The recursive nature of KVA: KVA mitigation from KVA

Luis Manuel García Muñoz and Juan Esteban Palomar Burdeus and Fernando de Lope Contreras

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Luis M. García Muñoz
Fernando de Lope
Juan E. Palomar

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Abstract

KVA represents the extra cost being charged by banks to clients in order to remunerate banks' shareholders for the mandatory regulatory capital provided by them throughout the life of the deal. Therefore, KVA represents earnings charged to clients that must be retained in the bank's balance sheet and not be immediately paid out as dividends. Since retained earnings are part of core TIER I capital, future KVAs imply a deduction in today's KVA calculation. In this paper we propose a KVA formula that is consistent with this idea and in line with full replication of market, counterparty and funding risks. Although the formula might seem cumbersome at first sight due to its recursive nature, we show how calculate it in a Montecarlo XVA engine without any approximation. Finally, we provide a numerical example where the KVA obtained under this new formula is compared with other approaches yielding significantly lower adjustments.

1 Introduction

Same as with any other economic activity, derivatives are financed with both equity and debt. Since equity holders are willing to accept higher levels of risk in exchange for greater expected returns, regulators enforce banks to fund a given proportion of their activity with equity, so that potential losses in the future are absorbed by shareholders. Due to losses experienced by banks in the last years, regulators have increased and are in the process of increasing capital requirements for banks, that is, the proportion of the derivatives activity to be financed by equity holders so that debt holders are better protected from losses.

The essential responsibility of bank managers is adding value for shareholders, who expect a higher return for the higher level of risk they bear. Furthermore, since regulatory capital requirements are being increased, the financial industry is putting more focus in the measurement and management of return on capital generated by trading activities.

Contrary to what happens with debt holders, where the return they receive depends solely on market conditions and can easily be extracted from bond quotes, the return expected by the bank's equity holders is unknown. Therefore, the management of the return on equity is an internal discipline that will pay out in the long term, when banks that have undergone this discipline are perceived as a better investment. In this paper we assume that the bank top managers have determined a return on capital (aka hurdle rate) r_t^K.

In this new environment, a new adjustment has emerged which reflects the extra cost being charged to banks' counterparties in order to compensate equity holders throughout the life of a new deal for the incremental regulatory capital implied by it. This new adjustment is broadly known as KVA (Capital Value Adjustment). Nevertheless, the new adjustment is still not in a mature stage and different questions arise with respect to how it should be measured, how should it be accounted and how should it be managed.

KVA represents a cost charged to bank clients but represents a profit for the bank, since it is money to be paid to the bank's shareholders. Nevertheless, due to the fact that KVA has been charged to compensate equity holders throughout the life of the deal, it should not be paid out as dividends at the time of closing the deal, but kept in the bank's balance sheet.

One key feature of KVA is that due to the fact that it represents retained earnings, it is part of Core TIER I capital. That is, KVA represents a source of core capital that has not been provided by equity investor's but by clients. This is crucial, since this means that the bank does not need to ask shareholders for the full regulatory capital K_t, but rather for $K_t - RE_t$, where RE_t represent retained earnings (in fact $RE_t = KVA_t$). As a consequence, we do not need to ask our counterparties for the cost of remunerating K_t at the hurdle rate r_t^K. It is enough to ask for the cost of remunerating $K_t - KVA_t$. But this changes the magnitude of KVA_t, and thus the quantity that we should fund via equity. It is in fact a recursive problem, but this can be solved with no approximation.

For clarity of exposition, but without loss of generality, we assume that the bank enters into a new uncollateralized derivative transaction with a positive NPV for the bank after all adjustments have been made (CVA, FVA, KVA). We do not take DVA into consideration since it is must be deducted from capital. Nevertheless, we include FVA since, as shown in this paper, both funding cost and benefit can actually be hedged, although a clear position with respect to this has not yet been clarified by regulators.

2 Impact of retained earnings in the cost of capital

In this section we present the impact of retained earnings on KVA. We will first introduce the "traditional" KVA approach and then we will explain what we think the right way of taking into account the cost of capital should be.

2.1 "Traditional" approach to KVA

KVA is a topic that is currently being discussed in the industry, but most papers devoted to KVA follow the guidelines of [6, 7, 5, 2]. The approach establishes a hedging equation for the full price (including capital costs) of the derivative. Since regulation imposes that the derivative must be supported by capital to absorb possible unexpected losses, the bank should charge a quantity that allows it to remunerate the shareholders for their investment. Under this approach, it is assumed that all of the regulatory capital supporting the deal comes from shareholders. It is also suggested in [6] that this capital reduces external funds obtained from debt holders. This seems to make sense, although it is not always the market practice.

If we assume that regulatory capital is used to partially fund the derivative, therefore reducing funds obtained from debt holders, we are in a situation like the one in figure 1.

Figure 1 represents the contribution to the balance sheet of the bank of a particular deal (or set of deals). V_t^F is the value of the derivative taking into account market risk, counterparty credit risk and funding costs but not considering shareholder's compensation.

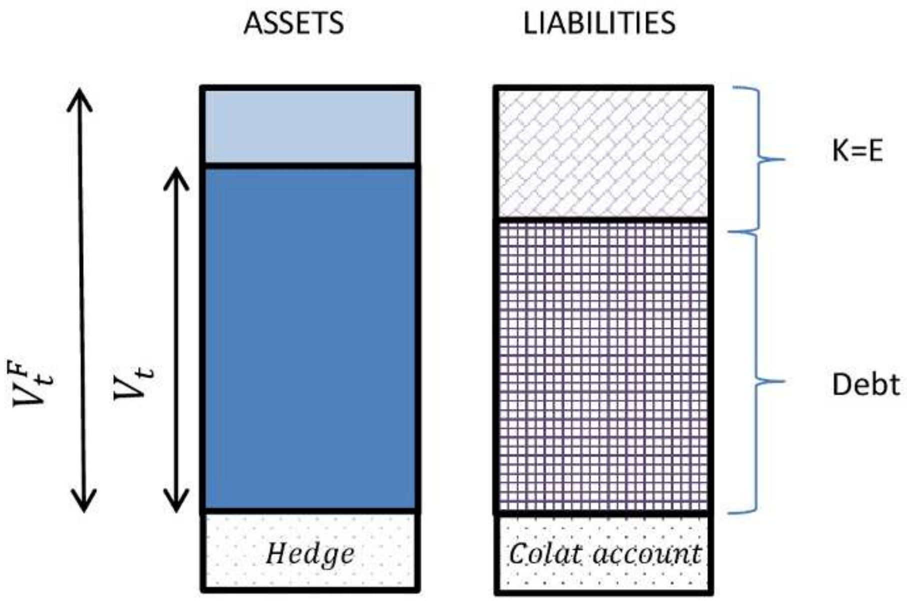

Figure 1: Assets and liabilities: K accounts for capital and E accounts for shareholder's equity.

That is, V_t^F represents the NPV if it was funded only with debt. V_t represents the value of the derivative taking into consideration every component, including shareholder's remuneration. We have also included hedges (market and counterparty credit risk) closed with interbank counterparties (which we have assumed to be positive in the picture without loosing generality). Notice that due to the fact that market hedges are collateralized, they are funded through the corresponding collateral account.

To summarize, assets consist of the value of the derivative V_t^F plus the value of the hedges. Liabilities are composed of the collateral account (to fund collateralized hedges) plus equity and debt (to fund the uncollateralized derivative). Notice that the amount of equity is determined by regulatory capital. Notice also that $V_t^F - V_t$ represents retained earnings, since the bank has paid V_t for a derivative whose value would be V_t^F had it been fully financed with debt.

The idea behind traditional KVA approaches is that since K_t represents capital, it all has to be remunerated at the hurdle rate r_t^K. The cost of remunerating K_t at r_t^K during the life of the derivative is precisely the KVA under this approach. To be precise, the term known as KVA in [6] does not fully account for this cost, since there is also a contribution in the funding term due to the full V_t appearing in the formula, which is also affected by KVA_t. The capital amount K_t can obviously be used to fund the derivative. In [6] this possibility is discussed, so that two different extremes can be contemplated: one under which capital is not used to reduce external funding and the opposite, where it is recognized that capital partially offsets funding through debt.

2.2 Our approach

The main difference with the traditional approach is that we consider the implications of the fact that KVA is a profit that it is not immediately distributed among shareholders. This means that it is a **retained earning**. But retained earnings are considered as CET1 capital by regulators, thus reducing the amount the bank needs to get from shareholders. Since the shareholder's contribution is lower, KVA will be lower. The KVA calculation becomes recursive, since KVA has an impact on shareholder's equity, and shareholder's equity has an impact on KVA. We will see in section 4 that this recursivity can be solved. As a consequence of all this, the KVA figures will be in most cases lower than in the "traditional" approach.

The bank's balance sheet contribution of a deal under our approach can be seen in figure 2

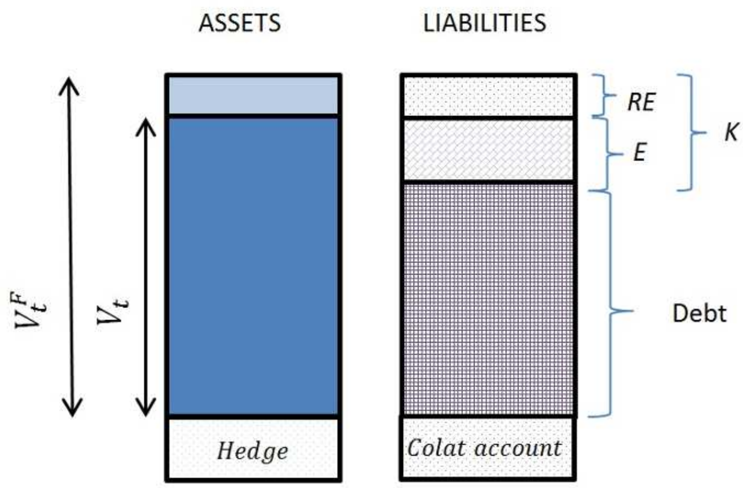

Figure 2: Assets and liabilities: K accounts for capital, E accounts for shareholder's equity and RE accounts for retained earnings. V_t and V_t^F are seen from investor's point of view.

Note that KVA at value date can be higher than the regulatory capital. This can be the case of long maturity derivatives. This means that at value date we do not need any shareholder's equity. In the rest of the paper we will assume that, in that case, the surplus of capital we get via retained earnings is also used to reduce shareholder's equity requirements (thus we still get a r_t^K benefit from them) in other trading activities. A similar consideration will be made with respect to funding, avoiding any non linear term in the pricing equations. This is in line with realistic situations, since banks will always fund their activities with both equity and debt, and a situation in which any of the two terms vanishes is not probable.

In next section we present the mathematical framework for KVA, starting from the replicating portfolio for a derivative taking all these effects into account.

3 Obtaining the pricing equation through replication

For the seek of simplicity, we will study the case of a single derivative, but extension to portfolio level can easily be done. Let us consider a non-collateralized derivative, as seen from the bank's perspective, whose price V_t depends on the state of certain underlying S_t at maturity T. We make explicit its dependence on the different risk factors,

$$V_t := V(t, S_t, h_t^I, N_t^I, f_t^H)$$

Where

- h_t^I is the investor's overnight CDS premium. We will assume, for simplicity but without loosing generality, that the dynamics of the CDS curve are driven by one factor (the short term CDS spread). Thus, under the real measure, $\mathbb{P}$, we assume that
$$dh^I(t) = \mu_h^{\mathbb{P}}(t)dt + \sigma_h(t)\, dW_h^{\mathbb{P}}(t)$$
- $N_t^I = \mathbf{1}_{\{\tau_I \leq t\}}$ accounts for the investor default's time.
- f_t denotes the short term funding rate at which the trading desk can borrow money from the bank's internal treasury. We will assume, for simplicity but without loosing generality, that the dynamics of the bank's funding curve are driven by one factor (the short term funding curve). Therefore, under $\mathbb{P}$
$$df(t) = \mu_f^{\mathbb{P}}(t)dt + \sigma_t^f\, dW_f^{\mathbb{P}}(t)$$

At anytime t, assets must be equal to liabilities. Therefore

$$\underbrace{V_t^F + \underbrace{\alpha_t H_t}_{\text{Market Hedge}} + \underbrace{\sum_{j=1}^{2} \epsilon_t^j CDS(t, t_j)}_{\text{CVA Hedge}}}_{\text{Assets}} = \underbrace{\underbrace{\omega_t B^f(t,T) + \beta_t^f}_{\text{Debt}} + \underbrace{\beta_t^C}_{\text{Collateral Account}} + \underbrace{\underbrace{E_t}_{\text{Equity}} + \underbrace{RE_t}_{\text{Ret. Earnings}}}_{\text{Capital}=K_t}}_{\text{Liabilities}} \tag{1}$$

where

- H_t represents the price of a perfectly collateralized derivative that is written on S_t.

- $CDS(t, t_j)$ denotes the price of a perfectly collateralized CDS with maturity t_j written on the investor. Notice that in a one factor world for the dynamics of the investor's CDS curve, two CDSs with different maturities must be used to hedge both default and spread risks.

- β_t^C stands for the collateral account due to collateralized hedges. At time t it will equal to:

$$\beta_t^C = \alpha_t H_t + \sum_{j=1}^{2} \epsilon_j CDS(t, t_j) \tag{2}$$

  Thus,

$$d\beta_t^C = \left(\alpha_t H_t + \sum_{j=1}^{2} \epsilon_j CDS(t, t_j) \right) c_t dt \tag{3}$$

  where c_t the collateral accrual rate (OIS rate).

- RE_t represents retained earnings coming from the extra cost charged to the investor to remunerate shareholders. Notice that it is fundamental for the retained earnings component to be homogeneous in time. This means that at a future time $u > t$, the retained earnings adjustment should be the same as if the deal was closed at time u. Other retained earnings metric would benefit some shareholders at the expense of some others throughout time. This implies that at any time, the following must hold:

$$RE_t = V_t^F - V_t \tag{4}$$

- E_t represents shareholders' equity. Notice that it is the only component in (1) that is not marked to market, since this term is accounted on a historical basis. Since time t capital must be compensated, a stream of dividends must be paid in the $(t, t + dt)$ interval. Therefore

$$dE_t = r_t^K E_t dt \tag{5}$$

- K_t: denotes the regulatory capital associated to the deal and its hedges at time t. Since retained earnings are part of CET1:

$$K_t = E_t + RE_t \tag{6}$$

- β_t^f denotes the un-secured bank account (short term funding) and $B^f(t, T)$ a term bond issued by the derivatives hedger (long term funding). Notice that the bank must fund the portion of the derivatives that is not funded with Equity. Therefore

$$\beta_t^f + \omega_t B^f(t,T) = V_t - E_t \tag{7}$$

In line with [3] we assume that the mixture of short and long term funding will be determined so that shareholders become immune to changes in f_t (the bank's funding curve).

Since f_t represents the bank's short term funding rate

$$d\beta_t^f = f_t \beta_t^f dt \tag{8}$$

- α_t, ϵ_t^j, ω_t are determined so that the different sources of risks (market, credit and funding) are eliminated under normal market conditions. Therefore, shareholders receive the stream of dividends r_t^K unless an unexpected loss occurs. By normal market conditions, we refer to continuous changes in market variables, credit default swap spreads and counterparty defaults. Obviously, if unexpected losses occur, shareholders should absorb them. Unexpected losses could arise due to sudden moves in market variables and / or spreads or if non market quoted volatilities or correlations, recoveries or any other unhedgeable parameters are mispriced (model risk).

Notice that the bank does not try to hedge its own default since this source of risk cannot be hedged. Therefore, no DVA component will be reflected in our pricing equation, in line with regulation.

If we differentiate both sides of (1) and eliminate all sources of uncertainty as in [3, 1] and if we apply (2), (3), (4), (5), (6), (7) and (8), we get the following PDE for V_t

$$\begin{aligned} &\mathcal{L}V_t + \frac{h_t^I}{(1-R)}\,\Delta V_t = V_t f_t + E_t \underbrace{\left(r_t^K - f_t\right)}_{\gamma_t} \\ &\text{s.t} \qquad V(T) = V_T \end{aligned} \tag{9}$$

Where R represents the recovery rate of the counterparty and

$$\begin{aligned} \mathcal{L}V_t \;=\; & \tfrac{\partial V_t}{\partial t} + (r_t - q_t) S_t \tfrac{\partial V_t}{\partial S_t} + (\mu_t^f - M_t^f \sigma_t^f) \tfrac{\partial V_t}{\partial f_t} + (\mu_t^I - M_t^I \sigma_t^I) \tfrac{\partial V_t}{\partial h_t^I} \\ & + \tfrac{1}{2} \tfrac{\partial^2 V_t}{\partial S_t^2} S_t^2 (\sigma_t^S)^2 + \tfrac{1}{2} \tfrac{\partial^2 V_t}{\partial {f_t}^2} (\sigma_t^f)^2 + \tfrac{1}{2} \tfrac{\partial^2 V_t}{\partial {h_t^I}^2} (\sigma_t^I)^2 \\ & + \tfrac{\partial^2 V_t}{\partial S_t f_t} S_t \sigma_t^S \sigma_t^f \rho_t^{S,f} + \tfrac{\partial^2 V_t}{\partial S_t h_t^I} S_t \sigma_t^S \sigma_t^I \rho_t^{S,I} + \tfrac{\partial^2 V_t}{\partial h_t^I f_t} \sigma_t^I \sigma_t^f \rho_t^{I,f} \end{aligned} \tag{10}$$

Using the same arguments as before, it can be seen that V_t^F must fulfill with the following PDE,

$$\mathcal{L}V_t^F + \frac{h_t^I}{(1-R)}\,\Delta V_t^F = V_t^F\, f_t$$
$$\text{s.t} \qquad V^F(T) = V_T \tag{11}$$

After applying *Feyman-Kac*, equation (11) is equivalent to,

$$V_t^F = \underbrace{E^{\mathbb{Q}}\left[e^{-\int_t^T f_s ds}\, V_T \middle| \mathcal{F}_t\right]}_{V_t^{f_t}} - \underbrace{E^{\mathbb{Q}}\left[e^{-\int_t^{\tau_I} f_s ds}\, \mathbf{1}_{\{\tau_I<T\}}\, \left(\pi_{\tau_I} - V_{\tau_I}^{f_t}\right) \middle| \mathcal{F}_t\right]}_{\textbf{CVA over price with funding}} \tag{12}$$

where

$$\pi_t = R\left(V_t^{\text{Close-Out}}\right)^+ + \left(V_t^{\text{Close-Out}}\right)^-$$

In [3], a different expression which implies the same expectation is obtained by using the collateral rate as discounting rate. In the next section we will make use of (12)

Going back to equation (9), using identity (6) and (4), the final PDE for the value of the derivative, accounting for capital becomes,

$$\mathcal{L}V_t + \frac{h_t^I}{(1-R)}\,\Delta V_t = V_t\, c_t + \underbrace{V_t\,(f_t - c_t)}_{\text{FVA Contrib.}} + \underbrace{K_t\,\gamma_t}_{\text{KVA Contrib.}} + \underbrace{\left(V_t - V_t^F\right)\gamma_t}_{\text{REVA Contrib.}}$$
$$\text{s.t} \qquad V(T) = V_T \tag{13}$$

Where $REVA$ represents a retained earnings value adjustment contribution.

And by applying *Feyman-Kac*,

$$\begin{aligned}
V_t =& \underbrace{E^{\mathbb{Q}}\left[e^{-\int_t^T c(s)ds}\, V_T \middle| \mathcal{F}_t\right]}_{V_t^{c_t}} - \underbrace{E^{\mathbb{Q}}\left[e^{-\int_t^{\tau_I} c(s)ds}\, \mathbf{1}_{\{\tau_I<T\}}\, \left(\pi_{\tau_I} - V_{\tau_I}^{c_t}\right) \middle| \mathcal{F}_t\right]}_{\textbf{CVA Contrib.}} \\
&- \underbrace{\int_{s=t}^T E^{\mathbb{Q}}\left[e^{-\int_t^s c(u)du}\, \mathbf{1}_{\{\tau_I>s\}}\, V_s\, \left(f_s - c_s\right) \middle| \mathcal{F}_t\right] ds}_{\textbf{FVA Contrib.}} - \underbrace{\int_{s=t}^T E^{\mathbb{Q}}\left[e^{-\int_t^s c(u)du}\, \mathbf{1}_{\{\tau_I>s\}}\, K_s\, \gamma_s \middle| \mathcal{F}_t\right] ds}_{\textbf{KVA Contrib.}} \\
&+ \underbrace{\int_{s=t}^T E^{\mathbb{Q}}\left[e^{-\int_t^s c(u)du}\, \mathbf{1}_{\{\tau_I>s\}}\, \left(V_s^F - V_s\right)\gamma_s \middle| \mathcal{F}_t\right] ds}_{\textbf{Retained Earning VA Contrib. (REVA)}}
\end{aligned} \tag{14}$$

Notice that a new term arises compared to the pricing equation in the existing literature. This term reduces the capital value adjustment. Notice also that the full price V_s appears in the expressions of FVA Contribution and REVA Contribution, so the formula is recursive. Furthermore, the term V_s^F in REVA Contribution is also complex since it is given by (12).

It is fundamental to distinguish between retained earnings, which is equal to KVA, and the pure KVA contribution. KVA (and retained earnings) is equal to $V_t^F - V_t$, whereas the pure KVA contribution is given by $-\int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s c(u)du}\,\mathbf{1}_{\{\tau_I>s\}}\,K_s\,\gamma_s\middle|\mathcal{F}_t\right]ds$.

4 Calculation in a Monte Carlo framework

In this section we show how to solve the recursive nature of equation (14). The PDE in (13) can be re-expressed in its equivalent form,

$$\begin{aligned}
&\mathcal{L}V_t + \frac{h_t^I}{(1-R)}\,\Delta V_t = V_t\, r_t^K + \left(K_t - V_t^F\right)\gamma_t \\
&\text{s.t} \qquad V(T) = V_T
\end{aligned} \tag{15}$$

or in terms of expected values,

$$\begin{aligned}
V_t = &\underbrace{E^{\mathbb{Q}}\left[e^{-\int_t^T r_K(s)ds}\,V_T\middle|\mathcal{F}_t\right]}_{V_t^{r_K}} \\
&\underbrace{-\,E^{\mathbb{Q}}\left[e^{-\int_t^{\tau_I} r_K(s)ds}\,\mathbf{1}_{\{\tau_I<T\}}\,\left(\pi_{\tau_I} - V_{\tau_I}^{r_K}\right)\middle|\mathcal{F}_t\right]}_{\textbf{CVA over price with capital}} \\
&\underbrace{-\int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s r_K(u)du}\,\mathbf{1}_{\{\tau_I>s\}}\,K_s\,\gamma_s\middle|\mathcal{F}_t\right]ds}_{\textbf{KVA Contrib. discounted at } r_K} \\
&\underbrace{+\int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s r_K(u)du}\,\mathbf{1}_{\{\tau_I>s\}}\,V_s^F\,\gamma_s\middle|\mathcal{F}_t\right]ds}_{r_t^K \textbf{ discounted REVA Contrib.}}
\end{aligned} \tag{16}$$

At first sight, this term might seem difficult to solve. Let us try to further develop it,

$$
\begin{aligned}
REVA'_t &= \int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s r_K(u)du}\, \mathbf{1}_{\{\tau_I > s\}}\, V_s^F\, \gamma_s \middle| \mathcal{F}_t \right] ds \\
&= \underbrace{\int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s r_K(u)du}\, \mathbf{1}_{\{\tau_I > s\}}\, V_s^{f_t}\, \gamma_s \middle| \mathcal{F}_t \right] ds}_{\mathbf{I}} \\
&+ \underbrace{\int_{s=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^s r_K(u)du}\, \mathbf{1}_{\{\tau_I > s\}} \left[\int_{u=s}^{T} E^{\mathbb{Q}}\left[e^{-\int_s^u f_x dx} \mathbf{1}_{\{\tau_I > u\}} \left(\pi_u - V_u^{f_t}\right) dN_u \middle| \mathcal{F}_s \right] \right] \gamma_s \middle| \mathcal{F}_t \right] ds}_{\mathbf{II}}
\end{aligned} \tag{17}
$$

The first term, **I**, in last equation does not imply further complications with respect to those found to solve for the CVA term. In general terms, we must only provide a pricer that is allows us to price the derivative conditional to the state of the economy at future dates.

The second term in the latter equation can be simplified by changing the integration order. so this term becomes

$$
\mathbf{II} = \int_{u=t}^{T} E^{\mathbb{Q}}\left[\left(\pi_u - V_u^{f_t}\right) \mathbf{1}_{\{\tau > u\}} \left(\int_{s=t}^{u} e^{-\int_t^s r_K(x)dx} e^{-\int_s^u f_x dx} \gamma_s\, ds \right) dN_u \middle| \mathcal{F}_t \right] \tag{18}
$$

Just by taking into account that $r_K(t) = f_t + \gamma_t$,

$$
\boxed{\mathbf{II} = \int_{u=t}^{T} E^{\mathbb{Q}}\left[e^{-\int_t^u f(x)dx}\, A^{\gamma}(t,u)\, \mathbf{1}_{\{\tau > u\}} \left(\pi_u - V_u^{f_t}\right) dN_u \middle| \mathcal{F}_t \right]} \tag{19}
$$

where $A^{\gamma}(t,u) = \left(1 - e^{-\int_t^u \gamma_s ds}\right)$.

Note that this term is very similar to the CVA over price with funding in (12).

5 Numerical results

In this section we provide numerical results for the price of a FX forward for different maturities and strikes. Note that the conclusions obtained here will be easily extrapolated to cross-currency swaps. For illustrative purposes, we have considered counterparty risk capital under SA-CCR and CVA regulatory capital under Basel III. We are neglecting market risk capital, but this can be a fair assumption if we consider that it is a back to back trade with a collateralized counterparty and hedging CDS are also collateralized. We assume the counterparty's rating to be BBB. The only stochastic magnitude is the FX underlying, with volatility 10%. The different rates involved are: funding rate = 2%, counterparty credit spread = 2%, domestic rate = 1%, foreign rate = 0.5%, collateral rate = 1% and hurdle rate = 15%. Notional is set to 1 and FX spot is 1. We have not considered the effect of the hedging portfolio in regulatory capital calculations.

In figure 3 we show the results obtained for different levels of moneyness for a maturity of 10y. The strike is set to 1 in all cases. We have called Trad KVA_0 the KVA calculation introduced in [6] (what we call "traditional" KVA) without using capital to reduce funding needs ($\phi = 0$ in that paper), and Trad KVA_1 the traditional KVA using capital to reduce funding needs ($\phi = 1$ in that paper). We can see that there is a strong KVA reduction for all levels of moneyness, being the reduction of around 50% for the ATM forward.

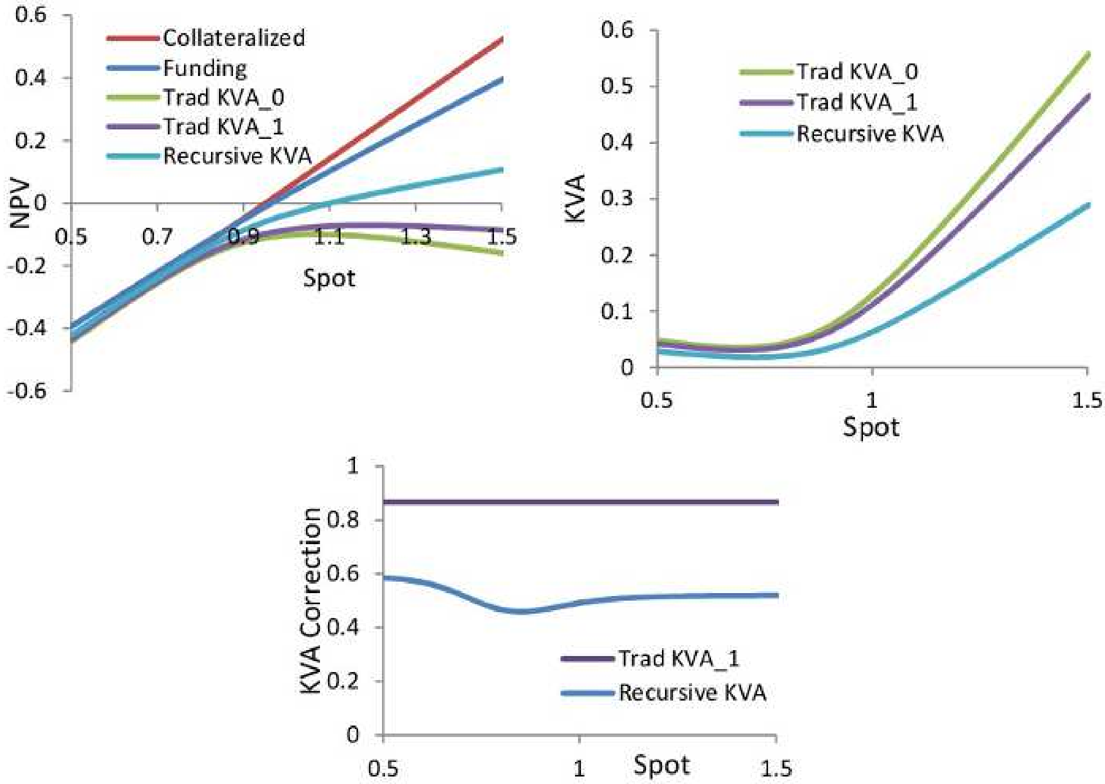

Figure 3: NPV and KVA for different approaches as a function of the spot. The KVA correction is the ratio between KVA and traditional KVA with no capital used for funding. Legend: Collateralized: price without any XVAs. Funding: price with CVA and FVA, Trad KVA_0: traditional KVA, capital not used for funding the deal. Trad KVA_1: traditional KVA, capital used for funding the deal

In figure 4 we show the results obtained for different maturities for an ATM deal. We see that the retained earnings KVA reduction increases with maturity. For a 30y maturity, the recursite KVA is 27% of the value obtained under the traditional approach. The KVA values for significant maturities are given in table 1

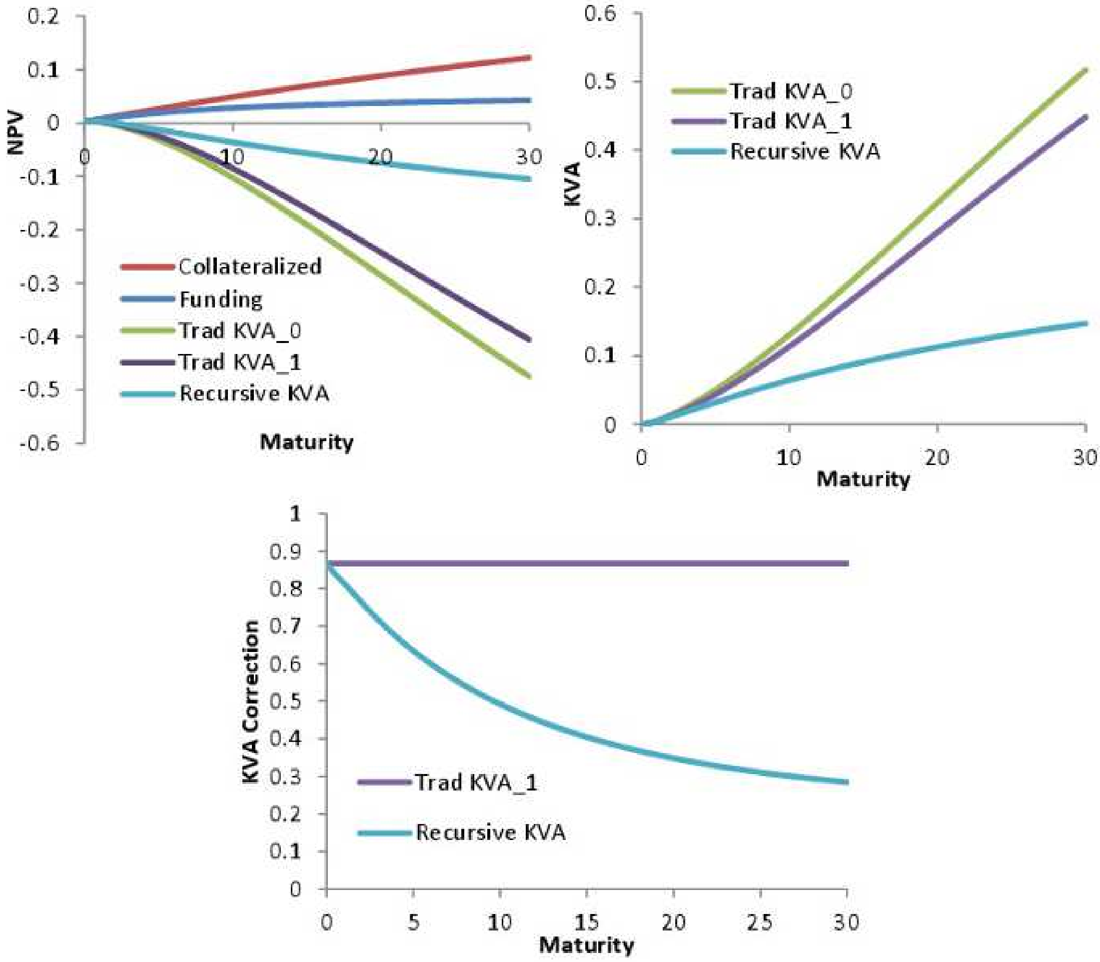

Figure 4: NPV and KVA for different approaches as a function of maturity. The KVA correction is the ratio between KVA and traditional KVA with no capital used for funding. Legend: Collateralized: price without any XVAs. Funding: price with CVA and FVA, Trad KVA_0: traditional KVA, capital not used for funding the deal. Trad KVA_1: traditional KVA, capital used for funding the deal

Maturity	Trad KVA_0	Trad KVA_1	Our KVA	**Savings wrt Trad KVA_0**
1y	0.0048	0.0042	0.0039	18.6%
3y	0.0248	0.0215	0.0177	28.4%
5y	0.0502	0.0435	0.0318	36.6%
10y	0.1309	0.1134	0.0644	50.8%
20y	0.3231	0.2800	0.1125	65.2%
30y	0.5169	0.4480	0.1470	71.6%

Table 1: KVA values under the different approaches for significant maturities.

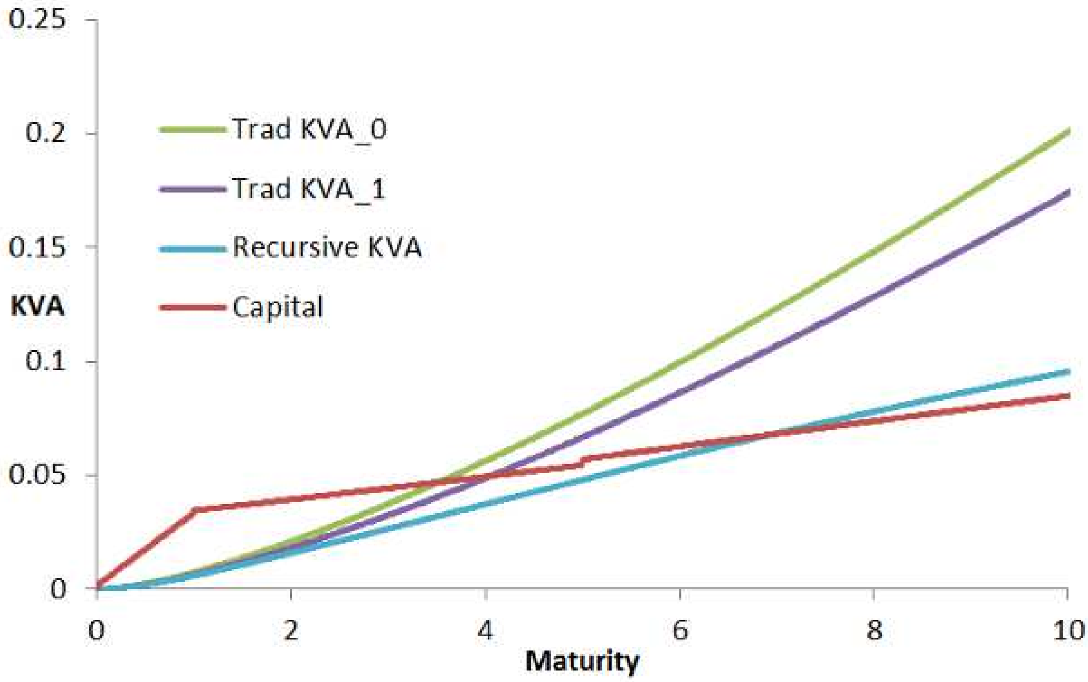

Figure 5: KVA under the three different approaches compared with spot capital for an ATM deal as a function of maturity.

In figure 5 we have plotted spot capital and KVA under the 3 approaches for an at the money forward as a function of maturity. Notice that with the exception of short maturities, KVA is greater than spot capital, specially for non recursive KVA approaches. The situation where KVA is greater than spot capital is a situation under which the shareholder's equity is decreased since the KVA charged to clients exceeds the regulatory capital. Notice that in this situation, non recursive KVA approaches assume that the equity holder receives a return on capital r_t^K even in situations under which the shareholder's investment is not increased, but reduced. We believe that this is a drawback of non recursive approaches.

6 Conclusions

The main conclusions of the paper are:

- Due to regulation, a given percentage of derivative businesses must be financed with shareholder's equity.
- KVA is the quantity that banks charge to clients to remunerate the shareholders for their investment throughout time.
- KVA is a cost charged to clients, but a profit for banks.

- KVA must be kept in the bank's balance sheet as retained earnings, and therefore it is eligible as capital.
- Thus, not all the capital needs associated to the derivative must be obtained from shareholders since the KVA term is charged to clients.
- Since retained earnings (RE_t) are capital, we do not need to remunerate the shareholders for full regulatory capital K_t but for $K_t - RE_t$.
- The problem has a recursive nature, but can be solved.
- KVA gets significantly reduced compared to the "traditional" KVA calculation.
- This can have a deep impact in trade approval criteria.

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