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Abstract

Banking operations are being rewired around XVA metrics quantifying market incompleteness. This paper focuses on the cost of funding of variation margin and the cost of capital, i.e. FVA and KVA. The two metrics are intertwined since economic capital is itself a source of funding. Accurate valuations require simulations of capital and funding costs.

Motivated by Basel Pillar II, Solvency II and IFRS 4 Phase II, we propose a principled approach to accounting regulatory treatments for FVA and KVA.

1 Introduction

As explained in [2], the CVA and FVA are adjustments to entry prices that flow into Reserve Capital and are meant to compensate shareholders for the systematic losses they incur due to counterparty defaults and funding costs. Core Equity Tier I Capital (CET1) is the difference between Assets and Liabilities minus Reserve Capital and plays the role of a further capital cushion aimed at absorbing *exceptional losses*.

According to Basel II Pillar II, CET1 must exceed Economic Capital computed as the 99% VaR over a one-year holding period. Following the Fundamental Review of the Trading Book, a more conservative definition of Economic Capital makes reference to an Expected Shortfall measure with 97.5% confidence. Pillar I capital charges are given by regulatory formulas which approximate Pillar II Economic Capital, see [10].

CET1 receives funds from both shareholders and clients. The portion coming from clients is called Risk Margin and is usually abbreviated as KVA (from Capital Valuation Adjustment). The KVA is loss absorbing capital which is also earmarked to remunerate shareholder capital over the lifetime of the portfolio at a given *hurdle rate*. Since the KVA is sourced from clients, it is also an adjustment reflected in entry prices. Although Basel III and accounting standards for trading books do not envisage a role for a KVA-type entry, Solvency II and IFRS4 Phase II for the insurance industry have a principled framework for this purpose which has been extensively debated for over a decade.

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In our proposed accounting framework, the KVA is configured as a retained earnings account which ensures profits are reported and distributed in a sustainable fashion throughout the portfolio lifetime. From a regulatory standpoint, Solvency II adopted a principle first stated in the Swiss Solvency Test (SST) according to which Economic Capital is at all times the maximum between the Expected Shortfall measure on CET1 mentioned above and the KVA itself. The reason is that Risk Margin is considered as capital meant to absorb exceptional losses and thus represents an integral part of Economic Capital. However, Economic Capital must be larger than or equal to the KVA in order to ensure that it is sufficient to cover the cost of capital throughout the portfolio lifetime, a principle first introduced in SST.

By ignoring capital costs in fair valuation, IFRS 9, GAAP and tax codes force banks to release fair valuation profits prematurely into the dividend stream. This turns derivative markets into a gigantic Ponzi Scheme whereby dealers are able to pay dividends on capital only at the condition of exponential growth of assets and escalating leverage ratios. When a 2007-type crisis hits, it then takes decades to restore acceptable returns on equity. By building KVA Risk Margins into the fabric of banking regulation, accounting standards and executive compensation schemes, derivative markets will be better positioned to finally overcome this explosive systemic instability.

The paper is organised as follows. Section 2 contains a high-level discussion of the inter-relation between capital and funding. Section 3 sets out a model for Economic Capital. Section 4 is about the KVA risk adjustment, earnings and transfer pricing policies for capital costs. The last Section concludes.

See [4] for a detailed version of the present work.

2 Capital and Funding

Since banks may default, lenders ask for a credit spread on unsecured funding. As explained in [2], the FVA quantifies the cost of paying a spread to carry assets. In accounts, Core Equity Tier I Capital (CET1) represents the fair valuation of Shareholder Capital and FVA deducts from it. Since total wealth is preserved, see [9], the FVA is also a benefit for senior creditors and ultimately has no impact on the portfolio fair valuation. The FVA is however reflected into entry prices as a compensation to shareholders for the wealth transfer to creditors. This follows from the intrinsic market incompleteness plaguing banks: the only way to prevent wealth transfers to creditors is to fully deleverage the firm, an obvious impossibility for banks.

Desks are assigned economic capital and are tasked to generate returns at a certain "hurdle rate" set by management at a level sufficiently high for the bank to be profitable but not so high for it to be uncompetitive. In our case study, we choose a hurdle rate $h = 10.5\%$.

CET1 differs from the market price of equity liabilities since investors are risk averse and demand a discount, i.e. a risk adjustment. In this paper, we introduce the concept of Risk Adjusted CET1 (RACET1). The KVA is the risk adjustment, i.e. the difference CET1 minus RACET1. To recognise market incompleteness, earnings are reported as variations of RACET1 and banks aim at optimising their balance sheet by reducing the KVA.

Mathematically, the KVA is a stochastic process that converges to zero at the final maturity of the portfolio by decreasing on average at a rate given by the product of a hurdle rate h and the shareholder capital at risk.

Economic Capital is a concept defined in Basel II Pillar II to quantify shareholder capital at risk. Economic Capital is earmarked to absorb exceptional losses and is supposed to exceed Pillar I Regulatory Capital. Our Economic Capital model is defined consistently with the Fundamental Review of the Trading Book as the Expected Shortfall (ES) metric with confidence level equal to 97.5% computed on CET1 returns with a yearly holding period. We are interested in Economic Capital as a stochastic process $\mathrm{EC}(t)$ over the lifetime of the portfolio. We assume the portfolio is held on a run-off basis, i.e. that no new trades are entered in the future. Since trades gradually expire, $\mathrm{EC}(t)$ systematically decreases with time, see Figure 1.

Reserve capital is always struck at the mark-to-market value of CVA and FVA adjustments. However, as losses due to defaults, funding costs and CVA and FVA volatility occur the residual variation has an impact on CET1. These losses are compensated by the systematic decrease of the CVA and FVA deductions, to the point that CET1 follows a martingale process, i.e. has zero drift. In the event CET1 is depleted to an extreme degree with a one-in-40-years event of probability 2.5%, CET1 should still be able to absorb losses since it exceeds Economic Capital.

As new trades are booked in the portfolio, an incremental KVA is received from clients and is retained. KVA is loss absorbing and contributes to Economic Capital, the difference being provided by Shareholder Capital. See Figure 2 for a schematic of the economic structure of a bank. As time progresses, the KVA is regularly marked-to-market and gradually released into earnings. This wealth flow compensates CET1 variations which, as mentioned, follow an unbiased martingale process. If losses in the reserve capital account exceed KVA earnings, the bank issues new shares and shareholders suffer dilution losses. If instead released earnings are in excess of losses in reserve capital, shareholders either receive a dividend or benefit of share appreciation.

As explained in [1], capital is a form of funding and as such it can be used for the purpose of posting Variation Margin. As a consequence, the presence of Economic Capital mitigates the FVA. In this paper, we discuss a representative case study of an OTC portfolio of mostly long-dated derivatives where the reduction is by a third.

Our definition of KVA follows closely the principles of the Swiss Solvency Test and Solvency II. They however deviate substantially from the definition put forward by Green, Kenyon and Dennis in [7] in several respects.

Firstly, the KVA in [7] is conceived as a CET1 deduction. However, the Basel III Accord was calibrated in terms of a CET1 defined as the fair value of Shareholder Capital, not to the risk-adjusted variant RACET1. Also Solvency II considers the Risk Margins as loss absorbing capital and not as deductions.

Secondly, the KVA in [7] is defined on the basis of replication arguments. We work instead under Classical Finance Theory and see the KVA and FVA as the quantification of market incompleteness.

Thirdly, we perform portfolio level aggregation and avoid the practice of restricting metrics to ones requiring only netting set aggregation, see [1] and [2] for a discussion.

Fourthly, we use Pillar II Economic Capital as opposed to Pillar I Regulatory Capital. One reason is that Regulatory Capital is only a lower bound to Economic Capital, another is that Regulatory Capital is computed by means of simplified formulas that can potentially distort risk sensitivities. Regulatory Capital should still be simulated to ensure that Economic Capital actually exceeds Regulatory Capital, a non-trivial condition given the large overlap that plagues simplified Pillar I charges.

Pykthin discusses the logic behind regulatory formulas for CVA capital charges in [10], where he explains how these formulas aim at capturing the 99% VaR of CVA mark-to-market variation. Assuming normality, this is equivalent to Expected Shortfall within 97.5% confidence. In general, fat tails make Expected Shortfall more conservative. Granularity of default losses is accounted for by modelling credit factors explicitly. We account for the volatility risk of funding costs and FVA. Model risk can also be included by means of a Bayesian approach a la Black-Litterman, as discussed below.

A further consideration is that Pillar I capital formulas are not stable and are improving with the passing of time. It is natural to speculate that over the lifetime of long-dated trades they will be better approximated by Economic Capital than by present day Pillar I formulas. In our view, Economic Capital should best be computed directly with a holistic credit-market simulation and should be projected to the furthest time horizon in the portfolio.

One more difference with [7] is that we use nested Monte Carlo simulations. Market and credit factors are jointly simulated through primary and secondary scenarios and we aggregate at the funding-set level. Nested simulations are used to simulate CVA/FVA metrics through time. The total number of scenarios we generate between primary and secondary adds up to about one billion. To compute Economic Capital, we find the distribution of CET1 returns over yearly periods. Although challenging, this modelling exercise is fully within the bounds of feasibility also for massive portfolios at the condition of using suitable mathematics optimised to the right hardware and software architectures.

As discussed in [3], an additional requirement for this sort of nested simulation is that the models used for derivatives ought to be of high quality. In [3] we discuss credit limits, stress testing and model risk within the framework set out in this article. We show that low-quality models such as the Hull-White model for interest rates are inaccurate in low interest rate environments.

3 A Model for Economic Capital Projections

Consider a situation where we are given an OTC portfolio at time 0 and we evolve it in the future on a run-off basis. To this end, we interpret Common Equity Tier I (CET1) capital as the fair valuation of Shareholder Capital.

Following [2], CET1 is given by

$$\text{CET1 } (t) = \text{EC}(t) + A(t) - L(t) - \text{UCVA}(t) - \text{FVA}(t). \tag{1}$$

Here,

- EC is the Economic Capital at time (t);

- $A(t)$ (resp. $L(t)$) is the fair value of assets (resp. liabilities) at time t computed neglecting counterparty credit risk;
- UCVA(t) is the unilateral Credit Valuation Adjustment at time t given by

  $$\mathrm{UCVA}(t) = \sum_i \mathbb{E}_t \left[e^{-\int_t^{\tau_i} r_{\mathrm{OIS}}(s)\, ds} \mathbb{1}_{\{t<\tau_i<T\}} (1 - R_i)(V_i(\tau_i) - c_i(\tau_i))^+ \right]. \tag{2}$$

  Here, the index i runs over counterparties; $V_i(t)$ is the exposure of the i-th netting set, i.e. the value of the i-th netting set ignoring counterparty risk and funding costs; $c_i(t)$ is the total margin posted by the counterparty in virtue of the CSA agreement.

- FVA(t) is the Funding Valuation Adjustment computed at time t, given in first approximation by [1]

  $$\mathrm{FVA}(t) \approx \mathbb{E}_t \left[\int_t^{\tau_B} e^{-\int_t^u r_{\mathrm{OIS}}(s)\, ds} s_B(u) \left(\sum_i \big(V_i(u) - \bar{c}_i(u)\big) 1_{u<\tau_i} \right)^+ du \right]. \tag{3}$$

  Here, $\bar{c}_i(t)$ is the re-hypothecable margin received, net of the margin posted by the bank in virtue of the CSA agreement, s_B is the funding spread of the bank on short-term unsecured debt, τ_B is the default time of the bank and τ_i is the default time of the i-th counterparty.

The funding spread is sometimes computed as a "blended rate" which is lower than the CDS spread to account implicitly for the possibility of using economic capital for funding purposes and avoid double counting with the hurdle rate. In this paper, we will model equity financing explicitly and hence choose s_B to be the CDS spread. However, one of the applications of our methodology is precisely to provide a principled calculation of a blended funding curve including capital funding.

The CVA and FVA flow into Reserve Capital. Regulatory Reserve Capital $\mathrm{RRC}_t(s)$ measured at time s and priced in dollars at time t is given by

$$\mathrm{RRC}_t(s) = M_t(s)^{-1}(\mathrm{UCVA}(s) + \mathrm{FVA}(s)) \tag{4}$$

where

$$M_t(u) = e^{\int_t^u r_{\mathrm{OIS}}(s)\, ds}. \tag{5}$$

The Realised Reserve Capital at time s is given by initial reserve capital at a previous time $t < s$ minus realised costs of funding and default losses in the time interval $[t, s]$, i.e.

$$\mathrm{RC}_t(s) = \mathrm{RC}(t) - \int_t^s M_t(u)^{-1}(dD(u) + dF(u)) \tag{6}$$

Here $\mathrm{RC}(t) = \mathrm{RC}_t(t)$, $D(t) = \sum_{\tau_i<t} M_{\tau_i}(t)(1 - R_i)(V_i(\tau_i) - c_i(\tau_i))^+$ is the cumulative default losses suffered by the bank, $F(t) = \int_0^t M_s(t) s_B(s) \left(\sum_i \big(V_i(s) - \bar{c}_i(s)\big) 1_{s<\tau_i}\right)^+ ds$

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[1] This formula is not exact as it does not account for the use of capital as a source for funding and is only used as the initial guess for an iterative solution of a fixed point problem, see Equation (13) below.

is the cumulative funding cost expenditures. The difference between Regulatory and Realised Reserve Capital

$$L_t(s) = \mathrm{RRC}_t(s) - \mathrm{RC}_t(s). \tag{7}$$

is a discounted martingale process in s. While regulatory reserve capital is funded by equity liabilities, the difference $L_t(s)$ represents a loss that can be funded with debt and adds to the FVA costs of funding.

Derivative portfolios are often simulated on a run-off basis, i.e. assuming no new trades are added to the portfolio in the future. This is particularly useful when the objective is to assess the incremental impact of new trades. From this viewpoint, CET1 at time s measured in dollars at time t follows the discounted martingale process:

$$\mathrm{CET1}_t(s) = \mathrm{CET1}(t) - L_t(s). \tag{8}$$

Banks allocate Economic Capital as a buffer against events of exceptional losses of Reserve Capital. Following the FRTB, we define $\mathrm{EC}(t)$ as the Expected Shortfall of CET1 variation at time t with confidence level 97.5% and holding period Δt of one year. The Value-at-Risk measure for CET1 at time t with confidence level 97.5% is

$$\mathrm{VaR}(t) = \inf\Big[\mathcal{E} : Prob_t(\Delta L(t) - \mathcal{E} > 0) \leq 2.5\%\Big]. \tag{9}$$

and Economic Capital at time t is given by Expected Shortfall:

$$\mathrm{EC}(t) = E_t\big[\Delta L(t) \ \mid \ \Delta L(t) \geq VaR(t)\big]. \tag{10}$$

Here

$$\Delta L(t) = L_t(t + \Delta t) - L_t(t). \tag{11}$$

To ensure that exceptional losses do not deplete CET1 entirely on average, one needs to ensure that

$$\mathrm{CET1}(t) \geq \mathrm{EC}(t) \tag{12}$$

As explained in [1], REPOing assets into cash to post as Variation Margin does not reduce CET1 since the margin posted against hedge payables is compensated by a reset of the hedge valuation to zero. Furthermore, the loss $L_0(t)$ on reserve capital incurred up to time t also needs to be financed from the same sources as variation margin itself. This implies that the formula for the FVA in (3) needs to be refined as follows:

$$\mathrm{FVA}(t) = \mathbb{E}_t\left[\int_t^{\tau_B} M_t(s)^{-1} s_B(s) \left(\sum_i \big(V_i(s) - \bar{c}_i(s)\big) 1_{t<\tau_i} - \mathrm{EC}(s) - \mathrm{RC}_t(s)\right)^+ ds\right] \tag{13}$$

This equation expresses a fixed-point problem for the process $FVA(t)$ which can be solved iteratively. Technically, (13) is a so-called backward stochastic differential equation (BSDE) for the process $\mathrm{FVA}(t)$, see [4].

Moreover, for numerical tractability, Economic Capital $\mathrm{EC}(t)$ therein is approximated by its time projection in the sense of the following term structure:

$$\overline{\mathrm{EC}}(t) = E_0\big[\Delta L(t) \;\mid\; \Delta L(t) \geq VaR(t)\big]. \tag{14}$$

The approximation in (14) reduces the evaluation to a simply nested simulation as opposed to a doubly nested simulation for (10), while introducing some convexity error.

4 KVA Risk Adjustments, Reported Earnings and Transfer Pricing

As returns on equity fell in the aftermath of the crisis, banks became increasingly aware of the need to design a sustainable and robust method to cost capital and distribute earnings. The recognition of risk adjustments in accounts is an essential part of the solution.

Since Solvency II already has a concept of KVA, international accounting boards already went through a decade-long process in this direction in the context of insurance contracts. Discussions are summarised in a series of Exposure Drafts for IFRS 4 Phase II, see [8].

Insurance markets are incomplete by their very nature. Hence the entry price at which an insurance firm agrees to accept a liability is not only a function of the discounted expectation of future expected cash flows, but also includes a risk adjustment. The risk adjustment is related to the capital at risk, i.e. to the term structure of Economic Capital projections.

The academic literature on the topic of risk adjustments is extensive and revolves around the notion of expected utility pricing.

Risk preferences of a rational investor are characterised by a utility function U and a probability measure P. A payoff A is preferable to the payoff B if and only if $E^P[U(A)] \geq E^P[U(B)]$. A useful class of utility functions is given by the coherent risk measures, one example being Expected Shortfall. In the special case of complete markets, replication is possible and preferences are irrelevant. The cost of replication is the OIS-discounted expectation of future payoffs under a risk-neutral measure.

IFRS 4 Phase II draws a distinction between the fair valuation of claims and a *risk adjustment* add-on. The risk adjustment is an inter-temporal portfolio-level metric which is not by itself a coherent risk measure, but is derived from a choice of coherent risk measure and has the financial interpretation of cost of capital.

In the case of derivative portfolios, we propose to use a risk adjustment $KVA(t)$ corresponding to retained earnings fitted to the objective of a sustainable remuneration of shareholders' capital at a target hurdle rate h, given a risk measure that is used for setting Economic Capital. Since retained earnings are part of Economic Capital, shareholder capital at risk is given by the difference $(EC(t)-KVA(t))$. We are looking for a dynamic amount $KVA(t)$ so that, starting from an initial profit $KVA(0)$ received at trade inception and deposited in a risk-free account yielding OIS, $KVA(0)$ can be distributed in time T by yielding on average $h(EC(t)-KVA(t))dt$ as dividends at each intermediate time t. In other words, we are looking for a process $KVA(t)$ satisfying

$$E_t\left[\frac{d\mathrm{KVA}(t)}{dt}\right] = r(t)\mathrm{KVA}(t) - h(\mathrm{EC}(t) - \mathrm{KVA}(t)) \text{ on } [0,T] \text{ and } \mathrm{KVA}(T) = 0. \quad (15)$$

The unique solution to (15) is given by

$$\mathrm{KVA}(t) = hE_t\left[\int_t^T e^{-\int_t^s (h+r(s))ds}\mathrm{EC}(s)ds\right], \quad (16)$$

so that

$$\mathrm{KVA}(0) \approx h\int_0^T e^{-hs}Z_0(s)\overline{\mathrm{EC}}(s)ds, \quad (17)$$

where Z_0 is the discount function at time 0. We emphasize that (16) is the only way to guarantee an average hurdle rate of h on shareholder capital $(EC(t) - KVA(t))$ at any time t. The quantity $(-dKVA_t)$ corresponds to dividends whenever positive and losses to shareholders due to recapitalisation and dilution when negative. Equations 15 and 16 hold up to the time where exceptional losses occur and the EC and KVA are subject to depletion, at which point the drift condition becomes invalid.

Managers may decide to induce a change of hurdle rate towards a target h_0. In this case, if $\mathrm{RE}(t)$ denotes the level of Retained Earnings at time t, we define the implied hurdle rate $h_i(t)$ by setting

$$\mathrm{RE}(t) = \mathrm{KVA}(t, h_i(t)) \quad (18)$$

To cause the implied hurdle rate to drift towards the target, managers would price new deals at the target hurdle rate and not pay dividends as long as $\mathrm{RE}(t) \leq \mathrm{KVA}(t, h_0)$. In the insurance industry, such strategies cause implied hurdle rates to move in cycles, whereby events of industry-wide capital depletion are followed by periods of gradual tightening of hurdle rates driven by competition.

The Risk Adjusted Common Equity Tier I Capital (RACET1) is defined as follows:

$$\mathrm{RACET1} = \mathrm{CET1} - \mathrm{KVA}. \quad (19)$$

RACET1 represents a model-based valuation for Shareholder Capital. As we explained in Section 2, RACET1 includes a KVA risk adjustment due to earnings' volatility and for the dilution risk shareholders face in case Economic Capital is depleted. The choice of the hurdle rate h and of the risk measure that is used for determining Economic Capital are entity-specific and reflect risk preferences. IFRS 4 Phase II leaves the choice entirely to management, except for specifying that the chosen definition should be applied consistently both for retained earnings and for entry prices. This policy is also consistent with the prohibition of day-one earnings.

In [2], we define the transfer pricing policy in such a way to preserve CET1 with respect to the addition of new trades. If we include economic capital funding and risk adjustments, this principle needs to be revised by saying that managers should ensure that RACET1 stays invariant. More precisely, the adjustment to fair valuation passed on to clients is the Risk Adjusted Funds Transfer Pricing amount given by:

$$\mathrm{RAFTP} = \Delta\mathrm{UCVA} + \Delta\mathrm{FVA} + \Delta\mathrm{KVA}. \quad (20)$$

We stress that Basel III does not make any reference to risk adjustments. Regulators calibrated the models in Basel III to CET1 defined as the fair value of Shareholder Capital, not to the risk-adjusted variant RACET1. In particular, it would be unjustified to consider the KVA as an adjustment to the fair valuation of trades that feeds into CET1.

A regulatory treatment for the KVA already exists in the context of Solvency II, which stipulates that Economic Capital must be larger than or equal to the KVA. This can be achieved by setting

$$\widetilde{\mathrm{EC}} = \inf\left\{C; C \geq \max(\mathrm{ES}, \mathrm{KVA}(C))\right\}, \tag{21}$$

where ES is Expected Shortfall and $\mathrm{KVA}(C)$ means the process obtained by Equation 16 with a putative Economic Capital process C instead of $\mathrm{EC} = \mathrm{ES}$ there. However, we often have $\widetilde{\mathrm{EC}} = \mathrm{EC}$. The equality stops holding when the hurdle rate is high enough and the term structure of EC starts very low and has a sharp peak in a few years.

Model risk can be included in our definition of KVA by adopting a Bayesian approach and averaging scenarios also over model uncertainty. This involves introducing a Bayesian prior over uncertain parameters and performing an average of the distribution of the loss process $L_s(t)$ prior to taking the expected shortfall which defines EC. This approach is particularly useful when studying the problem of robust hedging for CVA/FVA exposures by means of a variation of the Black-Litterman method for portfolio optimisation.

The Prudent Valuation document [5] by the European Banking Association mandates earnings provisions through Additional Valuation Adjustments (AVA). The AVA targets model risk and other unheadgeable risks not included in Basel III such as close-out risk. Our definition of KVA is in a similar spirit but covers all unhedgeable risks by reflecting them in Economic Capital. The point where we differ from the Prudent Valuation Document is that we do not advocate deducting the KVA from CET1, but instead treating it as a risk adjustment in IFRS 4 Phase II.

Banks are already in the habit of reporting earnings in a dual fashion, both on a GAAP and a non-GAAP basis. Typically, non-GAAP earnings neglect contra-liabilities. In the case of the DVA, since regulators have de-recognised DVA as a contributor to CET1 capital, banks do not recognise a DVA benefit to clients. The DVA still contributes to income and the P&L, giving rise to a day-one DVA profit. Day-one profits also arise because of the other contra-liability terms discussed in [2], i.e. the difference UCVA - FTDCVA and the FDA term. These profits however are not included in non-GAAP earnings. Given this precedent and in the spirit of IFRS 4 Phase II, we advocate deducting also the KVA from non-GAAP earnings.

5 Case Study

As a case study, we consider a representative fixed-income portfolio with about 2,000 counterparties, 100,000 fixed income trades including swaps, swaptions, FX options, inflation swaps and CDS trades. A nested simulation with 100 underlying time points and yearly secondary branching points up to 50 years in the future is launched to recalculate the CVA and FVA. Using 20,000 primary scenarios and 1,000 secondary scenarios, this amounts to a total of one billion scenarios. The calculation takes 3 hours using a single GVL Esther appliance. We compute the return distribution of CET1 and evaluate the quantiles that define Economic Capital according to (10), assuming a hurdle rate of 10.5%.

Primary scenarios are generated based on a historical measure while secondary scenarios are under the risk neutral measure and are used to value CET1 with yearly frequency. CET1 variations account for default losses, funding costs and the mark-to-market variation of both the UCVA and the FVA.

Risk neutral processes are calibrated to derivative data using broker datasets for derivative market data. The historical measure is obtained by adjusting parameters of the risk-neutral models in such a way to satisfy back-testing benchmarks. In particular, historical measures for interest rates have an adjusted drift to account for the fact that yields are not good predictors of future rates.

Table 1: KVA and Adjusted FVA

XVA	Value in Million $
UCVA	242
UDVA	198
FVA without EC, Stoch. UCVA and FVA	126
FVA with EC, Stoch. UCVA and FVA	62
KVA	275
FCA	296
FBA	179
SFVA	117

Table 1 shows the XVA results for the case study portfolio. Figure 1 instead shows the term structure of Economic Capital along with the term structure of KVA. The KVA computed as per (16) amounts to $275 M, roughly fifteen percent above the UCVA. We report several FVA numbers to show how this gets reduced when we consider additional funding sources.

The FCA (Funding Cost Adjustment) and FBA (Funding Benefit Adjustment) metrics are defined as follows, see [6]:

$$\mathrm{FCA}(t) = \sum_i \mathbb{E}_t \left[\int_t^{\tau_B} e^{-\int_t^u r_{\mathrm{OIS}}(s)\, ds} s_B(u) \left(\left(V_i(u) - \bar{c}_i(u) \right) 1_{u<\tau_i} \right)^+ du \right]. \tag{22}$$

$$\mathrm{FBA}(t) = \sum_i \mathbb{E}_t \left[\int_t^{\tau_B} e^{-\int_t^u r_{\mathrm{OIS}}(s)\, ds} s_B(u) \left(\left(V_i(u) - \bar{c}_i(u) \right) 1_{u<\tau_i} \right)^- du \right]. \tag{23}$$

Finally, SFVA = FCA - FBA. The FCA deducted from capital under FCA/FBA accounting (cf. [2]) is as large as \$296 M.

The FVA number accounting only for re-hypothecation of variation margin received on hedges amounts to approximately \$126 M. However, if we consider all additional funding sources due to Economic Capital and UCVA/FVA collateral, we arrive at an FVA figure of \$62 M - almost one half of the re-hypothecation-only FVA.

Neglecting the (FBA-DVA) correction to capital which is small anyway, the deduction from capital would be \$62 M as opposed to \$296 M, a reduction by about a factor 5. However, the KVA is significant at \$275 M and gives the leading contribution to risk-adjusted transfer prices.

The funding needs' reduction achieved by EC, UCVA and FVA is also clearly shown in Figure 3 for the *blended funding curve*. This curve is defined as the funding curve which, whenever applied to the FVA computed neglecting the impact of Economic and Reserve Capital, gives rise to the same term structure for the forward FVA as the calculation carried out including instead capital in the calculation as a source for funding. This blended curve is often inferred by consensus estimates based on the Markit XVA service. However, here it is computed from the ground up based on full-fledged capital projections.

6 Conclusions

We introduce the KVA as a risk adjustment aimed at compensating shareholders for the risk of earnings' volatility. Using an accounting framework inspired by IFRS 4 Phase II, shareholders are compensated in proportion to capital-at-risk times a hurdle rate decided by management. The KVA also enters into entry prices by quantifying cost of capital.

We conclude that KVA reporting would improve transparency in dividend distribution policies and make the derivative business more sustainable and less prone to developing bubbles. We also find that the FVA is materially reduced once we account for the possibility of pledging Economic Capital.

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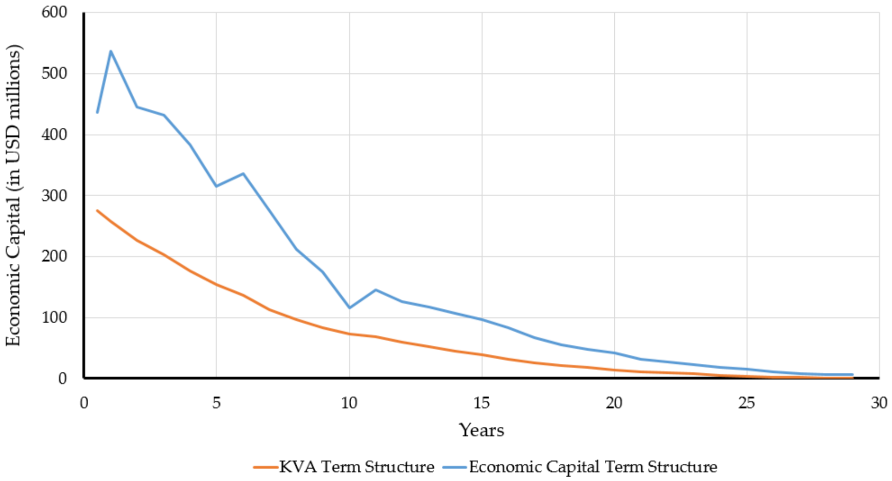

Figure 1: Term structure of Economic Capital computed as the Expected Shortfall with 97.5% confidence for capital return distribution compared with the term structure of KVA

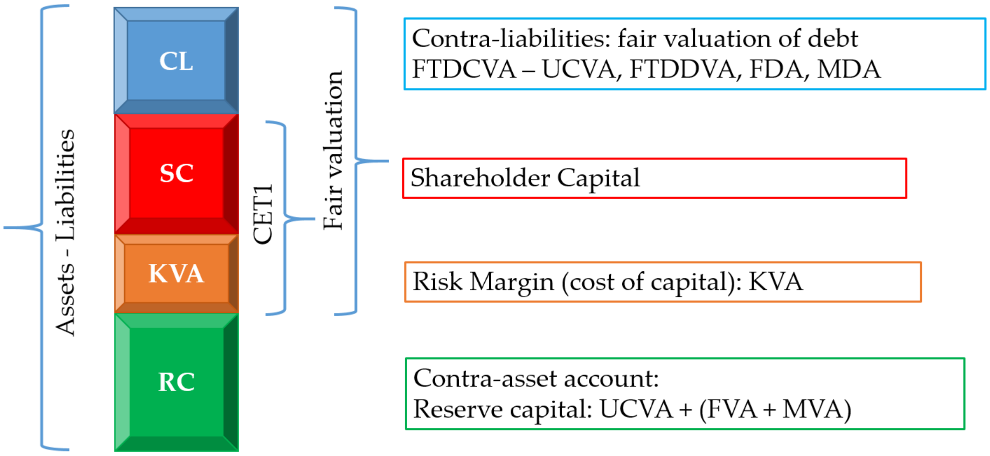

Figure 2: Diagram of the economic structure of a bank

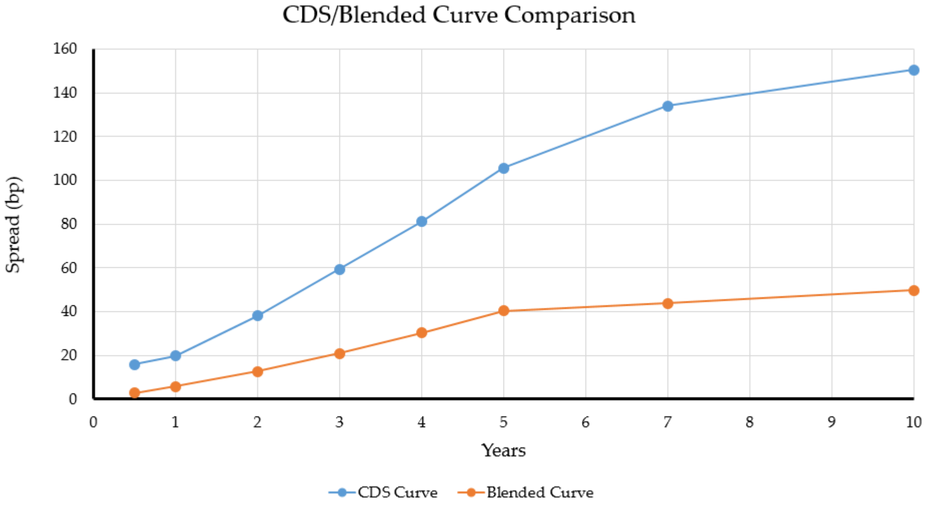

Figure 3: Rigorously computed blended curve