Consultation Paper

Guidelines on corrections to modified duration for debt instruments under Article 340(3) of Regulation (EU) 575/2013

Contents

1. Responding to this consultation

The EBA invites comments on all proposals put forward in this paper and in particular on the specific questions summarised in 5.2.

Comments are most helpful if they:

- respond to the question stated;

- indicate the specific point to which a comment relates;

- contain a clear rationale;

- provide evidence to support the views expressed/ rationale proposed; and

- describe any alternative regulatory choices the EBA should consider.

Submission of responses

To submit your comments, click on the 'send your comments' button on the consultation page by 22.06.2016. Please note that comments submitted after this deadline, or submitted via other means may not be processed.

Publication of responses

Please clearly indicate in the consultation form if you wish your comments to be disclosed or to be treated as confidential. A confidential response may be requested from us in accordance with the EBA's rules on public access to documents. We may consult you if we receive such a request. Any decision we make not to disclose the response is reviewable by the EBA's Board of Appeal and the European Ombudsman.

Data protection

The protection of individuals with regard to the processing of personal data by the EBA is based on Regulation (EC) N° 45/2001 of the European Parliament and of the Council of 18 December 2000 as implemented by the EBA in its implementing rules adopted by its Management Board. Further information on data protection can be found under the Legal notice section of the EBA website.

2. Executive Summary

Regulation (EU) No 575/2013 (CRR) establishes two standardised methods to compute capital requirements for general interest rate risk. Article 339 establishes the so-called Maturity-Based calculation for general interest risk, while Article 340 regulates the Duration-Based calculation of general risk.

The Duration-Based method applies the concept of Modified Duration (MD), defined according to the formulas in Article 340(3) of the CRR. This formula is valid only for instruments not subject to prepayment risk. Accordingly, a correction to the duration becomes necessary to reflect this risk. In this regard, Article 340(3) of the CRR establishes the mandate for the EBA to issue guidelines establishing how the 'correction shall be made to the calculation of the modified duration for debt instruments which are subject to prepayment risk.' This CP contains proposals with regard to those guidelines.

Two approaches are proposed in these draft Guidelines to correct the MD calculation:

    i.   Treat the debt instrument with prepayment risk as if it was really a combination of a plain vanilla bond and an embedded option. Correct the Modified Duration of the plain vanilla bond with the change in value of the embedded option, estimated according to its theoretical delta, resulting from 100 basis points (b.p.) movement in Interest Rates;

    ii.   Alternatively, calculate directly the change in value of the whole instrument subject to prepayment risk resulting from a 100 b.p. movement in Interest Rates.

Additionally, the guidelines propose to compute the following elements to the correction:

    i.   Under the first approach, the theoretical delta of the embedded option may, on occasions, overestimate the correction that should be applied to the MD. To avoid this, it is proposed that the effect of the negative convexity stemming from the embedded option is computed. The EBA considers it is not necessary to correct convexity for the second approach, since the effect of convexity would be already included in the repricing of the instrument;

    ii.   Under both approaches it is proposed that the effect of transaction costs and behavioural factors are also reflected (where relevant) in the correction. The guidelines propose the consideration of these factors to reflect the fact that some of the options' buyers, in particular retail clients, might decide not to execute the option despite being in the money.

3. Background and rationale

The CRR establishes two standardised methods to compute capital requirements for general interest rate risk. Article 339 establishes the so-called Maturity-Based calculation for general interest risk, while Article 340 regulates the Duration-Based calculation of general risk.

Duration (D) and Modified Duration (MD) are well known concepts used in finance to measure the sensitivity (percentage change) in price for a unit change (parallel movements) in its Internal Rate of Return (IRR) of any financial asset that consists of fixed cash flows.

According to the formula stated in Article 340(3) of the CRR Duration (D) is:

$$D = \frac{\sum_{t=1}^{M} \frac{t \cdot C_t}{(1+R)^t}}{\sum_{t=1}^{M} \frac{C_t}{(1+R)^t}}$$

Where R is yield to maturity, C_t is cash payment in time t and M equals the total maturity

The modified duration (MD) is an adjusted version of the duration, which accounts for changing yield to maturities. The formula for the modified duration is the value of the duration divided by 1 plus the yield to maturity.

$$MD = \frac{D}{1+R}$$

Of course, behind both concepts there is the fact that the price of a financial asset that consists of fixed cash flows is inversely related to interest rate. The relationship price-yield (curved) can be represented with a linear approximation, the duration. This linear approximation may be observed in graph 1 (a) below, where the modified duration and the net present value of a bond as a result of movements in yield of a 20 year bond with a 6% coupon is represented:
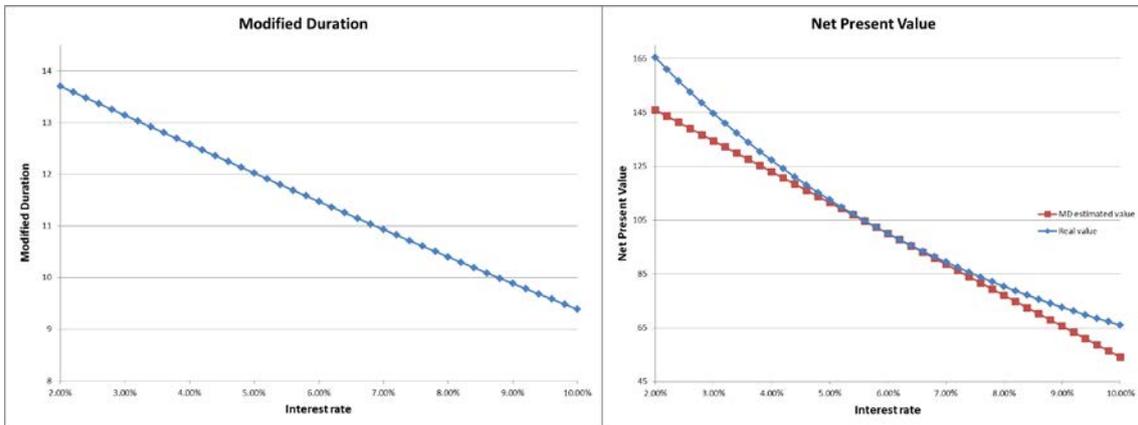
Graphs 1(a) Modified Duration and 1(b) Net Present Value, real and estimated with the Modified Duration

As it may be observed in graph 1(b), the actual relationship between the IRR and the value of a bond is non-linear, while the relationship between the IRR and the MD is linear. Therefore, the modified duration can be represented as the first derivative (or 'delta') of the value of the bond, divided by the current price of the bond. The price-yield curve is a convex function (i.e. has positive gamma) for long positions (i.e. where cash flows are received from the issuer) and 'concave' (negative gamma) for short positions.

As a result, for long directional positions, applying the modified duration would provide a conservative estimation of the real loss that a bank would experience in case of an increase in interest rate. Just like with convex options with positive gamma, the delta is overestimating potential losses in case of increase of interest rates and underestimating potential gains in case of decrease; this may be observed in graph 2 where the real and MD-estimated Profit and Loss, observed for increases and decreases in IRR starting from the 6% level, for the same bond described above is shown:
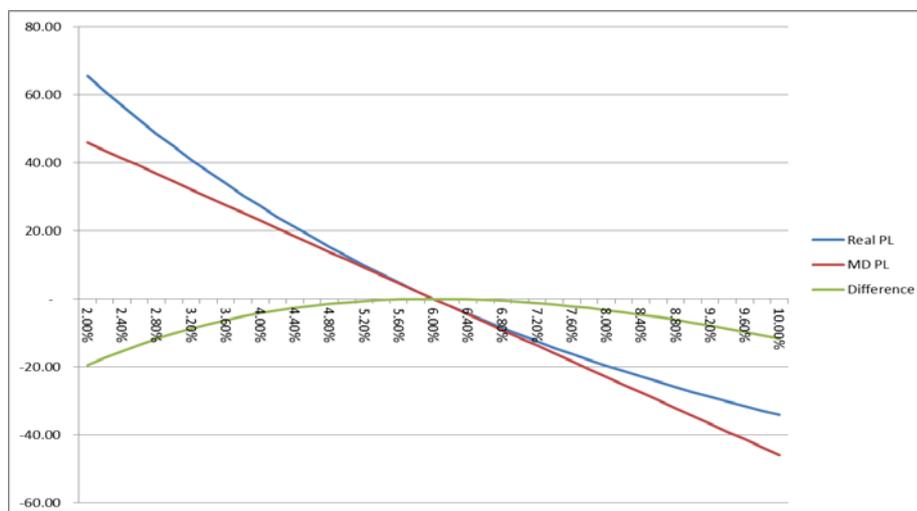
Graph 2: Real P&L vs MD-estimated P&L

Of course it can also be observed that, just like with delta profit and loss approximations used for options, the delta estimation of change in value (the MD in our example) is more accurate for small changes (i.e. when we are close to the current price of the bond) and is less precise when we try to assess large movements.

Nevertheless, the change in IRR would also affect the MD calculation, just like a movement in the underlying of an option affects its delta. Accordingly, if we recalculate the MD after every movement in IRR, we will observe a closer relationship between the 'real' and the 'estimated' profit and loss. This can be seen in graph 3, that represent 'real' and 'estimated' losses on the price of the bond used previously in case of an increase of 1% in IRR. It may also be observed that the loss based on the MD is consistently higher than the real one.
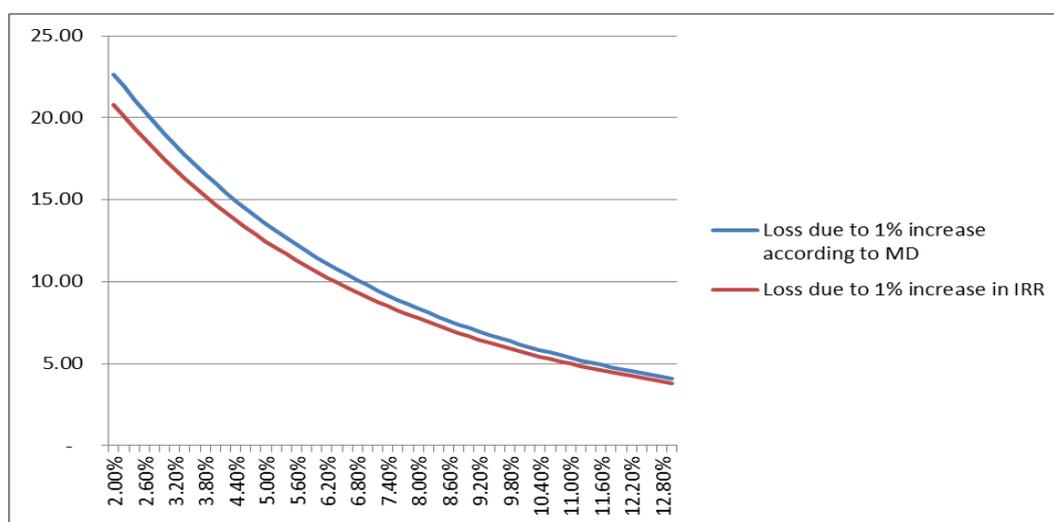
Graph 3: Real vs MD-estimated losses

Of course if we use the MD to estimate losses for short positions the situation would be the reciprocal one, so the real loss resulting from a decrease in IRR would be consistently higher than the one estimated based on the MD.

Duration-based metrics would be generally conservative for directionally-long portfolios, whilst might underestimate potential losses for directionally-short portfolios. Regardless of this, the standardised approach does not include any adjustment to correct convexity; however, the convexity stemming from any embedded optionality should be conservatively considered in these guidelines when calculating any correction to the modified duration.

3.1 EBA mandate

The concept of Modified Duration, as exposed in the introduction and defined according to the formulas in Article 340(3) of the CRR, is valid only for instruments not subject to prepayment risk. Accordingly, a correction to the duration becomes necessary to reflect this risk.

In this regard, Article 340(3) of the CRR establishes the mandate for the EBA to issue guidelines establishing how the 'correction shall be made to the calculation of the modified duration for debt instruments which are subject to prepayment risk.'

The mandate relates to the incorporation of 'prepayment risk'; accordingly, it could be argued that the institution has to reflect only the effect of sold embedded optionality. In other words, it would only have to introduce a correction in case the counterparty has the possibility of paying early a bond (for long positions) or asking for an early refund of debt issued by the institution (for short positions).

However, bought options also introduce 'prepayment risk', to the extent they are subject to P&L losses. Accordingly these guidelines also cover the situation in which the institution has the right to request an early prepayment (i.e. puttable bonds bought or callable bonds issued).

3.2   Effect in capital of the correction to reflect prepayment risk

It should be noted that the effect of any correction to the modified duration to reflect 'prepayment risk' will always be negative, i.e. the duration of a bond with embedded optionality will always be lower (or, at a minimum for deep out of the money options, equal) than the one obtained for the plain vanilla bond. Regardless of its sign, the same thing could be said for a short position where the counterparty has the option to call for an early payment (e.g. a put bond, putable or retractable bond).

Of course, since capital requirements under the standardised approach are higher for bonds with a longer maturity, the incorporation of the 'prepayment risk' would have the apparent paradoxical effect of reducing the capital requirement for the bond with embedded optionality, when compared to the same position without considering the optionality.

This result may seem counterintuitive; however it accurately reflects the real sensitivity stemming from a financial asset that consists of fixed cash flows with embedded optionality. Indeed, if for example we look at a callable bond whose embedded optionality is deep in the money, the Corrected Modified Duration (CMD thereafter) will be significantly lower than the MD we would observe without the optionality.

This reflects the fact that the real maturity of the bond would almost certainly be the first date in which the bond can be called; in addition, any increase in interest rate would have a negligible effect in the value of the bond due to the effect of the sold option. Both features (short time to effective maturity and nearly zero sensitivity to changes in interest rates) fully justify a lower capital requirement[1].

Conversely, if we consider now a callable bond whose embedded optionality is deep out of the money we will observe that both the value of option and the corresponding 'correction' of the

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[1] Of course, the valuation of the embedded option sold shall be reflected (deducted) in the value of the callable bond.

modified duration are close to zero. In this case, the behaviour of the callable bond is nearly the same as the one that would be observed for the plain vanilla bond alone; accordingly, the CMD becomes almost the same as the MD, the effect of changes in IRR would affect both bonds in a similar way and the capital requirement would also be the same.

Both effects can be observed in Graph 4 below, where the relationship price-yield of a 20 year callable bond is shown (see technical annex for further elaboration):

Price vs yield: 6% - 20 Year Callable Bond
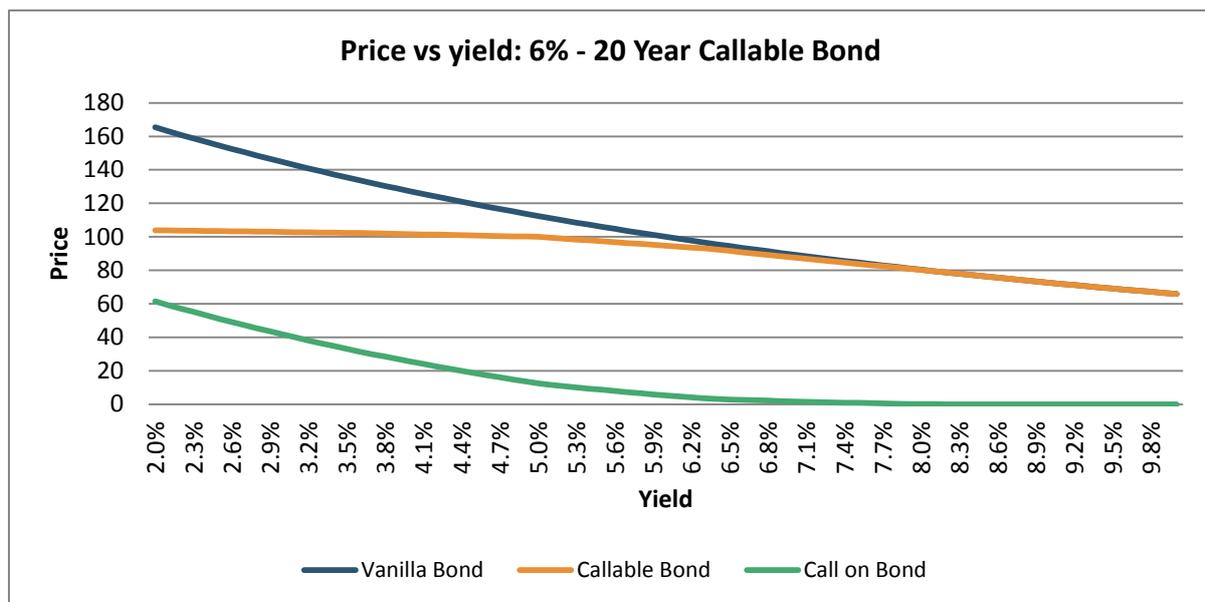
Graph 4: Price-yield relationship for a plain vanilla bond, a callable bond and the call option embedded

As it can be seen in Graph 4 above, an increase in IRR (e.g. moves up from 6% to 8%) causes a decrease in both the price of the Vanilla Bond and the Callable Bond. It is notable how the price of the two bonds tends to converge when IRR increases, of course this is due to the fact that the embedded option goes out of the money and its value gets close to zero. However, when the IRR decreases (e.g. moves form 6% down to 4%) the call option moves in the money (ITM) and the price of the two bonds diverge; the vanilla bond price increases significantly while the callable bond tends to be capped at 100. In this second case, the value of the sold option, now ITM, will be deducted

from the positive value of the Vanilla Bond[2], making the value of the Callable Bond almost insensible to movements in interest rates.

3.3   Main features of the embedded optionality

Any instruments subject to prepayment risk, typically debts security, differ from vanilla instruments because the maturity of the product is no longer fixed, but it becomes variable.

This uncertainty on the maturity of the product is introduced by the embedded optionality, which gives the right to extinguish in advance the underlying obligation.

The complexity of the embedded prepayment optionality varies, however it generally has the following features:

- Its value will be a factor of the shape of the yield curve and its dynamics, which represent the optionality nature of the callable/puttable feature.
- It usually has multiple exercise dates, which is represented by a Bermudan feature.
- Normally, the premium for the embedded optionality sold by the investor is incorporated in the bond by way of a higher coupon, relative to comparable non- callable transaction, and/or lower value.
- The optionality embedded to the instrument biases or reverses the classical convex relationship between price and yield of long bond positions; the same effect can be observed for the negative convexity stemming from short positions.

3.4   Convexity effect introduced by the embedded optionality

The data included in table 1[3] below show that, for a long position in a callable bond, the losses estimated using the CMD are smaller than the ones really produced by a shift in the IRR, while the gains estimated according to the CMD are higher than the real ones. This is the opposite of what happens with the MD, as it may be observed in graph 2.

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[2] Having a long position in a Callable Bond is equal to have a long position in a Vanilla Bond plus a short position in a Call option on the same bond.

[3] Theoretical example for a 20-year bond, 6% coupon, with a 10 years embedded American call option. The strike price of the call is 100, and the exercise dates of the option start after the 1st year. The data come from the same theoretical example reported in the technical annex, therefore the Bond and the option are valued through Hull-White model.

Table 1. In The Money Callable Bond

Interest rate	Shock BP	Price Vanilla Bond	Estimated P&L with MD		Actual P&L		Bond with Embedded Option	Estimated P&L with CMD		Actual P&L	
6.00%	100	100.00	-	13.59	-	12.46	94.70	-	3.47	-	5.29
5.80%	80	102.33	-	10.87	-	10.13	95.78	-	2.77	-	4.21
5.50%	50	105.98	-	6.80	-	6.49	97.34	-	1.73	-	2.65
5.20%	20	109.80	-	2.72	-	2.66	98.92	-	0.69	-	1.06
5.00%	-	112.46	-			-	99.98	-			-
4.80% -	20	115.21		2.72		2.75	100.33		0.69		0.34
4.50% -	50	119.51		6.80		7.05	100.81		1.73		0.83
4.20% -	80	124.04		10.87		11.57	101.30		2.77		1.31
4.00% -	100	127.18		13.59		14.72	101.63		3.47		1.65
Duration				12.08					3.47		

Table 1: CMD P&L approximation for a plain vanilla and a Callable Bond using only first order approximations

In this regard, the positive convexity stemming from the plain vanilla bond is fully compensated by the negative convexity that the embedded sold optionality (equivalent to a payer swaption) produces. Accordingly, for long positions in callable bonds, loss assumptions based on CMD would underestimate the real losses produced[4].

For callable bonds issued by the institution (i.e. short positions where the bank has the right to call for an early termination) the MD[5] would generally underestimate the loss, so the positive gamma (positive convexity) of the bought optionality (equivalent to a receiver swaption in this case) would compensate the underestimation of the loss produced by the MD of the short position.

For long positions in putable bonds (i.e. long positions where the bank has the right to call for an early termination), both the bond and the embedded optionality would show positive gamma while for puttable bonds issued by the bank, both the short interest rate position and the embedded optionality would show negative convexity.

Consistent with a conservative treatment, the regulation[6] for options under the delta-plus approach establishes that the convexity ('gamma impact') shall only be incorporated to the capital calculation when it is addressing a loss underestimation produced by the first-order estimation (Delta), in this case the delta is overestimating the potential gain due to the movement in the underlying, though from a capital perspective we are just concerned about loss underestimation. Accordingly, only negative gamma is included in the calculation of capital under standardized rules while positive gamma is ignored.

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[4] If the long position is in a puttable bond, both the plain vanilla bond and the embedded option bought would have positive convexity, making the CMD conservative.

[5] It may be argued that for short plain vanilla positions (i.e. with no embedded optionality) the MD should be corrected with the negative gamma in order to avoid underestimating the potential loss of the positions; however, the treatment for MD is clearly stated in Article 340 of the CRR. In addition the MD calculation is outside the scope of these guidelines.

[6] See EBA's RTS on non-delta risks http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOL_2014_148_R_0007

In the specific case of the correction to the MD, the conservative treatment would be the same one. As previously mentioned, the MD provides an estimation of the loss due to a movement in the bond's IRR, while the 'delta' of the embedded optionality would 'correct' this loss with an estimation of gains due to the same movement in IRR. Of course, when the 'delta' of the embedded optionality overestimates the real gain produced as a consequence of the movement in IRR, the correction to the MD produced by its computation would be excessive and has to be adjusted, by considering the option's negative gamma.

3.5 Proposed Correction to Modified Duration

It is the embedded optionality that makes the future cash flow payment variable, and makes the Modified Duration formula no longer reliable to approximate the change in value of the instrument due to a change in the interest rate.

It is common to treat this kind of 'hybrid instruments' by segregating them in two tractable components: the vanilla bond instrument and the interest rate option. Of course, the 'option' in this case is not a standalone independent instrument; indeed the embedded optionality is the feature of the bond that turns it into a 'hybrid instrument[7]' and which should be considered when correcting the MD.

It should be noted that this treatment is more straightforward for simple callable/puttable bond, while for mortgage backed obligation this relationship could be more complex.

The EBA is assessing the following formula to correct the Modified Duration (Corrected Modified Duration – CMD):

- Since the value of the instrument is equal to the value of the vanilla bond instrument, plus/minus (depending on whether the institution has bought or sold the option) the value of the embedded option, the CMD is approximated as the difference of the Modified Duration of the vanilla instrument and the first order approximation of the change in value of the option due the change of the underlying value (i.e. equivalent to the delta) of the option embedded, adjusted by the current price of the bond.

- As previously mentioned the negative gamma introduced by the embedded optionality should be factored, adjusted by the price of the bond, the change in value of the interest rate and divided by two (i.e. in consistency with Taylor series approximation).

- Apart from the previous adjustments, the EBA is proposing that an additional correction factor should be considered in order to reflect any significant transaction costs that the early payment of the callable bond might produce, as well as behavioural factors, which would reflect the fact that some of the options' buyers might decide not to execute the option despite being in the money.

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[7] According to IAS 32 and IAS 39 a financial instrument containing an embedded derivative is referred to as a 'hybrid financial instrument'.

$$CMD = MD \times \Phi \times \Omega$$

Where[8]:

$MD = Modified\ Duration\ as\ in\ Art.\ 340(3)$

$\Phi = \dfrac{B}{P}$

$\Omega = 1 + \Delta + \dfrac{1}{2}\,\Gamma\,dB + \Psi$

$P = Price\ of\ the\ Bond\ with\ the\ embedded\ optionality$

$B = Price\ of\ the\ Vanilla\ Bond$

$\Delta = Delta\ of\ the\ embedded\ option$

$\Gamma = Gamma\ of\ the\ embedded\ option$

$\Psi = Additional\ factor\ (consistent\ with\ a\ general\ IRR\ movement\ of\ 100\ b.p.)$

$dB = Change\ in\ value\ of\ the\ underling$

The additional factor, consisting of transaction costs and 'behavioural' factors, are introduced to ensure that the corrected modified duration reflects conservatively the maturity of the callable bond, so it should never be negative. If these effects are not included in the calculations, when they are significant, it may lead to a misrepresentation of the prepayment risk.

Transaction costs will reduce the value of the option, making it unlikely to be executed below the threshold established by the transaction costs.

Finally, 'behavioural' factors shall be introduced to reflect the fact that some clients, in particular retail ones, may not always exercise the option, even when it is in the money. These behavioural factors should only be considered where they are significant. In this regard, it is understood that for a majority of banks, very few, if any, of the hybrid instruments booked in the trading book will be held by retail clients; however, in some jurisdictions, retail clients do hold these kinds of hybrid positions. Where relevant, these behavioural factors may be explained by some known elements, such as:

- Size of the principal outstanding compared with initial lending: when the remaining principal is close to the initial amount lent, borrowers tend to react faster to gains from prepayment. These 'aggressive' borrowers tend to leave (or refinance) at an early state. Conversely, as time goes by, the remaining borrowers tend to be the most 'rigid' ones and are not likely to execute the embedded option.

- Principal size: the group of borrowers that has the largest loan size is the group likely to have the largest prepayment rate, as these borrowers have the largest gain from prepayment as the cost attached to prepayment is a fixed amount.

Institutions shall assess and incorporate these factors to their calculations of the CMD based on historical data, obtained from their own experience or from external sources. Data on the

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[8] An illustration of how the formula is derived is shown in the technical annex of these guidelines.

behavioural factors may be obtained from the assessment of other balance sheet elements subject to prepayment risk, such as those observed for retail clients in the non-Trading Book.

The additional factor should be determined by assessing any significant divergence between the real behaviour historically observed for a type of client (such as retail) and the theoretical behaviour that would have been envisaged for counterparties acting in a purely rationale way. These adjustments due to behavioural factors shall not be considered for those embedded options where the institution has the right to call for an early termination of the instrument (such as puttable bonds bought by the firm).

The consideration of these behavioural factors for certain kind of clients is a departure from the Market Risk framework in general, where the assumption is that any agent in the market will act in a fully rational way, so any opportunity costs will be avoided. However, as explained previously, the effect of introducing these factors allows the alignment of the duration of the instruments with the one historically observed, which would be generally longer and, thus, subject to higher capital requirements.

Alternatively, institutions may re-compute directly the Corrected Modified Duration (CMD) by repricing the instrument after shifting 100 b.p. the IRR. In this case, no gamma correction is necessary, since the instrument is fully revalued and no delta approximation is applied. Accordingly, only the additional factor described previously shall be computed.

Under this second alternative, the following methodology should be applied to the CMD:

$$CMD = \frac{P_{-\Delta r} - P_{+\Delta r}}{2 \times P_0 \times \Delta r} + Additional\ factors$$

Where:

$P_0 = The\ current\ market\ price\ of\ the\ product;$

$P_{\mp \Delta r} = theoretical\ price\ of\ the\ product\ after\ a\ negative\ and\ a\ positive\ interest\ rate\ shock\ equals\ to\ \Delta r;$

$\Delta r = hypotetical\ intrest\ rate\ change\ of\ 50\ b.p.$

$Additional\ factors$
$= transaction\ costs\ and\ behavioural\ variables\ consistent\ with\ a\ general\ IRR\ movement\ of\ 100\ b.p.$

Box for consultation – Illustration of the two methods proposed in the GL.

Theoretical example for a 20-year bond, 6% coupon, with a 10 years embedded American call option. The strike price of the call is 100, and the exercise dates of the option start after the 1st year. The data come from the same theoretical example reported in the technical annex, therefore the Bond and the option are valued through Hull-White model.

OTM

Interest rate	Shock BP	Price Vanilla Bond	Estimated	Real loss	Bond with Embedded Option	Estimated With Method 1	Estimated With Method 2	Real loss
8.00%	100	80.36	- 9.82	- 9.04	80.21	- 8.49	- 7.69	- 7.52
7.80%	80	82.06	- 7.85	- 7.34	81.71	- 6.80	- 6.15	- 6.01
7.50%	50	84.71	- 4.91	- 4.70	83.88	- 4.25	- 3.85	- 3.84
7.20%	20	87.48	- 1.96	- 1.92	86.16	- 1.70	- 1.54	- 1.56
7.00%	-	89.41	-	-	87.72	-	-	-
6.80% -	20	91.39	1.96	1.99	89.23	1.70	1.54	1.51
6.50% -	50	94.49	4.91	5.08	91.58	4.25	3.85	3.86
6.20% -	80	97.74	7.85	8.34	93.64	6.80	6.15	5.92
6.00% -	100	100.00	9.82	10.59	94.70	8.49	7.69	6.98
Duration			10.98			9.68	8.77	

MD	10.98
B/P	1.02
Omega	0.87
Delta	- 0.26
Gamma	- 0.03
dB	9.82

In the example of the table, we are supposing to represent a bond with the embedded option Out Of The Money (OTM), hence we start from 7% flat interest rate curve state.

In the first column of the table we report the level of interest rate, for a span from 6% to 8%. In the second column we can read the shift in basis point from the "current" state (i.e. from the 7% flat IR to e.g. 8%, we can read an increase of 100 b.p.).

In the third column we can read the actual price of the vanilla bond which is the first component of the callable bond. In the current state (i.e. 7% IR) the price of the bond is 89.41, quite below the par value. In the example the par value (100) is reached only if we would observe a negative shift in the interest rate curve of 100 b.p.

In the fourth column we can read the Modified Duration of this vanilla bond (at the bottom of the column), and the estimated losses or gains, using this modified duration, that we would obtain from an interest rate shift of X b.p. We can compare the results obtained in this column with the next one, that show the real losses or gains we would observe if an interest rate shift would been realised.

Starting from the sixth column, it is possible to observe the results for the callable bond. In this column it is reported the price of the callable bond. It is clear that the price of a callable bond it is always lower respect a price of an identical vanilla bond. The difference represents the value of the embedded call option. As expected, the higher the interest rate, the smaller is the difference, i.e. the call option keeps losing value as it goes OTM. Eventually, in a period of high level interest rate, the difference would be zero, because the call option will be deep OTM.

In the seventh column we can read, in the duration line, the value (9.68) of the duration computed according the first methodology suggested in this Guideline. In the same column it is reported also all the values of the different components of this formula used to correct the modified curation. The

values of the variables (i.e. Delta, Gamma, and Omega) are derived as reported in the Annex section.

Also in the seventh column it is possible to read the estimated changes in prices, profit and loss expected, using the Corrected Modified Duration, as in the first methodology.

In the eighth column it is reported the value of the Corrected Modified Duration (8.77) computed according the second methodology suggested in this Guideline, i.e. the ratio of the theoretical change in value of the callable bond (+/- 50 b.p.), divided by the current price. As for the precedent column, it is reported the estimated changes in prices of the callable, expected profit and loss expected, using the Corrected Modified Duration, as for the second methodology.

In the last column it is reported the real change in value of the callable bond when the interest rate increases or decreases. As expected, we can observe that both the methodology suggest a Corrected Modified Duration which is shorter than the Modified Duration. The difference is approximately 2 year, and this because, as we noticed above, this example was built on purpose to show an option OTM. Nonetheless, both methodologies better approximate the change is value of the callable respect the standard Modified Duration.

4. Draft guidelines

In between the text of the draft Guidelines that follows, further explanations on specific aspects of the proposed text are occasionally provided, which either offer examples or provide the rationale behind a provision, or set out specific questions for the consultation process. Where this is the case, this explanatory text appears in a framed text box.

EBA/GL-REC/20XX/XX

DD Month YYYY

Draft Guidelines

on corrections to modified duration for debt instruments under Article 340(3) of Regulation (EU) 575/2013

1. Compliance and reporting obligations

Status of these guidelines

1. This document contains guidelines issued pursuant to Article 16 of Regulation (EU) No 1093/2010[9]. In accordance with Article 16(3) of Regulation (EU) No 1093/2010, competent authorities and financial institutions must make every effort to comply with the guidelines.

2. Guidelines set the EBA view of appropriate supervisory practices within the European System of Financial Supervision or of how Union law should be applied in a particular area. Competent authorities, as defined in Article 4(2) of Regulation (EU) No 1093/2010, to whom guidelines apply, should comply by incorporating them into their practices as appropriate (e.g. by amending their legal framework or their supervisory processes), including where guidelines are directed primarily at institutions.

Reporting requirements

3. According to Article 16(3) of Regulation (EU) No 1093/2010, competent authorities must notify the EBA as to whether they comply or intend to comply with these guidelines, or otherwise with reasons for non-compliance, by ([dd.mm.yyyy]). In the absence of any notification by this deadline, competent authorities will be considered by the EBA to be non-compliant. Notifications should be sent by submitting the form available on the EBA website to compliance@eba.europa.eu with the reference 'EBA/GL/201x/xx'. Notifications should be submitted by persons with appropriate authority to report compliance on behalf of their competent authorities. Any change in the status of compliance must also be reported to EBA.

4. Notifications will be published on the EBA website, in line with Article 16(3).

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[9] Regulation (EU) No 1093/2010 of the European Parliament and of the Council of 24 November 2010 establishing a European Supervisory Authority (European Banking Authority), amending Decision No 716/2009/EC and repealing Commission Decision 2009/78/EC, (OJ L 331, 15.12.2010, p.12).

2. Subject matter, scope and definitions

Subject matter

5. These guidelines specify how to apply corrections to the calculation of the modified duration to reflect prepayment risk, in accordance with the mandate conferred to the EBA in the last subparagraph of Article 340(3) of Regulation (EU) No575/2013[10].

Scope of application

6. These guidelines apply in relation to the calculation of the modified duration for debt instruments which are subject to prepayment risk for the purposes of own funds requirements for General Interest Rate Risk under the standardized approach in accordance with Article 340 of Regulation (EU) No 575/2013.

Addressees

7. These Guidelines are addressed to competent authorities as defined in point (i) of Article 4(2) of Regulation (EU) No 1093/2010 and to financial institutions as defined in Article 4(1) of Regulation No 1093/2010.

Definitions

8. Unless otherwise specified, terms used and defined in Regulation (EU) No 575/2013 and Directive (EU) 36/2013 have the same meaning in the guidelines.

9. For the purpose of these guidelines, the following definitions apply:

    a) a callable bond is a type of debt instrument that gives the issuer of the bond the right, but not the obligation, to redeem the bond at some point before it reaches its date of maturity

    b) a putable bond is a type of debt instrument that gives the holder of the bond the right, but not the obligation, to demand early repayment of the principal.

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[10] Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investments firms and amending Regulation (EU) No 648/2012 (OJ L 176, 27.6.2013, p.1).

3. Implementation

Date of application

10.These guidelines apply from dd.mm.yyyy.

4. Correction to the modified duration to reflect prepayment risk

11. Institutions using the duration-based calculation for general interest rate risk in accordance with Article 340 of Regulation (EU) No 575/2013, should apply the formula of paragraph 12 or, alternatively, the formula of paragraph 19 of these guidelines to correct the modified duration, calculated in accordance with paragraph 3 of that Article, for all debt instruments subject to prepayment risk.

12. Institutions should apply the following formula to correct the Modified Duration and compute a Corrected Modified Duration ('CMD'):

$$CMD = MD \times \Phi \times \Omega$$

where:

$MD = Modified\ Duration\ as\ in\ Art. 340(3)$

$\Phi = \dfrac{B}{P}$

$\Omega = 1 + \Delta + \dfrac{1}{2}\,\Gamma\,dB + \Psi$

$P = Price\ of\ the\ Bond\ with\ the\ embedded\ optionality$

$B = Price\ of\ the\ Vanilla\ Bond$

$\Delta = Delta\ of\ the\ embedded\ option$

$\Gamma = Gamma\ of\ the\ embedded\ option$

$\Psi = Additional\ factor\ for\ transaction\ costs\ and\ behavioural\ variables\ consistent\ with\ a\ IRR\ shift\ of\ 100\ b.p.$

$dB = Change\ in\ value\ of\ the\ underling$

and where the gamma of the embedded option should be considered only for long callable positions or for short putable positions.

13. Where relevant, institutions should introduce the additional factor Ψ to reflect transaction costs and behavioural factors in the formulas stated in paragraphs 12 and 19 of these guidelines to ensure that the corrected modified duration reflects conservatively the maturity of the callable bond. As a result, the value of the additional factor should never be negative.

14. For the purposes of assessing the additional factor Ψ in accordance with paragraph 13 of these guidelines, institutions should take into account all of the following:

   a) that transaction costs reduce the value of the option, making the option unlikely to be executed below the threshold established by the transaction costs.

b) the behavioural factors reflecting the fact that some clients, in particular retail clients, may not always exercise an option, despite it being in the money, due to some known circumstances including, but not limited to, the following:

i. Size of the principal outstanding compared with initial lending: when the remaining principal is close to the initial amount lent, some borrowers react faster to gains from prepayment. These 'aggressive' borrowers tend to leave (or refinance) at an early stage. Conversely, as time goes by, the remaining borrowers tend to be the most 'rigid' ones and are not likely to execute the embedded option.

ii. Principal size: the group of borrowers that has the largest loan size is the group likely to have the largest prepayment rate, as these borrowers have the largest gain from prepayment as the cost attached to prepayment is a fixed amount;

15. The assessment of the additional factor Ψ should be based on historical data, obtained from their own experience or from external sources. Data on the behavioural factors may be obtained from the assessment of other balance sheet elements subject to prepayment risk, such as those observed for retail clients in the non-Trading Book.

16. Institutions should calibrate the additional factor Ψ by assessing significant divergences between the real behaviour historically observed for a type of client and the theoretical behaviour that would have been envisaged for counterparties acting in a purely rationale way.

17. These adjustments due to behavioural factors should only be factored where a relevant amount of these instruments with prepayment risk in the trading book is held by retail clients. In addition, they should not be considered for those embedded options where the institution has the right to call for an early termination of the instrument.

18. Alternatively to the formula stated in paragraph 12, institutions may re-compute directly the CMD by repricing the instrument after shifting 100 b.p. the IRR. In this case, no gamma correction is necessary, since the instrument is fully revalued and no delta approximation is applied. Accordingly, only the additional factor, reflecting behaviour and transaction costs in accordance with paragraph 13 to 17 of these guidelines, should be computed.

19. Under this second alternative, institutions should apply the following CMD formula:

$$CMD = \frac{P_{-\Delta r} - P_{+\Delta r}}{2 \times P_0 \times \Delta r} + \Psi$$

where:

$P_0 = \textit{The current market price of the product;}$

$P_{\mp\Delta r} = \textit{teoretical price of the product after a negative and a positive interest rate shock equals to } \Delta r;$

$\Delta r = \textit{hypotetical intrest rate change of } 50 \textit{ b.p.}$

$\Psi = \textit{Additional factor for transaction costs and behavioural variables consistent with a IRR shift of } 100 \textit{ b.p.}$

Box for consultation:

The EBA considers that to correct the MD appropriately it is necessary to factor the embedded optionality via its first and, where conservative, second order sensitivities. In addition, the EBA also believes that, where this is relevant, there should be an additional adjustment to account for transaction costs and behavioural factors.

Regarding the inclusion of these behavioural factors, it may be argued that the adjustment clearly increases the complexity of the framework and is not fully defined, leaving it open for institutions to assess its impact based on their own experience; on the other hand, the adjustment can only add conservativeness to the approach and the GL state it should be applied 'when significant' so, in many cases, the adjustment can be ignored by the firm.

In addition it is worth noting that 'behavioural risk' is one of the elements to be included in the 'residual risk add-on' of the new standardised under the FRTB.

https://www.bis.org/bcbs/publ/d352.pdf

(viii) The Residual Risk Add-On

58. The residual risk add-on is to be calculated for all instruments bearing residual risk separately and in addition to other components of the capital requirement under the standardised approach for market risk (….)

A non-exhaustive list of other residual risks types and instruments that may fall within the criteria set out in paragraphs 58(e) include:

• Gap risk: (…)

• Correlation risk: (…)

*• **Behavioural risk: risk of a change in exercise/prepayment outcomes such as those that arise in fixed rate mortgage products where retail clients may make decisions motivated by factors other than pure financial gain such as demographical features and/or and other social factors. A callable bond may only be seen as possibly having behavioural risk if the right to call lies with a retail client.***

Whilst it may be argued that, by considering this factor, the guidelines are in line with the latest regulatory developments, it is also true that the new FRTB Standardised Approach treats this 'residual risk' applying a crude percentage to the notional of the instruments bearing this risk, whereas the guidelines propose a potentially more 'model-based' assessment of this factor.

The EBA is consulting on the appropriateness of both types of adjustments from a methodological perspective, but is also interested in the potential burden that the implementation of these

provisions might entail, in particular for small firms with very limited, or even negligible, positions in these types of hybrid instruments.

In this regard, the EBA would like to get feedback on whether stakeholders can provide simpler alternative adjustments that may be generally conservative and appropriate.

Q1: Do stakeholders agree with the proposed approaches to correct the modify duration?

Q2: Do stakeholders agree that, under the first approach, the negative gamma stemming from the embedded option should be considered in the calculation of the correction?

Q3: Do stakeholders agree with the inclusion of behavioural factors in the calculation of the correction?

Q4: In case the approaches proposed to correct the negative gamma and/or the behavioural factors are deemed to be too burdensome, what simpler alternative adjustments may be applied to correct the modified duration?

Technical Annex

Illustration of the Corrected Modified Duration formula applied in the guidelines

It is possible to represent price of the Bond with the embedded optionality (P) as the s sum of the prices of two plain instruments: the price of the vanilla Bond (B) and (C) the price of the embedded bond option (short call or long put). We also know that the price of the vanilla Bond (B) is a function of r, the interest rate curve, so B = g(r), and C is a function of the underlying vanilla Bond price, so C = f(B), i.e. C = f[B(r)].

From the initial statement, we can write this as in Eq. 1):

Eq. 1) $P = B + C$

From Eq. 1 it follows:

Eq. 2) $dP = dB + dC$

We also know that:

Eq. 3) $dB = \frac{dB}{dr} dr$

So, according to a Taylor approximation:

Eq. 4) $dC = \frac{dC}{dB} dB + \frac{1}{2} \frac{d^2C}{dB^2} (dB)^2$

Using standard Greeks derivatives nomenclature, we may call:

Eq. 5) $\Delta = \frac{dC}{dB}$

Eq. 6) $\Gamma = \frac{d^2C}{dB^2}$

Substituting Eq. 5 and 6into Eq. 4, and then Eq. 4 into Eq. 2, to obtain:

Eq. 6) $dP = dB + \Delta\, dB + \frac{1}{2} \Gamma\, (dB)^2$

We can regroup dB, and call:

Eq. 7) $K = 1 + \Delta + \frac{1}{2} \Gamma\, dB$

The Modified Duration (MD) in the article 340 of the CRR can also be represented as follows:

Eq. 8) $\mathrm{MD}_{(B)} = -\frac{1}{B}\frac{dB}{dr}$

And we introduce the ratio:

Eq. 9) $\Phi = \frac{B}{P}$

And, similar to Eq. 8, we can write the (Corrected) Modified Duration of the Bond with the embedded option, which is the objective of EBA mandate on prepayment risk, as the sensitivities of the price of the Bond (P) with respect the interest rate (r), divided by the price of the bond:

Eq. 10) $\mathrm{MD}_{(P)} = -\frac{1}{P}\frac{dP}{dr}$

At this point we can simply substitute Eq. 6 and 7into Eq. 10 (just substitute $\mathrm{MD}_{(P)}$ with CMD (equation 11), and using definition in equation 8 and 9, we obtain:

Eq. 11) $\mathrm{CMD} = \mathrm{MD}_{(B)} \times \ \Phi \times \mathrm{K}$

The EBA is also consulting on a third adjustment to the duration to reflect eventual transaction cost and behavioural factors which, when significant, may also affect the duration of the bond. The additional effect should be represented as follow:

Eq. 12) $\Psi = Additional\ factors$

Then, we can write the K of equation 7 as:

Eq. 13) $\Omega = 1 + \Delta + \frac{1}{2}\ \Gamma\ dB + \ \Psi$

And Eq. 11 should be rewritten as presented in the guideline:

Eq. 14) $\mathrm{CMD} = \mathrm{MD}_{(B)} \times \ \Phi \times \Omega$

It is noted that the dB (equation 3) in the equation 13 should be consistent with the change in value of the bond, with respect the change in the interest rate.

Finally, it is noted that the formula in Eq. 14 and Eq. 10 are represented with Δ and Γ (equations 5 and 6) computed as respect the change value of the price of the Bond (dB, in equation 3). Clearly those Greeks can be valued also as respect the change in value of interest rate, because we know that C = f[B(r)].

Eq. 15) $\Delta_{\ r} = \frac{dC}{dr} = \frac{dC}{dB}\frac{dB}{d} = \ \Delta\ \frac{dB}{dr}$

And:

Eq. 16) $\Gamma_r = \dfrac{d^2C}{dr^2} = \dfrac{dC}{dB}\dfrac{d^2B}{dr^2} + \left(\dfrac{dB}{dr}\right)^2 \dfrac{d^2C}{dB^2} = \dfrac{dC}{dB}\dfrac{d^2B}{dr^2} + \left(\dfrac{dB}{dr}\right)^2 \Gamma$

From equation 15 and 16 is straightforward to obtain Δ and Γ to be applied in the formulation 13.

Behaviour of delta and gamma for instruments subject to prepayment related to moves in IRR

For the purpose of this annex, a 20 year Bond paying annually a 6% coupon, has been used. The embedded optional can be either a put or a call, so two types of instruments are contemplated: a puttable or a callable bond.

Regarding the embedded optionality, it has been assumed that the instrument included a 10 year American option, which could be exercised from the 1st to the 11th year, with a strike price of 100. The choice of an American option is compatible with the expected Bermuda feature, since the simplified exercise assume one specific node par years.

The valuation of the embedded option was made with Matlab, and utilised predefined financial function (Financial toolbox of Matlab), such as `RateSpec`.

In particular, the following functions have been applied in the Matlab code:

```
HWTimeSpec %specify time structure in Hull White framework
HWVolSpec %specify volatility structure in Hull White framework
HWTree %specify Hull White tree framework
PriceOptBondHW %price Bond with embedded option in Hull White framework
Bondbyhw % price Bond in in Hull White framework
optbndbyhw % price option on Bond in Hull White framework
hwsens %compute sensitivities Hull White framework
```

The choice of Hull White (HW) model was done for convenience, though the code can be adapted easily to Black–Karasinski model (BK) or to Black–Derman–Toy model (BDT).

Figure 1: Price-yield relationship for the bond, the callable bond and the call on the bond.
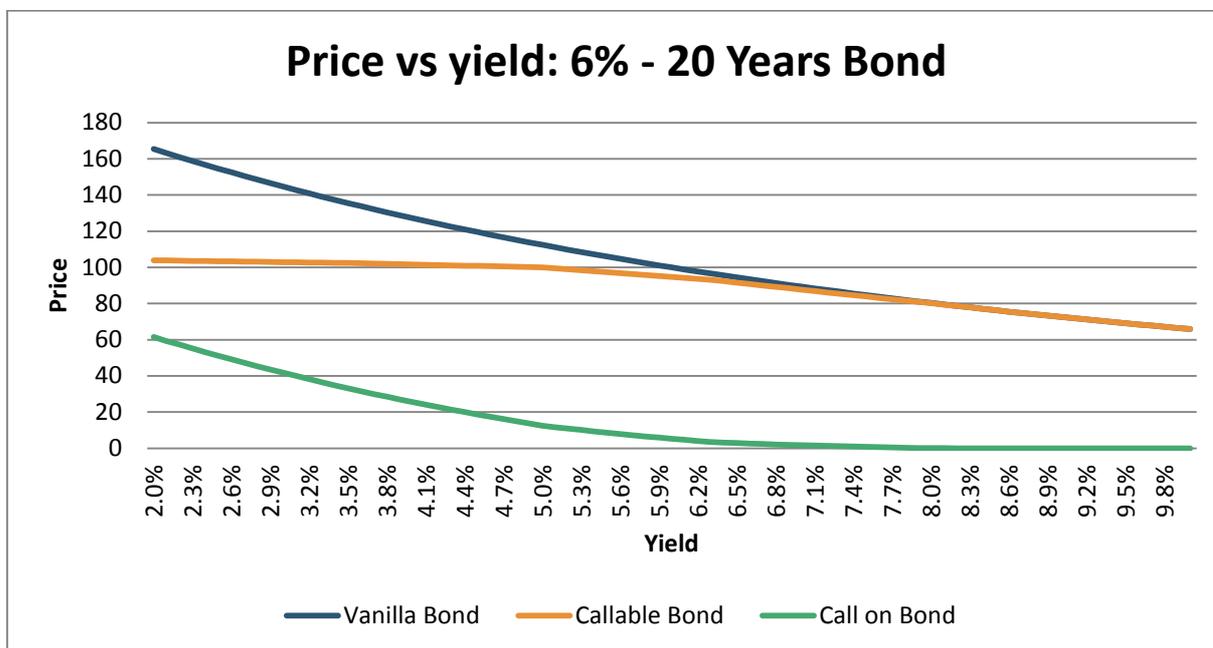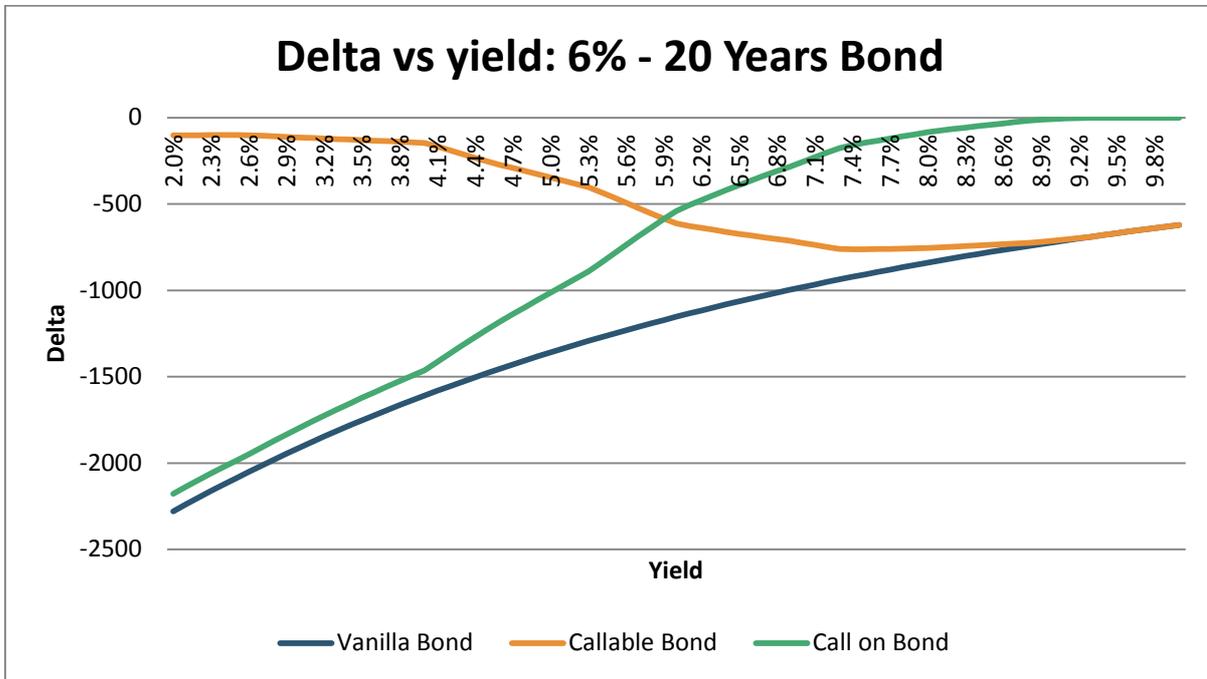

In Figure 1 we can observe the relationship price-yield of a callable bond. As the shocks on the yield curve move form the par value (6% in the example), increase the yield (e.g moves up to 8%), both the price of the vanilla bond and the callable bond decrease. It is notable how the price of the two bond tend to converge when the yield increases. However, when the yield decreases (e.g moves down to 4%) the call option moves ITM and the price of the two bonds diverge; the vanilla bond price raises significantly and the callable bond tends to be capped at 100.

Figure 2: Price-yield relationship for the bond, the putable bond and the put on the bond.

Price vs yield: 6% - 20 Years Bond
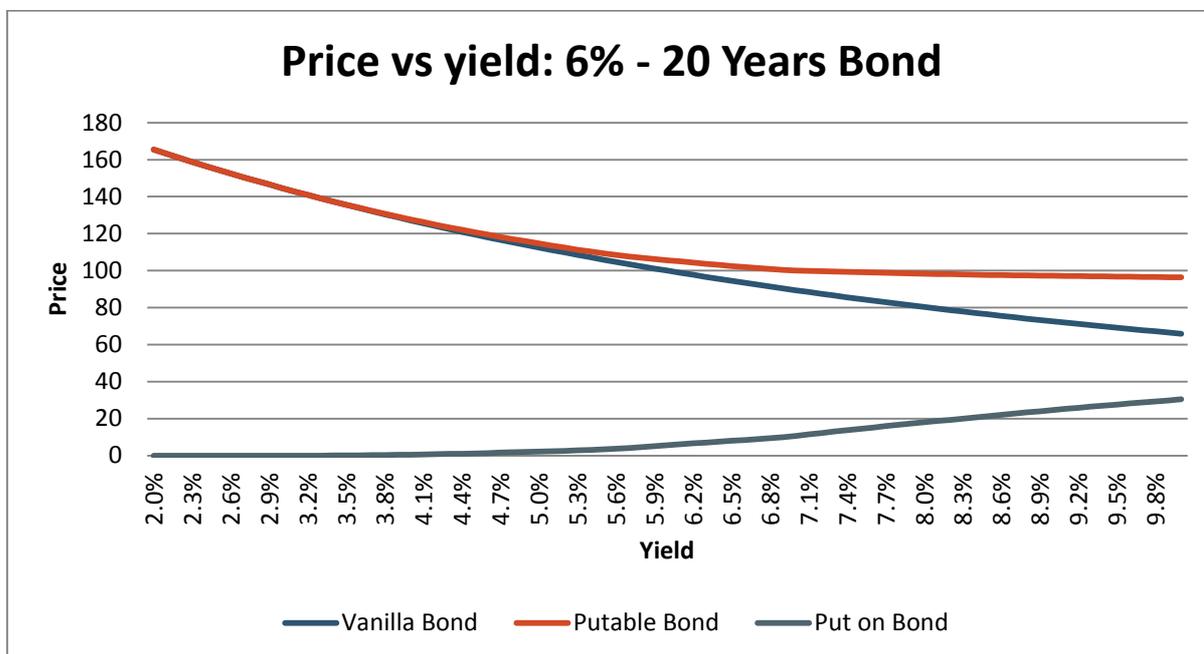
In Figure 2 we can observe the same relationship price-yield of figure 1 but for a putable bond. As the yield curve decreases (e.g goes to 4%), both the price of the vanilla bond and the putable bond increase. It is notable how the price of the two bonds tend to converge when the yield decreases. However, when the the yield increase (e.g moves up to 8%) and the put option moves ITM, the price of the two bond diverge: the vanilla bond price decreases significantly, while the putable tends to be flored near 100.
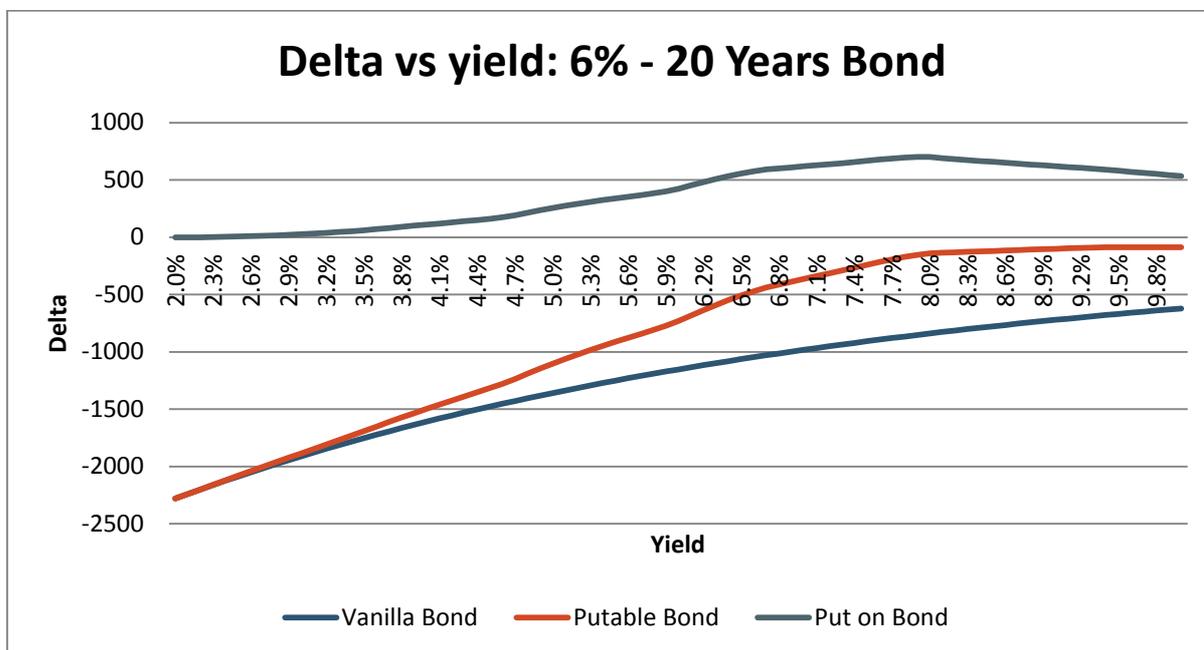
Figure 3: Delta-yield relationship for the bond, the callable bond and the call on the bond.

Delta vs yield: 6% - 20 Years Bond

In Figure 3 we can observe the relationship delta-yield of a vanilla bond, a callable bond and a call on the vanilla bond. We note that the sensitivities is always negative for the 3 instruments. We can observe that the sensitivities of the callable bond is always smaller than the sensitivities of the vanilla bond. Actually the sensitivities of the callable bond is equal to the difference of the sensitivities of the vanilla bond and the embedded option.

For this reason when the option is ITM, the sensitivities of the option is really close to the sensitivity of the bond, so the sensitivities of the callable bond, for yield far lower than the par (e.g 4%) is close to zero. On the other hand, for yield much higher than the par yield (e.g. 8%) the delta sensitivities of the option (OTM) tends to zero, and the vanilla and callable bond delta sensitivities tend to converge.

Figure 4: Delta-yield relationship for the bond, the putable bond and the put on the bond.

Delta vs yield: 6% - 20 Years Bond

In Figure 4 we can observe the relationship delta-yield of a vanilla bond, a puttable bond and a put on the vanilla bond. We note that the sensitivities is always negative for the bond, but it is positive for the put option. We can observe that the sensitivities of the puttable bond is always smaller than the sensitivities of the vanilla bond. When the option is ITM, the sensitivities of the option is really close to the sensitivity of the bond, so the sensitivities of the puttable bond, for yield far higher than the par (e.g 8%) is close to zero. On the other hand, for yield much lower than the par yield (e.g. 4%) the delta sensitivities of the put option (OTM) tends to zero, and the vanilla and puttable bond delta sensitivities tend to converge.

Figure 5: Gamma-yield relationship for the bond, the callable bond and the call on the bond.
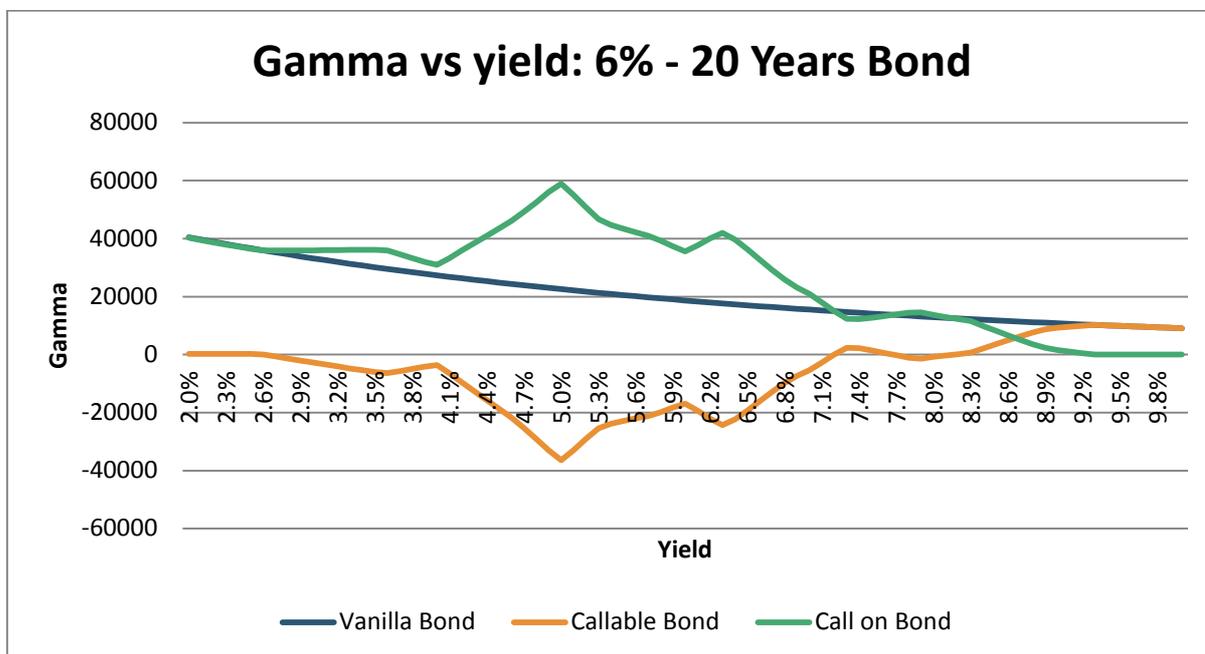
In Figure 5 we can observe the relationship gamma-yield of a vanilla bond, a callable bond and a call on the vanilla bond. We note that the sensitivities of the bond is always positive, while the gamma senistivities of the call option on the bond can be both positive and negative. The gamma sensitivities of the call on the bond tend to be significantly negative for values closer to the par value of the bond (6%). The gamma sensitivities of the option tends to zero the more we move far from the par yield, so gamma sensitivities for the vanilla bond and the callable bond tend to converge for value of the yield far from the par yield.

Figure 6: Gamma-yield relationship for the bond, the putable bond and the put on the bond.
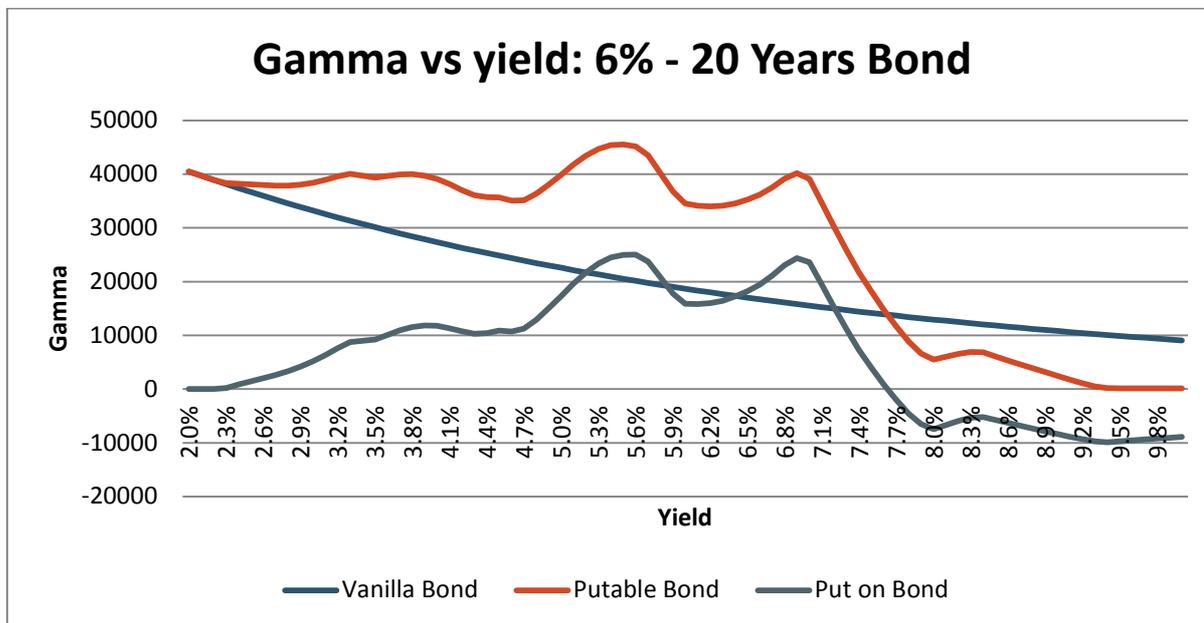

In Figure 6 we can observe the relationship gamma-yield of a vanilla bond, a puttable bond and a put on the vanilla bond. We note that the sensitivities of the bond are always positive, while the gamma sensitivities of the put option on the bond can be both positive and negative. We can observe that the gamma sensitivities of the call on the bond tend to be higher for values closer to the par value of the yield (6%). The gamma sensitivities of the option tends to zero the more we move far from the par yield, so gamma sensitivities for the vanilla bond and the puttable bond tend to converge for value of the yield far from the par yield.

5. Accompanying documents

5.1 Draft cost-benefit analysis / impact assessment

Article 340(3) of the CRR requires the EBA to develop guidelines on the application of the corrections to the calculation of the modified duration for debt instruments which are subject to prepayment risk.

As per Article 16(2) of the EBA regulation (Regulation (EU) No 1093/2010 of the European Parliament and of the Council), any guidelines developed by the EBA shall be accompanied by an Impact Assessment (IA) annex which analyses 'the potential related costs and benefits'. Such annex shall provide the reader with an overview of the findings as regards the problem identification, the objectives, the options identified to remove the problems and their potential impacts. This annex presents the IA with cost-benefit analysis of the provisions included in the guidelines described in this Consultation Paper.

A. Problem identification

The duration-based calculation of general risk is one methodology that the EU institutions may follow to calculate own funds requirements against general risk on debt instruments.[11] Prepayment risk refers to an early unscheduled return of principal and the specifications of the duration-based calculation under Article 340 of the CRR does not account for this risk. The core problem that the current guidelines aim to address is the risk associated with the uncertainty around the return of principal on a fixed-income security, and in this case on debt instruments.

For instance, the issuer of a callable bond, i.e. bond with an embedded call option has an incentive to exercise the call, i.e. to redeem the bond in advance when the interest rate in the market decreases, and reissue/refinance the original debt at a lower rate.

Similarly, an investor holding a puttable bond, i.e. a bond with a put option embedded, has an incentive to exercise the put option, i.e. sell the bond back to the issuer when market interest rates increase.[12] By reinvesting at a higher rate the investor has a larger return on the debt instrument. The larger is the spread between the rates, the higher the probability of the investor to use the put option.

The algebraic definition of the modified duration as defined under Article 340 does not account for the effect of the (call or put) option in the estimation of the price sensitivity of bond to yield.

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[11] The other methodology is the maturity-based calculation of general risk.

[12] This example assumes that the initial contract is on a fixed-coupon basis and the investor is interested in coupon return.

Conventional convexity of price-yield curve for long (plain vanilla) bond positions or the concavity for short positions do not hold. More precisely:

Long positions				
Plain vanilla bond (convex)	-	call option (concave)	=	callable bond (concave when the option is ITM, convex as usual for deep OTM option
Plain vanilla bond (convex)	+	put option (convex)	=	puttable bond (convex)
Short positions				
Plain vanilla bond (concave)	-	call option (convex)	=	callable bond (convex when the option is ITM, concave as usual for deep OTM option
Plain vanilla bond (concave)	+	put option (concave)	=	puttable bond (concave)

It is clear that the embedded option changes the price sensitivity of bond to the yield and can lead to underestimation of losses such as in the cases of long callable bond position and short puttable bond position.

Therefore, the current framework ignores such prepayment risk and hence for the associated own funds requirements. This can jeopardise level playing field in the EU banking sector, especially in terms of cross-border arrangements. Some Member States have national regulation adjusting the duration-based calculation to incorporate the prepayment risk therefore in theory institutions subject to this regulation have to correct[13] own funds against this risk while in other EU jurisdictions institutions are not subject to capital requirements under prepayment risk.

Policy objectives

The main objective of the current guidelines is to incorporate into the current duration-based calculation of general risk a correction term for the modified duration. In other words, the objective is to correct the calculation of the modified duration so that the estimation of the price-yield sensitivity and of associated own funds requirements internalise the prepayment risk inherent to debt instruments, e.g. debt instruments with embedded options. This correction is expected to provide a more accurate estimation of the price sensitivity and adjust the methodology for the potential underestimation of losses and overestimation of gains.

The correction is also expected to contribute to level playing field and further harmonisation of the estimation of own fund requirements across EU jurisdictions and institutions.

The table below summarises the objectives of the current guidelines:

---

[13] Below it is shown that the own funds requirements would actually decrease when the prepayment risk is taken into account.

Problems to be addressed	Specific Objectives	General Objectives
Methodology is insensitive to prepayment risk	Risk adjustment of the modified duration to calculate own funds requirements	Improving general risk sensitivity of debt instruments
Inaccurate calculation of own funds requirements	Addressing issues related to overestimation of losses	Differentiating the risk profiles of the EU institutions more accurately
Lack of clear and common framework across the EU	Harmonisation of the general market risk methodology across EU institutions	Contributing to level playing field across EU institutions

Baseline scenario

COREP data (as of Q3 2015) show that there are currently 37 EU institutions that use duration-based approach in order to calculate for debt instruments the own funds requirements against general market risk. Note that the data from COREP for the current analysis is based on C 18.00 template and covers 125 institutions[14] across 26 EU Member States and Norway. The total assets figure of the sample is about EUR 25,070 billion corresponding to approximately 60% of the total EU sample[15]. Country and bank level data on total assets have been extracted from FINREP[16].

Table 1 shows the number of institutions that use maturity-based approach and/or duration-based approach by jurisdiction. Currently, there is only Denmark in the EU that have methodology accounting for the instruments with pre-payment risk in the calculation of own funds requirements. If national jurisdictions do not have any similar regulatory provisions in place then the current guidelines are expected to have an impact on the institutions using duration-based approach provided that the trade for the debt instruments have prepayment risk.

Table 1 indicates that about 30% of the institutions use duration-based approach to calculate the own funds requirements for traded debt instruments. Total assets of these institutions are EUR 11,622 billion, 46% of the sample considered for the current analysis. This indicates that, on average, banks using the duration-based approach are larger in size than those using the maturity-based approach. Table 1 further presents by jurisdiction descriptive statistics specific to the institutions using duration-based approach.

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[14] Total number of institutions available in COREP template C 18.00 is 135. Some institutions have been dropped from the analysis since all values for the positions under both maturity-based and duration-based approaches are zero. The analysis team did not categorise these institutions under the SA.

[15] The aggregate EU total assets figure (EUR 47,074 billion) is based on EBA statistics and includes 28 EU Member States and Norway. http://www.eba.europa.eu/supervisory-convergence/supervisory-disclosure/aggregate-statistical-data

[16] Note that the sample between COREP and FINREP is not consistent therefore for a number of institutions that are considered for the analysis (based on COREP) the total assets figures (FINREP) are not available. This underestimates the total asset of the sample for the analysis.

Table 1 Descriptive statistics on EU institutions with duration-based approach as of Q3 2015 (monetary values are expressed in EUR million)

	No. of banks in the analysis sample	Total assets of the banks in the sample (i.e. asset coverage of the sample)	No. of banks using maturity-based approach	No. of banks using duration-based approach	No. of banks using both approaches	Share of banks using duration-based approach	Total assets of banks using duration-based approach	Asset share of the banks using duration-based approach in total assets	Share of duration-based positions in total positions	Own funds requirements of the banks with duration-based approach	Own funds share of the banks with duration-based approach in total own funds
			Sample-related statistics					**Descriptive statistics on banks using duration-based approach**			
AT	6	451,396	6	0	0	0%	0	0%	0%	0	0%
BE	4	785,515	3	1	0	25%	35,751	5%	47%	12	22%
BG	2	14,552	2	0	0	0%	0	0%	0%	0	0%
CY	2	7,511	2	0	0	0%	0	0%	0%	0	0%
CZ	2	72,126	2	0	0	0%	0	0%	0%	0	0%
DE	10	1,814,307	5	6	1	60%	1,129,075	62%	35%	226	33%
DK	3	276,151	0	3	0	100%	276,151	100%	100%	165	100%
EE	2	14,326	1	1	0	50%	9,179	64%	0%	0	15%
ES	9	2,673,869	9	0	0	0%	0	0%	0%	0	0%
FI	2	133,948	1	1	0	50%	102,553	77%	34%	69	91%
FR	8	6,624,317	6	4	2	50%	4,361,704	66%	67%	223	74%
GB	15	7,330,717	13	4	2	27%	3,006,183	41%	1%	142	5%
GR	3	266,677	3	0	0	0%	0	0%	0%	0	0%
HR	3	37,110	3	0	0	0%	0	0%	0%	0	0%
HU	4	55,447	1	3	0	75%	47,745	86%	77%	27	82%
IE	4	258,298	2	2	0	50%	219,852	85%	99%	42	91%
IT	14	2,173,040	13	3	2	21%	1,625,813	75%	70%	158	23%
LT	3	16,959	2	1	0	33%	6,364	38%	7%	2	33%
LU	4	168,774	4	0	0	0%	0	0%	0%	0	0%
LV	3	13,613	2	1	0	33%	5,276	39%	63%	0	85%
NL	2	475,001	2	0	0	0%	0	0%	0%	0	0%
NO	2	330,832	0	2	0	100%	330,832	100%	100%	71	100%
PL	3	131,887	1	2	0	67%	100,068	76%	59%	46	65%
PT	6	299,069	5	1	0	17%	76,330	26%	10%	4	3%
RO	3	34,548	3	0	0	0%	0	0%	0%	0	0%
SE	3	591,681	1	2	0	67%	289,339	49%	34%	11	18%
SI	3	18,797	3	0	0	0%	0	0%	0%	0	0%
Total	**125**	**25,070,467**	**95**	**37**	**7**	**30%**	**11,622,215**	**46%**	**11%**	**1,201**	**17%**

Source: COREP and FINREP data as of Q3 2015

The aggregate volume of the (short and long) gross/non-netted positions under the duration-based approach in the sample is EUR 7,223 billion (not shown). For both short and long positions, about 65% of the positions fall under the maturity zone 1, 12% under maturity zone 2 and the remaining 23% under the maturity zone 3 (not shown).[17]

The corresponding own funds requirements with the (short and long) positions under the duration-based approach is EUR 1,201 million (not shown). The share of own funds requirements for these positions under duration-based approach is about 17% of the total corresponding own funds requirements under both maturity-based and duration-based approaches. This is reasonable given that the share of positions under duration-based approach is about 11% of the total positions including both maturity-based and duration-based approaches. The overview suggests that the guidelines would have a greater impact on DK, FR, GB, IT and NO, i.e. jurisdictions where the institutions have relatively large volume of (long and short) positions under the duration-based approach.

The figures on banks using duration-based approach include both traded debt instruments with and without prepayment risk. Of these (EUR 7,223 billion) positions an average of 8% is expected to include prepayment risk. In other words, an estimated total position of EUR 578 billion with prepayment risk would be impacted by the current guidelines. The statistics suggest that approximately 1% of the total positions under the standardised rules (including both maturity-based and duration-based approaches) fall under the scope of the current guidelines. About 80% and 20% of these positions are callable (EUR 462.3 billion) and puttable (EUR 115.6 billion) debt instruments, respectively.[18]

When jurisdiction have already in place regulatory provisions accounting for the prepayment risk in the duration-based approach, the impact is expected to be less or none for the institutions under these jurisdictions.

Impact of the correction on own funds requirements

When the duration-based approach accounts for the prepayment risk, the corresponding level of own funds requirements is expected to fall. Background section (Section 3.2 in particular) of the draft CP explains in detail the logic for the argument.

It is therefore expected to observe in the baseline that for a given volume of positions own funds requirements for institutions in jurisdictions where the methodology already accounts for prepayment risk is lower than the own funds requirements in another country where such regulatory provisions do not exist. However this cannot be assessed based solely on COREP data. A reason is that the country level data is not available for the share of positions with prepayment risk, i.e. the data do not display the share of positions with prepayment risk in each jurisdiction.

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[17] The maturity zones are as described in C 18.00 of COREP template and the share figures are rounded and decimals points are ignored.

[18] As of 03 February 2016, there are 142,715 active debt instruments in the EU market of which 11,673 are with embedded call (9,255) or put options (2,418). The analysis is based on Bloomberg public data.

In addition, it is challenging to capture the variations due to such implementations since the data have been extracted in an economic environment where the interest rates are low. This point is important because it implies that the institutions are operating in the money and for a call option (which form a large part of the debt trade with prepayment risk) the option's strike price is below the price of the underlying asset. In other words, it is very likely that that the banks have used the call options long before the market rates hit their current low levels.

Assessment of the options considered and the preferred option(s)

a. Inclusion/exclusion of the gamma factor in the correction formula

The rationale to discuss on whether the formula calculating the corrected modified duration should include gamma factor or not is based on the underestimation of losses. Underestimation of losses occurs when the counterparty takes a long position in a callable bond or when it takes a short position in a puttable bond.

The major disadvantages of the inclusion of the gamma factor are:

    i)   It is more costly for banks to calculate the gamma factor. There are currently only few banks (in Denmark) that have similar provisions that account for the prepayment risk. Therefore, calculating gamma factor for a bond with an embedded option will have further cost to most of the banks in the EU.

    ii)   Adding a gamma factor may increase the complexity of the guidelines to correct the modified duration.

However, the inclusion of the gamma factor is expected to have the following advantages:

    iii)   It adjusts for the convexity (for long positions) and concavity (for short positions), and provides a more accurate estimate to capture risk associated with the positions.

    iv)   It is a more prudent approach to capture the risk associated with the positions.

    v)   Inclusion of gamma is in line with the EBA regulation on non-delta risk (EBA/2013/16). Convexity risk is accounted in the calculation of own funds requirements.

The analysis team argues that the expected benefits of the inclusion of the gamma factor will exceed the potential costs associated with the exclusion of the option. Therefore the inclusion of the gamma factor is the preferred option.

        The cost associated with the option will fall on the institutions. The institutions that fall under the scope of the current guidelines will need to use an appropriate pricing model to obtain the gamma factor for positions with prepayment risk. Since the Level 1 text does not require any pre-authorisation for the adaptation of the duration-based approach, the current guidelines do not require pre-authorisation

for the gamma factor in the calculation of corrected modified-duration. Therefore, the guidelines would not create additional cost for the competent authorities.

b.   Inclusion/exclusion of the behavioural factors in the correction formula

The inclusion of the behavioural factors aims to provide a more precise interpretation of the prepayment risk. When such factors are significant they can have a great impact on the duration of the bond. The practice is also in line with the BCBS framework on the Fundamental Review of the Trading Book where behavioural risk is defined as a risk of a change in exercise/prepayment outcomes as e.g. in fixed rate mortgage products due to other retail client decisions, such as demographical features and/or and other social factors, rather than pure financial gain. As well as accurate it also provides a more conservative approach as the factor is always positive, i.e. the corrected modified-duration will increase with the factor.

Another advantage of the practice is that it does not apply a rigid specific formula and therefore gives the parties some discretion given the materiality of the behavioural factors. Institutions with limited portfolio and with no historical relevance do not have to estimate the factors on a regular basis.

The analysis team argues that the benefits associated with the inclusion of the behavioural factors would exceed the costs such as the complexity of the methodology and further cost to institutions.

The source of potential costs to the institutions stems from the observation of the portfolio behaviour in historical data. On the other hand, in line with the Level 1 text the guidelines do not introduce any approval process for the behavioural factors therefore the expected cost to the competent authorities is none.

5.2 Overview of questions for consultation

Q1: Do stakeholders agree with the proposed approaches to correct the modify duration?

Q2: Do stakeholders agree that, under the first approach, the negative gamma stemming from the embedded option should be considered in the calculation of the correction?

Q3: Do stakeholders agree with the inclusion of behavioural factors in the calculation of the correction?

Q4: In case the approaches proposed to correct the negative gamma and/or the behavioural factors are deemed to be too burdensome, what simpler alternative adjustments may be applied to correct the modified duration?