THE FVA PUZZLE:

Accounting, Risk Management and Collateral Trading

CLAUDIO ALBANESE[1] & LEIF ANDERSEN[2] [3] & STEFANO IABICHINO[1]

ABSTRACT

In [1] we introduced the FVA/FDA accounting framework for funding costs, aiming to provide an accounting method that reasonably balances the conflicting concerns of accountants, regulators, traders, and financial economists. In this paper, we provide a concise comparison of FVA/FDA accounting with the FCA/FBA method currently endorsed by several large banks. We discuss FTP policies, risk management implications, and quantify the notion of funding arbitrage.

1 INTRODUCTION

The notion of charging for "funding costs" became painfully relevant for banks as their borrowing spreads jumped up during the financial crisis. Drawing inspiration from work by Piterbarg [9] and Burgard and Kjaer [5], [6], several banks recently instituted accounting changes aimed at capturing the funding costs for uncollateralized derivative transactions. The prevalent *FCA/FBA accounting method* is simple but controversial (see [7]) and has raised concerns about breakages of asset-liability symmetry, double counting of DVA, and embedding of entity-specific costs in exit prices. Additionally, it appears that the FCA/FBA method is interpreted quite differently from one bank to the next.

In [1], we proposed the FVA/FDA accounting method as a compromise between financial asset valuation principles, "going-concern" accounting principles and regulatory capital requirements. The method explicitly models the re-hypothecation option of variation margin on hedges, and remedies many of the theoretical inconsistencies of the FCA/FBA method.

Here, we review the key ideas in [1] and contrast it to FCA/FBA numerically and conceptually. We proceed to consider certain risk management implications of funding cost accounting, and propose to use CET1 simulations as a tool for hedging, collateral optimization, and reverse stress testing. We also discuss strategies to exploit funding arbitrage by means of CVA reducing trades.

[1] *Global Valuation, London*
[2] *Bank of America Merrill Lynch, New York*
[3] The views expressed in this article represent those of the authors and do not necessarily represent those of Global Valuation or Bank of America Merrill Lynch

2 CVA/DVA ACCOUNTING

Before discussing funding adjustments in earnest, let us review how accounting rules work for the classical case where a bank's OTC portfolio value is adjusted for credit risk (CVA and DVA).

First, accounting ledger rules for OTC portfolios typically assign trades with positive valuations (i.e. receivables) to an asset account, and trades with negative valuations (i.e. payables) to a liabilities account. In the absence of credit risk, the Portfolio Fair Valuation (PFV) to the bank holding the positions is then given by the default-free value of assets A minus the default-free value of liabilities L:

$$\mathrm{PFV} = \mathrm{A} - \mathrm{L}. \tag{1}$$

Counterparty credit risk adds a few complexities and necessitates the introduction of "contra" accounts as well as a change in the "unit of account" from individual trades to counterparty-specific netting sets. Downward adjustments to asset values from counterparty credit risk are recorded as *Credit Valuation Adjustment* (CVA) entries in a "Contra-Asset" (CA) account. The CA value aggregates CVA against all counterparties and is subtracted from default free asset values.

In addition to the contra-asset account, there is also a "Contra-Liability" (CL) account which includes *Debt Valuation Adjustment* (DVA) entries for each counterparty. The bank's total DVA equals the total CVA recorded by all counterparties *against* the bank, and ensures that the accounting system is symmetric and does not create wealth out of zero-sum bilateral trading. DVA entries are benefits and represent the present value of the bank's option to default on its liabilities.

To summarize, the fair value associated with the derivatives portion of the balance sheet may be written as

$$\mathrm{PFV} = \mathrm{A} - \mathrm{L} - \mathrm{CA} + \mathrm{CL}. \tag{2}$$

If we include a cash account (Cash), we may complete a simplified balance sheet by writing total assets as $\mathrm{Cash} + \mathrm{A} - \mathrm{CA}$, with the accounting *Equity* defined as

$$\mathrm{Equity} = \mathrm{Cash} + \mathrm{PFV} = \mathrm{Cash} + \mathrm{A} - \mathrm{CA} - \mathrm{L} + \mathrm{CL}. \tag{3}$$

While DVA is a rational and well-defined component of the bank-wide PFV, it should arguably not contribute to regulatory capital as benefits associated with a bank default are neither loss absorbing, nor do they contribute to the wealth of bank equity holders (who are wiped out by a bank default). DVA entries in the CL account are therefore excluded by regulators (see [4] and [10]) from *Common Equity Tier I Capital* (CET1). That is,

$$\mathrm{CET1} \; = \mathrm{Equity} - \mathrm{CL} = \mathrm{Cash} + \mathrm{A} - \mathrm{CA} - \mathrm{L}. \tag{4}$$

The interpretation of DVA as not benefiting equity holders will often manifest itself in quotation practices, where it is common for traders to internally de-recognize all or part of DVA benefits in the prices they quote to counterparties, in effect charging the DVA through to the client on top of PFV. If trades get done at the quoted levels, the bank will consequently recognize day 1 trading gains that ultimately hit Retained Earnings and, in turn, contribute to CET1.

3 THE FCA/FBA METHOD

In the aftermath of the financial crisis, funding costs for variation margin collateral that banks post on hedges against uncollateralized derivatives have escalated from tens to hundreds of basis points. This has elevated collateral trading strategies to a role of prominence and has motivated banks to seek metrics to capture a "Funding Valuation Adjustment", in addition to ordinary CVA and DVA.

The commonly used FCA/FBA method of funding cost accounting can be presented in several different ways. One simple approach takes as its starting point the notion that the bank cannot default and, in effect, that funding spreads paid on collateral lending are due to friction and lack of liquidity. This assumption is undoubtedly a strong one, as liquidity spreads are typically in the order of a handful of basis points while banks funding spreads can run into the hundreds of basis points. Nevertheless, if we accept the premise we can price derivatives as their cost of replication while ignoring the possibility of bank default. Details can be found in [1], but ultimately the relevant funding metric for fully uncollateralized trading involves evaluating a *symmetric funding adjustment* metric (SFVA) given by

$$\mathrm{SFVA} = \mathbb{E}_0\left[\int_0^\infty e^{-\int_0^t r_B(s)\,ds} s_B(t) \sum_i V_i(t)\,dt\right], \tag{5}$$

where $\mathbb{E}$ denotes risk-neutral expectation; $V_i(t)$ is the default-free value of the i-th unsecured netting set; $r_B(t)$ is the bank's funding rate; and $s_B(t) = r_B(t) - r_{OIS}(t)$ is the bank's funding spread over the OIS rate.

It should be noted that there has been considerable debate (and disagreement) about whether default events or expected unwind times should be merged into (5). Others have advocated that the funding spread s_B should actually be replaced with an industry average spread or[1] with the most favorable spread of any bank in the market ("best funder"); the latter is presumably meant to be consistent with auction-style *exit price* principles favored in accounting definitions of fair value (see Section 5.3).

Equation (5) may be split into contributions from assets and liabilities. Starting with the latter, one defines the *Funding Benefit Adjustment* (FBA) as follows:

$$\mathrm{FBA} = -\mathbb{E}_0\left[\int_0^\infty e^{-\int_0^t r_B(s)\,ds} s_B(t) \sum_i V_i(t)^-\,dt\right], \tag{6}$$

where the $-$ superscript is defined as $x^- = \min(x, 0)$. The FBA is closely related to (unilateral) DVA and gives rise to a double-counting paradox that the FCA/FBA method elects to resolve by *removing* DVA from the PFV altogether. However, as DVA is required by current accounting rules (e.g., IRFS13), FCA/FBA will normally institute this by, say, leaving DVA in the CL account, and then adding FCA-FCA+DVA to the CA account. Note that the DVA entries then cancel.

The asset component of SFVA,

$$\mathrm{FCA} = \mathrm{SFVA} + \mathrm{FBA} = \mathbb{E}_0\left[\int_0^\infty e^{-\int_0^t r_B(s)\,ds} s_B(t) \sum_i V_i(t)^+\,dt\right], \tag{7}$$

1 Some banks appear to be using proprietary blends of their own spread and the spreads observed for other banks.

is known as the *Funding Cost Adjustment* and is kept as a metric for funding costs. The FCA adds to the contra-asset account and is therefore subtracted from CET1.

4 FVA/FDA ACCOUNTING

In FVA/FDA accounting, the unit of account for funding cost metrics is expanded from the netting sets in CVA/DVA accounting to the larger notion of a "funding set", a collection of unsecured trades across which cash received for derivatives funding can be re-hypothecated. Equivalently, a funding set is a collection of trades for which the variation margin posted on collateralized hedges with dealers may be re-hypothecated. For a large bank, funding sets could, say, be defined at the legal entity level and may contain hundreds or even thousands of counterparties and netting sets.

Assuming for simplicity that all unsecured trades in the derivatives portfolio of a bank constitute one single funding set, the present value of funding costs is now given by the following *FVA (Funding Value Adjustment)* metric for uncollateralized trading:

$$\mathrm{FVA} = \mathbb{E}\left[\int_0^{\tau_B} e^{-\int_0^t (r_{\mathrm{OIS}}(s))\,ds} s_B(t) \left(\sum_i V_i(t) 1_{t<\tau_i}\right)^+ dt\right]. \tag{8}$$

Here, the + superscript denotes the positive part, and τ_i and τ_B are the default times of the i-th counterparty and the bank, respectively.

In (8) funding costs only arise when portfolio valuation $\sum_i V_i(t) 1_{t<\tau_i}$ is positive and the bank therefore is a net poster of variation margin in its hedges over the funding set. States of the world where the bank is a net receiver of variation margin are assigned zero benefit, as would be the case if excess collateral was invested short-term at the risk-free rate. This investment assumption is prudent, and many investment strategies conjectured in the literature, such as retirement of long-term debt, are often not practical due to the volatility and short-term nature of any excess funds generated by derivatives trading[2].

From an accounting standpoint, the FVA computed in (8) is configured as a *contra-asset* entry. The FVA also has a contra-liability "twin", denoted *Funding Debt Adjustment* (FDA). The FDA term fundamentally arises from conservation principles: if funding is a cost to bank shareholders, other agents must receive a benefit of equal size[3]. Concretely, we can think of FVA costs as originating from the lack of a REPO market for unsecured OTC derivatives, forcing banks to borrow variation margin on hedges on an unsecured basis at substantial spreads to OIS. The flip side of unsecured borrowing is that senior creditors are entitled to recover from the pool of unsecured derivative receivables after a bank default. Under mild assumptions, the value of this recovery option may be shown (see [1]) to be equal to the FVA, i.e.

$$\mathrm{FDA} = \mathrm{FVA}. \tag{9}$$

It should be noted that the DVA originates from similar zero-sum considerations as the FDA, but there is an important difference: while the CVA represents a wealth transfer from the bank to counterparties due to the acceptance of counterparty credit risk, the FVA

2 For extensions and a fuller discussion on the possible benefits of cash positions, see [1].
3 Hull and White [8] first introduced the FDA concept with the name DVA2 but we prefer a more descriptive moniker.

is an *internal* wealth transfer from bank shareholders to bank senior creditors. Hence, the FDA is a contra-liability number that contributes to the wealth of bank senior creditors but should be excluded from CET1.

With FVA and FDA entries being recorded in equal and opposite CA and CL accounts, funding ultimately has no impact on the PFV since the FVA and FDA entries cancel. This preserves the symmetry of CVA/DVA accounting, eliminates bank-specific costs from fair valuations, and allows much of standard finance theory to escape unscathed at the level of PFV. At the CET1 level, however, we depart from CVA/DVA accounting by requiring that FVA be deducted from CET1, to reflect the fact that bank shareholders are penalized by funding costs and do not share the FDA recovery benefit. [1] demonstrates that the own-spread sensitivities of the FVA term defined above are such that FVA qualifies as a valid deduction from regulatory CET1.

Finally, note that our definition of FVA in (8) recognizes that funding needs for a netting set vanish with either the default of the bank or the counterparty. While CVA and DVA metrics are nearly always computed on a unilateral basis in FCA/FBA accounting, FVA/FDA accounting is therefore best done with a bilateral definitions of both CVA and DVA. Accordingly, FVA/FDA accounting excludes CVA contributions after the bank's own default and replaces FCA/FBA accounting's unilateral CVA (UCVA) definition with a bilateral CVA measure known as *first-to-default CVA* (FTDCVA)[4].

As FTDCVA decreases in the banks credit spread, a slight modification of the accounting rules in Section 2 is needed in order to not run afoul of regulatory guidelines. In particular, rather than registering the entire FTDCVA as a CA entry, we write $FTDCVA = UCVA - CVA_{CL}$ and record the UCVA as a CA entry and the "DVA of CVA" term CVA_{CL} as a CL entry. This way we are ensured that self-default benefits are relegated to the CL account[5].

A summary of accounting entries under both the FCA/FBA and FVA/FDA frameworks is in Table 1 below. For both methods, PFV and CET1 are computed as per (2) and (4). Note that the DVA entries in the table for the FCA/FBA and FVA/FDA methods are unilateral ("UDVA") and bilateral ("FTDDVA"), respectively.

	CA adjustment	CL adjustment
FVA/FDA	UCVA + FVA	CVA_{CL}+FTDDVA+FDA
FCA/FBA	UCVA+FCA-(FBA-UDVA)	UDVA

Table 1: Contra-Asset and Contra-Liability adjustments in FCA/FBA and FVA/FDA accounting.

5 FUNDS TRANSFER PRICING

Managing FVA costs requires, as a minimum, a well-designed Funds Transfer Pricing (FTP) policy[6] for proper recognition of costs and benefits of new trades.

4 For the (well-known) mathematical definitions of UCVA and FTDCVA, we refer to [1] which also discusses the effects of ISDA close-out protocols on CVA.

5 Similar break-outs can be entertained for DVA, which in FVA/FDA accounting must be computed bilaterally as the FTDDVA. We here simply place the entire FTDDVA in the CL account.

6 For a discussion of the implementation of FTP and the role of a *central funding desk*, see [1].

5.1 FCA/FBA Accounting

In the standard FCA/FBA accounting method, the prevailing policy is to charge to clients (at a minimum) the amount

$$\text{FTP} = \Delta\text{UCVA} + \Delta\text{SFVA} \tag{10}$$

over the basic default-free trade value. We here use Δ to denote marginal portfolio impact, so ΔUCVA and ΔSFVA terms cover the credit risk and funding charge impacts, respectively, as a new trade is added to the overall portfolio.

Using the FTP in (10), the inflow to the Cash account at the time of trade is

$$\Delta\text{Cash} = -\Delta\text{A} + \Delta\text{L} + \text{FTP} = -\Delta\text{A} + \Delta\text{L} + \Delta\text{UCVA} + \Delta\text{SFVA} = -\Delta\text{PFV},$$

where the last equality follows from (2). By (3) it is clear that

$$\Delta\text{Equity} = 0, \tag{11}$$

so the FCA/FBA FTP policy ensures that the impact on Income (and Retained Earnings) from adding a new trade is zero. On the other hand, the incremental impact of a new trade on CET1 is, from (4),

$$\Delta\text{CET1} = \Delta\text{Equity} - \Delta\text{CL} = -\Delta\text{UDVA}. \tag{12}$$

By tailoring the FTP in such a way that new trades have no impact on Income, deal flow induces volatility in CET1, as is evident from (12). Since CET1 is a proxy for shareholders' wealth, it may be argued that (10) does not fully align executive incentives with shareholders' interests. An FTP policy designed for CET1 indifference would, however, likely not be viable with FCA/FBA accounting, due to the sheer size of the full FCA.

5.2 FVA/FDA Accounting

As the bank enters unsecured OTC transactions, FVA/FDA accounting recognizes a transfer of wealth in the amount FVA = FDA, from bank shareholders to bank senior creditors. Assuming that bank managers act on behalf of shareholders, entry prices need to be set such that this wealth transfer is countered by a corresponding increase in the equity account. Equivalently, charges to clients be set such that the proxy for shareholder wealth, CET1, stays constant. From (4), the client charge must therefore be ΔCL above the PFV. Expressed as a surcharge on default-free trade value, the FTP amount required to ensure that $\Delta\text{CET1} = 0$ is

$$\text{FTP} = \Delta\text{UCVA} + \Delta\text{FVA}. \tag{13}$$

Notice that (13) requires that the benefit of DVA terms (including the DVA part of FTDCVA) are not passed on to clients, as we discussed earlier. In addition, FVA/FDA accounting now adds an FVA funding term to the charge.

The FTP policy of FVA/FDA accounting has a net impact on Income given by

$$\Delta\text{Equity} = \Delta\text{CL} = \Delta\text{FTDDVA} + \Delta\text{FDA} + \Delta\text{CVA}_{\text{CL}}. \tag{14}$$

By focusing on CET1, (13) expresses a shareholder-centric view in the computation of FTP, in effect requiring that trading strategies be self-financing only to bank shareholders and not to the bank as a whole. For trades that involve bondholder benefits post bank default, any such benefits are ignored in trading and when quoting to the client. Again, the shareholder view is here only expressed in deal charges, not in the recording of bank-wide PFV.

5.3 Notes on Exit Pricing and Asset-Liability Symmetry

The notion of fair market value in the FVA/FDA framework accounts for the risk-neutral values of *all* flows associated with a unit of account, irrespective of the identity of the stakeholder that benefits from the flow. This notion preserves asset-liability symmetry and can be considered an exit price in a competitive auction where entities of all types, including unlevered real money funds with negligible funding costs, are allowed to participate.

In contract, *entry* prices in the FVA/FDA methods deviate from the fair value metric by effectively neglecting all cash flows that do not benefit shareholders. The resulting price contains entity-specific costs and should, of course, not be confused with an exit price. Yet, in a sufficiently illiquid market dominated by banks with pricing power, one can imagine a situation where a set of banks with similar entry price procedures may create a non-competitive equilibrium where the exit price can be equated to the most favorable entry price across the banks. Usage of the most favorable bank entry price provides a conceivable alternative to our definition of a market price, but is not an unproblematic one. First, the definition is not consistent with the asset-liability symmetry principles that underpin the IFRS 13 requirement of including DVA in market prices. Second, clean determination of the most favorable entry price for a non-trivial collection of trades and providers is subject to complex portfolio effects and effectively impossible to determine with any accuracy[7].

It should be noted that irrespective of one's precise definition of fair value, the CET1 write-down in FVA/FDA accounting – which in many respects is our key value metric – is unchanged.

5.4 Extensions

For ease of exposition, our FVA expression (8) ignores variation margin collected on CVA hedges and assumes that counterparty positions are fully uncollateralized. A more accurate expression that captures collateral will basically replace the V_i in (8) with $V_i - c_i - UCVA_i$, where c_i is the amount of collateral posted to the bank by counterparty i. More details can be found in [1] which also entertains the notion of multiple funding rates co-existing in a single funding set. Such situations can conceivably occur whenever one attempts to align funding spreads with the observed bond-CDS basis for the various counterparties. They may also occur whenever various legal entities of the bank have different cost of funding, while variation margin cash can freely flow between them.

6 SOME NUMERICAL RESULTS

In [1] we discuss the implementation of the FVA/FDA accounting metrics and the complications that arise as the netting set scope of traditional CVA systems is expanded to the larger funding set level. Basic results for a case study on a large (> 100,000 trades)

7 While some pricing service data exists, it is very limited and does not consider portfolio effects.

representative bank portfolio are reported in Tables 2 and 3. Market data calibrations are as of July 8, 2013.

UCVA	FTDCVA	CVA_CL	UDVA	FTDDVA	FVA	SFVA	FCA	FBA
210.18	162.94	47.24	163.06	91.45	86.91	78.34	271.84	193.5

Table 2: XVA metrics for our case study in million USD.

	CA (funding only)	CL (funding only)	CA total	CL total	Write-off	CET1 Write-off
FVA/FDA	86.91	86.91	297.09	225.6	0	86.91
FCA/FBA	241.4	0	451.4	163.06	241.4	241.4

Table 3: Contra-Asset and Contra-Liability adjustments for the case study, in million USD. The funding-induced Write-off in Net Income is calculated assuming that pre-funding CVA and DVA numbers were unilateral for the FCA/FBA method and bilateral for the FVA/FDA method.

	par	payable	receivable
FVA/FDA methodology			
FTP	2.94	1.37	5.76
Δ CET1	0	0	0
Δ Equity	0.93	0.53	1.66
FVA/FBA methodolofy			
FTP	5.05	2.25	10.08
Δ CET1	1.45	0.37	3.4
Δ Equity	0	0	0

Table 4: Incremental metrics for the case-study example for three 16-year swaps of notional 100,000 CHF; increments are given in units of basis points of swap notional per year. 100,000 Monte Carlo scenarios.

As confirmed from Table 3, the CA adjustment in FCA/FBA accounting is substantially larger than in ordinary CVA/DVA accounting (being approximately the sum of CVA and FCA), whereas the CL adjustment is the same. As a result, FCA/FBA accounting has a marked asset-liability asymmetry and its introduction will often result in a substantial write-off of Net Income, nearly $240M in the case study. In contrast, FVA/FDA accounting leads to no Net Income write-off, although a write-off of CET1 will still be needed. In the case study, this write-off is about one third of the CET1 write-off for the FCA/FBA method, a consequence of the FVA/FDA method's explicit recognition of the re-hypothecation option for variation margin.

FTP results for three 16-year swaps with quarterly payments when added to our case study portfolio can be found in Table 4. The three swaps have 10 M notional, and the total notional of the book is 1452 B. While the FTP policy in FVA/FDA accounting is based on principles more conservative than those used for FCA/FBA, inclusion of the re-hypothecation option into FVA causes the funding cost component of the CA account to be materially smaller in absolute value than in FCA/FBA accounting (by about a factor

2 in our case study examples). As a consequence, CET1 immunization is practical in the FVA/FDA method, and results in an FTP principle which, we feel, aligns the interests of bank managers and shareholders well.

Notice in Table 4 how the FCA/FBA method assigns larger funding benefits (costs) to payables (receivables) than the FVD/FDA method. This has implications for trade positioning, as FCA/FBA accounting incentivizes, say, traders to sell out-of-the-money options in exchange for upfront premia that implicitly earns the full funding rate (as opposed to OIS).

7 BALANCE SHEET SIMULATIONS AND REVERSE STRESS TESTING

CET1 capital volatility due to credit and market risk needs to be managed by hedging and capital buffer provisioning. Sensitivity analysis is a viable technique here, but is of limited use for longer time horizons and for stress scenarios, such as those applied in the Comprehensive Capital Analysis and Review (CCAR) assessments. Besides the standardized CCAR scenarios, regulators encourage banks to identify stress conditions specific to their portfolios. Simulation-based *reverse stress testing* is useful in this context and can pinpoint the precise circumstances that are associated with capital depletion.

To implement a long-term scenario analysis, we evolved the case-study portfolio for two years on bi-monthly intervals, registering UCVA variation, FVA variation, default losses, and realized funding costs. Our simulation was based on 20,000 primal scenarios for which XVA metrics were computed dynamically on the path by generating 1,000 secondary scenarios at each simulation time point. Secondary scenarios were stepped through 100 time points over a 40 years' time span with simulation of all market and all credit factors, accounting for wrong-way risk. In total, this calculation involved 240 million scenarios. Using the mathematical framework in [2], overnight execution times can be achieved on two servers.

In our calculations, we assume that no new trades are added over time and consider only scenarios where the bank does not default. The net metric of interest was computed at each time t as the time 0 present value of

$$\mathrm{CET1}(t) - \mathrm{CET1}(0) = [\mathrm{UCVA}(0) - \mathrm{UCVA}(t)] + [\mathrm{FVA}(0) - \mathrm{FVA}(t)] - \mathrm{CDL}(t) - \mathrm{FC}(t) \quad (15)$$

where $\mathrm{CDL}(t)$ is the cumulative default loss on the time internal $[0, t]$ present-valued to time 0, and $\mathrm{FC}(t)$ is defined as follows:

$$\mathrm{FC}(t) = \int_0^t e^{-\int_0^u r_{\mathrm{OIS}}(s)\,ds} s_B(u) \left(\sum_i V_i(u) 1_{u<\tau_i} \right)^+ du.$$

Here we assume that A and L are perfectly hedged on a back to back basis while the CVA and FVA are unhedged. The sign convention is such that counterparty defaults and increases in FVA or CVA are all registered as negative numbers (corresponding to reductions in CET1).

Figure 1 graphs the fixed-time distribution of CET1 losses. Due to the inevitability of default losses, the distribution becomes increasingly skewed in the direction of losses as the time horizon is extended. Notice that we ran the simulation under the risk-neutral measure, but simulations in the historical probability measure ("P-measure") are, of course, also possible.

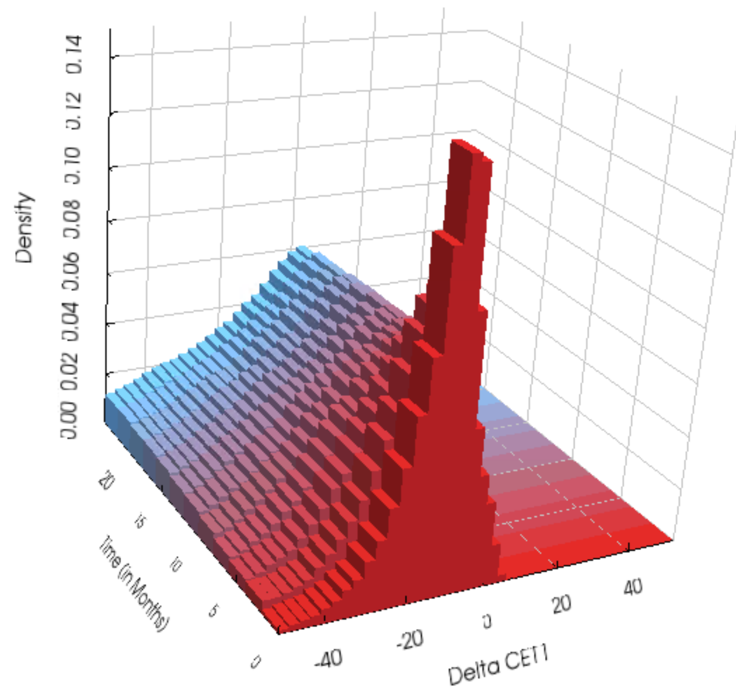

Figure 1: Distribution of changes in CET1 on a 2-year horizon. Results were obtained with a nested Monte Carlo simulations with 20,000 primal scenarios and 1,000 secondary scenarios emanating from simulation time-points.

For the reverse stress testing purposes, tail events can be extracted from the data used to generate Figure 1. We may focus on any market variable in examining these stress scenarios, but for illustration Figure 2 investigates the USD OIS overnight rate in the scenarios that produce the 200 worst 2-year losses in the sample of 20,000 runs. In the figure, each of the 200 stress paths has been assigned to the point in time on the path on which the biggest net loss was registered. Notice that stress scenarios are characterized by interest rates which are substantially lower than their unconditional expectation. Note also that quite a few stress scenarios produce their largest losses over relatively short time horizons, a consequence of the fact that the portfolio has less FVA and CVA variation as trades expire over time.

8 STRATEGIES FOR EXPLOITING FUNDING ARBITRAGE

As discussed, unsecured OTC trades have capital structure implications as they trigger wealth transfers from shareholders to bondholders. The classical Modigliani-Miller theory ignores this aspect since the discussion is typically framed within the Efficient Market Hypothesis (EMH) under which shareholders would immunize such losses by acquiring

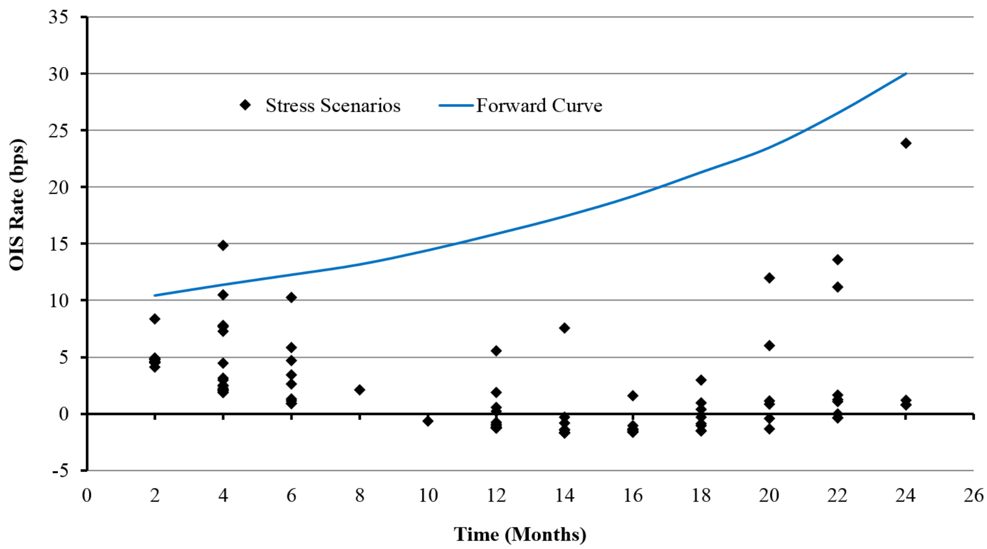

Figure 2: USD OIS overnight rate for stress scenarios using a 2-factor short rate model which floors negative rates at 10bp below the time 0 forward rates.

bank debt. In this view, trading decisions should be pursued as long as they have non-negative value to the bank as a whole, i.e., if the incremental PFV is non-negative. Of course, if shareholders were to implement this strategy systematically, banks would develop a pure-equity capital structure. In practice this is not reasonable, and FTP charges are, as discussed, needed to ensure that shareholder are immunized against losses. This, in turn, opens up the possibility of funding arbitrages.

In designing funding strategies, it should be kept in mind that bond covenants constrain outright transfer wealth from bondholders to shareholders. A viable strategy goal should therefore be to simply prevent, or at least minimize, wealth transfers from shareholders to bondholders. This can be accomplished in numerous ways, starting from straightforward trade intermediation strategies. For instance, if the funding FTP calculated by a bank is too large to prevent a particular client trade from being viable, the bank may act as an intermediary and, for a fee, take the client to an investor with smaller funding cost.

The intermediation strategy is a special case of the general principle that investors with low funding costs (or funding axes for specific trades) may be inserted into transactions to provide funding at levels cheaper than those of the arranging bank. Loosely, we can think of all such strategies as being examples of *margin lending*.

A particularly simple version of margin lending is where a third party investor makes available an amount K_0 in cash to the bank for a fixed time period (e.g. two years) up to date T. The amount K_0, on which interest obviously must be paid, is meant to be used as a capital buffer, by absorbing default losses arising from the OTC derivatives book and providing funds for variation margin. Any funds not used for OTC variation margin purposes are kept in a segregated account and not re-hypothecated for other purposes. Then:

- If the OTC book suffers a default loss L prior to expiry, the amount L is deducted from the capital buffer.

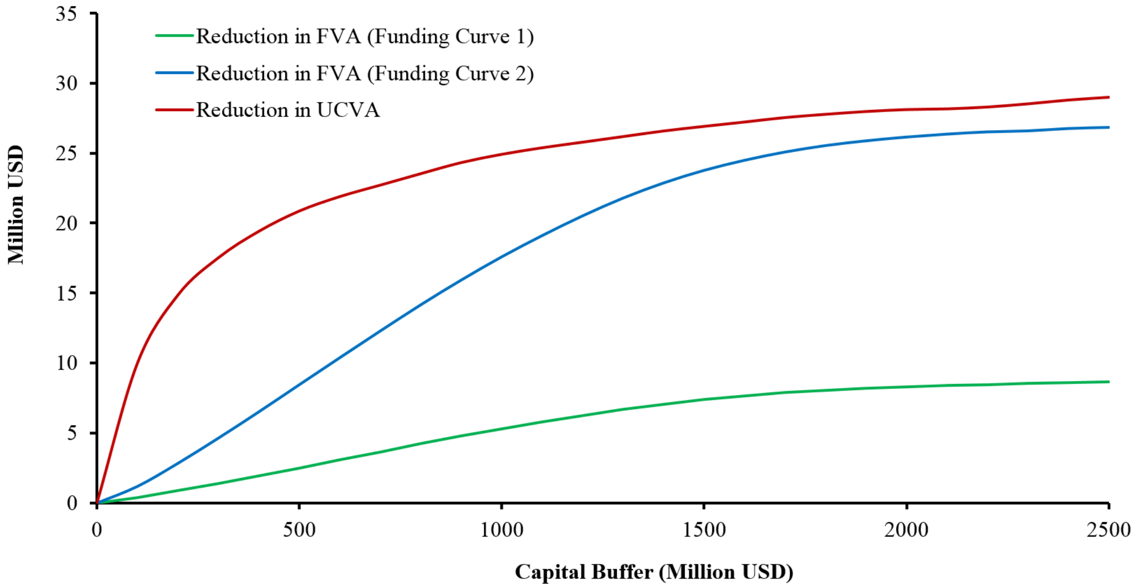

Figure 3: Variations of UCVA and FVA as a function of the size of a capital buffer assumed to be posted over a two year time frame. Funding Curve 1: 5-year funding spread of 106bp. Funding Curve 2: 5-year funding spread of 274bp.

- Any capital left in the buffer at time t during the life of the trade may be used for variation margin postings to OTC hedge counterparties.
- In case the bank defaults during the lifetime of the trade, any (segregated) amount of the capital buffer not posted as variation margin will be repaid.
- The part of the capital buffer used as variation margin will be repaid, with priority over all other creditors, by funds obtained by settlement of unsecured derivatives receivables.
- If, as a consequence of the bank default, some counterparties default and fail to fully settle their obligations, first losses are apportioned to the capital buffer.

The structure above does not break pari passu bond covenants since the structure is a form of collateralized lending. If funds are provided by the margin lender at a sufficiently low interest rate cost, the strategy may produce a funding arbitrage and a lower FTP. For our case study, Figure 3 shows that the FVA reduction accompanying the primary UCVA reduction can be very substantial for large funding spreads. For instance, an attractive gearing of better than 90% on the ratio FVA/UCVA is achievable at a funding spread of 274bps. Since the investment structure above may naturally be tranched, a similar ratio can arguably be applied across the entire capital structure. Additional gearing would then also be provided by regulatory capital reduction.

The strategy outlined above may be extended in many ways, and can even be arranged to eliminate CVA completely, see for instance [3]. Our main points here are simply that funding costs can be managed and monetized, and FVA/FDA accounting establishes clear metrics for structuring desks to work with.

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