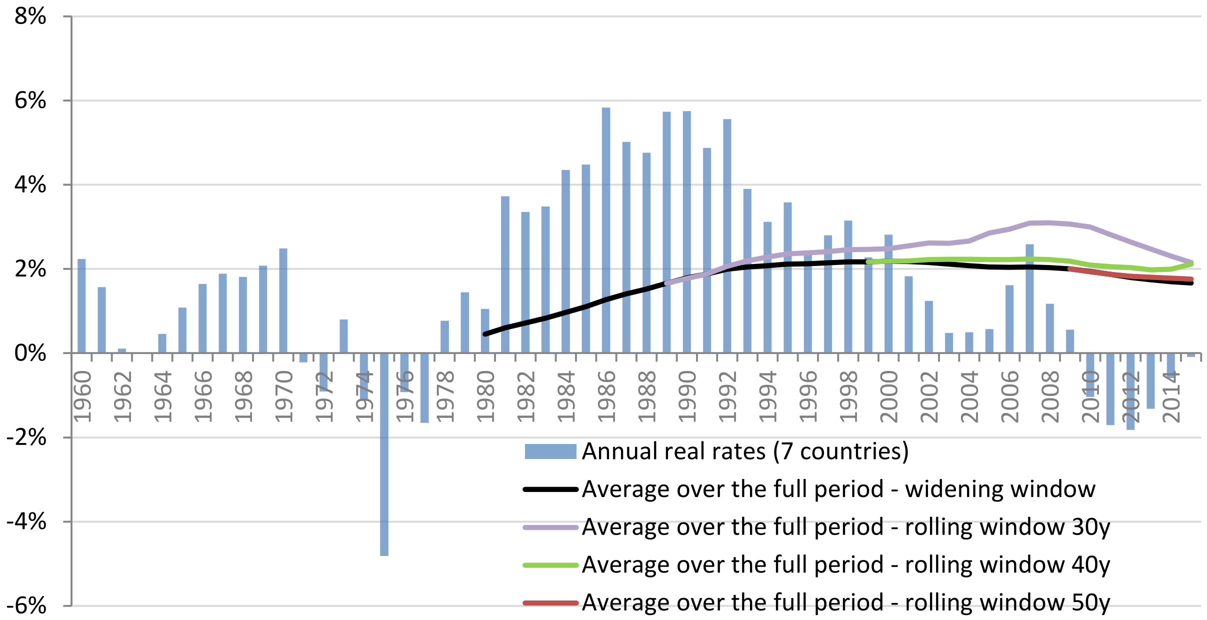
94. Figure 9 shows the evolution of the average real rate computed with a widening window (from 1960 to 2030) or rolling windows with a length of 30 years (from 1990 to 2030), 40 years (from 2000 to 2030) and 50 years (from 2010 to 2030). Until 2015, the graph provides the actual averages of real rates under each option. After 2015, a projection is made to show the evolution of the averages under each option under the assumption that the low yield and low inflation environment continues till 2030 (i.e. it is assumed that futures real rates after 2015 = real rates in 2015). The objective of this scenario is not to do a prediction, but to show how reactive the level of the UFR under each option is to persistently low rates.

Figure 9. Average real rates trends under each option (scenario with constant rate from 2015 onwards)



95. Figure 10 displays the same values as Figure 9 but it shows in addition the annual real rates (bar diagram). The difference between the bar diagrams and the curves highlights the smoothing effect provided by each averaging method.

Figure 10. Smoothing effect of averaging the real rates



Stakeholders feedback from the July 2015 consultation

96. Not applicable (no question was asked on this particular point).

Findings

97. Under a rolling-windows approach, the yearly change of the UFR would solely depend on the difference of the oldest observation leaving the window and the new observation entering the window. This could hide significant downward (resp. upward) trends if the oldest data points leaving the window happen to lie below (resp. above) the new points. For example, the 50 years rolling window approach would lead to an increase of the UFR in 2021 and a few years onwards because the low real rates of the 1970s fall out of the window, although the calculation is based on the assumption that low real rates persist from 2015 onwards.

98. In contrast to this, under a widening window approach, the direction of change only depends on the relative difference between the long-term historical average and the new value. Hence emerging trends from newer data would be recognised.

99. In addition, the widening window provides for a more stable average real rate component while the application of the geometric weighted average addresses the concern that old date may not reflect the current and future real rate level anymore.

<u>Conclusion of the review</u>: EIOPA intends to use a widening window starting in 1960 to average the real rate component.

3.4 Review of the determination of the expected inflation rate

3.4.1 Current approach

100. The current approach is based on three buckets of inflation rates. By default, currencies are allocated to a 2% inflation rate bucket, consistently with the most commonly used inflation target by central bank of developed markets.

101. Where past inflation experience over the last 10-15 years shows material deviations from 2% on a long-term basis, currencies are allocated either in the low inflation bucket of 1% or in the high inflation bucket of 3%.

3.4.2 Pros and cons of the current approach

102. It is easier to derive expected inflation rates than real interest rates since a large number of central banks operate with explicit or implicit inflation targets. All analysed existing methods based on a decomposition of nominal rates (QIS5 calibration, Barrie & Hibbert and IAIS calibration, see Annex I) use inflation targets as the main driver of expected inflation.

103. Inflation targets of central banks may not always be reached in practice in the short-term, but they usually have an important influence on the expected inflation.

	Pros	Cons
3 buckets approach with 2% as default expected inflation rate	• This approach is simple to implement, easy to replicate and allows for a stable output.	• The allocation method, based on past inflation experience, is not clearly specified and may rely too much on an expert judgment. • The inflation component may be deemed too low or too high for a specific currency where the inflation target does not coincide with one of the bucket values.

3.4.3 Assessment of alternatives

104. Three alternatives have been assessed. The main difference between those alternatives and the current approach is that the allocation to buckets is not based on an assessment of historical inflation rates but on the inflations targets themselves.

105. However, in a few cases (Croatian kuna, new Taiwanese dollar, Hong Kong dollar, Singapore dollar, Malaysian ringgit), a methodology needs to be implemented to overcome the absence of explicit inflation targets. It is based on the observation of historical inflation rates and a projection of expected inflation rates. The past inflation experience is assessed against the average of annual inflation rates of the last 10 years.

106. The projection of inflation rates is derived on the basis of an autoregressive–moving-average model (ARMA) calibrated with at least 10 years of monthly data. The projection is performed over a 50 years horizon from the date of calculation. The result of those simulations is used as an indicator but not as a prediction since projections that far in the future are model-dependent.

Alternative 1: Three buckets

107. As in the current system of UFRs, there are three buckets corresponding to three levels of expected inflation: 1%, 2% and 3%.The currencies are allocated to the three buckets according to the following rules:

- Currencies with an inflation target are allocated by default to the 2% bucket. However, where the inflation target is 1% or lower they are allocated to the 1% bucket and where the inflation target is 3% or higher they are allocated to the 3% bucket.
- Where a central bank is not targeting a specific inflation figure but tries to keep inflation in a corridor, the midpoint of that corridor is relevant for the allocation to the buckets.
- Currencies without an inflation target are also allocated by default to the 2% bucket. However, where past inflation experience and projection of inflations both clearly indicate that the inflation of a currency is expected in the long-term to be at least 1% higher or lower than 2%, the expected inflation rate will be chosen in accordance with those indications.

Alternative 2: Four buckets

108. There are four buckets corresponding to four levels of expected inflation: 1%, 2%, 3% and 4%. The currencies are allocated to the four buckets according to the following rules:

- The expected inflation rate is:
    - 1%, where the inflation target is lower than or equal to 1%,
    - 2%, where the inflation target is higher than 1% and lower than 3%,
    - 3%, where the inflation target is higher or equal to 3% and lower than 4%,
    - 4%, where the inflation target is 4% or higher.
- Where a central bank is not targeting a specific inflation figure but tries to keep inflation in a corridor, the midpoint of that corridor is relevant for the allocation to the buckets.
- Currencies without any inflation target are allocated by default to the 2% bucket. However, where past inflation experience and projection of inflations both clearly indicate that the inflation of a currency is expected in the long-term to be at least 1% higher or lower than 2%, the expected inflation rate will be chosen in accordance with those indications.

Alternative 3: Pure inflation target

109. The expected inflation for a currency is equal to the inflation target for that currency. Where a central bank is not targeting a specific inflation figure but tries to keep inflation in a corridor, the expected inflation is equal to the midpoint of that corridor.

110. For currencies without an inflation target the expected inflation is by default 2%. However, where the current monetary policy for that currency and the recent inflation clearly indicates that the inflation is in the long-term expected to be significantly lower or higher than 2%, a different expected inflation will be derived on the basis of the monetary policy of that currency.

	Pros	Cons
Alternative 1	• This approach is simple to implement, easy to replicate and allows for a stable output. • The allocation method, based on explicit inflation targets, is fully transparent for currencies with inflation target. (For the 5 remaining currencies without inflation target the method used is specified).	• The inflation component may be deemed too low or too high for a specific currency where the inflation target does not coincide with one of the bucket values.
Alternative 2	• This approach is simple to implement, easy to replicate and allows for a stable output. • The allocation method, based on explicit inflation targets, is fully transparent for most of currencies (for the 5 remaining currencies without inflation target, the method used is specified). • The fourth bucket better reflects the situation of some non-EEA currencies.	• The inflation component may be deemed too low or too high for a specific currency where the inflation target does not coincide with one of the bucket values.
Alternative 3	• The level of the inflation component is currency-	• Since the inflation component is not rounded to a bucket

	specific. • The inflation component will not be deemed too low or too high for a specific currency where the inflation target does not coincide with one of the bucket values.	value it may be more volatile with regard to small changes. • The expectations on long-term inflation may not always be in line with the inflation target. • No longer convergence of the European yield curves to the same discount rate.

111. The table below provides the existing official targets and shows the inflation component of the UFR under each alternative.

Table 5. Impact of the three alternatives on the inflation rate component (in bold are the changes compared to the current approach)

Currency		Inflation target (IT)	Current inflation component of the UFR	Alternative		
				1	2	3
EUR	Euro	below, but close to 2%	2%	2%	2%	2%
CHF	Swiss franc	less than 2%[29]	1%	1%	1%	1%
CZK	Czech koruna	2%	2%	2%	2%	2%
GBP	Pound sterling	2%	2%	2%	2%	2%
HRK	Kuna	No IT	2%	2%	2%	NA
HUF	Forint	3%	2%	**3%**	**3%**	**3%**
ISK	Króna	2.5%	2%	2%	2%	**2.5%**
NOK	Norwegian krone	2.5%	2%	2%	2%	**2.5%**
PLN	Zloty	2.5%	2%	2%	2%	**2.5%**
RON	Leu	2.5%	2%	2%	2%	**2.5%**
SEK	Krona	2%	2%	2%	2%	2%
AUD	Australian dollar	2%-3%	2%	2%	2%	**2.5%**
BRL	Real	4.5%	3%	3%	**4%**	**4.5%**
CAD	Canadian dollar	2%	2%	2%	2%	2%
CLP	Chilean peso	3%	2%	**3%**	**3%**	**3%**
CNY	Renminbi-yuan	4%	2%	**3%**	**4%**	**4%**
COP	Colombian peso	3%	2%	**3%**	**3%**	**3%**
HKD	Hong Kong dollar	No IT	2%	2%	2%	NA
INR	Indian rupee	8%	3%	3%	**4%**	**8%**
JPY	Yen	2%	1%	**2%**	**2%**	**2%**
KRW	South Korean won	2.5%-3.5%	2%	**3%**	**3%**	**3%**
MYR	Ringgit	No IT	2%	2%	2%	NA

[29] For the Swiss franc the objective to keep the inflation below 2% is interpreted as an inflation corridor from 0% to 2%.

MXN	Mexican peso	3%	3%	3%	3%	3%
NZD	New Zealand dollar	2%	2%	2%	2%	2%
RUB	Russian rouble	4.5%	2%	**3%**	**4%**	**4.5%**
SGD	Singapore dollar	No IT	2%	2%	2%	NA
THB	Baht	2.5%	2%	2%	2%	**2.5%**
TRY	Turkish lira	5%	3%	3%	**4%**	**5%**
TWD	New Taiwan dollar	No IT	2%	2%	2%	NA
USD	US dollar	2%	2%	2%	2%	2%
ZAR	Rand	3%-6%	3%	3%	**4%**	**4.5%**

112. Table 6 provides a summary of the results obtained for currencies without inflation targets according to alternatives 1 and 2.

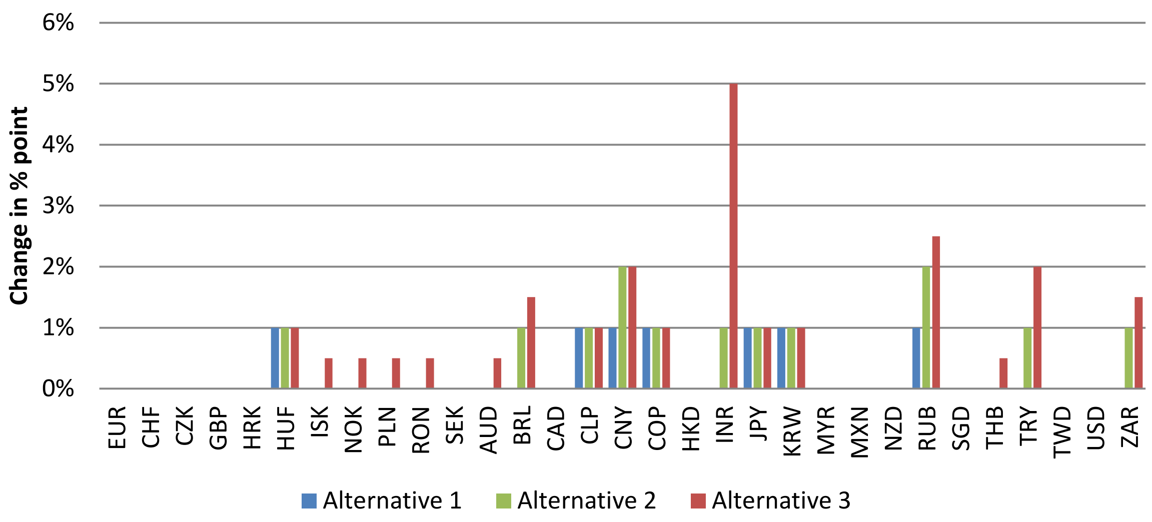
Table 6. Assessment of past and future inflation rates for currencies without inflation targets

Currency	**Average inflation rate over the last 10 years**	**Projection**	
		2050	2065
Croatian kuna	2.66	2.7	2.6
Malaysian ringgit	2.64	2.4	2.4
Hong Kong dollar	3.03	2.6	2.6
New Taiwan dollar	1.48	1.7	1.7
Singapore dollar	2.66	2.6	2.6

113. Both past inflation rates and projection of inflation rates indicate that those currencies can be allocated to a bucket of 2%. For Hong-Kong, the trend is downward and tends to the 2% bucket. Conversely, for Taiwan, the trend is upward and tends to the 2% bucket as well.

114. Figure 11 shows, for each currency, the increase or the decrease of the UFR under each option compared to the respective QIS5 UFR.

Figure 11. Change in inflation component by currency under each alternative



3.4.4 Stakeholders feedback from the 2015 public consultation

115. The use of inflation targets to derive the inflation component of the UFR is in line with the stakeholder feedback during the consultation in July 2015.

3.4.5 Findings

116. Inflation targets are appropriate instruments to measure expected inflation rates. This approach should be retained. However, the current approach lacks a clearly specified method to allocate currencies by buckets.

117. Among the alternatives, the compelling argument to retain the second alternative is that it ensures methodological continuity with the current approach while improving the representativeness of the UFR by the inclusion of a fourth bucket. Furthermore, compared to the third alternative, the impact on the currently used UFRs is more limited.

<u>Conclusion of the review</u>: EIOPA intends to retain the use of a bucketing approach based on inflation targets but to add a fourth bucket for high inflation markets.

3.5 Implementing changes of the UFR over time

3.5.1 Current approach

118. Since the current UFRs were derived in a one-off calibration, there is currently no specification as to how the UFR is to change as a result of changes in long-term expectations.

3.5.2 Assessment of alternatives

119. EIOPA intends to update the UFRs annually. A more frequent update would not be in line with the objective of stability. The updated UFRs will be announced every year by end of March. Three months after the announcement of the updated UFRs, EIOPA will use them to calculate the risk-free interest rate term structures. This warning period of three months should allow insurance and reinsurance undertakings to prepare for the possible change of the UFR.

120. Two elements have been assessed to stabilise the UFR:

- a method limiting the magnitude of annual changes,
- a method limiting the frequency of annual changes.

Limiting the magnitude of annual changes

121. On an on-going basis, large jumps of the UFR should be rare events. In particular, the expected real rate should not change significantly. However, the inflation component could change significantly when central banks change their inflation targets. A limitation of annual changes of the UFR might therefore be necessary to ensure the stability of the UFR.

Option 1

122. In order to avoid large jumps of the UFR, annual changes of the UFR shall be limited to 10 bps.[30]

123. For example, the inflation component of the UFR may increase by 1% because the central bank has increased the inflation target by that amount. That change would be phased in over 10 years, provided the real rate component of the UFR does not change during the 10 years.

Option 2

124. Same as option 1, but with a threshold of 20 bps.

[30] This can be ensured by applying the following corridor formula: $UFR_t^L = \max\left(UFR_{t-1}^L - 0{,}1\%; \min(UFR_t ; UFR_{t-1}^L + 0{,}1\%)\right)$, where the *UFR* denotes the calculated UFR before limitation of jumps and UFR^L denotes the applicable UFR after limitation of jumps.

Option 3

125. No such mechanism to limit annual changes.

126. In order to test the mechanism, Figure 12 and Figure 13 illustrate the effect of a cap of 10 bps and 20 bps for a sudden change of the inflation target from 2% to 1% and 3% respectively. The graph shows that the cap at 20 bps addresses effectively a sudden change of inflation target but it does not modify the "natural" course of the real rate average. Conversely, the cap at 10 bps does not specifically address the change of inflation target because it primarily modifies the course of the real rate average.

Figure 12. Effect of the cap following a change of inflation target from 2% to 3% in 1991

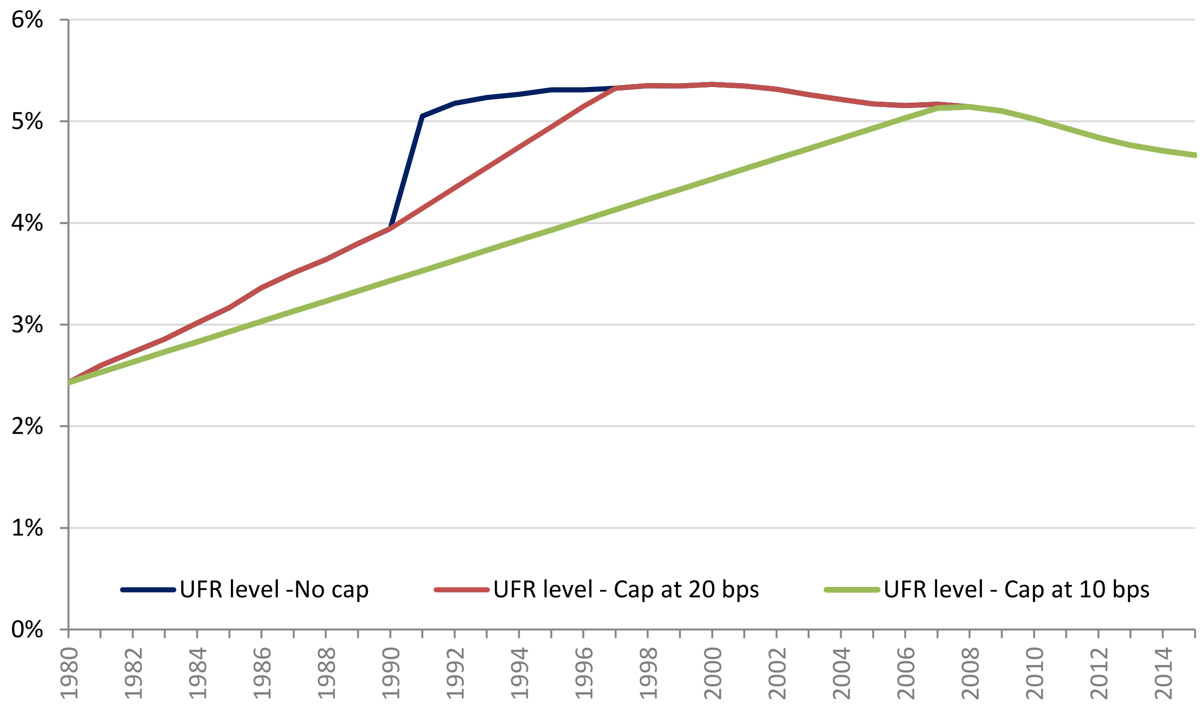
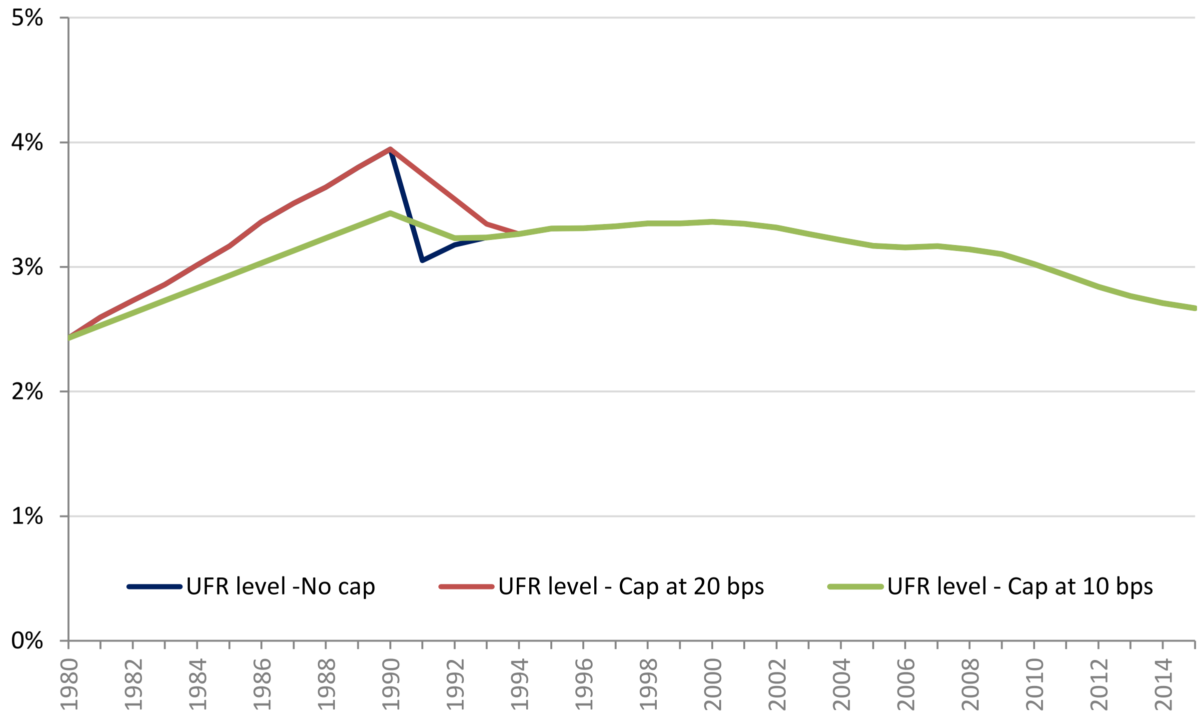


Figure 13. Effect of the cap following a change of inflation target from 2% to 1% in 1991



	Pros	Cons
Option 1	• The UFR is stabilized because it cannot move more than 10 bps per year.	• The UFR applicable can diverge largely from the UFR really calculated as it is not tailored to only capture change of the inflation component. • Additional layer of complexity to replicate and simulate the method.
Option 2	• The UFR is stabilized in case of large jumps caused by a change of inflation bucket. • The cap does not distort the trend embedded in the real rate component.	• Additional layer of complexity to replicate and simulate the method.
Option 3	• A change of inflation target is an indicator of change of long-term expectations. • Simplify the understanding of the UFR	• The UFR will change more sharply when long-term expectations change resulting in significant changes in insurers and reinsurers' technical provisions and own funds.

	level. • The method already includes smoothing mechanisms (long-term average/widening window/nearly fixed inflation component).	

Limiting the frequency of annual changes

127. It was also assessed whether little fluctuations in long-term expectations of real rates should be reflected in the annual update of the UFR.

Option 1

128. Little fluctuations of the real rate component of the UFR are avoided by the application of the following rounding rule. The real rate is rounded to full five basis points (i.e. to 2.00%, 2.05%, 2.10% etc) in the following way:

- When the unrounded real rate is lower than last years rounded real rate then the rounding is upward.
- When the unrounded real rate is higher than last years rounded real rate then the rounding is downward.

129. For example, if the rounded real rate is currently 2% and the unrounded real rates change annually as follows: 2.01%, 2.00%, 2.04%, 2.02%, 2.06%, 2.03% then the real rate is constant during the first 4 years and then changes to 2.05%.

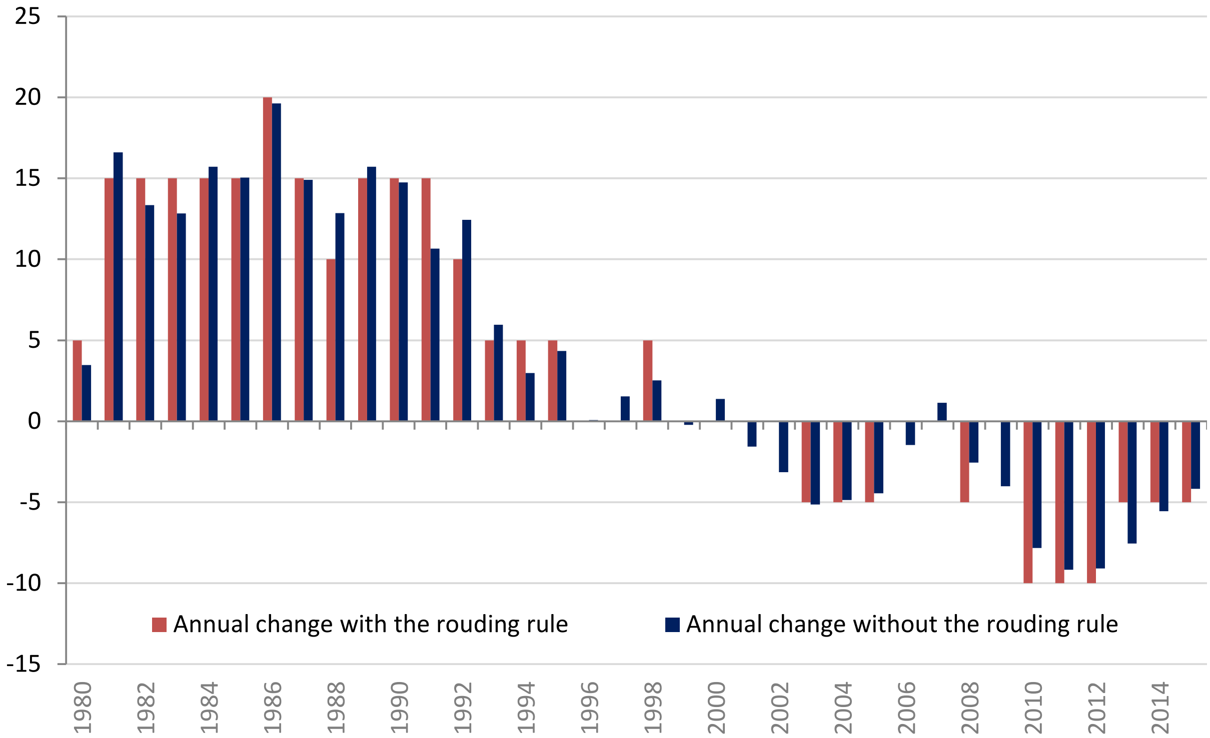
130. The rounding rule ensures that the rate only changes in if the unrounded real rate leaves a corridor of ±5 bps around the last rounded rate.

Option 2

131. No such mechanism.

132. Figure 14 shows that over the period 1980 to 2015, the UFR would have changed 26 times under Option 1 against 36 times (every year) under Option 2. However, changes are smoother under Option 2 than under Option 1.

Figure 14. Annual changes with and without mechanism to smooth little fluctuations



	Pros	Cons
Option 1	Avoids annual little erratic changes of the UFR.	Increased complexity in the understanding of the UFR level.
Option 2	Simplify the understanding of the UFR level.	The UFR is likely to change for a few basis points every year.

3.5.3 Stakeholders feedback from the July 2015 consultation

133. The introduction of a limit to the annual change of the UFR is in line with the stakeholder feedback during the consultation in July 2015.

3.5.4 Findings

134. The compelling argument to use a mechanism limiting the magnitude of annual changes, despite the fact that the methodology includes already various elements of stabilization of the outputs, is the possibility that a central bank changes suddenly and drastically its inflation target. In such a case, the application of a cap would avoid market disruptions.

135. On the other hand, it needs to be acknowledged that a change of inflation target indicates a change of long-term expectations. Therefore, the cap should not delay too much the update of the UFR in accordance with the new long-term expectations. In addition, the primary effect of a cap at 10 basis points is not to dampen sudden change of inflation bucket but to modify the trend of the real rate component.

136. It is thus considered that a cap of 20 basis points strikes the right balance between the necessity to update the UFR to changes of long-term expectations and financial stability. In addition, it does not distort the long-term expectations embedded in the trend of the real rate component.

Regarding the limitation of the frequency of annual changes, the argument to include such mechanism is that reflecting tiny fluctuations of the real rate component in the UFR level has little value added for supervision.

Conclusion of the review: EIOPA intends to apply mechanisms to limit the frequency of annual changes as well as the magnitude of annual changes (cap at 20 basis points).

3.6 Conclusion of the review

137. EIOPA intends to base to the methodology to derive the UFR on the following core guidelines:

- UFR = expected real rate + expected inflation rates
- The expected real rate:
  - is a single real interest rate for all currencies
  - is based on a widening window average of historical data obtained using the public AMECO and OECD databases,
  - includes time-dependent weights following a geometric series with a control parameter of 0.99,
  - excludes the term premium by using short-term interest rates.
- The expected inflation rates:
  - are based on central banks' inflation targets,
  - are allocated to four buckets of 1%, 2%, 3% or 4%.

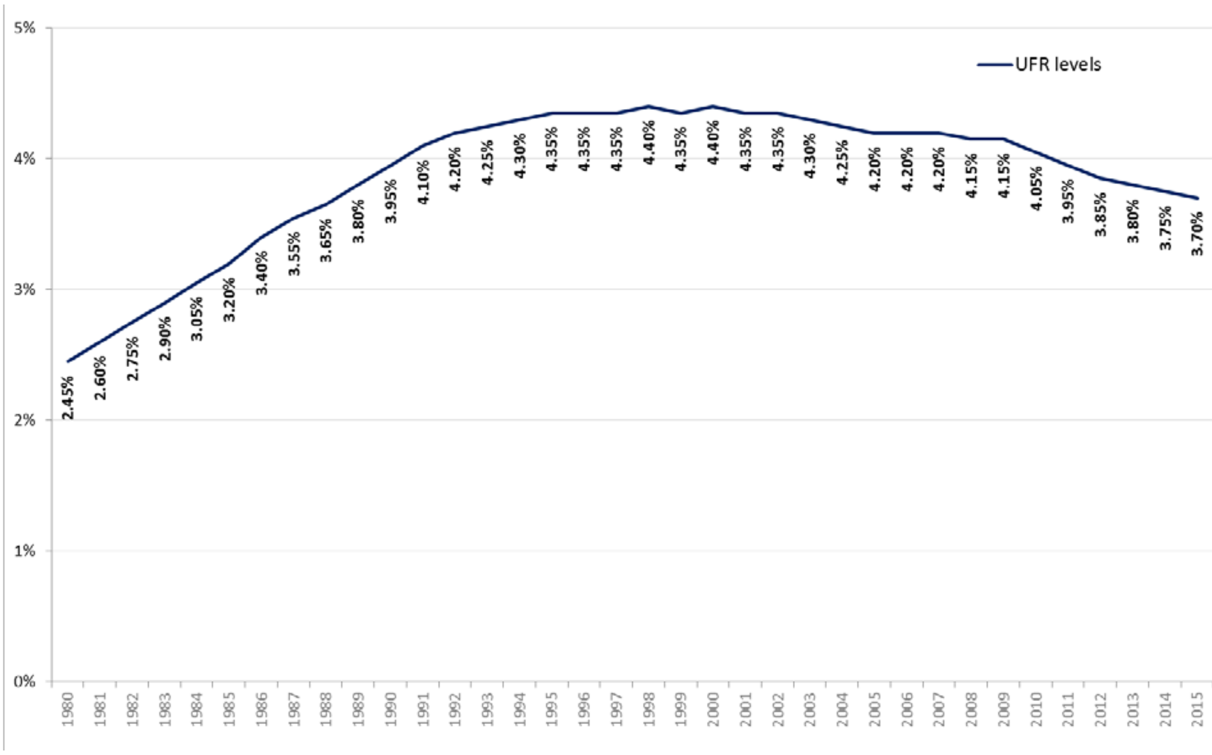
- Annual changes of the UFR cannot exceed 20 basis points and annual changes of the real rate component are discarded when the updated value does not differ from the previous one by more than 5 basis points.

Table 7. Comparison between the current approach and the revised methodology

Items	Current approach	Revised methodology
1. Review of the general approach	UFR = real rate + inflation	Same
2.1 Review of the instruments used for estimating the expected real rate	Arithmetic average of historical data	Weighted average of historical data with geometric weights
2.2 Review of the database to compute the real rate component of the UFR	A study from E. Dimson, P. Marsh and M. Staunton (2000) Credit Suisse Yearbook OECD	European Commission OECD
2.3 Review of the number of real rate estimates	A single averaged real rate for all currencies	Same
2.4 Review of the way to exclude the term premium	Not known	Use of short-term real rates to exclude the term premium
2.5 Review of the time span of the average real rate component	A fixed window from 1950 to 2000	A widening window starting in 1960
3. Review of the determination of the inflation rate component of the UFR	Inflation target of 2% by default + past inflation rates to possibly allocate currencies in the low or in the high inflation buckets	Use of inflation targets to allocate currencies into four buckets
4. Implementing changes of the UFR over time	Not specified	Annual changes of the real rate component are discarded when the updated value does not differ from the previous one by more than 5 basis points. Annual changes of the UFR cannot exceed 20 basis points.

138. Figure 15 exhibits the UFR estimated according to this methodology from 1980 to 2015.

Figure 15. UFR levels estimated according to the reviewed methodology (for a constant inflation rate component of 2%)



The graph starts in 1980 but the UFR levels depicted include data going back to 1960 (see 2.4 for further details). This means that the real rate component of the UFR is an average of 56 annual real rates in 2015, 55 in 2014 … and 20 in 1980. The smoothness of the curve increases with the number of constituents of the average.

139. **Table 8** below sets out the UFRs by currency for 2016 obtained with the revised methodology.

Table 8. UFRs by currency in 2016 with the revised methodology

UFR	Currency
2.7%	CHF
3.7%	AUD, CAD, EUR, CZK, GBP, HRK, HKD, ISK, JPY, MYR, NOK, NZD, PLN, RON, SEK, SGD, THB, TWD, USD
4.7%	COP, CLP, HUF, MXN, KRW
5.7%	BRL, CNY, INR, RUB, TRY, ZAR

3.7 Initial Implementation of the revised methodology

140. EIOPA intends to implement the methodology in 2017. Since a change of the UFR affects the valuation of payments with a maturity after the last liquid point, the impact of changing the UFR on the technical provisions is expected to be material for insurance and reinsurance undertakings with significant long-term liabilities. It may therefore be unnecessarily disruptive to immediately apply the new UFR methodology without, for example phasing it in.

3.7.1 Assessment of alternatives

141. The revised methodology includes a limitation of annual changes to 20 bps. The UFR for a specific year therefore depends in particular on the UFR of the previous year. In particular, at the first year of the implementation in 2017, the UFR of the previous year needs to be specified. If for example for the euro the current UFR of 4.2% is chosen as the UFR of the previous year, then the 20 bps limit will result in a phasing in of the new UFR level: the UFR will change every year by at most 20 bps until the new level is reached. For example, if the UFR for the euro calculated with the revised methodology stays at 3.7% during the following years, then the UFR after limitation of annual changes would be 4.0% in 2017, 3.8% in 2018 and 3.7% in 2019.

142. A slower phasing in could be achieved by applying a lower limit to the annual UFR changes for a specified period of time. For example, the limit to annual changes could be 10 bps for the first 5 years of the application of the revised methodology. If the UFR for the euro calculated with the revised methodology stays at 3.7% for the following years, then the UFR after limitation would be 4.1% in 2017, 4.0% in 2018, 3.9% in 2019, 3.8% in 2020 and 3.7% in 2021.

143. As an alternative, the revised methodology could be applied in 2017 based on a UFR for 2016 that is also calculated with the revised methodology (e.g. 3.7% for the euro). Then the new UFR level would not be phased in. For example, if the UFR for 2017 calculated with the revised methodology would still be 3.7%, then the UFR would fall from 2016 to 2017 by 50 bps, namely from 4.2% to 3.7%.

- Option 1: To apply the methodology in 2017, based on the UFR for 2016 that is currently used (e.g. a UFR of 4.2% for the euro), but limit annual changes to 10 bps for five years – phasing in by 10 bps per year.

- Option 2: To apply the methodology in 2017, based on the UFR for 2016 that is currently used (e.g. a UFR of 4.2% for the euro) – phasing in by 20 bps per year.
- Option 3: To apply the revised methodology in 2017, based on a UFR for 2016 that is calculated according the same methodology (e.g. a UFR of 3.7% for the euro) – no phasing in.

	Pros	Cons
Option 1	• The UFR is stabilized because it cannot move more than 10 bps per year.	• The adjustment to more appropriate level of the UFR is delayed. • Limitation not consistent with ongoing application of the methodology.
Option 2	• The UFR is stabilized because it cannot move more than 20 bps per year. • The limitation of annual change is consistent with the ongoing application of the methodology.	• The adjustment to more appropriate level of the UFR is delayed, although not as long as under option 3.
Option 3	• UFR immediately reaches more appropriate level. •	• May cause UFR jump at the implementation of the methodology; this is not in line with the stability objective of the UFR and may have significant impact on the technical provisions and own funds of insurance and reinsurance undertakings.

3.7.2 Findings

144. Because of the significant impact on the financial position of insurance and reinsurance undertakings option 3 is not considered appropriate. On the other hand, a stronger limitation of annual changes at implementation than on an ongoing basis, as provided by option 1, does not appear to be necessary. In particular, the UFR changes that need to be phased in at the implementation of the methodology are not larger than the changes that may occur on an ongoing basis, for example when an inflation target is changed significantly. It is therefore proposed to implement the revised methodology in accordance with option 2, consistent with the treatment of changes of the UFR on an ongoing basis.

Questions to stakeholders:

Q1: The proposed methodology is based on the same calculation approach that was used to calculate the current UFRs, in particular UFR is proposed to be the sum of expected real rate and expected inflation. Do you agree with that approach?

Q2: According to the proposed methodology the expected real rate is calculated on the basis of past real rates since 1960 (widening window approach). Do you consider that to be an appropriate period for averaging the past real rates?

Q3: The expected real rate of the proposed methodology is derived as a weighted average of past real rates. Which weights do you consider appropriate for that purpose?

Q4: According to the proposed methodology, there are four buckets for the expected inflation rate (1%, 2%, 3% and 4%). Do you consider it appropriate to use inflation buckets and the choice of buckets adequate?

Q5: The proposed methodology includes a limit to the annual change of the UFR of 20 bps. Do you consider such a limit necessary and appropriate?

Q6: According to the proposed methodology the expected real rate component is rounded to 5 bps. Do you consider such a rounding necessary and appropriate?

Q7: Do you consider the proposed implementation of the methodology appropriate?

4. Impact of changing the UFR

4.1 Introduction

145. This section sets out analysis of the impact of changing the UFR on:

- the risk-free interest rate term structures,
- the time value of money,
- the value of two example contracts,
- the value of life insurance portfolios submitted to the 2014 stress test.

146. The results presented in this section show in particular:

- The impact of a UFR change on the term structures differs significantly by currency.
- The impact of a UFR change on the time value of money is usually limited.
- The impact of a UFR change on the present value of an immediate annuity of a 65 year old person is usually small, but may be more relevant for deferred annuities.
- Based on data of the 2014 stress test, the impact of a UFR change for the euro is not material for the present value of guaranteed benefits of most life insurance portfolios. However, there are insurance portfolios with long-term guarantees that could be significantly affected by a change of the UFR.

147. The analysis set out in this section is based on the risk-free interest rate for end-December 2015. For the analysis of the 2014 stress test data risk-free interest rates for end-August 2015 were used. The impact is not expected to be materially different for more recent interest rates.

4.2 Impact on term structures

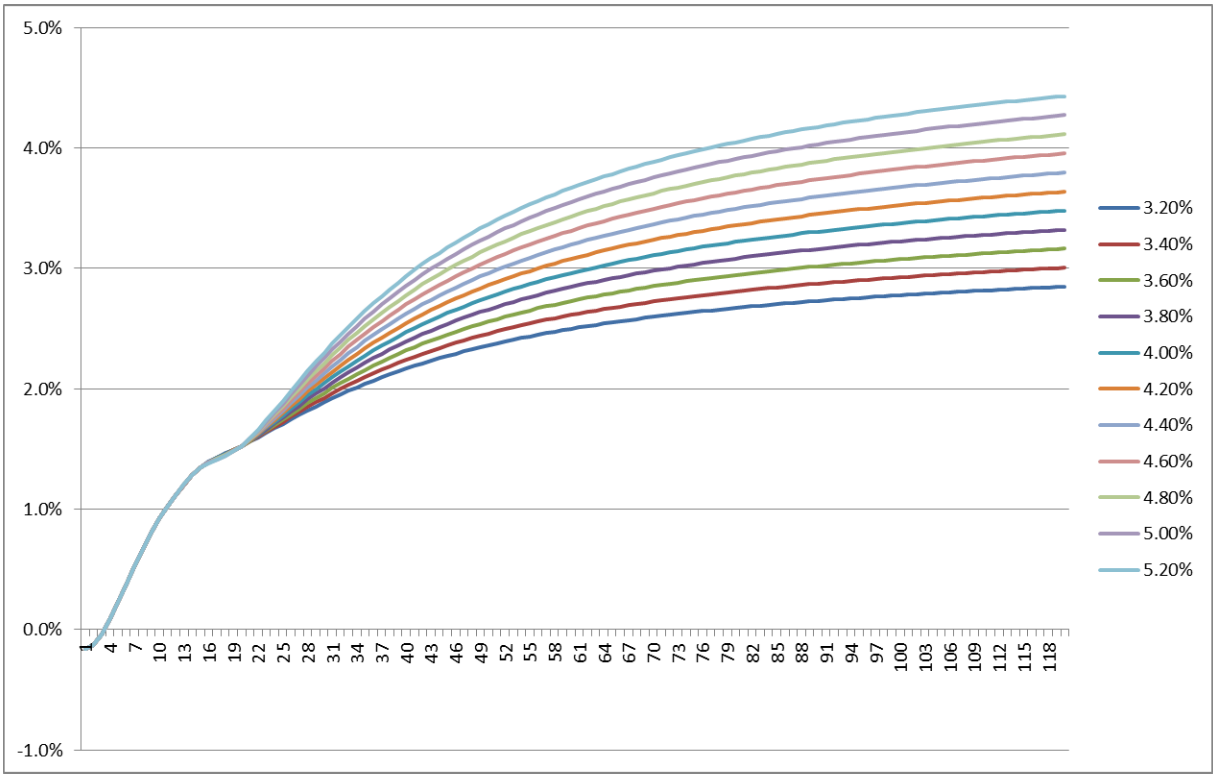
148. Figure 16 show basic risk-free interest rate term structures for the euro, calculated for a range of UFRs differing by up to ± 100 bps from the currently used UFR.

149. A change of the UFR primarily affects the risk-free interest rates beyond the last liquid point of the term structures. The impact on the maturities up to the last liquid point is immaterial. Beyond the last liquid point, the impact increases with the maturity of the risk-free interest rates. The change in

risk-free interest rates converges slowly to the amount whereby the UFR was changed.

150. For the euro the last liquid point is 20 years. A change of the UFR therefore affects the maturities beyond 20 years. For example an increase of the UFR by 10 bps would increase the risk-free interest rate for the maturity of 30 years by about 2.1 bps. For the maturity of 40 years the increase in the rate is about 3.9 bps and for 50 years about 5 bps.

Figure 16. Euro term structure for different UFRs

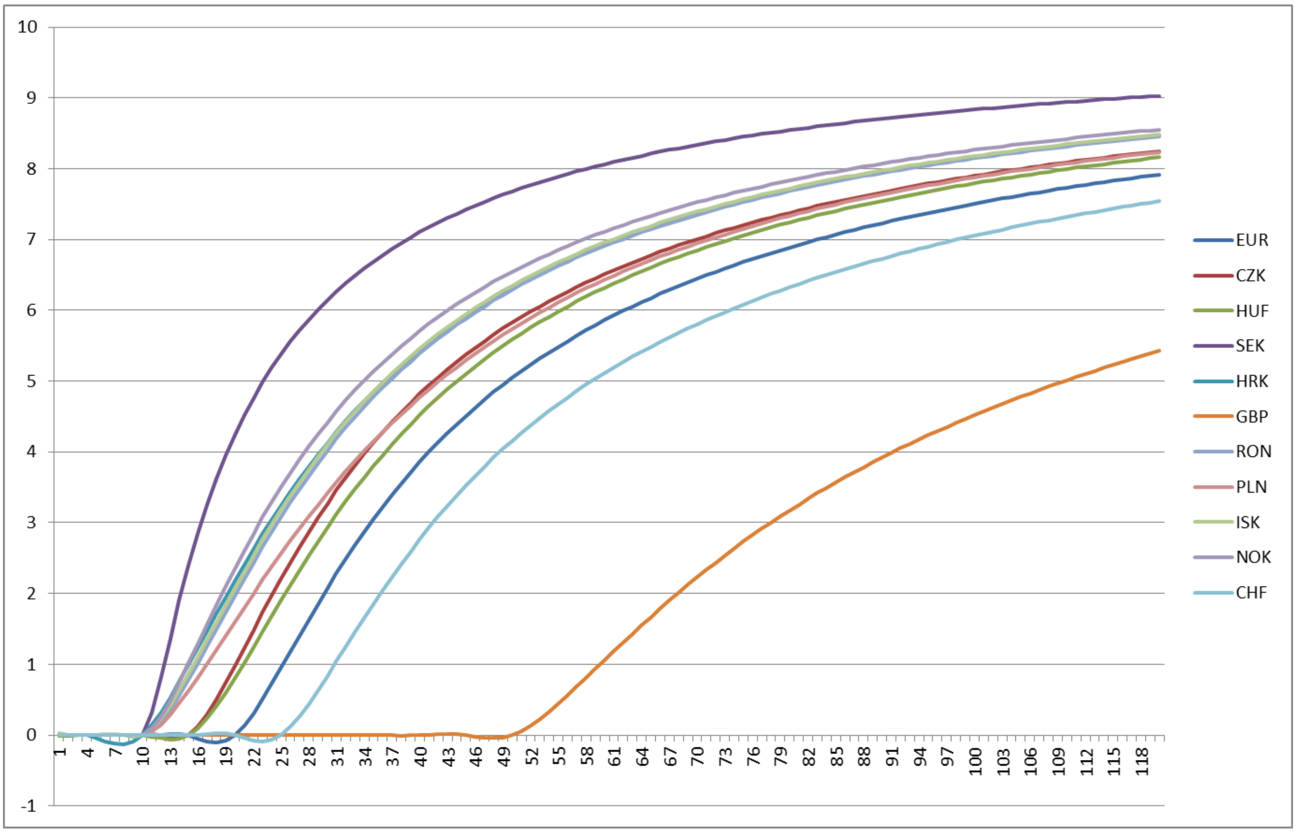


151. Similar figures for all other EEA currencies and for the US dollar and the yen can be found in Annex III.

152. The change of the extrapolated risk-free interest rates depends approximately linearly on the change of the UFR. Figure 17 shows the impact on the risk-free interest rates (in bps) for an increase of the UFR by 10 bps. The impact of a decrease by 10 bps or a larger increase or decrease easily derived from the graph by an appropriate multiplication of the depicted impact. For example, for the euro and the maturity of 30 years the impact of increasing the UFR by 10, 20 or 30 bps is an increase of risk-free interest rates of 2.1, 4.2 or 6.3 bps respectively. Decreasing the UFR by 10, 20 or 30 bps would lower the rates by 2.1, 4.2 or 6.3 bps respectively

153. Please note that in the graph the curves for the Hungarian forint and the Norwegian krone are partly hidden by the curve for the Icelandic króna because they almost coincide.

Figure 17. Change of risk-free interest rates (in bps) for an increase of the UFR by 10 bps



154. The impact depends in particular on the last liquid point and the speed of convergence towards the UFR. The highest impact can be observed for the Swedish krone (LLP of 10 years, convergence period of 10 years) and the lowest impact for the pound sterling (LLP of 50 years, convergence period of 40 years). The following table sets out how the risk-free interest rates of 30 years maturity increase when the UFR is raised by 10 bps.

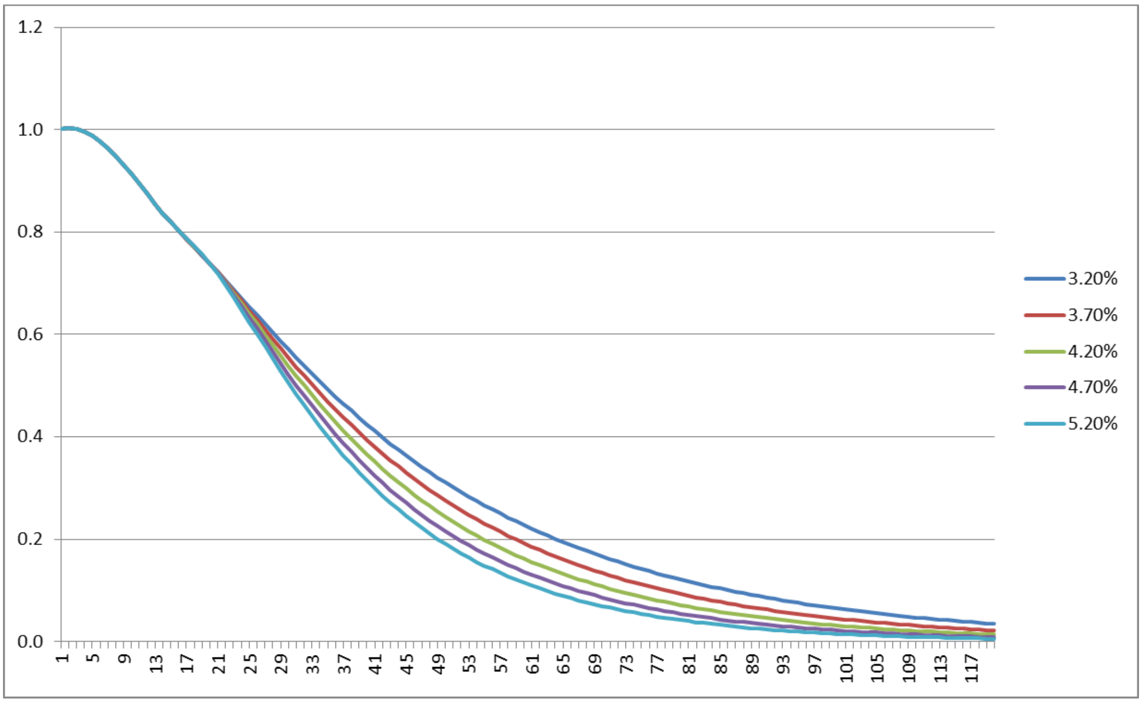
Table 9. Impact of increasing the UFR by 10 bps on the 30y risk-free interest rate of different currencies

Currency	EUR	CZK	HUF	SEK	HRK	GBP	RON	PLN	ISK	NOK	CHF
Rate increase (in bps)	2.1	3.3	2.9	6.1	4.1	0.0	4.0	3.4	4.1	4.4	0.8

4.3. Impact on time value of money

155. Figure 18 shows the discounted value of a future payment of 1 euro for different maturities (time value of money). The curves correspond to the current UFR and changes of its amount by ±50 bps and ±100 bps.

Figure 18. Impact of different UFRs on the time value of money for the euro



156. Figure 19 shows the absolute change of the time value of money and the relative change (percent) for the euro and a range of UFRs.

157. The absolute change is rather limited. For a decrease of the UFR by 50 bps the time value of money changes by up to 0.032 euro, reaching a maximum at a maturity of about 50 years.

158. The relative change, set out in figure 20, increases with the maturity. For a decrease of the UFR by 50 bps the time value of money at the maturity of 30 years increases by 3%.

Figure 19. Absolute change of time value of money

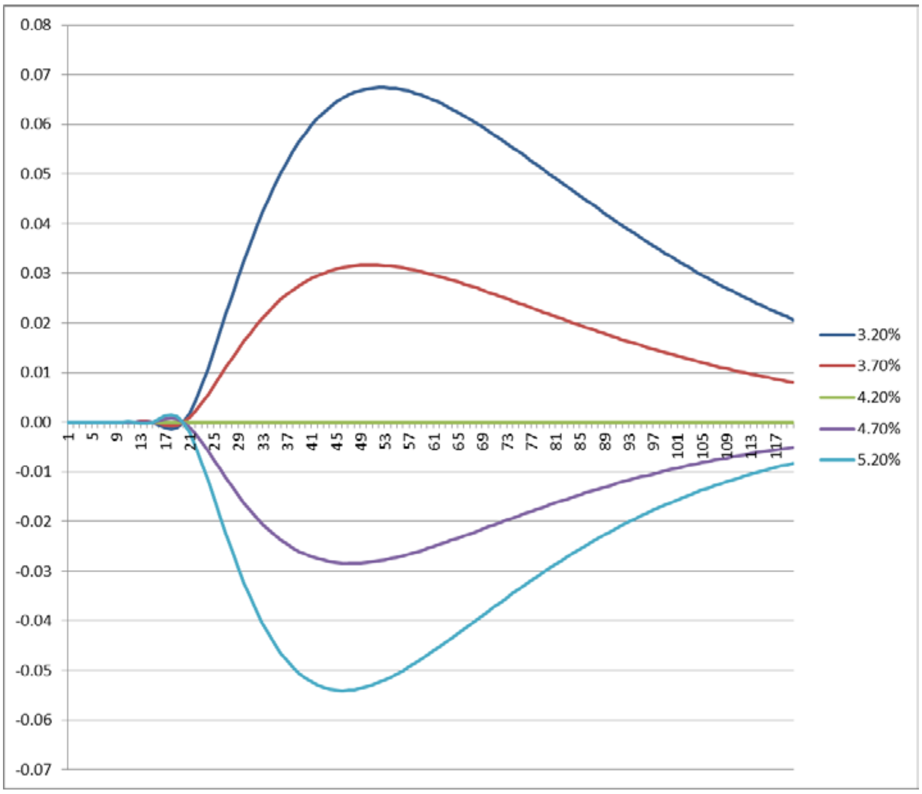
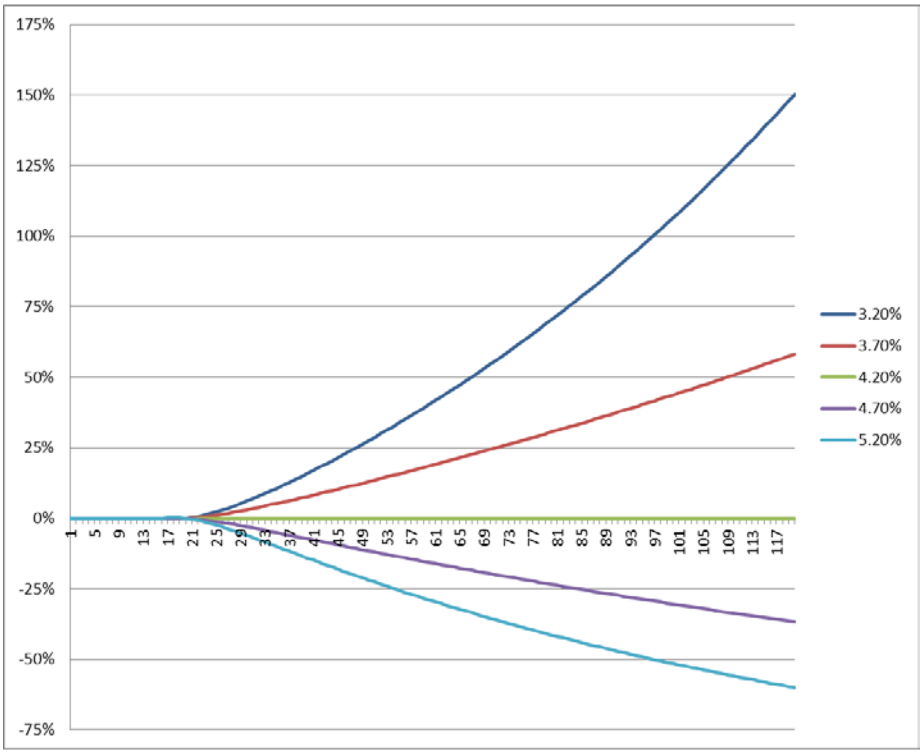


Figure 20. Relative change of time value of money



159. The impact is higher for the currencies that whose rates are more affected by a UFR change. For example, for the Swedish krona a decrease of the UFR by 50 bps results in an increase of the time value of money by up to 0.037 krona. For a decrease of the UFR by 50 bps the time value of money at the maturity of 30 years increases by 9%.

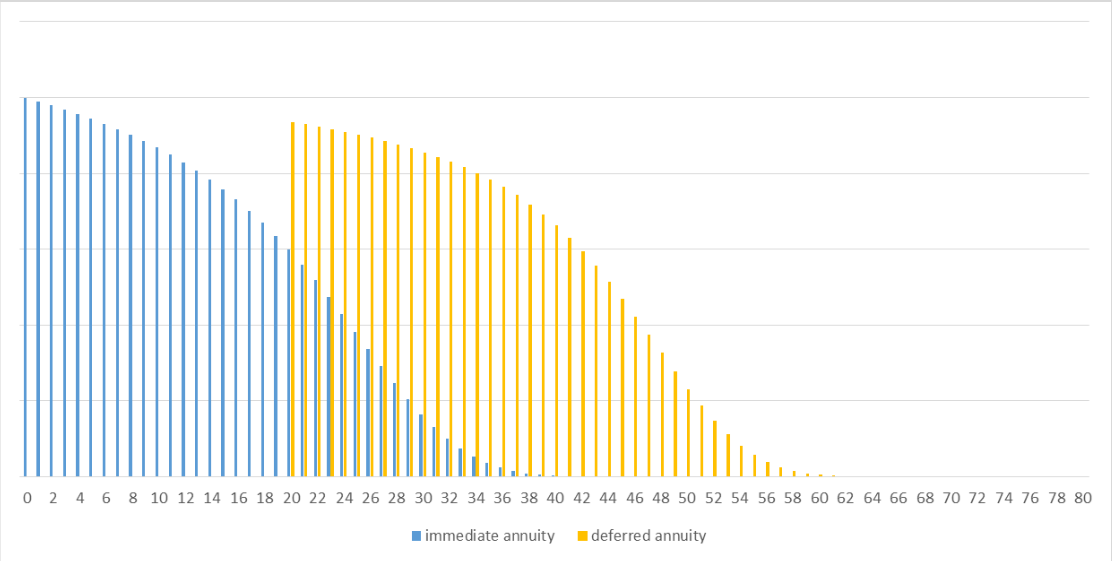
4.4 Impact on value of example contracts

160. In order to illustrate the impact of a UFR change on technical provisions, two simple life insurance contracts were constructed and analysed:

- An immediate life-long annuity for a 65 year old person
- A deferred life-long annuity for a 45 year old person. Annuity payments will start in 20 years. Premiums are paid in.

161. The cash-flow pattern of both contracts is shown in Figure 21.

Figure 21. Cash-flow pattern of example contract



162. The cash-flows were derived according to Dutch mortality tables since the Dutch mortality is close to the average European mortality. For reasons of simplicity no premium payment for the deferred annuity is taken into account.

163. Such contracts may be typical for some but not necessary all national insurance markets. The calculated changes of technical provisions are not representative for the average change of life insurance technical provisions

(see section 5 for such an analysis). However the calculations are relevant to assess the impact on newly concluded contracts of the analysed type.

164. The following tables set out the impact of UFR changes on the present value of cash-outflows for the example contracts. The impact significantly depends on the currency of the obligation. For the immediate annuity the impact is small because a larger part of the cash-flows correspond to maturities before the last liquid point. A decrease of the UFR of 10 bps would result in an increase of technical provisions by up to 0.3%.

165. For the deferred annuity the impact is much more severe because the cash-flows have a higher duration. A decrease of the UFR of 10 bps would lead to an increase of present values by up to 1.8%.

Table 10. Example contract immediate annuity – Impact of UFR change on present value of cash-outflows

UFR change	EUR	CZK	HUF	SEK	HRK	GBP	RON	PLN	ISK	NOK	CHF
-1.0%	0.3%	0.8%	0.5%	2.6%	1.2%	0.0%	1.1%	1.1%	1.1%	1.5%	0.1%
-0.9%	0.3%	0.8%	0.5%	2.4%	1.1%	0.0%	1.0%	1.0%	1.0%	1.4%	0.1%
-0.8%	0.3%	0.7%	0.4%	2.1%	1.0%	0.0%	0.9%	0.9%	0.9%	1.2%	0.1%
-0.7%	0.2%	0.6%	0.4%	1.8%	0.9%	0.0%	0.7%	0.8%	0.8%	1.1%	0.1%
-0.6%	0.2%	0.5%	0.3%	1.6%	0.7%	0.0%	0.6%	0.7%	0.6%	0.9%	0.1%
-0.5%	0.2%	0.4%	0.3%	1.3%	0.6%	0.0%	0.5%	0.5%	0.5%	0.8%	0.1%
-0.4%	0.1%	0.3%	0.2%	1.0%	0.5%	0.0%	0.4%	0.4%	0.4%	0.6%	0.0%
-0.3%	0.1%	0.3%	0.2%	0.8%	0.4%	0.0%	0.3%	0.3%	0.3%	0.5%	0.0%
-0.2%	0.1%	0.2%	0.1%	0.5%	0.2%	0.0%	0.2%	0.2%	0.2%	0.3%	0.0%
-0.1%	0.0%	0.1%	0.1%	0.3%	0.1%	0.0%	0.1%	0.1%	0.1%	0.2%	0.0%
+0.1%	0.0%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	0.0%
+0.2%	-0.1%	-0.2%	-0.1%	-0.5%	-0.2%	0.0%	-0.2%	-0.2%	-0.2%	-0.3%	0.0%
+0.3%	-0.1%	-0.3%	-0.1%	-0.8%	-0.3%	0.0%	-0.3%	-0.2%	-0.3%	-0.5%	0.0%
+0.4%	-0.1%	-0.3%	-0.2%	-1.0%	-0.5%	0.0%	-0.4%	-0.3%	-0.4%	-0.6%	0.0%
+0.5%	-0.2%	-0.4%	-0.2%	-1.2%	-0.6%	0.0%	-0.5%	-0.4%	-0.5%	-0.8%	-0.1%
+0.6%	-0.2%	-0.5%	-0.3%	-1.5%	-0.7%	0.0%	-0.6%	-0.5%	-0.6%	-0.9%	-0.1%
+0.7%	-0.2%	-0.6%	-0.3%	-1.7%	-0.8%	0.0%	-0.7%	-0.6%	-0.7%	-1.1%	-0.1%
+0.8%	-0.3%	-0.7%	-0.4%	-2.0%	-0.8%	0.0%	-0.8%	-0.7%	-0.8%	-1.2%	-0.1%
+0.9%	-0.3%	-0.8%	-0.4%	-2.2%	-0.9%	0.0%	-0.9%	-0.8%	-0.9%	-1.4%	-0.1%
+1.0%	-0.3%	-0.8%	-0.5%	-2.4%	-1.0%	0.0%	-1.0%	-0.9%	-1.0%	-1.5%	-0.1%

Table 11. Example contract deferred annuity – Impact of UFR change on present value of cash-outflows (without premium payments)

UFR change	EUR	CZK	HUF	SEK	HRK	GBP	RON	PLN	ISK	NOK	CHF
-1.0%	7.5%	10.8%	9.7%	20.0%	13.7%	0.0%	13.0%	12.6%	13.3%	14.0%	5.0%
-0.9%	6.7%	9.7%	8.7%	17.9%	12.2%	0.0%	11.6%	11.2%	11.8%	12.6%	4.5%
-0.8%	5.9%	8.6%	7.7%	15.7%	10.8%	0.0%	10.3%	9.8%	10.4%	11.1%	4.0%
-0.7%	5.2%	7.5%	6.6%	13.6%	9.3%	0.0%	8.9%	8.5%	9.1%	9.7%	3.5%
-0.6%	4.4%	6.4%	5.6%	11.5%	7.9%	0.0%	7.6%	7.2%	7.7%	8.3%	3.0%
-0.5%	3.6%	5.3%	4.7%	9.5%	6.5%	0.0%	6.2%	5.9%	6.3%	6.9%	2.5%
-0.4%	2.9%	4.2%	3.7%	7.5%	5.2%	0.0%	4.9%	4.6%	5.0%	5.5%	2.0%
-0.3%	2.2%	3.1%	2.8%	5.6%	3.8%	0.0%	3.7%	3.4%	3.7%	4.1%	1.5%
-0.2%	1.4%	2.1%	1.8%	3.7%	2.5%	0.0%	2.4%	2.2%	2.5%	2.7%	1.0%
-0.1%	0.7%	1.0%	0.9%	1.8%	1.2%	0.0%	1.2%	1.1%	1.2%	1.3%	0.5%
+0.1%	-0.7%	-1.0%	-0.9%	-1.8%	-1.2%	0.0%	-1.2%	-1.0%	-1.2%	-1.3%	-0.5%
+0.2%	-1.4%	-2.0%	-1.8%	-3.5%	-2.4%	0.0%	-2.3%	-1.9%	-2.4%	-2.6%	-1.0%
+0.3%	-2.1%	-3.0%	-2.6%	-5.2%	-3.6%	0.0%	-3.5%	-2.6%	-3.5%	-3.9%	-1.4%
+0.4%	-2.8%	-4.0%	-3.5%	-6.9%	-4.7%	0.0%	-4.6%	-3.4%	-4.7%	-5.2%	-1.9%
+0.5%	-3.5%	-5.0%	-4.3%	-8.6%	-5.8%	0.0%	-5.7%	-4.4%	-5.8%	-6.5%	-2.4%
+0.6%	-4.2%	-5.9%	-5.1%	-10.2%	-6.8%	0.0%	-6.8%	-5.4%	-6.9%	-7.7%	-2.8%
+0.7%	-4.8%	-6.9%	-5.9%	-11.7%	-7.8%	0.0%	-7.8%	-6.5%	-7.9%	-8.9%	-3.3%
+0.8%	-5.5%	-7.8%	-6.7%	-13.3%	-8.5%	0.0%	-8.9%	-7.5%	-9.0%	-10.1%	-3.7%
+0.9%	-6.1%	-8.8%	-7.4%	-14.8%	-9.3%	0.0%	-9.9%	-8.6%	-10.0%	-11.3%	-4.2%
+1.0%	-6.8%	-9.7%	-8.2%	-16.3%	-10.1%	0.0%	-10.9%	-9.6%	-11.0%	-12.5%	-4.6%

4. Impact on with-profit life insurance portfolios

166. This annex illustrates the impact that a change in the UFR for the euro would have on the value of the most important long-term life insurance business.

167. The analysis is based on cash-flows reported by solo-undertakings which participated in the low-yield satellite of EIOPA's 2014 insurance stress test. Insurers were asked to provide projections of expected future cash-flows from several lines of business that may include long-term guarantees. Among those lines of business, *life insurance with profit participation* not only makes up the largest part in terms of reported best estimate, but is also known to contain the most significant and long-term part of guaranteed business in most Member States.

168. To evaluate the impact of a UFR change, 60 years of cash-flow projections for life insurance with profit participation were analysed. For this line of business, companies were asked to provide five cash-flow projections:

1. Cash outflows
   a. Future benefits (fixed guarantees part)
   b. Future benefits (discretionary part)
   c. Future expenses and other cash outflows
2. Cash inflows
   a. Future premiums
   b. Other cash inflows

169. In order to perform the analysis, the data of some insurers had to be excluded due to poor data quality. In most of those cases, the cash-flows were missing in their entirety or they were only available for a few years instead of the full 60 years required. In other cases data could not be used because the reported cash-flows were obviously flawed or not available in the necessary granularity, for example because guaranteed benefits were not separated from discretionary future benefits.

170. For this analysis we eventually used cash-flow data of 107 solo-undertakings. In numbers, these undertakings make up about half of the overall stress test sample. In terms of assets, the sample captures more than 75% of the insurers with life insurance with profit participation that participated in the stress test.

171. In aggregate, the 107 undertakings in the sample reported total assets of 2757 billion euro and had eligible own-funds of 218 billion euro.

172. Undertakings reported data as of year-end 2013. We make the assumption that overall cash-flow profiles have not changed substantially in the intervening time and apply the August 2015 risk-free interest rates under

the assumption of a UFR ranging from 3.0% to 4.5%. No differentiation of currencies was made in the analysis. All cash-flows were discounted with euro risk-free interest rates, being the dominating currency of the sample.

173. The following table shows the present values of the three outflow components calculated with a UFR of 4.2%:

Cash-flow component	Present value
Future benefits (fixed guarantees part)	€ 1843 bn.
Future benefits (discretionary part)	€ 328 bn.
Future expenses and other cash outflows	€ 375 bn.

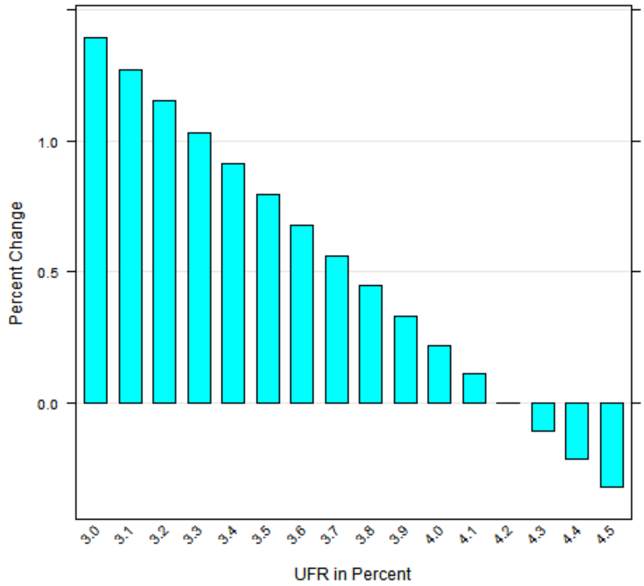
174. The following table shows the values of the best estimate for the two inflow components calculated with a UFR of 4.2%:

Cash-flow component	Present value
Future premiums	€ 479 bn.
Other cash inflows	€ 13 bn.

175. A change in the UFR would usually result in a change of the cash-flow projections of undertakings, an effect that cannot be captured in the analysis carried out for this impact assessment. For instance, lowering the UFR would likely result in lower profits in the near term, thereby lowering the projections of future discretionary benefits. This analysis was therefore based only on the projection of fixed guarantees since they make up the largest part of best estimate, have the longest duration and because their projected cash-flows are unlikely to change in response to a UFR adjustment.

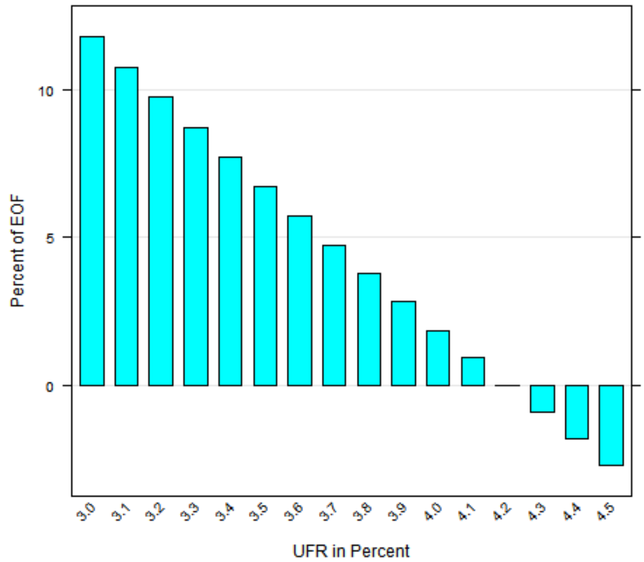
176. To gain insight into the relative impact of a change of the UFR, its impact on the fixed guarantees component of the best estimate is analysed. The following diagram indicates that lowering the UFR from 4.2% to 3.5% would increase the present value of fixed guarantees of life insurance with profit participation by 0.79%.

Figure 22. Relative change of the present value of guaranteed benefits for different UFRs



177. Putting this figure in terms of solvency capital, a decrease from 4.2% to 3.5% would consume 6.7% of reported eligible own funds. The following diagram shows the result in terms of eligible own funds for the full range of UFR levels.

Figure 23. Relative change of the eligible own funds (EOF) corresponding to the change in present value of guaranteed benefits for different UFRs

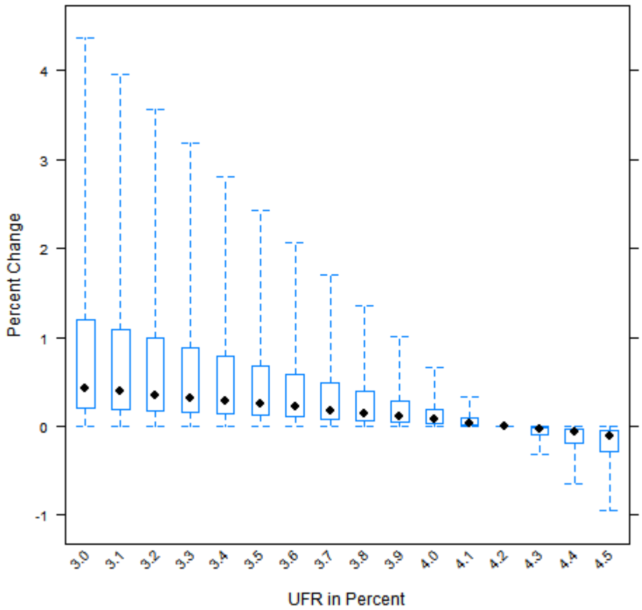


178. While the aggregate results indicate a rather muted valuation impact of a lower UFR, this ignores the considerable heterogeneity across all 107 undertakings in the sample. The next diagram comprises the distribution of the relative change across all insurers: for each UFR in the range from 3%

to 4.5% the figure displays a box plot, where the box shows the median as well as the 25th and 75th percentile. While the median (solid black dot) confirms the aggregate analysis from above, the distribution, there are significant outliers (whiskers).

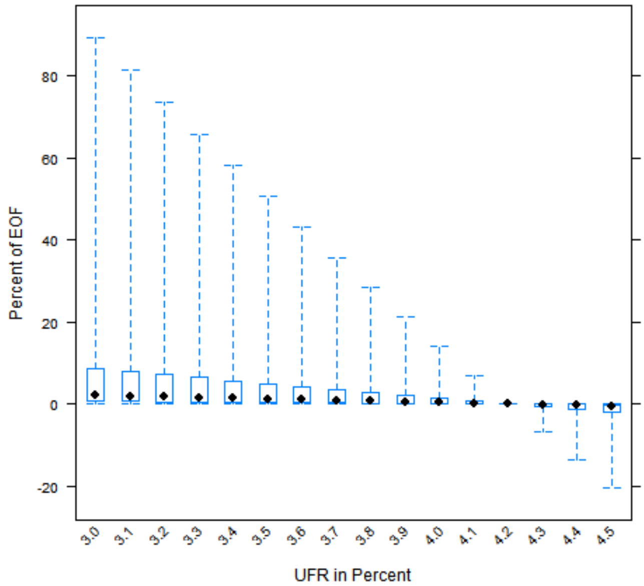
179. For most undertakings, moving from a UFR of 4.2% to a UFR of 3.5%, for instance, would have a minor impact, with a median value of 0.25% and three quarters of companies below 0.68%. There are, however, few companies with an increase in the present value of the fixed guarantees of up to 2.4%.

Figure 24. Distribution of relative change of the present value of guaranteed benefits for different UFRs



180. A similar picture emerges in terms of eligible own funds. While for three quarters of insurers a decrease in the UFR to 3.5% would consume less than 5% of eligible own funds (median=1.15%), for a few insurers this figure makes up more than 50% of eligible own funds.

Figure 25. Distribution of relative change of the eligible own funds (EOF) corresponding to the change in present value of guaranteed benefits for different UFRs



181. The main driver for the impact differences is duration of the fixed guarantees. For guarantees with long duration the impact is much stronger than for short-term guarantees. In particular, guarantees with durations up to the last liquid point of the euro of 20 years are not materially affected.

182. The estimates presented here should not be understood as representing the impact of a UFR change on insurance undertakings. They may deviate from that in particular for the following reasons:

- Only life insurance with profit participation was analysed.
- Only the cash-flows for fixed guarantees were analysed, but not other cash-flow components like premiums and future discretionary benefits.
- The cash-flows data of the stress test may include approximations.

Annex I - Review of existing models

1. The QIS5 UFR

Description of the model

183. For QIS5, the choice was made to retain a method based on an estimate of the long-term equilibrium of the economy, such that:

$$UFR = LT_{IR} + LT_I$$

where LT_{IR} denotes the long-term average of real interest rates and LT_I the long-term expectations of inflation. The term premium included in the long-term average of real rates was not removed. The convexity effect was ignored.

Data sources

184. The estimate of long-term expected real interest rate was based on a study from E. Dimson, P. Marsh and M. Staunton (2000) and supplemented by a more recent study from the same authors for the Credit Suisse Global Investment Returns Yearbook 2010 to take account of years from 2001 to 2010. Those studies provide a global comparison of annualized long-term government bonds real return over the last 100 and 109 years respectively.

185. The following table exhibits those annualized real returns (reported in the Millennium Book and the Credit Suisse Yearbook respectively) for long-term government bonds. For the average annualized return, a simple arithmetic average without weight is used.

Long-term government bonds annualized real return (in %)			
Country	E. Dimson et alii (1900-2000)	E. Dimson et al. (1950-2000)	CS Yearbook (1900-2009)
Australia	2.6	1.1	1.4
Canada	2.3	2.4	2
Denmark	3.4	3.9	3
France	0.2	4.7	-0.2
Germany*	0.2	3.6	-2
Italy	-0.9	1.8	-1.6
Japan	1.4	3.2	-1.2
Netherlands	1.6	1	1.4
Sweden	3	1.5	2.5
Switzerland**	2.4	1.6	2.1
USA	2	1.6	1.9

UK	2.2	1.6	1.3
Belgium	-	-	-0.1
Finland	-	-	-0.3
Ireland	-	-	1.1
New Zealand	-	-	2
Norway	-	-	1.7
South-Africa	-	-	1.7
Spain	-	-	1.4
Average All	1.7	2.3	1.0
*** average excludes 1922/23**			
**** from 1911**			

186. In light of these figures it was decided to choose 2.2% as an estimate of the expected real interest rate.

187. The standard expected long-term inflation rate was set consistently with the explicit or implicit target for inflation most central banks operate with from the 1990s (around 2%).

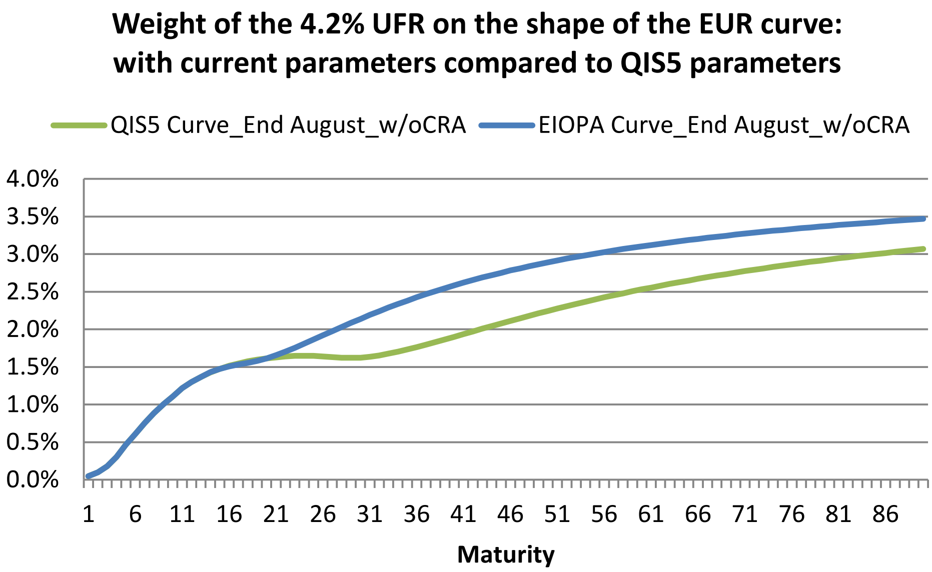
188. In addition, based on historical data for the last 10-15 years (1994 – 2009) at the date of QIS5 and inflation rate in 2010, two additional categories (+1%/-1%) were introduced to capture significant deviations either up or down in the expected long term inflation rate for certain countries compared to the standard expected long-term inflation rate. For the allocation into the 3 buckets (standard/+1%/-1%), data used were extracted from OECD database and from Eco-Win (Reuters) database (for Singapore, Malaysia, Thailand, Hong Kong and Taiwan not included in the list from the OECD database).

Results

189. The QIS5 calibration provided a UFR level of 4.2%. With today's values of long term real rates as published in the Yearbook 2015, the UFR would be 5.7% (if retained period is 1965-2014) or 3.3% (if retained period is 1900-2014).

190. It is noteworthy that using a general approach similar to QIS5 calibration does not mean that the weight of the UFR on the shape of the basic risk-free interest rate curves will be the same as in 2010. Other key parameters (last liquid point, speed of convergence from the LLP to the UFR) changed in accordance with the Omnibus II Directive. The following graph shows the

shape of the euro curve (at end of August 2015) with an UFR of 4.2%, using either the QIS5 parameters or the current parameters.[31]



2. The Barrie & Hibbert UFR[32]

Description of the model

191. The Barrie & Hibbert method aims at computing an expected nominal long-term (unconditional) forward interest rate with 4 components:

Long-term expected real returns

+ Long-term expected inflation

+ Long-term nominal term premium

+ Long-term nominal convexity effect.

Data sources

192. Two versions of the computation exist depending on the type of instruments involved: government bond or swap rates (see the results section).

193. Real interest rates are computed as the yield on a 3-month interest rate less CPI inflation, using historical data (over an unknown period). This allows calculating an historical average of real cash returns for a set of 16 countries (Australia, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Netherlands, South Africa, Spain, Sweden, Switzerland, Japan, UK and USA).

[31] For QIS5, the LLP of the EUR curve was the 30 years maturity (20 years today) and the convergence point was the 90 years maturity (60 years today).
[32] Description based on S. Sorensen, *How to set long-term interest rates in the absence of market prices*, Barrie & Hibbert, 2010.

194. Inflation is determined based on a fixed target of 2% and exponentially weighted average of historical CPI (with a weighting parameter set to 0.96) for the same set of 16 countries. The 2% target and the exponentially weighted average of historical CPI are then averaged, with a weight of 80% for the former and 20% for the latter assuming that this is a credible inflation target.

195. The term premium is computed using the historical average of the excess return on a 10 year nominal government bond using data from Dimson, Marsh and Staunton (2002)[33]. No more details are given. One can notice that the term premia obtained by Barrie & Hibbert are strangely different than those obtained by E. Dimson et al. (2000).

196. The convexity effect is derived from the excess return on a 10 year nominal government bond (over a period not specified).

Results

197. The Barrie & Hibbert method provided in 2010 the following results:

	Government bond		
	2005	2009	2010
Expected real rate	1.8%	1.9%	1.9%
Expected inflation	2.4%	2.4%	2.3%
Expected nominal short rate	4.2%	4.3%	4.2%
Term premium	2.3%	1.7%	1.9%
Convexity adjustment	-0.4%	-0.5%	-0.4%
Limiting forward rate	6.1%	5.5%	5.7%

	Swap rate		
	2005	2009	2010
Expected real rate	2%	2.1%	2.1%
Expected inflation	2.4%	2.4%	2.3%
Expected nominal short rate	4.4%	4.5%	4.4%
Term premium	2.5%	1.9%	2.1%
Convexity adjustment	-0.4%	-0.5%	-0.4%
Limiting forward	6.5%	5.9%	6.1%

[33] *Triumph of the Optimists: 101 Years of Global Investment Returns.*

3. The Dutch UFR[34]

198. In order to assess the design of the UFR method in the Dutch pension funds regime, the Dutch government set up a UFR committee in 2013. This UFR committee proposed to adjust this method and to not retain the fixed level of 4,2% derived from past EIOPA's suggestion. According to the UFR committee, the level of 4,2% is "*insufficiently substantiated*". Furthermore, the UFR committees "*prefers the use of market data to an estimate of the equilibrium value of the UFR based on macro-economic considerations, which in the Committee's opinion is surrounded by too many uncertainties*". DNB is implementing the UFR committee proposal since July 2015.

Description of the model

199. The UFR is a moving average of the EUR 20-years forward rate with a tenor of 1 year over the previous 10 years. It is recalculated each month.

$$UFR(t) = \frac{1}{120} \sum_{m \in M(t)} f(m, 20{,}21)$$

where 120 corresponds to the 120 months over the last 10 years and M(t) stands for the set of the 120 months-end immediately prior to time t.

Data sources

200. EUR 20-year forward rates can be derived by EIOPA using the Smith-Wilson technique. Alternatively, they can be found on BBL.

Results

201. The new method implemented by DNB provides an UFR level of 3.3%.

4. The IAIS UFR[35]

Description of the model

202. The UFR is defined as an economic view on long-term forward rates, such that:

[34] Description based on the *Advisory report of the UFR committee*, 2013; D. Jiang, *Comparison of UFR implementation in Europe*, Netspar Theses, 2014; *UFR method for calculating the term structure of interest rates*, 2012.
[35] Description based on IAIS calibration presentation produced for the 2015 Field Testing exercise and adopted by the FTWG-CDWG during the Basel meeting in April 2015.

$$UFR = LT_{economic\ growth} + LT_{inflation\ target}$$

203. Following Von Neumann (1932) and Solow (1956), the real interest rates are assumed to be equal to the economic growth in the very long-term, should the economic growth be sustainable (i.e. the economic growth equals the potential growth). The long-term economic growth relies on an economic growth forecast at 50 years. Due to persistent growth differentials between OECD and emerging non-OECD economies over the next 50 years, the IAIS differentiates 2 buckets for $LT_{economic\ growth}$:

- OECD: 1,5%
- Non-OECD: 2,75%

204. The long-term inflation target relies on explicit or implicit inflation targets or on the mandates of Central Bank. On this basis, the IAIS differentiates between 6 buckets of countries:

- Default: 2%
- Australia, Poland, Iceland and Norway: 2,5%
- Chile, Hungary, Mexico and Korea: 3%
- Argentina, China, India and Russia: 4%
- Brazil, Indonesia and South Africa: 4,5%
- Turkey: 5%

Data sources

205. Long-term economic growth forecasts are taken from the published OECD macroeconomic study "*Policy challenges for the next 50 years*" (2014). Long-term inflation targets come from the published OECD study "*Growth prospects and fiscal requirements over the long-term*" (2013).

Results

206. The IAIS calibration provided for 2015 the following results:

#	ISO 4217	Currency	Country	UFR
1	AUD	Australia Dollars	Australia	4.0%
2	BRL	Brazil Reais	Brazil	7.3%
3	CAD	Canada Dollars	Canada	3.5%
4	CHF	Switzerland Francs	Switzerland	3.5%
5	CLP	Chile Pesos	Chile	4.5%
6	CNY	China Yuan Renminbi	China	6.8%
7	COP	Colombia Pesos	Colombia	4.5%
8	CZK	Czech Republic Koruny	Czech republic	3.5%
9	DKK	Denmark Kroner	Denmark	3.5%
10	EUR	Euro	Euro Area	3.5%
11	GBP	United Kingdom Pounds	UK	3.5%
12	HKD	Hong Kong Dollars	Hong Kong	6.8%
13	HUF	Hungary Forint	Hungary	4.5%
14	IDR	Indonesia Rupiah	Indonesia	7.3%
15	ILS	Israel Shekel	Israel	3.5%
16	INR	India Rupees	India	6.8%
17	JPY	Japan Yen	Japan	3.5%
18	KRW	South Korea Won	South Korea	4.5%
19	MXN	Mexico Pesos	Mexico	4.5%
20	MYR	Malaysia Ringgits	Malaysia	7.3%
21	NOK	Norway Kroner	Norway	4.0%
22	NZD	New Zealand Dollars	New Zealand	3.5%
23	PEN	Peru Nuevo Sol	Peru	4.5%
24	PHP	Philippines Peso	Philippines	7.3%
25	PLN	Poland Zlotych	Poland	4.0%
26	RON	Romania New Lei	Romania	3.5%
27	RUB	Russia Rubles	Russia	6.8%
28	SAR	Saudi Arabia Riyal	Saudi Arabia	4.8%
29	SEK	Sweden Kronor	Sweden	3.5%
30	SGD	Singapore Dollars	Singapore	7.3%
31	THB	Thailand Baht	Thailand	7.3%
32	TRY	Turkey Lira	Turkey	6.5%
33	TWD	Taiwan New Dollars	Taiwan	6.8%
34	USD	United States Dollars	US	3.5%
35	ZAR	South Africa Rand	South Africa	7.3%

5. The Swiss UFR

207. The Swiss supervisory authority FINMA introduced a UFR discount curve for insurers and pension funds in 2011. The method (the Smith-Wilson method) and the parameters of this curve are in line with the ones currently used by EIOPA, save for the following two factors:

- Since the Swiss discount curve is based on government bonds, the UFR has been fixed 0.3% lower than in EIOPA's proposals.
- FINMA uses different parameters for different currencies. For example, it has adopted an LLP of 30 years and a UFR of 3.9% for the US dollar and the euro and an LLP of 15 years and a UFR of 2.9% for the Swiss franc.

208. FINMA will revise shortly its methodology to construct the UFR. Similarly to the UFR Committee's proposal, the new methodology will be based on observable market data, to allow for the UFR to be sensitive to the economic cycle, while using an average approach to smooth the variation of the UFR over time.

Annex II - Summary of stakeholder feedback during the consultation in July 2015

209. EIOPA carried out a consultation on specific topics of the RFR methodology including the main decision points of the UFR methodology from 1 to 21 July 2015. EIOPA's IRSG, four European associations, two (re-)insurance undertakings and one national association submitted comments.

210. Most stakeholders call on EIOPA **not to change the UFR** before the beginning or during the first two or three years of Solvency II. The main reasons given for that were that the current UFRs were part of the political agreement on Omnibus II, that any change would trigger market reactions and put the industry at risk and that the industry has already to cope with a lot of other changes introduced by Solvency II.

211. With regard to the **number of UFRs** to be used, stakeholders agreed that UFRs per buckets of currencies should be derived. That approach was believed to be more simple and to be tested and known. It was also mentioned that the use of buckets better reflects that inflation and real rates are global drivers, while a more granular approach was considered unrealistic.

212. Stakeholders agreed that the UFR should not include a **convexity adjustment**. It was considered a spurious refinement and there were concerns that it cannot be determined in a predictable and reliable manner.

213. Most stakeholders agreed that the **real interest rate** component of the UFR should only be based on **historical data**. This approach would ensure reliable and stable results, while current market data are affected by the current macro-economic conditions and short-term expectations and give rise to short-term volatility. One stakeholder nevertheless saw a role for current market data if it was combined with historical data. Views on the **time period** for averaging differed. One stakeholders suggested very long periods ("centuries"), another data since 1900, another suggested the start point of the time series should be in the 50s in order to exclude WWII effects. Most stakeholders suggested a simple average (rather than a weighted average).

214. With regard to the determination of the **expected inflation**, stakeholders recommend to use **inflation targets** of the central banks. Some stakeholders suggest adjusting that information for example for market expectations, historical experience or credibility. Some stakeholders stress that the methodology should ensure a smooth transition when inflation targets change.

215. Most stakeholders think that the use of **judgement** in the derivation of the UFRs is unavoidable. Examples mentioned include the ruling out of

objective errors, solving problems (e.g. data provider fails to continue its service) and where there are insufficient data for a currencies.

216. The consultation paper also asked about the way the UFRs should **change**. Should the UFRs be kept constant and then jump or should it gradually change? In that respect most stakeholders were in favour transitional smoothing of major changes. All changes should be accompanied by a **consultation of stakeholders** and an impact assessment and should be announced to undertakings in advance. One stakeholder suggested that minor changes in the underlying rates should not be reflected in the value of the UFR.

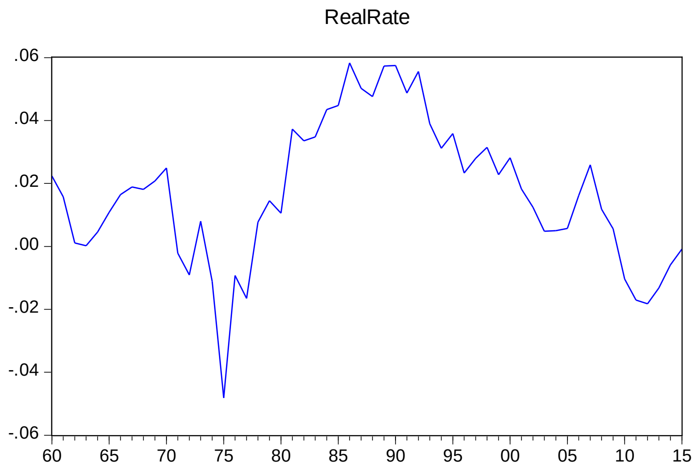
Annex III – Analysis of historical real rates with ARMA models

Introduction

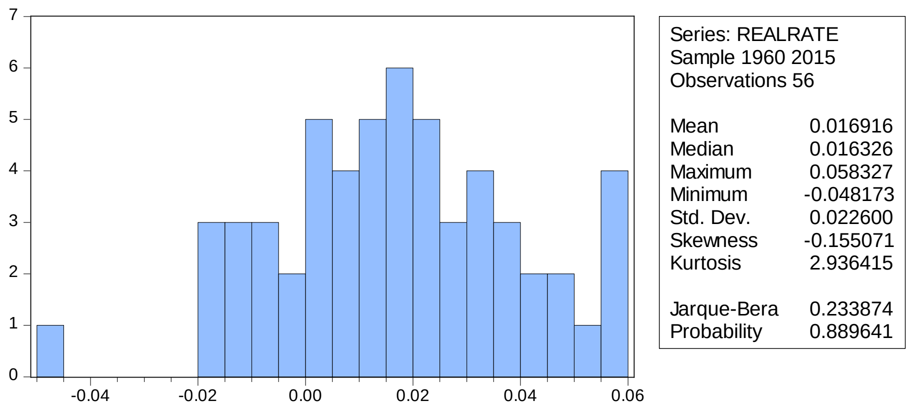
217. In this Annex the time series of real rates is analysed by means of autoregressive–moving-average (ARMA) models. The time series is constructed as an arithmetic mean of real rates of seven countries for the period 1960-2015.

Description of the time series of real rates

218. The time series of real rates consist of 56 observations as shown in the following figure.



219. The stylized facts of the time series are given in the following figure.



220. The mean of the real rate over the observed period equals 1.69%, which is close to the median of 1.63%. Based on the Jarque-Bera statistic there is no strong evidence for non-normality, although normality is not accepted

either as there is some minor excess kurtosis as well as some skewness to the left. Based on these results normality seems more acceptable.

221. The autocorrelation (ACF) and partial autocorrelation (PACF) of the series are set out in the following figure.

Date: 03/15/16 Time: 15:09
Sample: 1960 2015
Included observations: 56

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.845	0.845	42.142	0.000
		2	0.737	0.081	74.808	0.000
		3	0.642	0.003	100.03	0.000
		4	0.472	-0.305	113.93	0.000
		5	0.365	0.053	122.42	0.000
		6	0.250	-0.086	126.48	0.000
		7	0.168	0.107	128.36	0.000
		8	0.134	0.060	129.58	0.000
		9	0.055	-0.142	129.79	0.000
		10	-0.034	-0.217	129.87	0.000
		11	-0.103	-0.078	130.63	0.000
		12	-0.165	0.055	132.63	0.000
		13	-0.217	0.020	136.18	0.000
		14	-0.285	-0.138	142.47	0.000
		15	-0.342	-0.141	151.71	0.000
		16	-0.326	0.132	160.34	0.000
		17	-0.358	-0.126	171.02	0.000
		18	-0.370	0.020	182.72	0.000
		19	-0.360	-0.080	194.10	0.000
		20	-0.387	-0.129	207.60	0.000
		21	-0.373	-0.046	220.50	0.000
		22	-0.369	0.015	233.52	0.000
		23	-0.377	-0.013	247.51	0.000
		24	-0.342	-0.053	259.42	0.000

222. The observed pattern of the ACF and PACF indicates that an AR(1) model is the best choice to describe the behaviour of the observed time series.

Model estimation of the time series of Euro geo real rates

223. Based on the analysis so far a set of ARMA-models has been estimated on the real rate time series. All possible combinations of ARMA(2,2) models have been analysed with the following results:

Model Selection Criteria Table
Dependent Variable: REALRATE
Date: 03/15/16 Time: 15:14
Sample: 1960 2015
Included observations: 56

Model	LogL	AIC*	BIC	HQ
(1,0)(0,0)	168.540515	-5.912161	-5.803660	-5.870096
(2,0)(0,0)	168.798613	-5.885665	-5.740997	-5.829577
(1,1)(0,0)	168.789309	-5.885332	-5.740664	-5.829245
(1,2)(0,0)	168.907034	-5.853823	-5.672988	-5.783713
(2,1)(0,0)	168.800248	-5.850009	-5.669174	-5.779900
(2,2)(0,0)	169.760661	-5.848595	-5.631593	-5.764464
(0,2)(0,0)	157.531949	-5.483284	-5.338616	-5.427196
(0,1)(0,0)	153.791555	-5.385413	-5.276912	-5.343347
(0,0)(0,0)	133.273413	-4.688336	-4.616002	-4.660292

Although the AR(1) model choice doesn't give the highest log-likelihood score, its Akaike information criterion (AIC) score is the lowest over all possible models.

This means that the AR(1) model choice is optimal with respect to the number of parameters. Although other model specifications give higher log-likelihood scores as a result of more parameters, the AIC scores corrects for this by penalizing the use of to many parameters.

The AR(1) estimate of the time series of real rates

224. The AR(1) model is given by the following set of equations:

$$Y_t = \omega + u_t \tag{0.1}$$

$$u_t = \rho u_{t-1} + \varepsilon_t \tag{0.2}$$

$$\varepsilon_t \sim i.i.d.\ N(0, \sigma^2) \tag{0.3}$$

225. In (1.1) the variable Y_t represents the observed real rates, where ω is the long-term level of the real rate. The annual deviation of the observed real rate from the long term level, i.e. $u_t = Y_t - \omega$, follows a first order autoregressive process.

226. With some substitution these equations can be re-arranged into:

$$Y_t = \omega + \rho\left(Y_{t-1} - \omega\right) + \varepsilon_t \tag{0.4}$$

Or equivalent into:

$$Y_t = \left(1 - \rho\right)\omega + \rho Y_{t-1} + \varepsilon_t \tag{0.5}$$

Hence Y_t can be seen as a weighted average of the long-term level of the real rate ω and the former observation Y_{t-1} plus white noise.

227. Estimating this model on the constructed real rate series results in the following parameter estimates:

Dependent Variable: REALRATE
Method: ARMA Maximum Likelihood (BFGS)
Date: 03/15/16 Time: 15:14
Sample: 1960 2015
Included observations: 56
Convergence achieved after 6 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.015940	0.011208	1.422170	0.1608
AR(1)	0.840919	0.059064	14.23740	0.0000
SIGMASQ	0.000139	1.97E-05	7.080695	0.0000

R-squared	0.722371	Mean dependent var	0.016916
Adjusted R-squared	0.711894	S.D. dependent var	0.022600
S.E. of regression	0.012131	Akaike info criterion	-5.912161
Sum squared resid	0.007799	Schwarz criterion	-5.803660
Log likelihood	168.5405	Hannan-Quinn criter.	-5.870096
F-statistic	68.95109	Durbin-Watson stat	2.134877
Prob(F-statistic)	0.000000		

Inverted AR Roots	.84

Based on these estimates we see that:

$\hat{\omega} = 1.59\%$

$\hat{\rho} = 0.84$

$\hat{\sigma} = 1.18\%$

Note that the t-value for the long-term level estimate only indicates weak significance of the parameter being different from zero. As the AR(1) model is the best alternative based on the AIC value we have to accept this.

228. The interest of this analysis is not in predicting the next observation for the real rates series but rather in estimating the long term level of this series.

It can be shown that the estimator for the long term level is given by:

$$\hat{\omega} = \overline{Y} + \frac{\hat{\rho}\left(Y_1 + Y_T - 2\overline{Y}\right)}{T + \left(2 - T\right)\hat{\rho}} \tag{0.6}$$

where:

$$\overline{Y} = \frac{1}{T}\sum_{t=1}^{T} Y_t \tag{0.7}$$

From the stylized facts we can see that $\overline{Y} = 1.69\%$ where $\hat{\omega} = 1.59\%$.

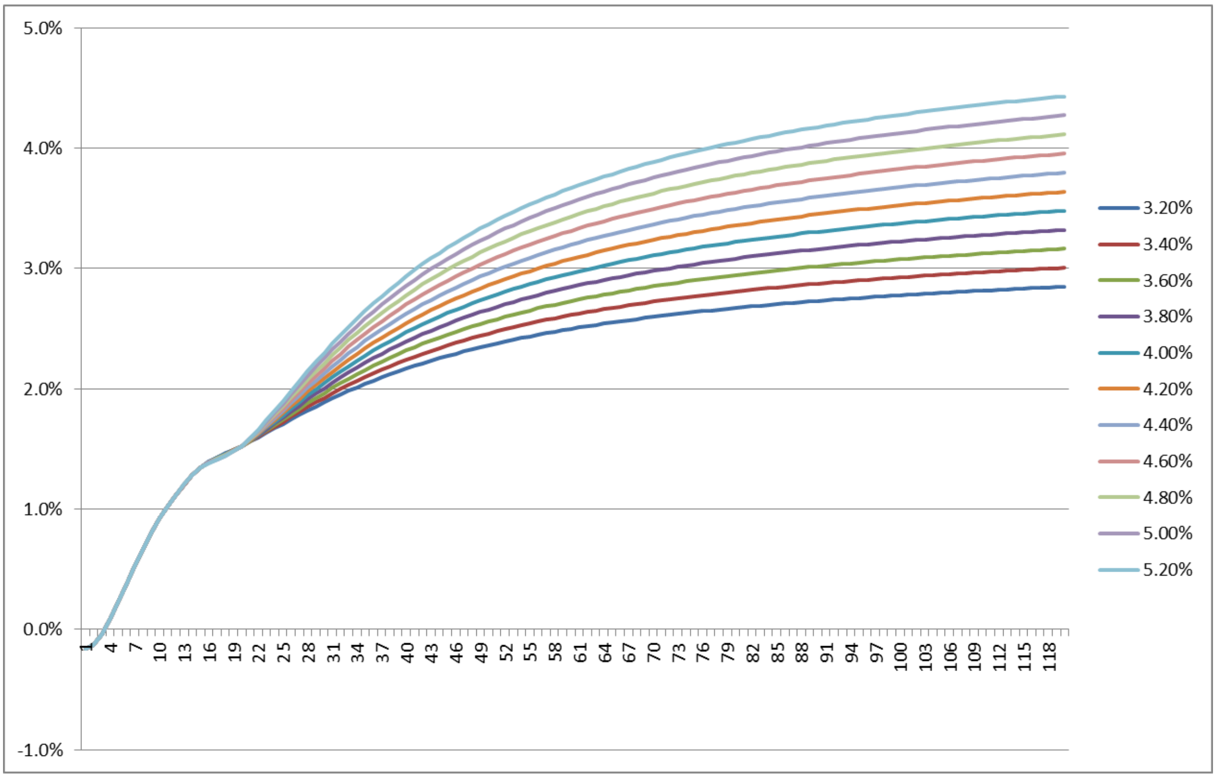
229. By taking the limit of (1.6) for $T \to \infty$ it will follow that $\hat{\omega} \to \overline{Y}$ in the long run. However at this moment the nature and length of the times series produces an estimate for the long term level of the real rate being 10bp less than the average of the time series.

Annex IV – Impact of changing the UFR on the risk-free interest rate term structures

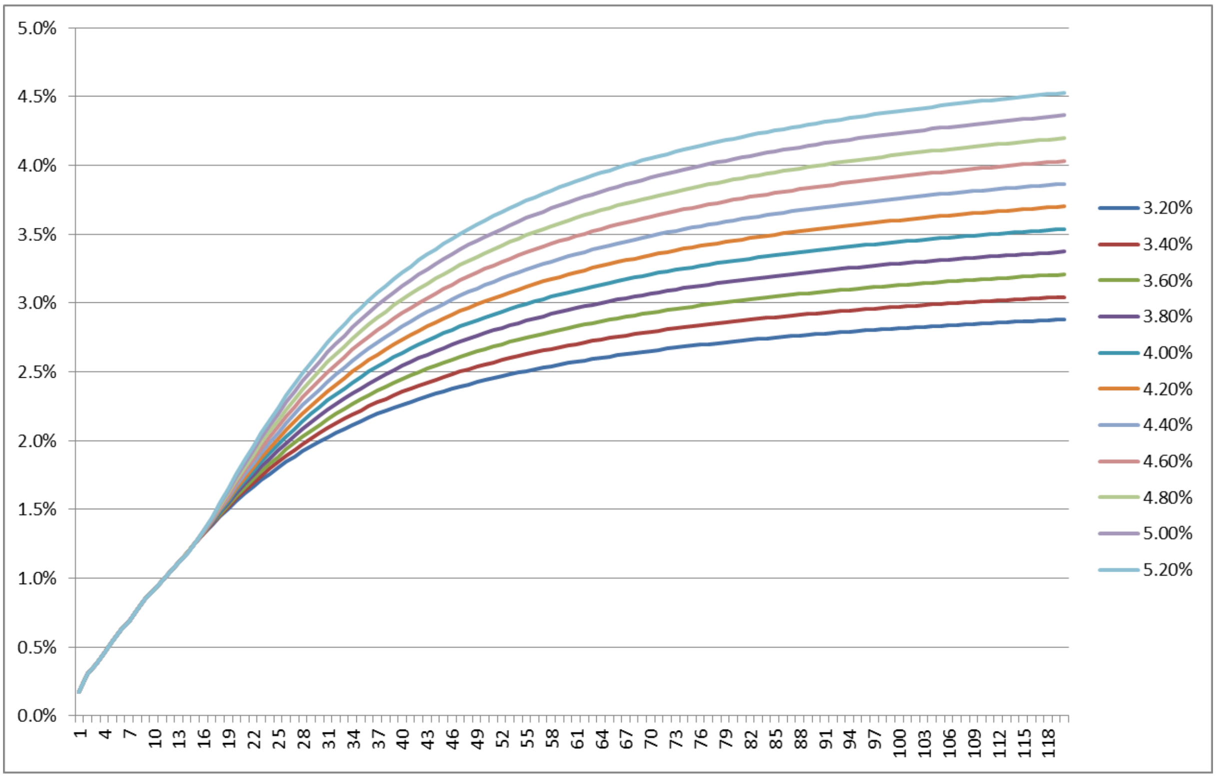
230. The following graphs show the basic risk-free interest rate term structures calculated for a range of UFRs differing by up to ± 100 bps from the currently used UFR. The analysis covers all currencies of the EEA, the US dollar and the yen. There are no separate graphs for the Bulgarian lev and the Danish krone because they do not materially differ from the graph for the euro.

231. A change of the UFR primarily affects the risk-free interest rates beyond the last liquid point of the term structures. The impact on the maturities up to the last liquid point is immaterial. Beyond the last liquid point, the impact increases with the maturity of the risk-free interest rates. The change in risk-free interest rates converges slowly to the amount whereby the UFR was changed.

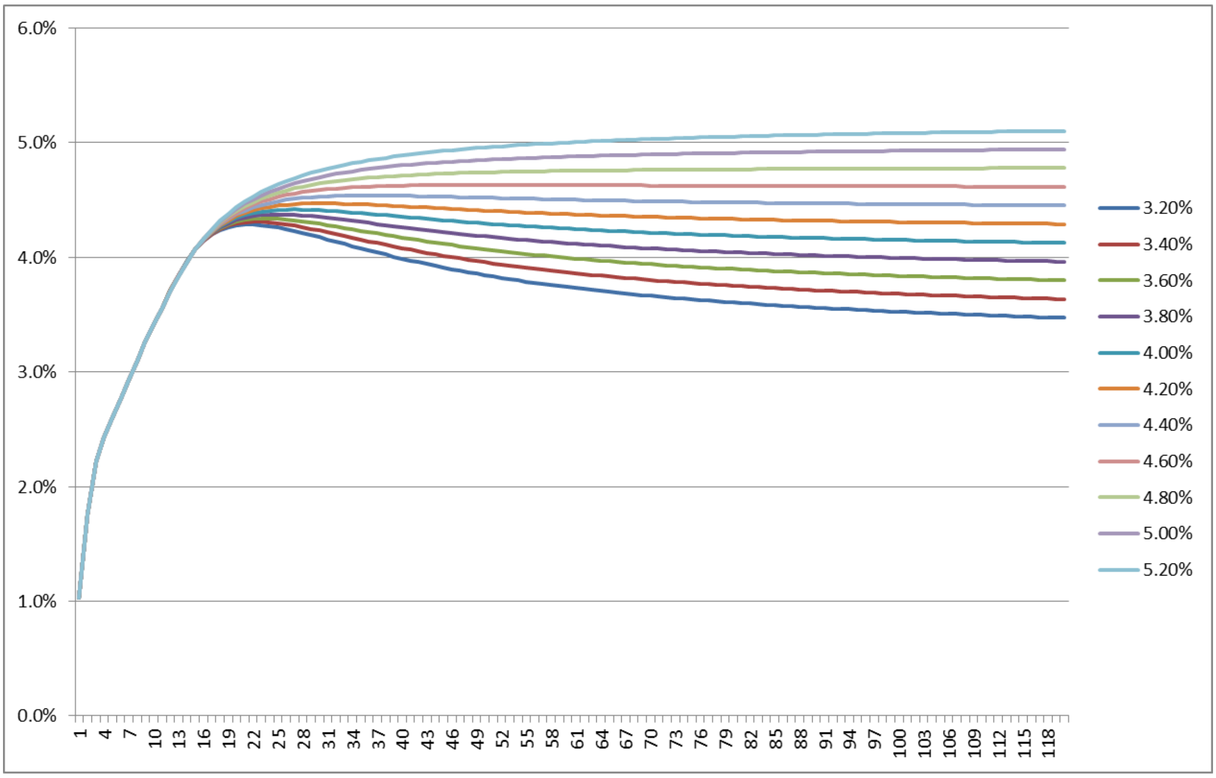
Euro



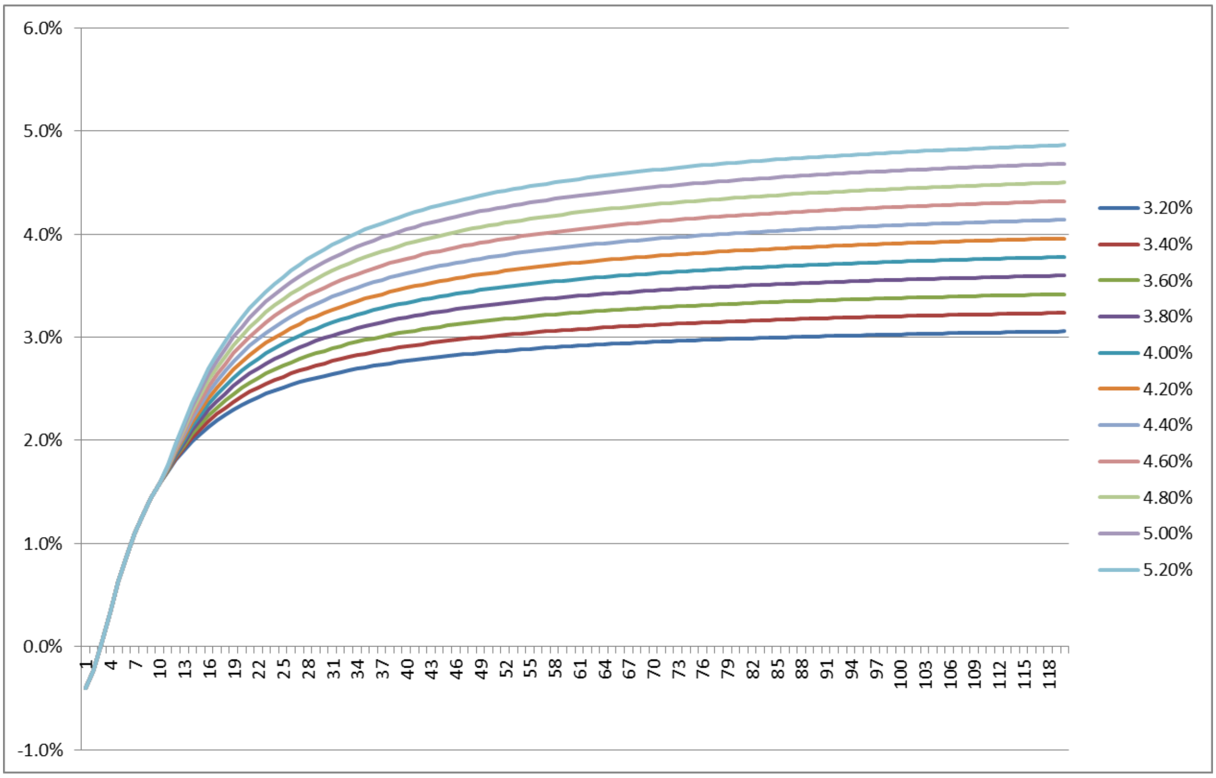
Czech koruna



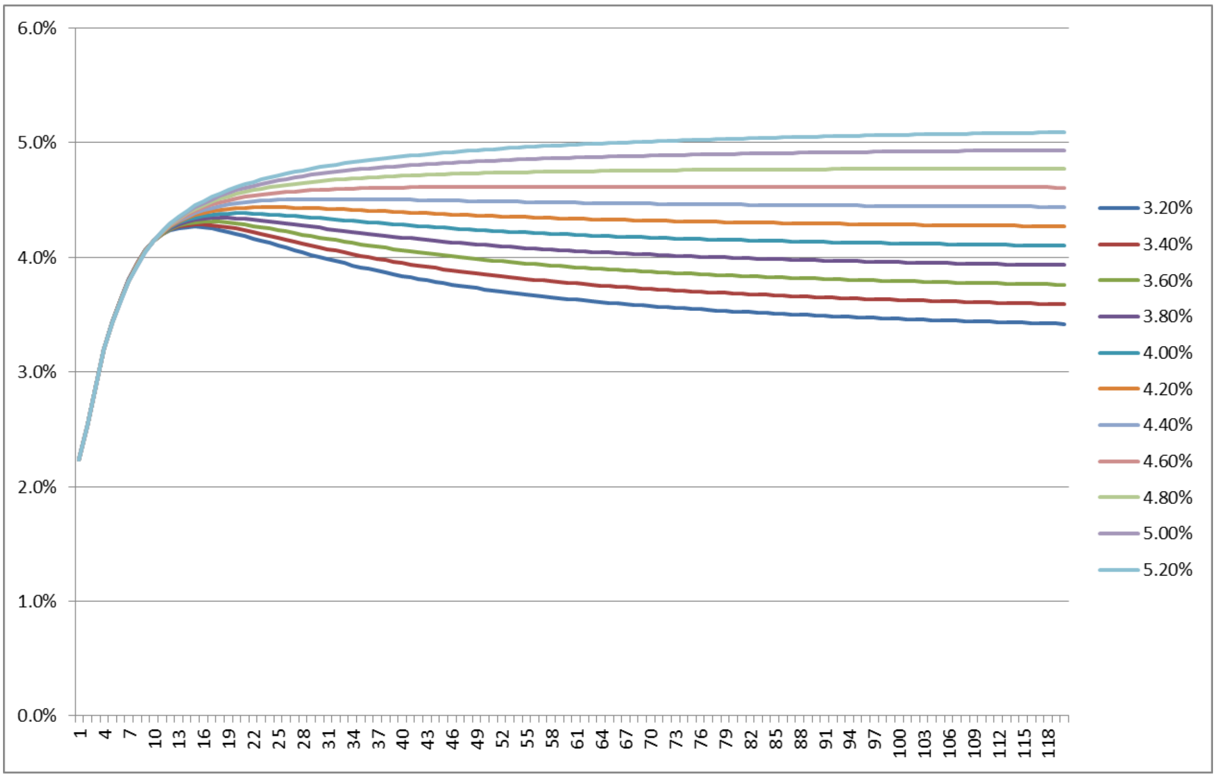
Hungarian forint



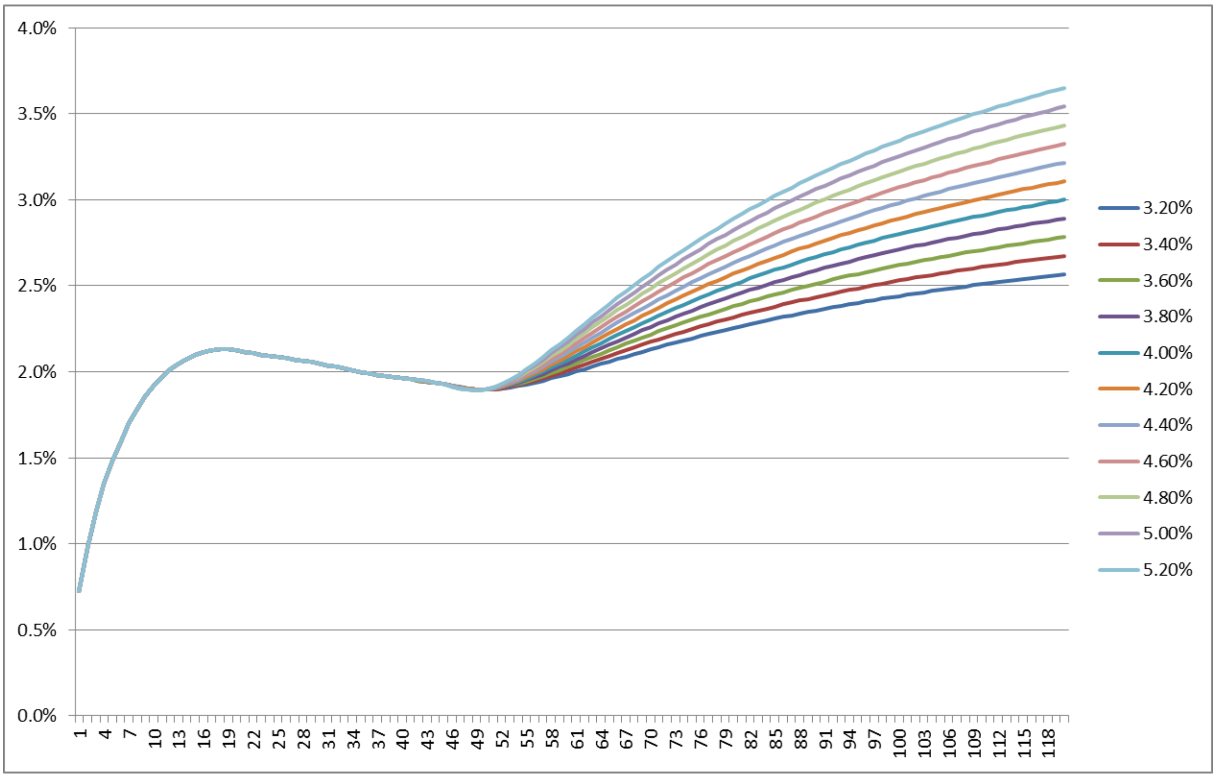
Swedish krona



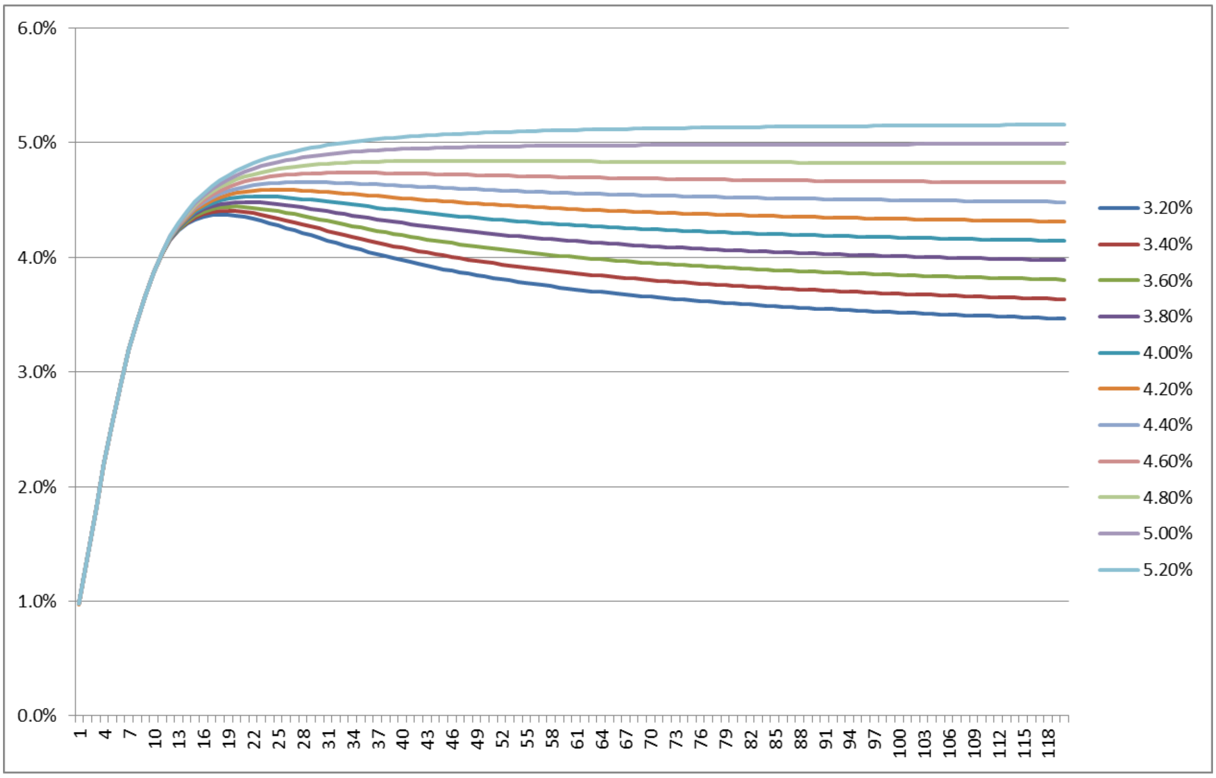
Croatian kuna



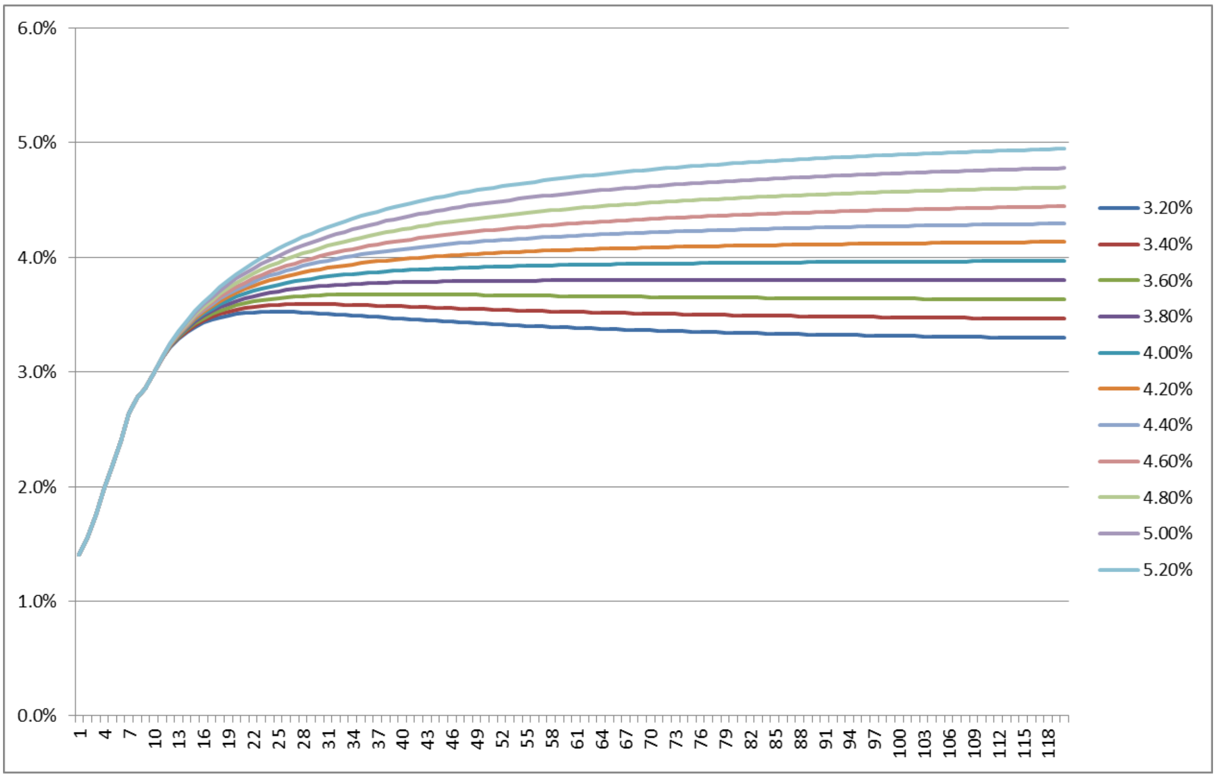
Pound sterling



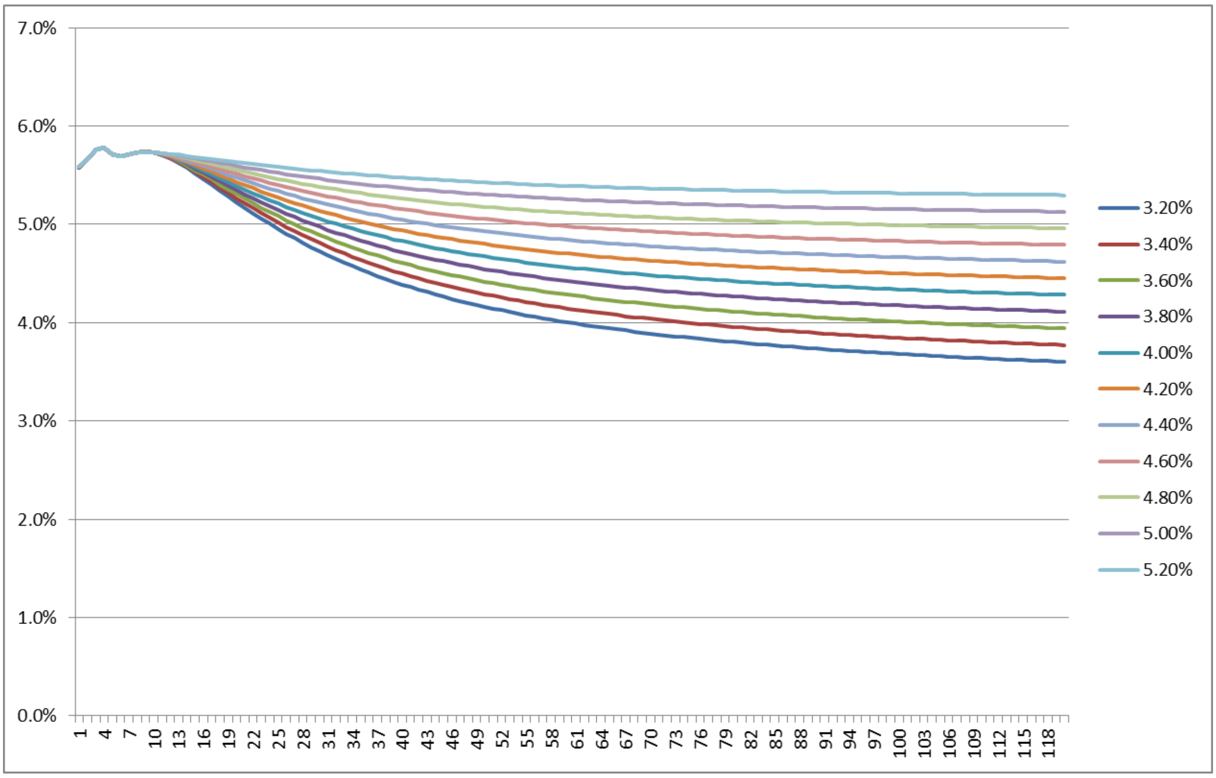
Romanian leu



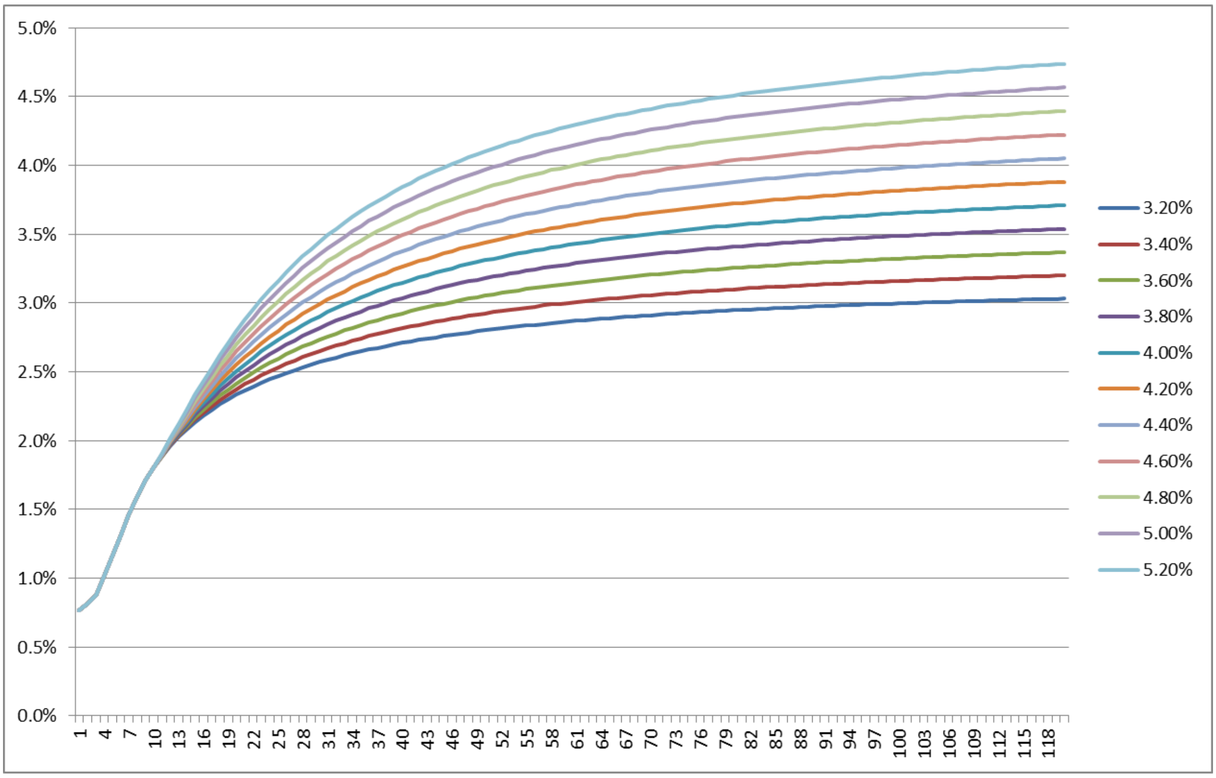
Polish zloty



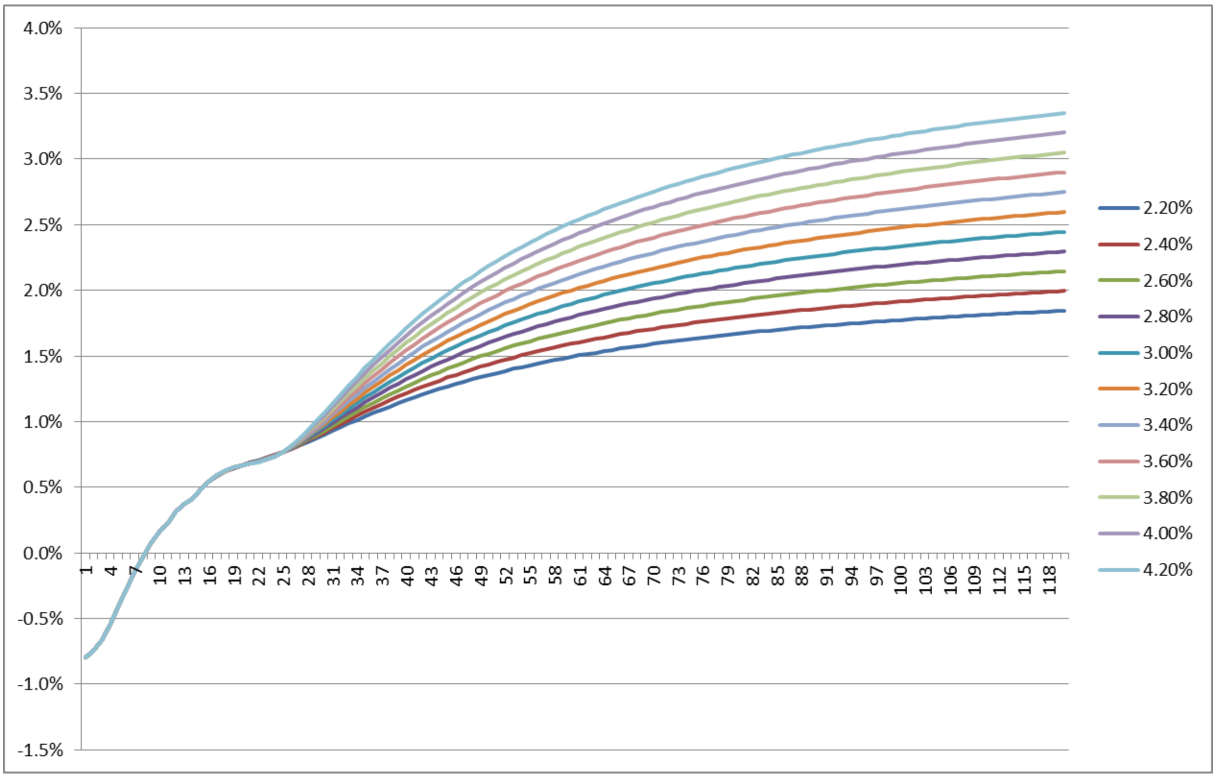
Icelandic króna



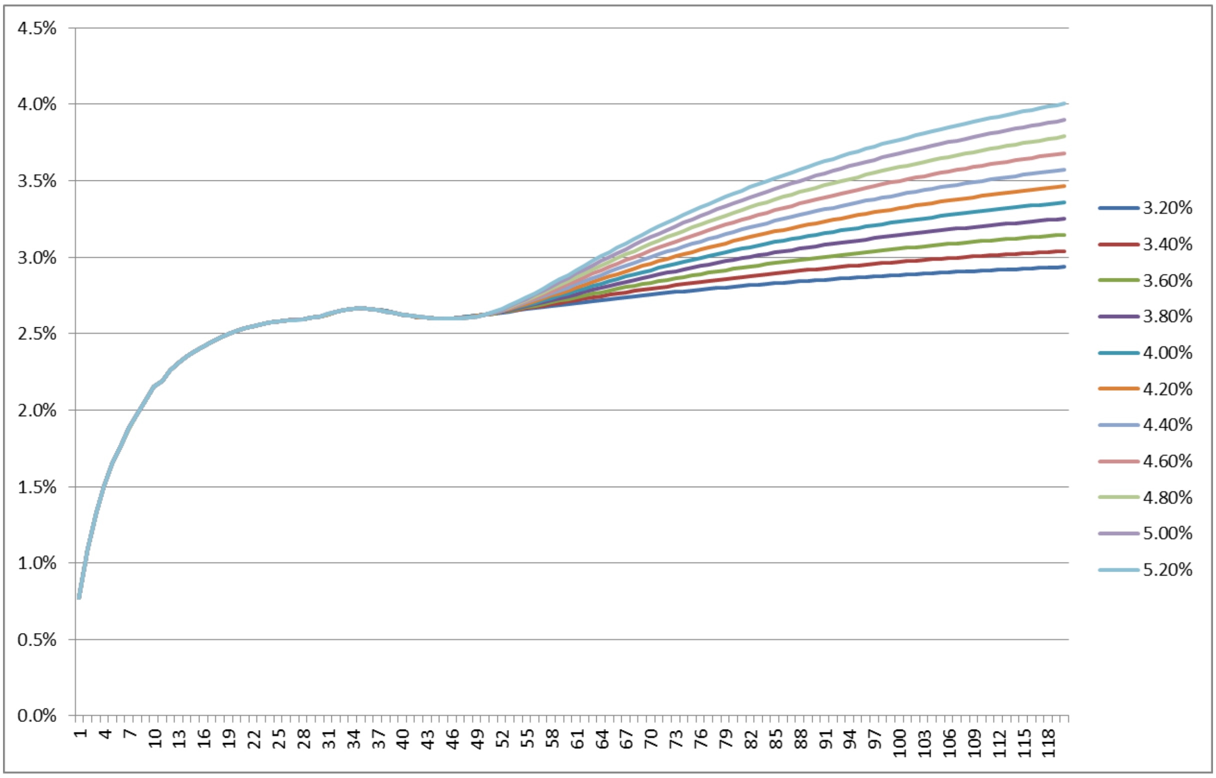
Norwegian krone



Swiss franc



US dollar



Japanese yen