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To :	BCBS
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Re :	KBC's view on fundamental problems in FRTB/CP3, including counter proposals, and a request for clarification on the SBA vega risk charge

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Revision history: compared to the version uploaded to the official BIS-website on Friday, February 20, section 3 on asymmetric correlations has been revised and expanded. Please discard the previous version.

1. Summary

During the Bank industry associations' January 14, 2015 meeting with the Trading Book Working Group (TBG) of the Basel Committee, the TBG urged the banks to focus their feedback on the CP3 document on what the banks perceive as "fatal flaws".

Consequently, the present document focuses on features which we regard as fundamentally problematic, based on two closely related criteria: risk sensitivity of the proposed charge (be it a Standardized or an Internal model based charge) and "scenario consistency".

In section 2, we single out FRTB's proposal to separate SBA's delta-risk and curvature risk charge as fatally flawed, and we advocate re-instituting the option for banks to base their standardized Market Risk charge for option desks on a straightforward scenario analysis which looks for the Worst Case Loss over a 2-dimensional grid of underlying and implied volatility levels, as allowed by the 1996 Market risk accord for option desks. In section 3 we argue that CP3's revised proposal for the GIRR-charge, replacing the "netting disallowance" with a "sensitivities split by curve" requirement, but sticking to CP2's asymmetric correlation matrix approach, is flawed.

Spotting some fundamental problem in the FRTB proposal assumes that the specification is clear. However, in our opinion, some parts of the text (like e.g. on SBA's vega-risk charge) leave some crucial details hanging in the dark, to the extent that any implementation would require a substantial amount of guesswork. Section 4 contains our questions on the SBA vega-risk charge to which we need answers before we can implement this charge.

Section 5 states KBC's views on FRTB's drill-down requirement for Stock indices and Equity baskets (relevant to SBA and to the standardized and modelled default risk charges). In section 6 we turn to FRTB's IMA-provisions, and we state KBC's views on FRTB's proposal to account for differences in liquidity horizon, including two counter proposals.

2. A fundamental problem with FRTB/CP3 SBA's separate delta-, curvature and vega-risk charges for option desks

2.1. FRTB/SBA's separation of the Curvature risk and Delta risk charge

2.1.1. Statement of the problem using two simple examples

This section focuses on how the market value of a derivatives portfolio reacts to varying the underlying spot level. Even if we know that implied volatility also affects the Worst Case Loss of a Scenario analysis over Underlying and Implied Volatility, we will treat implied volatility as fixed in this section, purely for expositional purposes.

We will rely on two examples, one involving a vanilla European call, the other involving an up-and-out Call (single barrier option).

Example 1 : long 1 stock, short 2 European calls, current spot=300, strike=312, maturity = 0.04 year, implied vol = 15%, riskfree rate = div.yield = 0% (delta of each call = -0.1).

Example 2 : Up-and-Out call on a stock with current spot = 100, strike = 112, barrier=135, Rebate=0, maturity=1 year, implied vol = 20%, div.yield=4.88%, riskfree = 9.53%.

In each case, we follow the SBA-approach by first calculating a Delta-risk charge and then a separate Curvature risk charge, obtained by subtracting the delta-effect from the Full Scenario P&L. Throughout, we assume a shock of +/-50% in the underlying as FRTB's applicable risk weight. We compare the sum of these Delta and Curvature risk charges to the WC Loss from a full reval based scenario analysis (no separation of Delta and Gamma).

See Figures 1-2 at the end of this document, and the numerical summary below each set of figures. Clearly, both portfolios exhibit a substantial degree of curvature. In the 1st example, the curvature is uniformly negative, while the curvature of the Up&Out call's P&L even changes sign from positive to negative over the range Spot +/- 50%. Either way, the strong curvature causes the P&L of the "delta-equivalent" position to diverge quickly from the Full Reval Scenario P&L. Specifically, in the examples presented, the positive "current" delta causes the P&L of the delta-equivalent position to increasingly exceed the Full Reval P&L with increasing spot levels, and in the FRTB proposal, this translates into a (very) large negative "non-Delta" P&L for Spot +50%. At the same time, the most negative Delta-equivalent Scenario P&L is found at Spot -50%. Now consider the simple sum of the resulting Delta- and the Curvature charges, as per the FRTB SBA proposal. As this involves the addition of two loss-figures which correspond to mutually exclusive events, the FRTB proposal goes against the basic requirement of "scenario consistency". Generally speaking, the contributions of different risk factors to the final charge should be driven by one and the same market risk scenario. Translating back to our two examples, by separating Delta- and Curvature risk charge, the FRTB proposal creates a material risk of the two charges being driven by opposite spot moves, which is unsound.

Let us summarize the points we are trying to make :

- For portfolios with a material (and possible changing) curvature risk, the applicability of a "delta" + "gamma" approach is limited to a **local neighbourhood** of current market conditions. As FRTB's proposal typically targets LARGE market shocks (representative of stressed conditions), any such delta-plus proposal is fundamentally flawed if applied uniformly. This is evidenced by the fact that the "Delta-equivalent" Scenario P&L strongly deviates from the Full Reval based Scenario P&L as a function of Spot in examples 1 and 2, for spot shocks in the order of 20%-50% (typical of the FRTB proposal). This leads to the sum of the Delta- and Curvature risk charge overshooting the Full-reval based WC Loss by a multiple (2.5 in example 1, 3.0 in example 2).
- By exposing the problem for these altogether simple option portfolios, we hope to drive home the message that this is not a "marginal" problem, but an inherent and material flaw which affects any portfolio with a substantial degree of curvature. The charges from the FRTB SBA proposal for such portfolios are grossly exaggerated and lack risk sensitivity.

By switching to the simple Scenario analysis over Spot levels with no separation of Delta and Gamma, these flaws can be easily overcome.

2.1.2. Hindsight : how the flawed FRTB/SBA for option desks came about

It is instructive to look back on how the separate Delta and Curvature charges of FRTB's SBA proposal came about, starting with FRTB/CP2 of October 2013.

The FRTB/CP2 document advocated the idea of so-called cash flow maps, both for GIRR and for Specific Risk. The banking industry strongly opposed the idea of approximately replicating instruments via cash flow maps as it lacks a firm grounding in financial engineering, rendering its implementation onerous and prone to interpretation difficulties for

all but the simplest instrument types. As an alternative the banks asked to be allowed to re-use their tested and validated instrument pricing models to compute risk factor sensitivities. This evidently covers only the “1st order terms” in a Taylor expansion of an instrument’s market value as a function of underlying risk factors.

Over the course of 2014, the Basel committee deliberated and decided in favor of the “sensitivities-based approach” (SBA) advocated by banks, but with one important twist: BCBS specified SBA as a “one-stop” solution to cover all instrument types, including options, and to that end, BCBS augmented the “Sensitivities” based approach with a Curvature- and Vega-risk part, with the Curvature risk charge conceived as a “Delta-plus” charge (as per the QIS of July 2014). At that point, banks found themselves in an awkward position: as the regulators had just gone along with their preference for a Sensitivities-based over a “cashflow based” approach, it would have seemed strange to voice strong opposition to the SBA proposal. Still, as we have shown in section 2.1.1, the current SBA proposal with its isolated treatment of Delta- and Curvature risk is a thoroughly bad proposition for option desks.

2.1.3. Is the SBA proposal salvageable ?

An interesting question is: for what type of desks viz. for what types of portfolios would SBA be acceptable in the sense that the resulting capital charge is at least approximately risk-sensitive. Answer: SBA is acceptable for portfolios which are approximately linear in the underlying risk factors, even if their market value exhibits a “mild” degree of curvature.

Consider example 3 below, which is obtained from example 1 by scaling up the straight equity position by 10 (dividing the equity spot price 10 in the process to keep the same x-axis). From Figures 3.a and 3.b, this portfolio behaves approximately linear in the Spot price. Also, FRTB/SBA’s sum of Delta+Curvature risk charges exceeds the Simple Scenario analysis WC Loss by a “mere” 14.5% in this case (to be compared to 250% and 300% in examples 1 and 2). Note that the fundamental problem remains, as the maximum Loss on the Delta risk side still occurs for a spot move opposite to the spot move which triggers the maximum Loss on the Non-Delta side. However given the limited numerical impact (14.5%), we as KBC would be willing to regard this as an acceptable price to pay for the unified treatment offered by SBA, and other banks are likely to think the same.

2.1.4. Statement of KBC’s counter proposal

KBC Bank asks the regulators to re-institute the 2-dimensional scenario analysis on Underlying and Implied Volatility as an option available to Banks to calculate their (revised) Standardized Market risk charge. Specifically, we mean the type of scenario analysis as per paragraphs 718(Lxiii) to 718 (Lxvii) of bcbs128b.pdf. An essential feature of this scenario analysis is that the WC loss considers simply the Full Reval based Scenario P&L’s, without any stripping of the “delta-effect”.

Note that we do not ask to abolish FRTB’s SBA proposal. However, if the 2-dimensional scenario analysis were allowed as an alternative, we would expect banks to choose the alternative approach for desks with a material degree of curvature risk and/or with non-linear dependence on implied volatility, while the existing SBA proposal would continue to be applied to desks characterized by approximately linear risks.

Finally, we would expect the regulators to calibrate the shifts applicable for that 2-dimensional Scenario analysis approach so as to yield a capital charge comparable to the

Sum of Delta + Curvature + Vega risk charge under the SBA-approach. It is imperative that the calibration be performed using hypothetical portfolios with at most a moderate degree of curvature (otherwise the results are likely to exhibit the same huge bias as in our examples 1 and 2). To avoid cherry picking, we propose that banks be required to choose between the SBA and the Scenario analysis approach on a permanent basis. More specifically, a change of method should be subject to a motivated application to and approval by the regulator.

2.2. SBA's vega-risk charge and non-linear Implied Vol effects as another argument in favor of a scenario analysis over Spot and Implied vol

In section 2.1 our primary focus was on the underlying spot price. However, with the advent of first and second generation exotic options, non-linear effects in the vol dimension have become an essential characteristic of a typical option desk's portfolio. Barrier options constitute one example (of 1st generation exotics) which exhibit this characteristic. To illustrate, we revisit the Up & Out call of example 2, and study both market value and its vega as a function of the implied vol, see figures 4.a and 4.b.

It is instructive to compare the behaviour of the Up & Out call's vega with the vega of a vanilla call : the latter is roughly constant, pointing to an approximately linear dependence on implied vol. In contrast, the vega of the Up & Out call varies dramatically over the implied vol range, meaning we have a large (and changing) **curvature** in the implied vol dimension (known as a large "volga" among FX options dealers).

Exactly as for the underlying spot price, the only sound approach to quantify the "volatility risk" under these circumstances is to perform a straightforward scenario analysis, as this approach is explicitly designed to cope with non-local behaviour. This brings us back to our request to the regulator to allow banks to capitalize (market risk for) option desks using the same type of two-dimensional scenario analysis as available to banks under the Standard approach of Basel 2 / 2.5 (as per paragraphs 718(LXiii) to 718 (LXvii) of bcbs128b.pdf).

This brings us to the following remark on SBA vega risk charge in CP3. From the hypothetical perspective of a Standardized approach which gives banks the option to switch to a 2-dimensional scenario analysis for particular (option) desks, the sophistication in the SBA Vega risk charge recently added by the CP3/SBA document seems overkill to us. Assuming that this 2-dimensional scenario analysis would be chosen for the vast majority of option desks, the vega-risk charge in SBA can be kept simple (as it was originally intended), e.g. by breaking down SBA/Vega only by option maturity, and dropping the underlying tenor and moneyness dimension (reasoning that their effect will be smallish for desks with only a moderate curvature and vega risk). We kindly ask the TBG to consider both our question for re-allowing the 2-dimensional scenario analysis and our question for an attendant simplification of CP3's vega-risk charge specification.

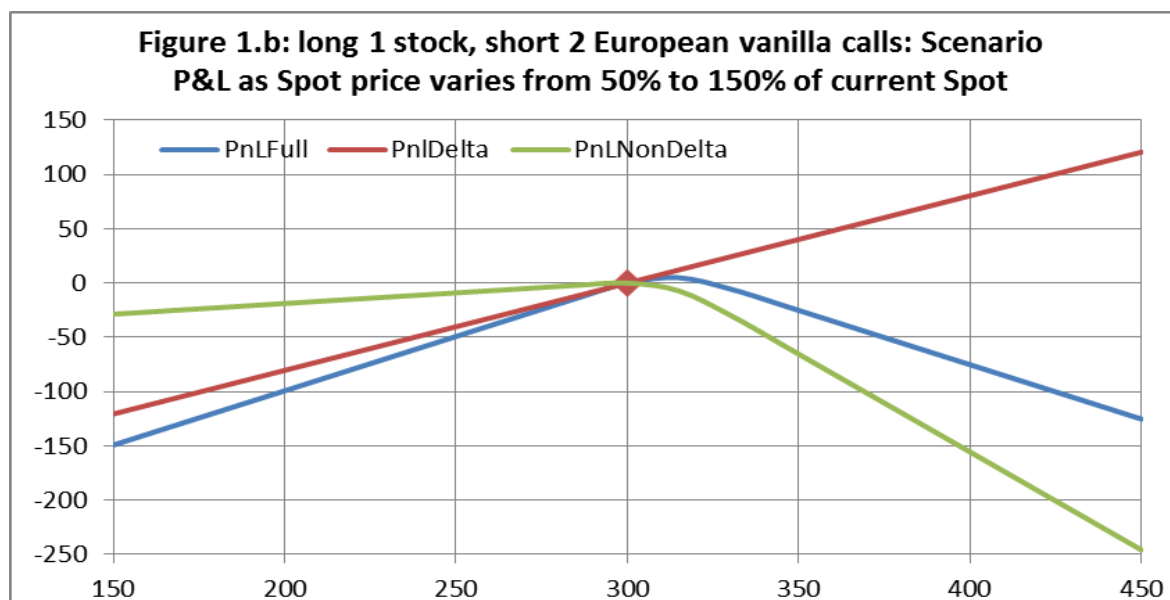
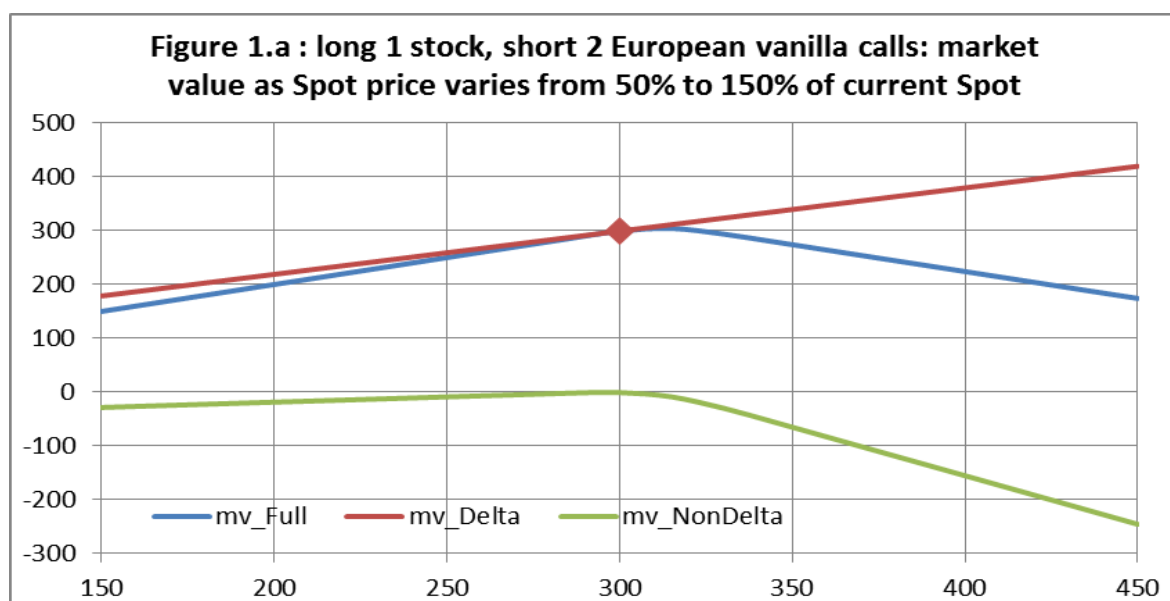
2.3. Aggregation issues

Our counter-proposal is not complete unless we add specifics on aggregation logic. This covers two aspects :

- how broad or how granular will an underlying be defined (especially critical in the interest rate derivatives asset class) ;
- how to aggregate the WC losses over underlyers (first by asset class, then over asset classes).

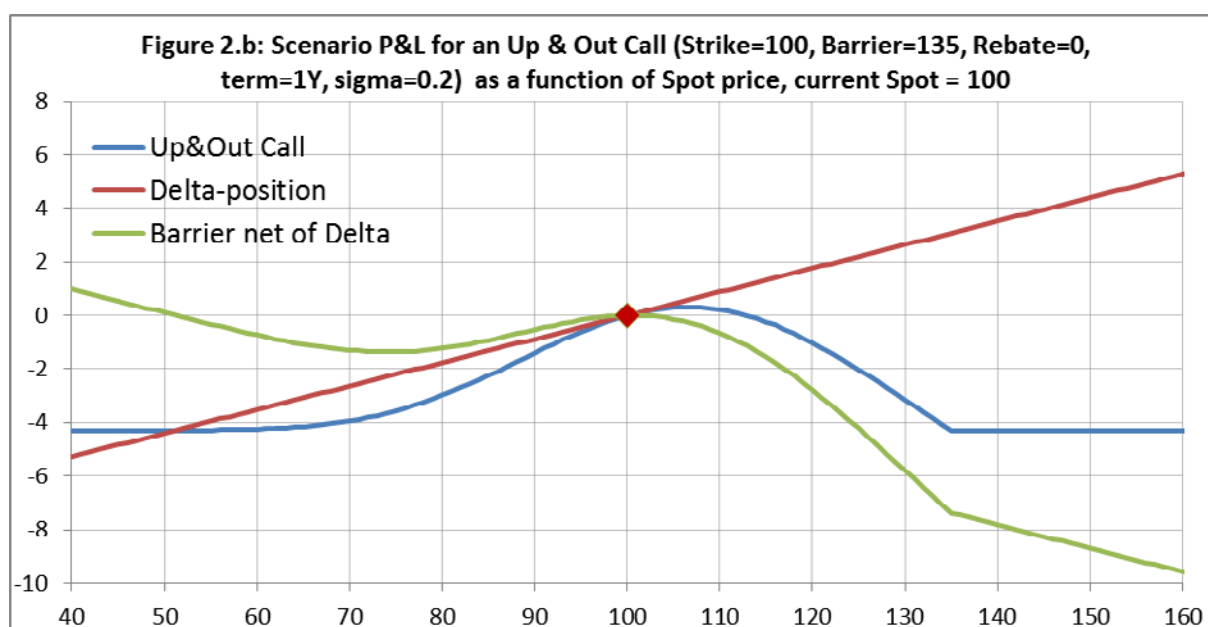
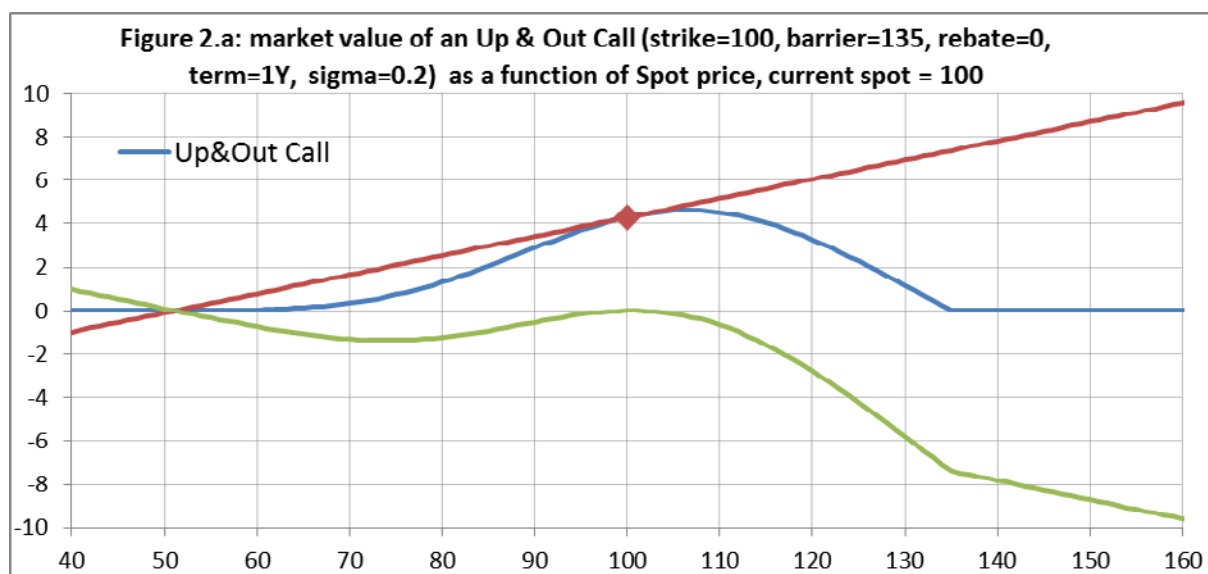
Regarding the “granularity” of an underlying (to be subjected to a separate Scenario analysis), this granularity would best be defined to be comparable to the granularity allowed for the SBA Curvature and/or Vega risk charge. Note that the WC Loss for a single underlyer may be negative, and we suggest to allow such a result (instead of imposing a zero floor on the WC Loss per underlyer).

Looking back at the Scenario analysis allowed under Basel 2 / Basel 2.5, paragraphs 718(LXiii) to 718 (LXvii) of bcbs128b.pdf do not contain any explicit statement on the aggregation of the WC losses by underlying. Hence by default, we infer that under Basel 2, a bank is expected to simply add up all the individual WC losses. As this corresponds to setting all correlations to 1, this recipe is guaranteed to yield a punitive market risk charge ; on the other hand, one of FRTB’s main improvements consists of allowing aggregation under the Standardized approach based on pre-specified correlation matrices. To do justics to this core idea of the FRTB proposal, we suggest that aggregation of the WC scenario losses per underlying within an asset class viz. over asset classes be based on a comparable correlation matrix approach.



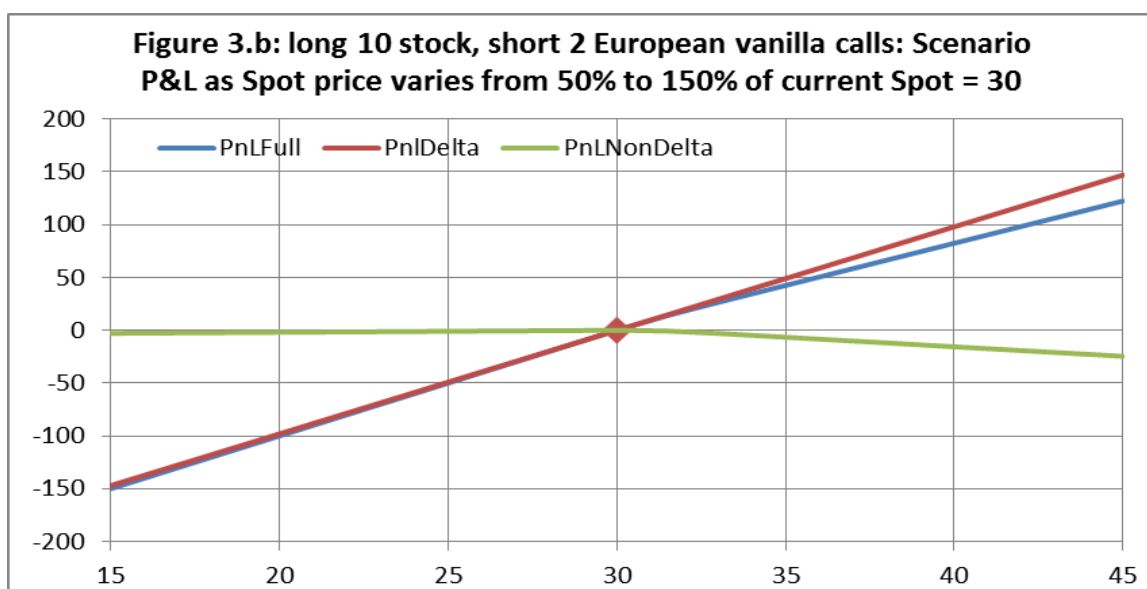
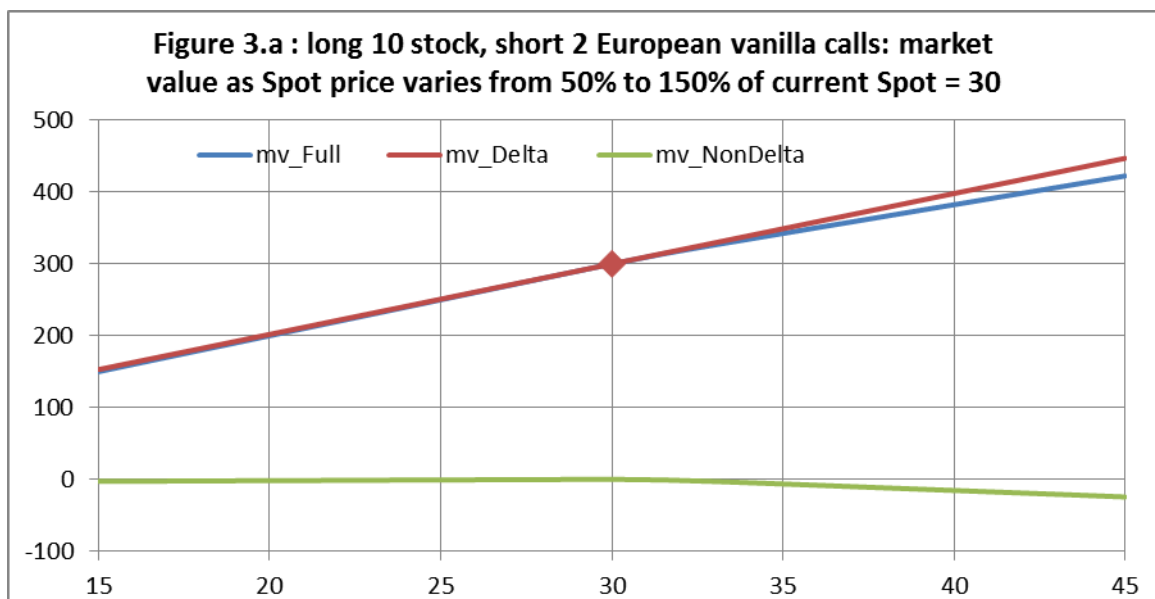
Summary of Scenario P&L results for example 1				
Scenario P&L	Full P&L	Delta	Curvature	Delta + Curvature
Spot -50%	-149.2	-120.6	-28.6	
Spot +50%	-125.2	120.6	-245.7	
WC Loss	-149.2	-120.6	-245.7	-366.3
FRTB_SBA / Old_SS*				2.5

* Ratio of Sum of the SBA Delta-Risk and Curvature risk charge to the WC Loss from the simple scenario analysis allowed under the Standardized approach of Basel 2 / 2.5.



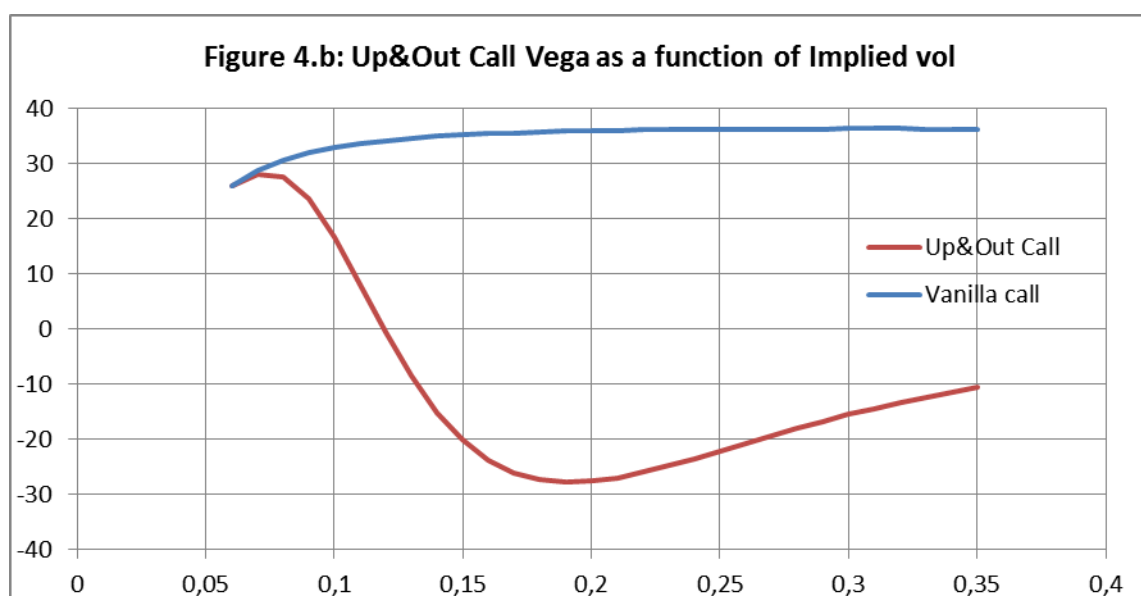
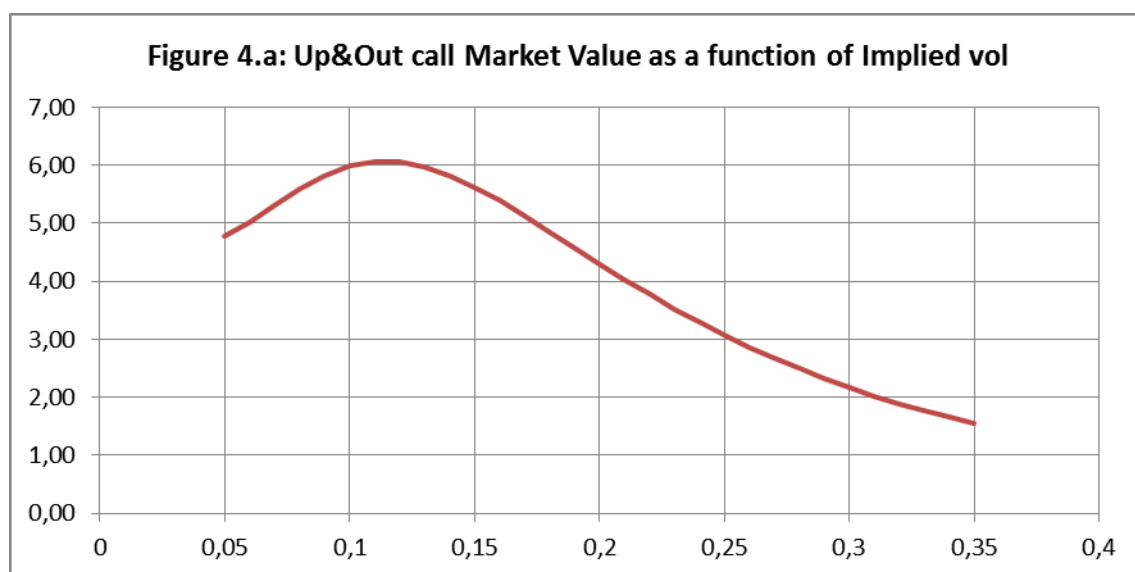
Summary of Scenario P&L results for example 2				
Scenario P&L	Full P&L	Delta	Curvature	Delta + Curvature
Spot -50%	-4.30	-4.40	0.10	
Spot +50%	-4.30	4.40	-8.70	
WC Loss	-4.30	-4.40	-8.70	-13.10
FRTB_SBA / Old_SS*				3.0

* Ratio of the Sum of the SBA Delta-Risk and Curvature risk charge to the WC Loss from the simple scenario analysis allowed under the Standardized approach of Basel 2 / 2.5.



Summary of Scenario P&L results for example 3				
Scenario P&L	Full P&L	Delta	Curvature	Delta + Curvature
Spot -50%	-149.9	-147.1	-2.9	
Spot +50%	-122.5	147.1	-24.6	
WC Loss	-149.9	-147.1	-24.6	-171.6
FRTB_SBA / Old_SS*				1.14

* Ratio of Sum of SBA Delta-Risk plus Curvature risk charges to the WC Loss from the simple scenario analysis allowed under the Standardized approach of Basel 2 / 2.5.



3. CP3's requirement to drill down sensitivities by curve within a currency leads to implausible GIRR-charges unless CP2's asymmetric correlations approach is revised or recalibrated

3.1. Problem statement and analysis

This section applies to both GIRR and CSR, however for expositional purposes we focus on the GIRR-charge.

Following industry remarks on CP2's 0.95 disallowance factor to be applied to convert gross Long and gross Short sensitivities by vertex to net sensitivities (intended to capture basis risk), CP3 dropped this disallowance factor. Instead the CP3 GIRR charge requires a bank to compute a separate set of net sensitivities by vertex, for each curve within a currency, thinking mainly of the different floating references (OIS, 1M Libor, 3M Libor, 6M Libor and 12M Libor), to which different "estimation curves" are linked. If we assume for a moment that for a certain currency, a bank has GIRR-exposure on just two floating references, say on 3M and 6M-estimation curves, then compared with CP2, aggregating the risk-weighted sensitivities within the currency under CP3 involves a correlation matrix with double the number of rows and columns of CP2.

In our example the correlation matrix can be partitioned as consisting of 4 blocks. The two diagonal blocks (describing the correlations between the 3M-Libor curve's vertices viz. between the 6M-Libor curve's vertices) are the same as under CP2, meaning they involve applying CP2's asymmetric correlation requirement. For the two off-diagonal blocks, CP3 also specifies re-using CP2's (asymmetric) correlation matrices, but with an additional markup $(1+x)$ or markdown $(1-x)$ depending on same sign vs. opposite signed weighted sensitivities. It is to be noted that CP3 sets the markup at the very small value of 0.001 (to be compared with a typical absolute excess of the "high" over the "low" correlation matrix of 0.05 to 0.10 near the diagonal and 0.15 to 0.25 further off the diagonal. Hence it is to be expected that the effect of this markup $(1+x)$ viz. $(1-x)$ will be smallish, and this is borne out by our preliminary results, discussed below.

Let us review and formalize FRTB's "asymmetric correlations" requirement, as it plays a key role in our analysis proper. As before, we focus on GIRR, but note that this applies to both GIRR and CSR. Consider either a single currency within the CP2-setting, or a single curve within the CP3-setting. Then, the correlation parameter between vertices i and j has to be selected as either the i,j -th element of a "high" correlation matrix P^+ or as the i,j -th element of a "low" correlation matrix P^- , depending on the sensitivities s_i and s_j having the same or opposite sign. This can be formalized as follows. Denote:

x = vector of weighted sensitivities by vertex ; $|x| = \text{abs}(x)$

$x_1 = \max(x, 0)$ $x_2 = -\min(x, 0) \Rightarrow x = x_1 - x_2$

P^+ = GIRR "high" correlation matrix (to be used for same sign exposures)

P^- = GIRR "low" correlation matrix (to be used for opposite sign exposures)

$Q = (P^+ + P^-) / 2$: the mean correlation matrix

$D = (P^+ - P^-) / 2$: (half) distance between P^+ and P^-

$P(x)$ = correlation matrix which emerges on picking from P^+ and P^- , dependent on x

Then it is straightforward to prove that the following holds :

$$x' P(x) x = x' Q x + |x'| D |x| \quad (1)$$

In words: GIRR's measure of the total portfolio variance (for the given currency) is made up of two components :

- (a) non-negative risk on assuming all correlations fixed (equal to the mean of P^+ and P^-);
- (b) a strictly positive penalisation, increasing in the distance D between P^+ and P^-

Note carefully that the penalisation (b) **occurs for both opposite signed and same-signed pairs of exposures**.

Now consider the basis risk between different curves within currency, thinking primarily of the different estimation curves linked with different floating references. A double essential feature of basis risk is that it is inherently linked to **decorrelation** between two curves (the hedger is "long" that correlation) plus it implies **opposite signed exposures** (the hedge operation). As such, **capitalizing basis risk in a risk-sensitive fashion cannot be achieved by relying solely on CP2's "asymmetric correlation" approach**.

Still, this is essentially what CP3's current specification does : it essentially clones the correlation matrices used to aggregate sensitivities on a single curve, to pairs of curves. What is sorely missing is an explicit feature in CP3 which imposes decorrelation between e.g. the 1M and the 3M curve, without appealing to "asymmetric correlation". Specifically, for any "opposite signed" pair of exposures, the correlation should be strictly lower if they happen to be on different curves than if they are on the same curve. The current $(1-x)$ markdown is chosen so low in CP3 as to make its effect almost negligible, compared to the huge differences between the "high" and "low" correlation matrices.

Before turning to concrete counter proposals, we report below on some preliminary numerical impacts on KBC's Trading book. Our focus is on orders of magnitude, not on exact figures.

	Single curve per currency *	Split curves, excl. CP3's $(1+x)$ & $(1-x)$ factors	Split curves, incl. CP3's $(1+x)$ & $(1-x)$ factors
Use "High" corr.matrix throughout	55.0	55.0	55.5
Use "Low" corr.matrix throughout	75.0	75.0	75.5
Asymmetric corr. approach of CP2/CP3	100.0	345.0	350.0

* assuming we can net each vertex over the curves per currency as in CP2, but with zero "netting disallowance"

For the first two rows, the equality between the "single curve" and the "split curve" column which excludes the markup / markdown for "different curve" exposures, is a mathematical identity, given CP3's recipe to re-use the "same curve" correlation matrices.

More importantly, note that on imposing the markup & markdown for "different curve" exposures, the GIRR charge increases by less than 1%. This means that – without appealing to its "asymmetric correlation" feature, FRTB's proposal is for all practical purposes insensitive to decorrelation, hence to basis risk. This is in our opinion, a (fatal) flaw.

Comparing the 3rd to the 2nd and the 1st rows, we see that for a single curve environment, CP3's asymmetric correlation feature yields a penalisation of about 50% (approximate ratio of 100 relative to the mean of 55 and 75). This is very substantial, but it might still qualify as a "reasonable" penalisation for the uncertainty regarding correlations. However, on moving to the multi-curve environment, we see that the penalisation for "correlation uncertainty"

explodes to about 600% (approximate ratio of 350 over the mean of 55 and 70); such a penalty cannot be rationalized as “reasonable” by any means.

To understand how this explosion comes about, it suffices to realize that for a bank active in today’s multicurve environment, for any given vertex, the size of the exposures on the different curves will typically be a **multiple** of the net exposure on that vertex (for the given currency). Returning to expression (1) this means that the contribution from the strictly positive “asymmetry” penalisation gets multiplied in two ways: once due to the fact that on any curve, the size of the exposures are multiples of the netted exposures by vertex, and once in proportion to the number of different estimation curves.

3.2. Counter proposal: outline

Based on the analysis in section 3.1, in our opinion, a solution requires two essential modifications, to be applied in tandem :

- either revise the “asymmetric correlation” parametrisation so as to substantially reduce the distance D between the “high” and the “low” correlation matrices (P^+ and P^-), or replace the “portfolio dependent” correlation matrix approach by an approach which considers the portfolio variance (for a given currency) using either P^+ or P^- , and then set the portfolio variance to the highest of the two results (for the given currency)
- at the same time, impose decorrelation between different curves independently of any “asymmetry” considerations. This can be achieved in various ways ; below we sketch a parsimonious but reasonable approach.

Regarding the 1st bullet, KBC (along with other banks) has a definite preference for the alternative which replaces the portfolio dependent (asymmetric) correlation matrix by a Worst Case Loss approach which relies on using two alternative fixed correlation matrices. Indeed, this rings with our preference for “consistent scenario” approaches. If the Basel-committee rejects such a route, then it is still indispensable to substantially reduce the distance between the “high” and “low” correlation matrices.

The counterproposal is detailed in the next subsection. Recognizing the Basel committee’s preference for capitalising correlation uncertainty via explicit asymmetric correlations, our counter proposal builds on that premise. As such, this is a “constructive” counter proposal to the regulators.

3.3. Counter proposal: details

As already indicated our proposal has two main ingredients:

- we slightly extend the parametrisation of the “high” and the “low” correlation matrices, so as to enable “tapering” the degree of asymmetry which is taken into account ;
- to incorporate decorrelation between different curves of the same currency, we start by parametrizing the decorrelation between (equal maturity) vertices at the (very) long end of the curves, and then add a parameter to control the additional decorrelation as the lowest of the two maturities slides down the maturity ladder. In that way, we incorporate the stylized fact that decorrelation is stronger at the short end of the curves. Note carefully that the starting value of the correlation between two vertices of different curves still equals the “same curve” (asymmetric) correlation, as in the original CP3 proposal.

a) Tapering the degree of asymmetry in the “same curve” correlations : parameter λ

We start from the pair of “high” and “low” correlation matrices specified by FRTB/CP2 and CP3, which we have denoted as P^+ and P^- in section 3.1, where we also introduced the mean of P^+ and P^- , denoted as Q , and their half distance $D = (P^+ - P^-) / 2$.

Our proposal is for the regulator to “try out” different values of a parameter λ , $0 \leq \lambda < 1$, to fix “tapered” variants of P^+ and P^- , which we will denote as Q^+ and Q^- , as follows :

$$Q^+ = Q + \lambda D \quad (2.a)$$

$$Q^- = Q - \lambda D \quad (2.b)$$

The idea is then to perform the asymmetric assignment of correlations using Q^+ and Q^- , driven by the exposure vector x , which leads to an exposure-driven correlation matrix $Q(x)$, analogous to $P(x)$ as in (1). The current CP2/CP3 proposal (which directly uses P^+ and P^-) re-emerges for $\lambda=1$. But note that we have used a strict inequality on the upper bound of λ , given that we find such strong evidence of an implausibly high penalty for correlation uncertainty (apart from decorrelation between different curves, i.e. true curve basis risk).

b) Incorporating decorrelation between different curves

Consider vertices i of curve k and vertex j of curve l , and denote these vertices as $i(k)$ and $j(l)$. We propose to specify the correlation between those vertices as

$$\text{corr}(i(k), j(l)) = Q(i,j) * \Phi(k,l) * \theta(i(k), j(l)) \quad (3)$$

where $Q(i,j)$ is obtained from the “tapered” Q^+ and Q^- as per point a) above, while :

- $\Phi(k,l)$ is a markdown factor which is thought to hold if both vertices are on the long end of their respective curves, specifically, for a (30y, 30y) pair of vertices on different curves (this is thinking of the GIRR charge, for which 30y is the longest maturity).
- $\theta(i(k), j(l))$ adds an additional markdown if the shortest of the two maturities is below 30y, specifically, we set $\theta(i(k), j(l))$ equal to a fixed positive constant between 0 and 1, say α for a (hypothetical) shortest maturity of 0 years, and then obtain $\theta(k,l)$ by interpolating linearly between α (if the shortest maturity were 0) and 1 if the shortest maturity equals 30 years.

To keep the parametrisation manageable and parsimonious, we propose a single parameter α to control the additional decorrelation on sliding down the maturity ladder. For the set of constants $\Phi(k,l)$ on the other hand, it seems advisable to take into account the relative “proximity” between various estimation curves. To fix ideas, consider the following set of estimation curves : OIS, 1M, 3M, 6M, 1Y. Then it is clear that 3M is “closer” to 6M than are OIS and 6M. Hence our proposal to specify a complete correlation matrix (with dimension equal to the number of curves for the given currency). E.g. the following correlation matrix would seem reasonable for this set of curves :

$\Phi(k,l)$	OIS	1M	3M	6M	1Y
OIS	1.0000	0.9900	0.9850	0.9800	0.9700
1M	0.9900	1.0000	0.9900	0.9850	0.9800
3M	0.9850	0.9900	1.0000	0.9900	0.9850
6M	0.9800	0.9850	0.9900	1.0000	0.9900
1Y	0.9700	0.9800	0.9850	0.9900	1.0000

To pin down the RHS of expression (3), we still need to further specify the factor $\theta(k,l)$. As already mentioned, we propose to rely on a single constant α (regardless of the pair of curves). A reasonable value would seem to set $\alpha = 0.975$. Then, given the maturities $t(i_k)$ and $t(j_l)$, the markdown factor $\theta(k,l)$ is chosen as follows. Denote $T = 30$ year and denote the shortest of the 2 maturities as

$$\tau = \min(t(i_k) , t(j_l)) \quad (4.a)$$

$$\text{Then we set } \theta(i(k) , j(l)) = \alpha (T - \tau) / T + \tau / T \quad (4.b)$$

which interpolates linearly between α at $t=0$ and 1 at $t=T$.

Numerical example

As a numerical example, consider the 1y-vertex on the 3M-curve and the 10 year vertex of 6M curve, and consider the values for $\Phi(k,l)$ and α as proposed above. For $\theta(i(k), j(l))$, we have $\tau = 1$ hence $\theta(i(k) , j(l)) = 0.975 * 29/30 + 1/30 = 0.975833$. Also $\Phi(k,l) = 0.99$ as per the table above. Then we would have $\text{corr}(i(k), j(l)) = Q(i,j) * 0.966075$ compared to a correlation for “same curve” exposures of $\text{corr}(i(k), j(k)) = Q(i,j)$, i.e. the decorrelation for this case amounts to markdown of about 3.4% on the “same curve” correlation.

Over the coming days and weeks, KBC hopes to perform some numerical experiments on its trading book based on this counter proposal.

4. SBA vega risk charge: clarifications needed

Our main reference is the new QIS instructions document published on Feb 2, 2015. Within that document, we will focus on the QIS sections (particularly p.182, section III), however our questions for clarification are equally relevant to the broader Accord text in Annex 4 of the QIS-instructions. As the spec for Equity and FX risk is a bit simpler, we will treat these first, and then move on to GIRR.

4.1. SBA Vega risk charge for Equity and FX risk

From Annex 4, par. 63, and section III on p. 182 of the QIS instructions document, the input required for calculating the vega-risk charge is a set of Vega's by option maturity and by moneyness level, where option maturity is discretized as a set of 11 maturity bands, and moneyness as 3 levels of the Strike to ATM ratio (0.8,1.0,1.2). Denoting that grid on the vol-surface as $\sigma(i,k)$ with i indexing option maturity and k index moneyness level, these vega's are turned into Vega Risk positions $VR(i,k)$ as follows: $VR(i, k) = \text{vega}(i,k) * rw(i,k)$ with $rw(i,k) = 0.55 \sigma(i,k) \sqrt{LH / 10}$.

The draft accord text merely states that these VR positions are to be aggregated based on prescribed correlations ; the QIS-specific section III on p.182 completes that recipe, but only to a certain extent. To fix ideas, consider a portfolio of straight Vodafone stock + options on Vodafone. For this single underlying, we have a vol-surface grid of $11 \times 3 = 33$ points, hence a set of 33 VR's by maturity and by moneyness. Section III on p.182 tells us to assume that correlation decays exponentially both in the moneyness dimension and in the option maturity dimension: with τ denoting option maturity and K moneyness, the QIS instructions posit:

$$\rho(\tau_i, \tau_j) = \exp[-\alpha (\tau_j - \tau_i)], \quad j > i \quad (5.a)$$

$$\rho(K_s, K_t) = \exp[-\beta (K_t - K_s)], \quad t > s \quad (5.b)$$

for some positive α and β .

Now, within an underlying, we have VR-positions for all 33 combinations of the 11 option terms and 3 moneyness levels. Section III on page 182 of the QIS instructions gives the final expression $\rho(i,j) = \rho(\tau_i, \tau_j) * \rho(K_i, K_j)$ but this clearly makes no sense, as the subscripts i and j in the LHS need to vary between 1 and 33, while their range is 1:10 in the first factor, and 1:3 in the second factor on the RHS.

Hence our first question: is the following alternative specification correct ?

Proposed correction : $\text{corr}(VR(\tau_i, K_s), VR(\tau_j, K_t)) = \rho(\tau_i, \tau_j) * \rho(K_s, K_t)$ (6.a)

Denote $i = 1, \dots, M$ and $t = 1, \dots, K$ as the index of option term viz. moneyness. Then, in matrix notation, the above corresponds to assuming that the correlation matrix of dimension $M \times K$ which specifies the correlations between each possible pair of VR's for a single underlying, is given by the Kronecker product of the correlation matrices Q and R as given in scalar form by (1.a) viz. (1.b). Specifically, if we denote the matrix of dimension $M \times K$ as S, then our proposed amended parametrisation is in matrix notation :

$S = Q \otimes R$ (6.b) with $\otimes$ the Kronecker product operator.

The quadratic form $(VR' * S * VR)$ yields a single vega-risk figure per underlying. These need to be aggregated further. This leads to our **second question**: how does BCBS expect banks to aggregate the vega-risk figures per underlying ? Are we correct in assuming that BCBS expects us to further aggregate the Vega-risk figures in a similar fashion to Delta-risks, meaning use paragraphs 114-118 to fix the correlations for Equity, and par. 130-131 for FX risk ?

4.2. SBA Vega risk charge for GIRR

For GIRR, as input for the SBA/Vega risk charge, FRTB expects banks to add “underlying tenor” as a 3rd dimension to the vol surface grid described for Equity and FX, stating that this “underlying tenor” dimension needs to be discretized in the same fashion as option term (11 maturity bands). This means that for any given underlying (forward rate or IRS-rate), the set of VR-figures consists of triples (option term, underlying tenor, moneyness), say (i,j,k) .

However, section III on p. 182 of the QIS instructions leaves two issues in the dark :

- first, how to set the correlations between different underlying tenors ;
- second, how to parametrize the correlation matrix which covers the 3 dimensions (option maturity, underlying tenor, moneyness).

More specifically, regarding the first bullet, does FRTB expect us to re-use the “exponential decay” parametrisation (1.a) $\rho(\tau_i, \tau_j) = \exp[-\alpha (\tau_j - \tau_i)]$, $j > i$, substituting underlying maturity for option term ? Or does FRTB expect us to set the correlations between underlying maturities to the correlation matrices of par. 78-79 for the Delta-risks ? If the latter is to be used, do we have to distinguish between “same sign” and “opposite sign” VR-figures, and how ?

Assume that the question in the first bullet is settled, and denote the correlation matrix which covers the “underlying maturity” dimension as P. Then, regarding the second bullet, are we correct in assuming that we need to set

$\text{corr}(VR(\tau_i, T_k, K_s), VR(\tau_j, T_l, K_t)) = \rho(\tau_i, \tau_j) * \rho(T_k, T_l) * \rho(K_s, K_t)$ (7.a)

or in matrix notation, and again denoting the “combined” correlation matrix as S :

$$S = P \otimes Q \otimes R \quad (7.b) \quad \text{with } \otimes \text{ the Kronecker product operator.}$$

4.3. Technical remark: vega by maturity bands vs. vega on a grid of vertices

Section III on p. 182 of the QIS instructions document requires banks to compute the “vega risk” positions $VR(i,k)$ for Equity and FX risk viz. the $VR(i,j,k)$ for interest rate sensitive instruments by option maturity bands, specifically by a set of 11 maturity bands, the boundaries of which coincide with the maturity vertices to be used for the GIRR charge.

The requirement to compute vega’s by maturity band is not just inconsistent with the treatment of delta-risk for GIRR and CSR : specifying vegas by option maturity band makes the results prone to cliff effects. This is especially true for shorter option terms : e.g. when an option’s maturity falls from 3 months to 3 months minus 1 day, its complete vega will shift from the 2nd to the 1st option maturity bucket, causing a “cliff effect”, meaning a sudden jump in the risk charge in the absence of any change in the true level of market risk. Such artefacts endanger the credibility of the risk charge, hence they are totally undesirable.

These artefacts can be simply eliminated by modifying the FRTB proposal in section III on p.182 so as to require the $VR(i,k)$ ’s (for Equity and FX risk) viz. the $VR(i,j,k)$ ’s for GIRR to be computed on the same grid of (option viz. underlying) maturity vertices as used for the GIRR delta-risk. We feel confident that other banks will welcome this harmonisation too.

5. **FRTB’s drill down requirement on Stock Indices and Equity baskets in SBA and in the (standardized viz. IDR) Default risk charge**

A constant through the successive consultative papers on FRTB is that BCBS insists on :

- expanding the scope of Issuer risk to positions on Equity and equity derivatives (both as part of the Standardized default risk charge and under the IMA-IDR charge) ;
- drilling down positions on equity baskets viz. on stock indices to the constituent names, be it for Equity risk or Default risk.

It is pretty clear that the Basel committee’s firm wish to quantify the (jump-to) default risk of equity positions was an important driver for the second requirement.

While we can understand the committee’s concern for consistency, KBC is of the opinion that an indiscriminate application of these rules constitutes overkill in terms of data requirements, and in the case of Equity risk measurement for options and structured products on Stock indices, lacks a sound basis in market risk management practice.

We now set out to explain our position, and formulate a counter proposal which covers the bulk of the material equity risks and default risks, without incurring a huge increase in data requirements.

As a starting point, we distinguish between Equity basket and Stock index as follows. Equity basket denotes “bespoke” baskets not listed on an exchange, typically arising from asset management demand (“buy side”). Structured products on these baskets are typically delta-hedged using the individual stocks, meaning that stock price and implied vol of the individual stocks are routinely available to the trading desk which takes the short position in the structured product. In contrast, structured products on stock indices are hedged completely

using futures viz. options on the index itself, meaning that the data on the individual constituents are not used by the trading desk which takes the position.

Regarding default risk, KBC's counter proposal is to exempt positions on stock indices from the Default risk charge except if at least one of the following holds:

- the stock index consists of less than a prespecified number of names (say 20) ;
- a single constituent has a weight in excess of a certain threshold (say 10%).

In other words, a bank would be required to drill down a stock index only where the credit risk / name risk is material. For all other stock indices, given the high degree of name-diversification, the Equity risk charge would be considered to be adequate by itself. For equity baskets on the other hand, the drill down requirement would apply throughout.

For most banks, the resulting increase in data cost would then consist mainly of adding rating information for the names making up the equity baskets, and adding both stock price, implied vol and rating data for the constituents of a stock index which has less than 20 names and/or with a single name which makes up more than 10% of the index.

With the name risk covered from a credit / issuer risk point of view, the main concern of the regulators seems covered.

For the "Delta, Curvature, and Vega risk" charge of stock index positions on the other hand, we fail to see any real benefit in terms of risk & capital measurement from FRTB's requirement to drill down to the constituents. Worse, we regard the requirement as infeasible because it goes against the way pricing models for structured products on stock indices work. To make this concrete, consider a European call on Eurostoxx50. Even for Delta and curvature, complying with the drill-down requirement would require a complete overhaul of the pricing model, because it's the index which now drives the delta- and curvature computation. For the vega-risk charge, the problem is even more evident, as the call on Eurostoxx50 is priced off the Implied vol of the Eurostoxx 50 in the market. Consequently, we ask the regulator to drop the drill down requirement for stock indices altogether as far as the Delta, curvature and Vega risk charges are concerned. To fit these stock indices into the existing framework, we propose to treat "national market" indices like CAC40, BEL20, DAX as "diversified" regarding sector. To accomodate a "diversified" position, it suffices to insert two "diversified" buckets in the table in par. 106 of Annex 4 of the QIS instructions document, one for the "Emerging Market" and one for the "Advanced" economies, with risk weights to be determined and added to par. 112.

6. FRTB/CP3's modified proposal to make the IMA / ES measure sensitive to differences in liquidity horizon depending on risk factor category

6.1. Overview of successive FRTB-proposals and a first counter-proposal

FRTB CP2 (October 2013) required banks to directly calibrate and simulate scenarios over a range of liquidity horizons (10 days up to 1 year). In Q2.2014, FRTB acknowledged industry remarks on the huge added complexity of this scheme, and proposed to estimate the risk from successively longer liquidity horizons by scaling a set of 10 day based ES measures:

$$ES^2 = ES_T(P,Q)^2 + \sum_{j>1} ES_T(P,Q_j)^2 (LH_j - LH_{j-1})/T \quad (8)$$

with ES the total ES-measure, $T = 10$ days, LH_j the j -th liquidity horizon (considered in ascending order), P the portfolio, Q the complete risk factor set, and Q_j a decreasing sequence of risk factor sets (Q_j contains only the risk factors with $LH \geq LH_j$).

While the industry welcomed the simplification offered by cascading scheme (8), it pointed out that this scheme will greatly overstate the true risk whenever a trading strategy crosses the boundaries of FRTB's liquidity horizon assignments (a small cap stock position hedged by large caps or stock indices is a typical example), i.e. the cascading approach (8) is prone to "broken hedges".

FRTB/CP3 sticks with expression (8) with one modification: CP3 proposes to treat the set of prescribed liquidity horizons henceforth as a set of floors. Specifically, to cope with the "broken hedge" problem, a particular trading desk may raise the liquidity horizon of a certain risk factor category (say of large cap equity) to match the horizon of another risk factor category (say of small cap stocks), on condition that the increase applies to the whole of the desk (CP3, section 3.2.2).

Along with other banks, KBC Bank is of the opinion that FRTB's "liquidity horizon floors" proposal constitutes at most a partial (and very conservative) solution. E.g. for an equity desk with both directional positions concentrated on large cap stocks and a "spread strategy" involving large caps and small caps, the "broken hedge" problem of the spread strategy would be "cured" (albeit very conservatively); however the risk of the directional position would be grossly overstated.

As an alternative to FRTB's "liquidity horizon floors" proposal, some banks have recently come up with a smart refinement to the cascading scheme (8) which imposes the intuitive and sound notion that freezing an additional risk factor category cannot yield an increase in the measured risk of a given portfolio. To that end (8) is replaced by (9) below

$$ES = \sqrt{(ES_T(P, Q_1))^2 + \sum_{j \geq 2} \left(\min_{k \leq j} (ES_T(P, Q_k)) \sqrt{\frac{LH_j - LH_{j-1}}{T}} \right)^2} \quad (9)$$

Returning to the example of the equity desk with both a directional strategy and a spread play, expression (9) will take care of both the problems spotted in (8) in a direct fashion, i.e. without recourse to "liquidity horizon floors". Moreover the proposal is clean: it doesn't cause added complexities like FRTB's liquidity horizon floors proposal.

For the reasons just stated, as KBC, we would be supportive if the Basel committee would consider to adopt expression (9) as its base approach, replacing (8).

At the same time, as KBC we feel strongly that FRTB's cascading scheme (8) has a fatal flaw at its root, by relying on a succession of joint risk factor scenarios which are highly "artificial". Indeed freezing increasing parts of the risk factor universe is a pretty drastic and artificial assumption: several examples come to mind where freezing one risk factor goes straight against the stylized facts, think e.g. of equity prices vs. equity implied vols. Even if we are sympathetic to the amended version of the cascaded approach as per (9), we feel that it "cures the symptoms" while leaving the root cause of the problem intact. In the next subsection we look at a simple counter-proposal which tackles the problem at its root.

6.2. A counter-proposal which circumvents freezing parts of the risk factor universe

The counterproposal presented below is not just an idea of KBC: it arose during industry discussions over FRTB/CP2's IMA in the course of 2014, and may have been presented to the Basel committee before. Still, as mentioned at the end of section 6.1, it has the considerable merit of eliminating the use of joint scenario sets which freeze some risk factor categories known to correlate with the risk factors which are actually shocked. It achieves this by estimating a weighted average liquidity horizon per desk in a first step, which is then used to scale the 10-day based ES measure of the desk portfolio.

As weighting criterion, the stand-alone ES of each risk factor category is proposed. Denoting the index of risk factor categories as i , and the i -th risk factor category as q_i , the stand-alone ES-measures for a given desk portfolio P are $ES(P, q_i)$, $i=1, \dots, n$, and define weights

$$w_i = ES_i / (\sum_i ES_i) \quad (10.a)$$

The weighted average liquidity horizon for the desk is then

$$d = \sum_i w_i LH_i \quad (10.b)$$

and the liquidity-horizon adjusted ES measure is obtained via a sqrt(time) scaling :

$$ES = ES_T(P, Q)^{\sqrt{d/10}} \quad (10.c)$$

The choice of the stand-alone ES measure by risk factor category is motivated by the fact that it is simple and guarantees non-negative weights. Note carefully that (10.c) essentially relies on a single, portfolio-wide ES-calc, with a subsequent scaling to "adapt" the measure to the portfolio's mix of liquidity horizons. The principle can be easily extended to encompass several desks, as in the numerical example below, which relies on FRTB's revised liquidity horizon assignment as per the CP3 document.

Counter proposal on ES and Liq.Horizons using a weighted average LH: numerical example

Standalone 10 day ES by Desk and RF-class		Entity =>				Entity (assume 20% diversif.)
AssetClass	Risk factor class	Desk => LH (days)	D1	D2	D3	
IR	IR-liquid ccies	10	40	20		50
	IR-Other ccies	20	50			50
	IR Vols	60	20			20
	IR Sum of Solo-ES		110	20		120
CR	CR Sov IG	20		30		30
	CR Sov HY	60		20		20
	CR Corp IG	60		20		20
	CR Corp HY	120		20		20
	CR Sum of Solo-ES			90		90
EQ	EQ LargeCap	10			50	50
	EQ SmallCap	20			50	50
	EQ Vol LargeCap	20				
	EQ Vol SmallCap	120				
	EQ Other	120				
	EQ Sum of Solo ES				100	100
FX	FX Rate - liquid ccy pair	10	10	10	10	25
	FX Rate - other	20	20			20
	FX Vol	60				
	FX Sum of Solo		30	10	10	45
AL	Sum of All Solo ES		140	120	110	355
Weighted Average LH			D1	D2	D3	E1
	IR		23.64	10.00		22.50
	CR			60.00		60.00
	EQ				15.00	15.00
	FX		16.67	10.00	10.00	14.44
	AL		22.14	47.50	14.55	28.87
10 day ES shocking all risk factors (assume 40% diversif.)			100	86	79	254
ES adjusted for Liq.Horizon			946	16,330	193	12,164