The OIS & FVA Relationship: The Evolution of OTC Derivative Funding Dynamics

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Satyam Kancharla, Chief Strategy Officer & SVP of Client Solutions Group, Numerix LLC

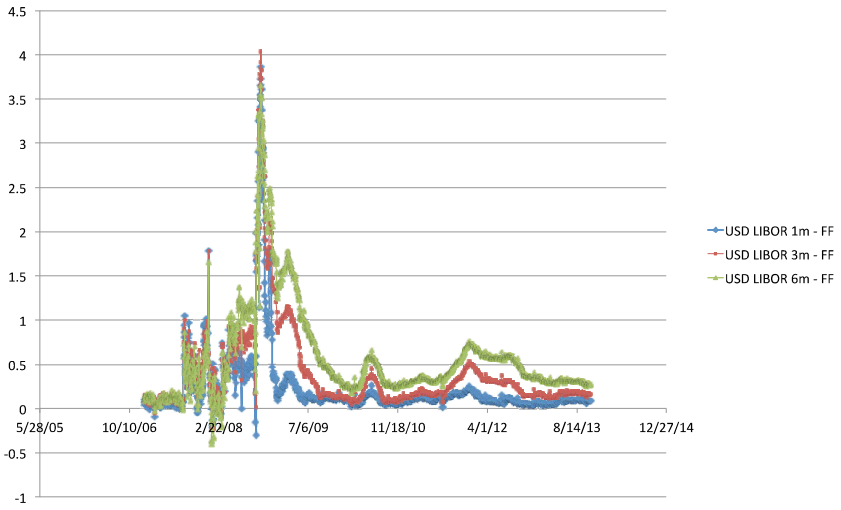
Overnight Index Swap (OIS) discounting and Funding Valuation Adjustment (FVA) have been hot topics in the Over-the-Counter (OTC) derivatives market since the global financial crisis. Today's market participants continue to see a large disparity in market quotes, leading us to take a deeper dive into the FVA relationship as part of the funding process—including how to incorporate a 'funding charge' in pricing to reflect a firm's true cost of funding. Moreover, optionality embedded in Credit Support Annexes (CSAs) can make the pricing exercise even more complicated.

We will begin this article with a discussion of the basics of OIS discounting and FVA for OTC derivatives—and then explore the relationship between the two concepts. We will also look at a case study that highlights the potential impact of FVA on trade profitability.

BACKGROUND: WHAT PRECIPITATED THE MARKET ADOPTION OF OIS DISCOUNTING?

In 2008, the global financial crisis dramatically changed the world. Prior to the financial crisis, life was simpler, where market participants relied solely on one interest rate curve—the LIBOR curve—to both forecast future LIBOR rates and discount future cash flows.

LIBOR vs. Fed Funds – Before and After the Global Financial Crisis



Source: Numerix

Numerix LLC
Corporate Headquarters
99 Park Avenue
5th Floor
New York, NY 10016
Tel: +1 212 302 2220

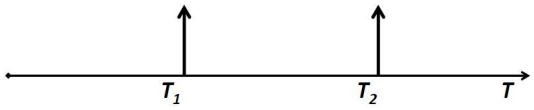
In today's post-crisis market, different tenors of LIBOR require separate curves, because longer term LIBOR started to command higher spreads. The underlying cause can be thought of in two ways, first as a liquidity preference, but more fundamentally reflecting the credit worthiness of the institutions that determine LIBOR. As a result, market practitioners can no longer rely on a single curve for estimating future LIBOR fixings and discounting future cashflows.

The inability of a single curve to both project (estimate future values) and discount (calculate the present value) meant that financial professionals had to rethink the way derivatives were priced. The correct projection curve to choose was clear as it was written into the derivative contract. However what rate, and therefore what curve, to discount future cashflows was not obvious. A debate ensued—if LIBOR has embedded credit risk, then it is no longer the risk-free rate that is required by the fundamentals of quantitative finance.[1] The consensus that emerged was the shortest tenor rate, the overnight index swap (OIS) rate should be used to discount future cashflows. These overnight rates are liquidly quoted in many regions, for instance the fed fund overnight rate in the United States, the sterling overnight rate (SONIA) in the United Kingdom and the Euro overnight (EONIA) in the European Union.

Nowadays, the fact is that discounting using the overnight rate is here to stay. It is the new standard for discounting, deemed the chosen proxy for the risk-free rate. The Financial Accounting Standards Board (FASB) recently announced its decision to adopt the OIS rate as the hedge accounting benchmark. It also has the distinction of being the rate of interest enshrined by the new Standard Collateral Support Agreements (SCSAs) for amounts to be paid on collateral accounts. The fact that OIS is tied to collateral accounts made practitioners pause and work through exactly how derivatives are funded, and how this has an effect on both the discounting the future cash flows, and ultimately on trade profitability.

COLLATERAL DISCOUNTING: WHAT DOES DISCOUNTING HAVE TO DO WITH A COLLATERAL AGREEMENT?

Let's take a look at a simple example to illustrate the connection. Consider an example where I buy two cashflows from a counterparty, paid at T1 and T2, as outlined in the diagrams below.



A collateral account is established in order to hedge the credit exposure, at each point in time, the amount is equal to the amount owed by the counterparty.

Since this is an asset, the counterparty posts collateral to me, and I must pay interest on this amount of money at the rate determined by the collateral agreement. In order to minimize the amount of collateral the counterparty posts, and correspondingly minimize the amount of interest I need to pay, we agree upon the amount that will exactly cover the cashflows. The correct way to determine this collateral amount is to discount at the collateral rate, since this amount uniquely answers the question "what is the value today that will grow to the exact amount I need to meet my obligation in the future?" In this way, my counterparty does not need to fund the derivative in the free market, and the correct discounting rate to use for fair value calculations is the collateral amount. The "ideal" example misses much of the complexities that exist in real trades, and the nature of the financial markets. Derivatives all have an accompanying addendum that governs the terms and conditions surrounding collateral posting and transfers, the Credit Support Annex, or CSA.

[1] *Risk25 July 2012, pages 83–85 or http://www.rotman.utoronto.ca/~hull/downloadablepublications/fva.pdf*

THE CREDIT SUPPORT ANNEX (CSA) RELATIONSHIP

Lately, CSAs have come under increasing scrutiny due to their collateral funding implications and how this relates to the profitability of trades. As a result, it is no surprise that the front and middle offices are now taking a closer look at these legal agreements.

The basic collateral parameters are as follows:

Collateral Parameters	Description
Collateral Threshold	The amount of exposure below which is not collateralized
Minimum Transfer Amount	The minimum change in exposure that is posted to collateral
Posting Frequency	The frequency at which exposure is calculated an collateral is adjusted

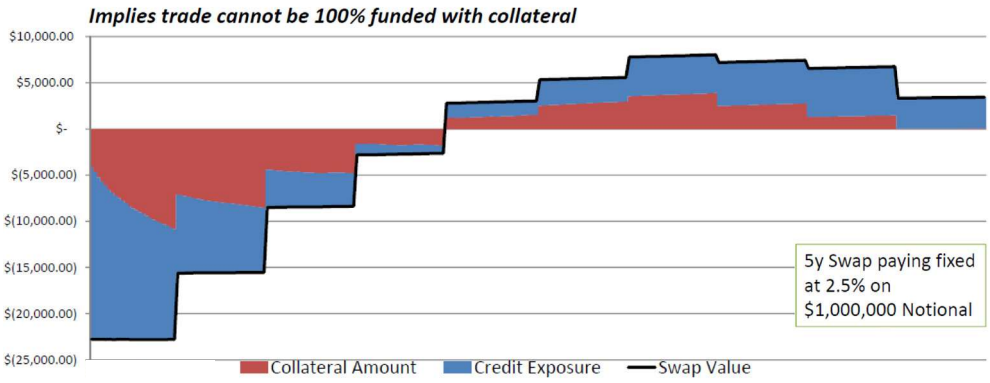
What came as a surprise to the practitioners of quantitative finance, was that the CSA agreements actually contained a great deal of optionality, that had a material impact on the profitability of the executed trade. The most salient features of the Real World CSAs are outlined in the chart below. The embedded optionality arises in two places: the choice of currency to post, and the choice of security to use.

The typical parameter ranges are described in the "Real World CSA" column. To contrast, we also describe a so-called 'utopian CSA' which cannot truly exist, but is helpful in gaining an intuition regarding how CSAs affect funding. In the Utopian CSA, there is no optionality and the derivative can be funded completely from the collateral postings. This corresponds to the illustrative two-cashflow example presented above.

	Utopian CSA	Real World CSA
Threshold	0	100,000-10,000,000 Depends on cpty
MTA	0	Typically a fraction of the Threshold
Posting Frequency	Instantaneous	Daily/weekly
Optionality	None	Choice of collateral currency
Collateral Instruments	Cash	Cash/Treasuries
Hedge Credit Exposures	100%	<100%
Collateral Funding	100%	<100%

Real World CSA

As we can see in the example below involving a 5-year swap (paying fixed at 2.5% on $1,000,000 notional), the trade cannot be 100% funded with collateral. But, why doesn't the Real World CSA hedge 100% of the credit exposure? The value of the trade changes faster than the collateral frequency, and MTA and threshold considerations must also be taken into account, in addition to cashflow events. We must also consider the movements in the value of the collateral itself.



Source: Numerix

The related graphic depicts the total exposure of a swap over the lifetime of the trade, and a hypothetical collateral amount. Since imperfections exist, the total exposure of the trade is not perfectly hedged. The mismatch between the current exposure and amount in the collateral account means funding is not purely OIS. Consequently, this is where our discussion of FVA comes in...

WHY HAS FVA RECENTLY COME TO THE FOREFRONT?

The question at the root of any OTC derivatives' trading decision process, *"Is this trade profitable?,"* may at its core seem like a simple proposition. But with the changing landscape of OTC derivatives, calculations have become increasingly complex—especially from a funding perspective.

Market practitioners recognize that collateral has been successfully introduced to mitigate CVA. However, since collateral affects the funding of the trade, it also affects profitability. There is no argument that the FVA charge is real, and passed onto traders by funding desks.

In addition, there are a number of ongoing issues related to FVA still being hotly debated. Making recent financial news have been debates surrounding how regulations should address FVA; how to calculate FVA; whether or not and how to pass the cost onto counterparties; and whether or not to build FVA into the MtM price/unrealized P&L.

WHAT IS FUNDING VALUE ADJUSTMENT (FVA)?

We will begin this part of our analysis, with a primer on FVA—a basic definition and how to calculate FVA.

Basic Definition and Background

FVA is an institution's cost, above the risk-free price, to fund the trade in the presence of a real world CSA.

$$FVA(t) = PV\,[Real\ World\ CSA] - PV\,[Utopian\ CSA]$$

FVA is the cost of the institution to fund the trade above that of the risk-free price.

$$FVA(t) = PV\,[Including\ Funding\ Costs] - PV\,[RiskNeutral]$$

FVA: How to Calculate

A. How to Calculate

$$^{1}FVA(t) = -E\left[\int_{t}^{T} (r_{eff}(u) - r(u))\, e^{-\int_{u}^{T} r_{eff}(s)ds}\, V(t)du\right]$$

- Uncollateralized exposure
- Effective Funding Discount factor
- Effective Funding Spread over OIS rate
- Expectation over future exposures V(t)

- Risk Factors: Self Credit rating via the funding rate, Uncollateralized Exposure
- For totally collateralized trades (ie, Utopian CSA), no funding adjustment, FVA = 0
- For totally uncollateralized trades, FVA represents the difference between funding discounting and OIS discounting
- Cannot be hedged, can be *optimized* (pathwise cheapest-to-deliver)

Source: Numerix

The related graphic defines all of the terms that go into the calculation of the funding value adjustment, defined as a difference between the purely OIS discounted price and the price taking into account collateral shortfalls. Put another way, it is the difference in price from the Utopian CSA and a Real World CSA.

The important point to note in the formula in the related graphic is that the *V(t)* is the *uncollateralized exposure*, and not the total exposure of the derivative. The average is taken over all possible future paths where both the derivative and the collateral change due to market movements.

Intuitively you can think of the FVA formula as averaging the amount of the derivative trade that cannot be funded by the collateral—in order to ensure you meet your future cashflows you will have to access funding at your free market funding rate, which will be higher than the OIS rate dictated by the CSA.

B. Effective Funding Rate

$$r_{eff}(t) = \Phi_C(t) r(t) + \underbrace{\left(1 - \Phi_C(t)\right)}_{\text{Fraction of trade value in the collateral account}} r_f(t)$$

Fraction of trade value with credit exposure

Two limiting cases

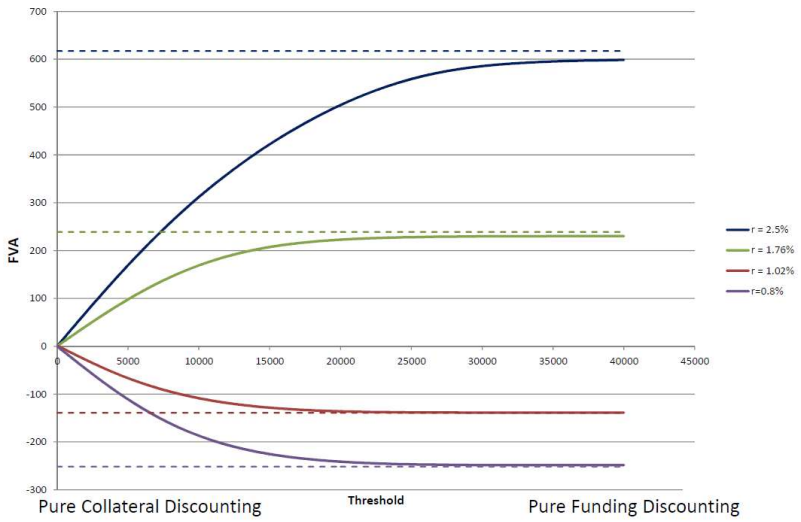
	100% collateral	100% funding
Φ_C	1	0
r_{eff}	Collateral (OIS) rate	Funding rate
CSA	"Utopian"	None

Source: Numerix

The effective rate is a path-dependent quantity, due to the collateral changing depending on the prevailing rate environment—or if a security is used as collateral—due to the market fluctuations of the collateral itself.

Over the lifetime of the trade, you can calculate the "effective funding rate" on each path, which is a weighted average of the collateral rate (OIS) and the firm's free-market funding rate, weighted by the amount inside and outside the collateral account respectively. Again, the intuition is that the collateral account cannot be 100% relied upon to ensure that you can meet your future cashflow obligations, due to the imperfect nature. The amount needed above the amount present in the collateral account will have to be funded in the market. This effective rate gives the average funding rate taking into account both sources of funding.

C. FVA As a Function of Threshold



Source: Numerix

The related graphic shows two limiting cases. The first limiting case is labeled "Pure Collateral Discounting", where the funding is entirely from the collateral account, giving rise to a vanishing FVA. Recall that FVA is defined as a difference between the price using the path-dependent effective funding rate and the price using OIS discounting. A zero FVA indicates that the price of the derivative is identical to the OIS price. The other limiting case if "Pure Funding Discounting", where the collateral account is empty, and the firm will need to fund at their free-market funding rate. The dotted line indicates the price difference of the derivative calculated simply using the funding rate as the discount curve, and serves to validate the FVA calculations.

A CASE STUDY: FVA CHARGES AND IMPACT ON TRADE PROFITABILITY

In the following case study, we examine how FVA charges can potentially impact trade profitability.
In particular, we will look at FVA in basis point value for three swaps:

1. *In-the-money*
2. *At-the-money*
3. *Out-of-the-money*

We will also look at three different funding spreads for each swap in the study:

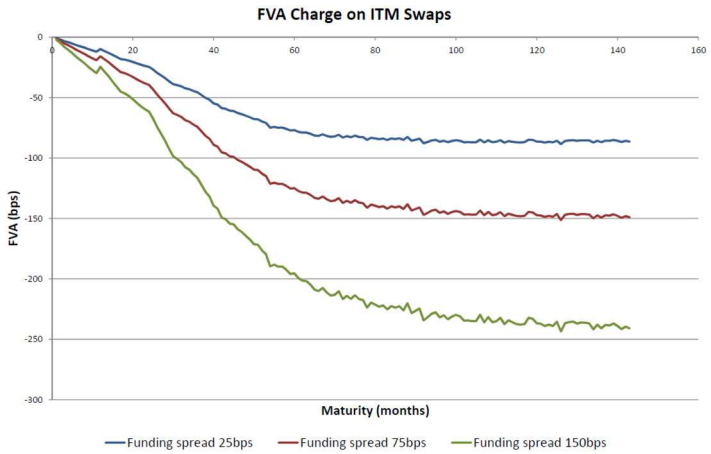
1. *25bps*
2. *75bps*
3. *150bps*

***Par Swap Rate** $R = \frac{\sum_i r(\tau_i)\,Df_i}{\sum_i Df_i}$ The par swap rate will depend on discounting, and therefore to funding when collateral discounting

Note that the two "fixed points" will have unique par swap rates, however the market will always quote par swap rates in terms of OIS discounting.

A. FVA Charge on ITM Swaps

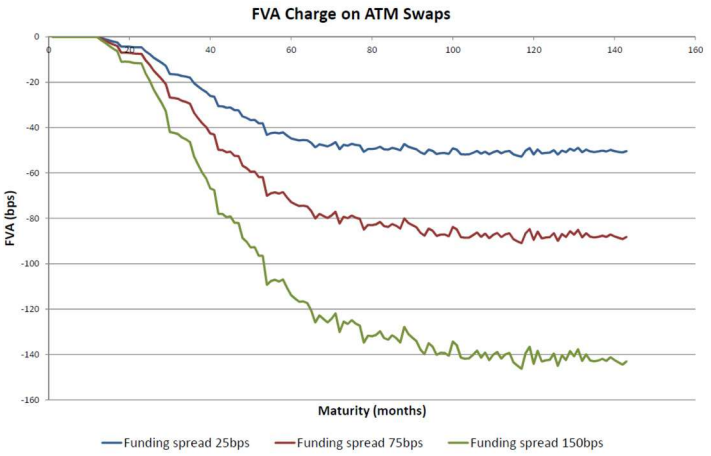
The following graphics show the results of a case study on the effect of funding and maturity on the FVA of an interest rate swap, when in the money, at the money and out of the money.



Source: Numerix

Would it be good for your business to enter this trade? Here we can see that the severity demonstrated in this chart indicates a potentially significant cost to your business.

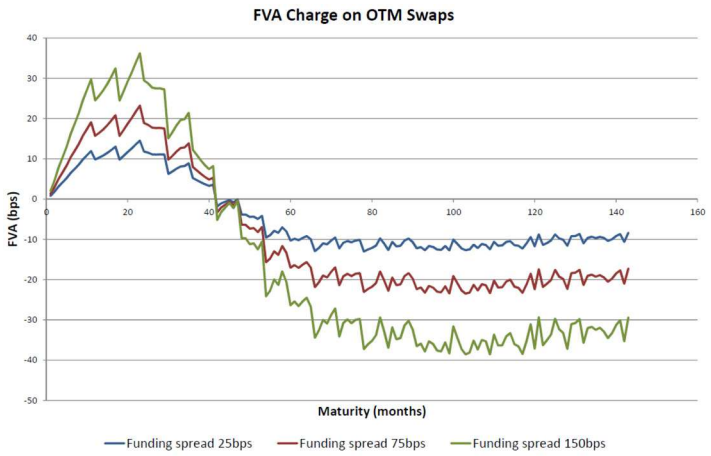
B. FVA Charge on ATM Swaps



Source: Numerix

Here, we can observe that profitability would not be impacted as much as the ITM swap above.

C. FVA Charge on OTM Swaps



Source: Numerix

Here, we see that the spread is not as severe, but the FVA charge does still impact the profitability of the trade.

MORE ABOUT FVA CHARGES

Does the 'Law of One Price' actually exist in the real world? In reality, if a corporate (price-taker) gets bids from a number of banks, that price-taker will certainly get different quotes. In fact, we have observed up to 100bps difference in some of these quotes. Clearly, we can see that FVA is a real charge to traders, reflecting their different costs of funding. Traders have passed this charge from their treasury/funding desks, and they will attempt to pass this charge onto the purchaser—using such vehicles as upfront fees and running spreads over floating rates. However, this isn't always easy to accomplish in competitive markets. In the end, the FVA will certainly affect the profitability of the trade.

Does the Executed Value Include the FVA Charge?

It should also be noted that the executed value does not include the FVA charge in the Interbank market, where the price is determined by the law of supply and demand. However, it is possible when dealing between sell-side and buy-side. Also, based on our research, it is interesting to note that only four banks reported listing funding valuation in financial statements. These banks include: RBS: £475M, Lloyds: £ 143M*, Goldman and Barclays.

Regulation: Should the MtM Value include the FVA Charge?

According to Fair Value Accounting, the value to report for a trade is the value that the free market would pay in an ordinary transaction for that derivative today. However, there are three ways of thinking about this per below:

1) Unwinding – which will incur a cost of executing the opposite trades. The funding rate should be the cost that will be charged to you by your counterparty to unwind.

2) Novation – having a similar counterparty take over the trade. The funding rate should be an industry average of funding rates.

3) Holding the trade to maturity – The funding rate should be your own institution's rate.

What is the correct solution? Here we should note that, as of today, no requirement exists from any accounting body to include this in regulatory accounting. Regulators and accountants are on the sidelines for now, waiting for a consensus among practitioners. It will be very interesting to see what the outcome will be.

CONCLUSION

While there is still no official consensus on reporting, FVA is a real charge that will affect the profitability of trades. Institutions will try to pass this cost on if they can; but, this may be difficult in competitive markets. At the least, practitioners need to understand what the FVA is and track it on a day-to-day basis. This should impact their decision-making about the trade. It is imperative that they know this cost in order to make the best decisions for their business.

AUTHOR BIOGRAPHY

Satyam Kancharla, Chief Strategy Officer & SVP of Client Solutions Group, Numerix LLC

Mr. Kancharla is currently the Chief Strategy Officer, as well as head of the Client Solutions Group responsible for Product Management, Requirements Gathering and Business Analysis. Prior to this, he has served in various roles in Quantitative Software Development, Financial Engineering and Pre-Sales at Numerix.

Before joining Numerix in New York, he was the CTO for Numerix Japan LLC in Tokyo, heading the Pre-Sales and Financial Engineering teams for Asia. Earlier in his career, Mr. Kancharla also worked with Merrill Lynch and GE Capital in Quantitative Finance and Product Development roles. He holds a MS degree in Applied Statistics and Informatics and a BS in Mathematics and Computers.

** Lloyds indicated this number will move £14M for every 10bp change in funding cost*

Corporate Headquarters

New York
125 Park Avenue
21st Floor
New York, NY 10017
Tel: +1 212 302 2220

Sao Paulo - Brasil
Avenida Brigadeiro
Faria Lima, 3729
5 Andar
Sao Paulo
04538905, Brasil
Tel: +5511 3443 7331

London
Numerix Software Limited
41 Eastcheap, 2nd Floor
London, UK EC3M 1DT
Tel: +44 20 7648 6100

Singapore
8 Eu Tong Sen Street
#24-85 The Central
Singapore 059818
Tel: +65 6501 0788

Hong Kong
Level 16
Man Yee Building
60-68 Des Voeux Road
Central
Central, Hong Kong
Tel: +852 3796 2720

Tokyo
Marunouchi Trust
Tower Main, 20th Floor
1-8-3 Marunouchi,
Chiyoda-ku
Tokyo, Japan 100-0005
Tel: +81 3 5208 1130

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