



# **CSA Implementation and Counterparty Collateral Application Development**

*Worcester Polytechnic Institute – Major Qualifying Project*

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December 12<sup>th</sup> 2012

## Abstract

This project involves the implementation of a Counterparty Collateral Lookup Tool, programmed in Excel using VBA and Macros. It was built to fit the requirements of its users, who are mainly Credit Derivative traders at Bank of America Merrill Lynch. The tool will reduce the time it takes a trader to find counterparty information, something they had to request the back office to do before the creation of this application. This time reduction increases the efficiency of the work stream processes at the bank.

## Executive Summary

The credit derivatives market has been one of the most widely discussed topics after the 2008 Financial Crisis, especially because of the role that credit default swaps played in the recession. Bank of America, along with other major banks, has taken the time to reconsider the original valuation methods for these products, specifically recognizing that the LIBOR (London Inter-Bank Offered Rate) curve is not the most appropriate benchmark to discount the future cash flows. Instead, it has been determined that the OIS (Overnight Indexed Swap) curve better reflects the true cost of a credit default swap. This change affects many departments of the bank, both in the front office and back office.

Collateral posting procedures and the systems used in the bank have to be adjusted to reflect this change. The main goal of our project was to create a tool for the traders to input simple data about a counterparty to receive relevant information regarding collateral posting. In order to achieve this, first we had to become familiar with the way credit derivatives function, by doing extensive research in the subject area, as well as understanding the importance of the switch from LIBOR to OIS and how this affected CDS pricing. Second, we read through all the documentation to learn how the in-house software and systems work within the bank, specifically those which we were going to be dealing with, directly or indirectly. Third, we found out the specific requirements of the application tool we developed and finally, we put together the application from these requirements.

# Acknowledgments

We could not have completed this project without the help of the following people. They provided extensive guidance and support in our project. We would therefore like to thank:

Professor Arthur Gerstenfeld

Professor Irvin Morgan

Professor Jon Abraham

William Carroll

Lucia Pino-Garcia

Kurt Vile

Ratheeson Thillainathan

Susan Bandidin

Selina Vinayaga-Pavan

Ajay Sikri

Ingemar Svensson

Sidhart Shah

Thomas Plein

Kaiyu Mu

Bank of America Credit Technology Team

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## I. Project Statement

Our project consisted of aiding the front office credit technology department make the switch from using the LIBOR curves to OIS curves as a benchmark to discount future cash flows to value credit derivatives, mainly credit default swaps. We worked with the credit technology department, specifically dealing with credit derivative products and took part in both the technical and business analysis side of the process. We were also in contact with other groups within the technology department as well as traders in the front office department. The business analysis part consisted of finding specific requirements from traders, understanding the concepts related to the products as well as becoming familiar with the programs used in the department, which included risk engines, counterparties information database and Excel manipulation. The technical analysis consisted of developing a new more streamlined tool for these yield curves, applying a specific logic to the program as to when to post collateral and what types, understanding the formulas associated with the valuation of the securities, and calculating the risk of the bank's counterparties.



## II. Background

### 1. Bank of America History

The story of Bank of America dates back to the early 20<sup>th</sup> century. In the year 1904, Italian immigrant and produce broker Amadeo Pietro Giannini saw a lack in the banking industry for the less fortunate and founded the Bank of Italy for the growing number of Italian immigrants in San Francisco, California. By 1928, Giannini had merged with many banks already, including *Banca dell'Italia* in 1922 and *Bank of America, Los Angeles* that same year. He had created the largest banking institution in the country and renamed the Bank of Italy to Bank of America in November, 1930.

Throughout its creation, Bank of America saw many large and small mergers with banks and other financial institutions, and in September 2008, it announced its intentions to purchase Merrill Lynch & Co. with an all-stock deal worth approximately \$50 billion. Merrill Lynch was at the time within days of collapse and the official acquisition on January 1<sup>st</sup>, 2009 saved it from bankruptcy. After this acquisition, Bank of America became the third largest company globally according to a Forbes composite measure.

Bank of America is involved in several different business areas including commercial banking, corporate banking, investment banking and private banking. With the purchase of Merrill Lynch, the bank became the world's largest wealth management corporation and the biggest bank with over \$2.1 trillion in total assets. It is also one of the Big Four banks in the United States.

Our MQP took place in the Credit Technology department of Bank of America, Merrill Lynch in London. This department, although not very big, is essential to the corporation and is the major link between the front office and the traders. They are in constant contact with the clients

and traders to support them with their transactions and are able to better understand and evaluate their needs.

## 2. Literature Review

### a. Derivatives

A derivative is simply a contract between two parties (technically more than two is possible, although uncommon). As such, it is a security and has an inherent price derived from a specific underlying asset or a number of assets. It can be anything from a simple European call option on the stock of BASF to a weather derivative used to hedge against a poor harvest of corn. There are three main types: equity derivatives, interest-rate derivatives and credit derivatives. The third will be the main focus of this paper.

Derivatives primarily function to hedge risk. They can be used to lock in future prices (e.g. a farmer wanting to ensure a certain price for his corn before he has harvested), eliminate or reduce a specific type of risk from a transaction (e.g. a bond holder wishing to buy “insurance” against a possible default), and countless other possibilities. While they are ideal instruments for hedging risk, they also prove to be invaluable to those wishing to speculate. An investor need not have any holdings in the underlying asset if he wishes to enter into a derivative contract, and because of the extremely high leverage associated with derivatives, such a speculative investor can put himself in a position to profit or lose immensely.

## **b. Credit Derivatives**

Credit derivatives are privately held, negotiable contracts designed to reduce or eliminate credit risk exposure. This can be done in a number of ways; usually it is achieved by transferring the credit risk to an entity other than the lender. Credit derivatives can be divided into two categories: funded and unfunded. Funded credit derivatives involve the protection seller making a required initial payment that is used in the event of a default payment, in other words posting collateral. Examples of funded credit derivative instruments include synthetic collateralized debt obligations and credit linked notes. Unfunded credit derivatives mean that there is a bilateral contract between two counterparties where each party is responsible for making the payments specified in the contract without recourse to other assets. Examples of unfunded credit derivatives include credit default swaps and total return swaps. It is important to understand that the market for credit derivatives is currently undergoing various changes, specifically due to their role in the 2008 financial crisis, for which they have been subject to a lot of criticism, along with instruments such as mortgage backed securities. Moreover, even though credit default swaps are considered a type of unfunded derivatives (as noted above), more counterparties are requiring the protection sellers to post collateral in the event that the reference entity defaults, especially after the number of defaults caused by the crisis. This will be explained in more detail in the following sections.

Credit derivatives arose in response to demand by financial institutions, mainly banks, for a means of hedging and diversifying credit risks similar to those which were already being used. They were also created to satisfy the demand for a low cost means of shifting credit exposure. The result of this has been that credit risk has gradually changed from being an illiquid asset which was not suitable for trading, to nowadays where it is a liquid asset with a market capitalization in 2008

of roughly \$62 trillion. This number experienced a significant drop after the crisis, but the market still has large volume and trading activity.

Pricing of credit derivatives is a very complicated process, mainly because of the complexity in monitoring the market price of the underlying credit obligation. Also, the creditworthiness of the debtor is difficult to quantify and the different ratings published by agencies tend to differ from one another, which makes it difficult to calculate the risk involved in the transactions. To put it simply, there are a lot of factors to consider when it comes to pricing these products.

### **c. Credit Default Swaps (CDS)**

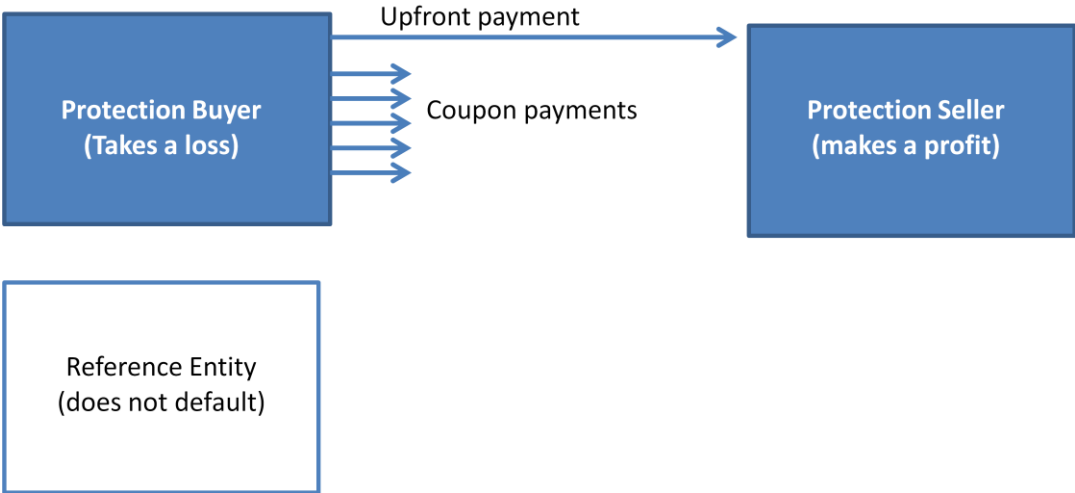
#### ***i. Introduction to Credit Default Swaps***

A credit default swap (formally a single name credit default swap, referred to as CDS from now on) is the foundation of the credit derivatives market and the most common type of credit derivative. A CDS is a bilateral contract which consists in the transfer of credit risk between two counterparties, the seller of protection and the buyer of protection. The buyer of protection usually has an outstanding bond or some other credit risk exposure with a reference entity, and in the event of a default of payment they are protected by the seller of protection, meaning the seller will pay the buyer whatever the reference entity owes to the buyer of protection. So essentially, he is transferring the credit risk to the seller of protection in exchange for a series of payments called premiums. The products between the protection buyer and the reference entity usually include

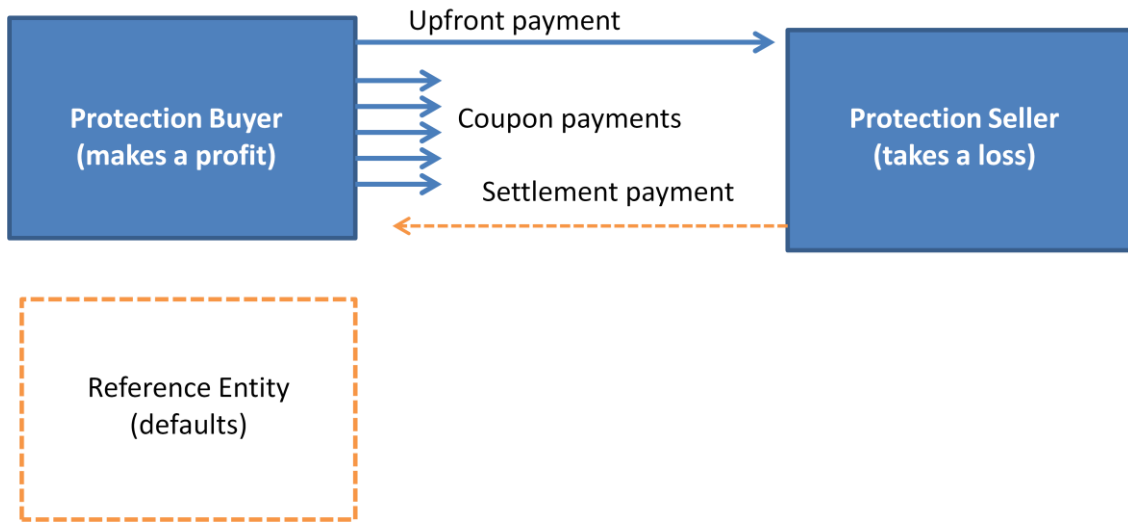
bonds, mortgage-backed securities or corporate debt. Again, the CDS is not actually tied to these securities but instead references them and refers to the issuer as a reference entity.

This transaction, in simple terms, would result in one of two scenarios: If the reference entity does not undergo a credit event during the term of the contract, the protection seller profits from the payments made by the protection buyer. His position is similar to owning a bond; it is referred to as “long risk”. If the reference entity defaults or is downgraded (in technical terms referred to as a “credit event”), the protection buyer profits from the settlement given by the seller. The protection buyer is taking a position similar to what would be selling a bond short, his position is therefore referred to as “short risk”.

**Scenario 1: Reference Entity does not default**



## Scenario 2: Reference Entity Defaults



There are two types of players in the market who use CDS: hedgers and speculators. An individual or company that is exposed to a lot of credit risk, for example a bank who has an outstanding loan that was issued to a counterparty with bad credit rating, can shift some of its risk by buying protection through a CDS contract. The bank would be therefore effectively hedging its credit risk. On the other hand, speculators can use CDSs to bet on the creditworthiness of a specific entity. There are two scenarios in this case: (1) if a speculator thinks that a specific company will have a credit event or default on its payments he or she can attempt to profit from this event by purchasing a CDS which references this entity, effectively “betting” that the reference entity will default. On the other hand (2) if the speculator thinks that the reference entity will not default on its payments, he or she can sell protection to attempt to profit from the premium payments.

It is of utmost importance to understand that *anyone* can buy protection for the default of a payment, meaning the company that is buying protection does not necessarily have to have credit

risk exposure to the reference entity. An interesting analogy would be to compare it to buying insurance against your neighbor's house catching on fire. The nature of a CDS has brought not only a lot of attention to them but a lot of criticism too. Moreover, it is very much tied to the fact that CDS and credit derivatives in general are the least regulated financial assets, which results in having very high speculator involvement.

Credit default swaps are not always held until expiration but instead are often traded over the counter before maturity. In proper terms, this is called unwinding the contract. The value of this contract is mainly dependent on the increasing or decreasing probability that the reference entity will have a credit event (in technical terms default probability or hazard rate), as well as the amount of time left until maturity. When the probability increases, the contract is worth more for the buyer of the protection and less for the seller. The opposite occurs when the probability decreases.

Even though CDSs have proven to be a useful portfolio management tool and very important players of the current financial markets, the lack of regulation and presence of leverage involved in the transaction has been largely criticized.

## *ii. Fundamentals of CDS*

To fully understand how a CDS works, relevant terms that are tied with the transaction have to be clearly defined. First, a quick recap from last section: there are two counterparties involved, the buyer of the protection and the seller of the protection. There is also a reference entity, the party on which the protection is written, usually a corporation or government, which is not involved in the transaction. In the event of a default of payment, the seller of protection pays the buyer.

There are four parameters that define a CDS:

- Notional amount: The amount of credit risk being transferred from the buyer to the seller; it is agreed upon the creation of the CDS and is usually around \$10 million. Notice that it is not necessarily the same amount that the reference entity owes the protection buyer.
- Which credit is being referenced: The CDS contract specifies the reference obligation, which is an outstanding bond or loan which defines the issuing entity. These bonds or loans are deliverable in the event of a default.
- Coupon: Refers to the annual payments, decided when the CDS is being underwritten and it is quoted in basis points. Payments are paid quarterly and accrue on an actual/360 day basis. Other names include: spread, fixed rate, or price.
- Maturity: The expiration date of the contract; most CDS contracts have a maturity of five years, and consequently those tend to be the most liquid as well.

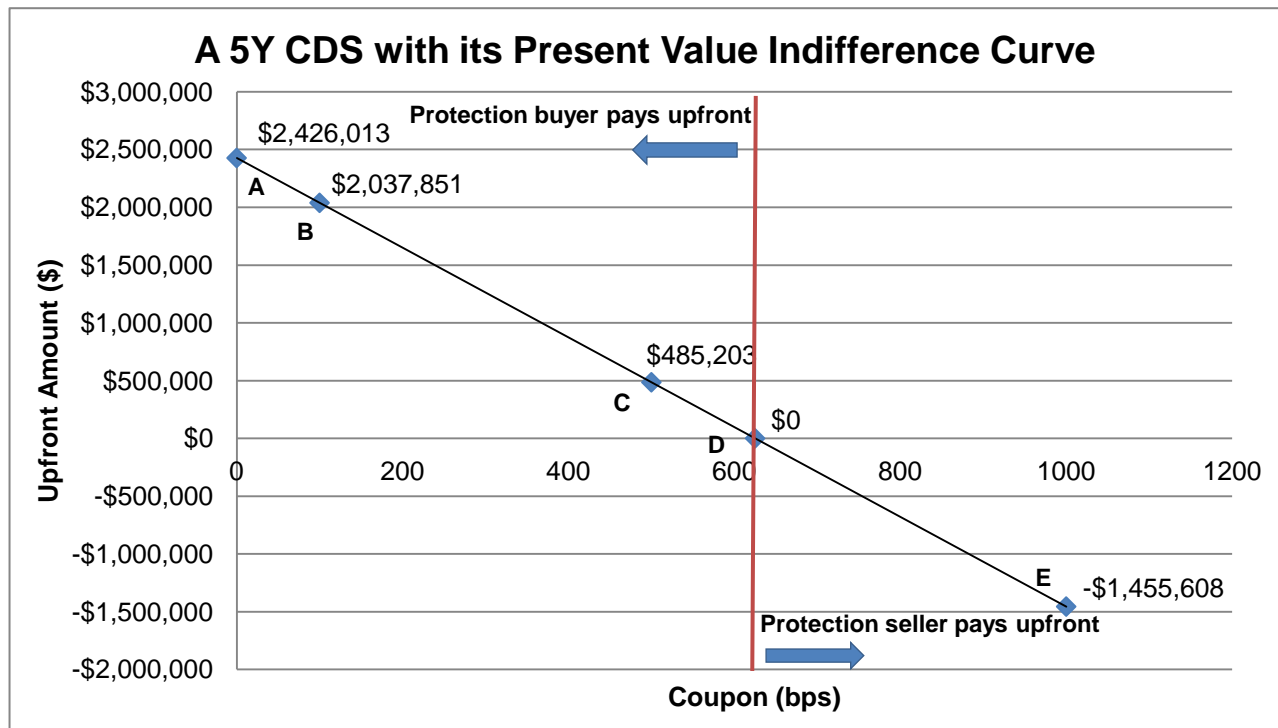
Upfront payments and coupons:

In the pre-crisis era, it was not common for CDSs to have an upfront payment tied to them. Each counterparty would suppose that the other one would meet their required payments depending on what the outcome was. Hence, in a no default scenario, the seller would expect the buyer of the premium to pay the coupon payments fully and on time. In a default scenario the buyer would expect to receive settlement from the seller accordingly. Nevertheless, after the recession, economic conditions changed, and so did risk models which were rethought. The idea of an upfront payment was emphasized in the CDS market. Nowadays, the majority of CDSs include



upfront payments. Once an upfront payment is delivered, which is usually paid from the buyer to the seller, the seller will post it as part of the collateral.

The upfront payment is directly related to both the coupon and the present value of the CDS. Both the amount of the upfront payment and the coupon are decided when the CDS is being underwritten. Depending on market conditions, as well as the type of reference entity, the CDS would trade in different coupons and have different upfront payments. The most common practice is for investment grade reference entities to trade under a 100 basis point coupon while a high yield reference bond would trade a 500 basis point coupon. Once the coupon is decided on, the counterparties use a present value indifference curve (which has a linear relationship where the slope depends on the discount curve used to calculate the present value) to determine how much upfront payment should be given to the protection seller. In some rare cases, the protection seller may pay the upfront amount to the protection buyer, e.g. if it is securing an extremely high risk entity. Refer to the table below for a better understanding.



The graph above shows the different options the counterparties have with regards to the upfront/coupon combinations. The options can be separated into four types: (1) paying the price of the protection in full, as is the case with point A where the buyer pays the seller \$2.4 million, (2) paying a combination of upfront and coupons, as is the case with points B and C (3) paying no upfront and only coupon payments as is the case in point D (4) or the rare case where the buyer receives the upfront payment and pays an even higher coupon, shown in point E. As it was mentioned earlier, the pre crisis standard practice would be point D, but as economic conditions changed points B and C are examples of the most common procedure, where the seller actually receives the upfront payment and proceeds to post it as collateral.

There are three major types of credit events:

- **Bankruptcy:** includes insolvency, creditor arrangements and appointment of liquidators or administrators

- Failure to pay: not receiving payment from the reference entity after expiration of any applicable grace period
- Restructuring: a change in the agreement between the reference entity and the holders of the obligation, mainly due to the deterioration in creditworthiness or the financial state of the reference entity

There are two types of settlements in the event of a default:

- Cash Settlement: The buyer and seller of the protection agree to unwind the trade based on the market price of the defaulted bond, and the buyer can receive the net amount depending on the price of the bond. For instance, the bond might have a post-default market value of 40 cents to the dollar, meaning that the buyer which currently holds the bonds can sell it for that amount thus requires a remaining 60 cents to the dollar that is paid for in cash by the seller of the protection. The 40 cents or 40% is also referred to as the recovery rate. The bonds in this case are not delivered to the seller of protection.
- Physical Settlement: The buyer of protection delivers the defaulted bonds to the seller and in exchange receives the agreed upon cash, equal to the notional value. The coupon payments are delivered up until the date of the credit event. This usually involves a three-step process: first, at default the buyer can notify the seller up to 14 days after maturity of the contract (notice this may take place years after the credit event). Second, once the seller is notified of the credit event the protection buyer has 30 days to send a notice of physical settlement, where they specify which bonds or loans they will deliver. Finally, after this notice is sent, the protection buyer has three days to physically deliver the bonds to the seller and in exchange they will receive the notional amount agreed upon, in cash.

### *iii. Risks associated with Credit Default Swaps*

Perhaps the most important aspect to consider when it comes to the risks associated with CDS is that they are not symmetrical. The protection buyer is effectively taking on a short position in the credit risk of the reference entity, consequently relieving the buyer of the exposure to default. The protection buyer is therefore taking the following risks: (1) counterparty default exposure of simultaneous default, meaning both the reference entity and the protection defaulting, also known as “double default” and (2) counterparty replacement risk of default by the seller of protection only.

On the other hand, the protection seller is taking a long position in the credit risk of the specified reference entity. If there is a credit event associated with the reference entity the protection seller will have to make payment to its counterparty. Moreover, the seller of protection is involved in counterparty risk in which case they could potentially lose expected income from the premium payments if the protection buyer defaults.

### *iv. The role of CDS in the 2008 Financial Crisis*

CDSs played an important role in the 2008 financial crisis. Before the meltdown, the CDS market had an estimated notional value of \$62.2 trillion and a gross exposure level of \$5.01 trillion according to the ISDA. The main problem with the CDS’s was that the seller of the protection did not have the capital requirements to pay the settlement to their counterparties in the event that the reference entities started defaulting. Their risk models assumed that only a small percentage of bonds would default, something that in a weak economy would clearly increase. What eventually happened was that companies started to fail and this not only meant that a lot of sellers of protection could not meet the settlement payments with their counterparties, but because the

market conditions were deteriorating, a lot of protection buyers asked protection sellers to post more collateral, which they also did not have enough capital to cover. Consequently this meant that many protection sellers started to fail. Big names such as AIG and Lehman Brothers were important players in this market, and this further worsened the situation effectively creating a domino effect.

#### *v. Collateral Posting on CDS*

In a credit default swap, the counterparties may decide to make collateral posting a requirement in the transaction. For instance, if counterparty A is buying protection from counterparty B for a notional amount of \$8 million, counterparty A may ask counterparty B to post collateral so they can be certain that they can meet payment requirements in case the reference entity has a credit event. The collateral is usually posted in cash, although other assets are sometimes accepted, such as government bonds. In the case of cash collateral, the holder of the collateral will reinvest it and give the counterparty a predetermined interest rate, such as the fed funds overnight rate when collateral is posted in USD. This is done so the cash does not lose any value during the lifetime of the contract. Depending on the type of collateral posted, the counterparty receiving it will accept different *haircuts*. A haircut is a percentage that is subtracted from the market value of the asset depending on its risk; treasury bonds for instance are considered very safe and therefore will have a much lower haircut than stock options. Cash of course, will have no haircut applied to it. A counterparty may post \$10 million worth of stock for a \$8 million notional, meaning that the stock has a 20% haircut assigned to it.

Before the crisis, CDS's did not have a lot of collateral tied to them. After the breakdown of various large corporations, there were many entities who sold CDS's which entered a situation

where they did not have the capital requirements to provide settlement payments to their counterparties. Consequently, other protection buyers saw this as a sign of worsening economic conditions and asked their counterparties who sold them protection to post more collateral, also known as a *margin call*.

## **d. Other types of credit derivatives**

### ***i. Credit Linked Notes (funded CDS)***

A credit linked note (CLN) is essentially a bond with an embedded CDS. The CLN issuer (a special purpose company or trust) sells a CDS and then issues the CLN to an investor. The investor pays a principal amount and then receives periodic coupon payments just like the case of a vanilla bond. The difference lies in that if the credit event of the respective CDS occurs, the coupon payments are terminated, (assuming a physical settlement of the CDS) the issuer receives the defaulted bond, pays the principal to the holder of the CDS and the investor receives the defaulted bond. In the event of no credit event, the coupon payments simply continue till maturity and the principal is repaid in full to the investor, again, as would be the case with a vanilla bond.

The advantage for the issuer is that the credit risk of the CDS is passed onto the investor and the issuer receives cash from the sale of the CLN, theoretically at or below the target cost of funding. The advantage to the investor is a higher yield on the coupons due to the periodic payments from the CDS, which are passed on partially or in full from the issuer.

### ***ii. Basket Credit Default Swaps***

A basket credit default swap is a CDS where multiple reference entities are specified in one contract. There are different types of basket CDS including first-to-default, nth-to-default and all-to-default swaps. The first or nth-to-default swaps happen when settlement is triggered when the

first or nth entity defaults and add-up default swaps where settlement is contingent on all of the entities in the basket.

### *iii. Synthetic Collateralized Debt Obligations (CDO)*

A synthetic CDO is a complex financial security negotiated between two or more counterparties who have different viewpoints on the credit risk and creditworthiness of the reference securities. Notice that it differs from a CDS in the way that there are multiple counterparties as well as multiple reference securities. It is quite a leveraged bet, meaning that depending on the outcome, a specific counterparty may have to make a large settlement payment with little or no collateral posted. In technical terms, synthetic CDOs are a type of CDO in which the underlying credit exposure is taken from a CDS rather than from a structured investment vehicle who buys the assets. They can be single tranche or fully distributed CDO. One advantage from a CDS is that investors can decide to take only as much credit risk as they can tolerate. After their role in the subprime mortgage crisis, synthetic collateralized CDO's became highly controversial securities.

### *iv. CDS Indexes*

The credit default swap indices are a type of credit derivatives that are used to mitigate risk or to take a position on a basket of credit entities. They are traded more and more over the past few years due to multiple facts. First of all, they are priced more easily than single name CDS's and cash bonds. Secondly, indices have a better liquidity and standardized terms because they are traded by all major dealer banks. This means that it is easier to hedge a portfolio with credit default swap indexes than it would be to buy single name CDS's. There are four main parties involved in credit indices:

- Banks trade them on their own behalf and provide liquidity for their clients.
- Markit (a global financial information services company) owns and operates the indices, including licensing, marketing, administration and calculation.
- Institutional Investors can hedge their positions or express views in specific market segments via credit indices
- And finally, the third parties, who made trading credit indices easier by integrating them into their platforms.

In 2004, iBoxx and Trac-x merged together to form the two major groups of credit default indexes: the CDX in North America and the iTraxx in Europe and Asia

We can look at the differences between the two in the following table:

	iTraxx	CDX
Region	Europe, Asia and Australia	North America and Emerging Markets
Credit Event	Bankruptcy, Failure to Pay, Modified Restructuring	Bankruptcy, Failure to Pay
Currency	Europe - EUR	USD and EUR
	Japan - JPY	
	Asia - USD	
	Australia - USD	
Reference Entities	Liquidity – A liquidity poll decides inclusions and	Dealer Poll - Dealers select reference entities to be



	exclusions	added and removed
Business Days	London and TARGET Settlement Day	USD - New York and London EUR - London and Target Settlement Day

***v. Loan Credit Default Swaps (LCDS)***

This instrument works exactly like a CDS but instead of referencing a bond or a normal loan, the reference entity is strictly limited to syndicated secured loans.

***vi. Contingent Credit Default Swaps (CCDS)***

This credit derivative is a variation of a CDS. Unlike a simple CDS, the settlement payment is triggered by a credit event and another specified event, which is usually a market or industry variable. These securities are generally employed to protect a specific exposure when there is economic turmoil and the market is deteriorating.

**e. The ISDA Master Agreement**

The ISDA (International Swaps and Derivatives Association) Master agreement is a document which provides the contract terms of the two counterparties involved in a Credit Default Swap. (Note: The ISDA Master agreement actually documents a large array of over-the-counter derivatives trades, but for the purposes of this project, the focus will be on its documentation of CDS trades.) The agreement includes:

- Which credit, if defaulted, will trigger the CDS

- The specific obligations that are covered under the contract
- The notional amount of the protection
- What specific event would fall under a credit event
- The procedures for settlement of a credit event

This standardized format aids the process both for the buyer and seller of protection; it has also been an enormous growth driver for the CDS market. The parties involved in the transaction usually specify the terms which inherently differ from trade to trade, that is, the terms unique to this transaction which would exclude details such as reference entity, maturity date, spread and notional.

Despite what the name might imply, the ISDA Master is not a single, sole way in which each type of OTC derivative may be traded. Rather, it is available in multiple versions (e.g. the 1992 and 2002 versions), to the convenience of counterparties to use either as it is, specifying the specific variables such as reference entity, maturity, etc., or to modify further with the use of a Schedule to the ISDA Master Agreement or an ISDA Credit Support Annex (see below for further information on CSA).

#### *i. Credit Support Annex (CSA)*

The credit support annex is a document that provides credit protection by establishing the rules of the mutual posting of a collateral between derivative counterparties (which trade private OTCs) to mitigate the credit risk arising from in-the-money derivative positions. The trade is documented in the ISDA Master Agreement as described above and the CSA is a part of the ISDA Master as an annex to the ISDA Schedule.

In order to mitigate the risk of the party which is in-the-money, the CSA requires a posting of collateral by the party which is out-of-the-money. The form of the collateral is generally restricted to cash, government securities or high-rated bonds. However, in order to post collateral other than cash, the out-of-the-money party must post in excess so that the amount is equal after being discounted for risk. The specific amount required to be posted is equal to the amount that would be owed in the case that all relevant, outstanding transactions were to be terminated.

A CSA is not a mandatory requirement when using the ISDA Master for OTC derivative trades (though it is illogical to use a CSA without the ISDA). The advantage, of course, is the subsequent decrease in counterparty credit risk.

## **f. Collateral Posting and Optimization**

With every derivative transaction the bank does with their counterparties, there is a reasonable chance that we will have to pay them money in the future, or vice versa. Bank of America is therefore subject to counterparty risk.

Collateral serves as a means to reduce counterparty risk. The Mark-To-Market (MTM) of the trades with the counterparty is netted on a daily basis. If the counterparty 'owes' the bank money, meaning that MTM is currently positive and theirs is negative, they post collateral either in the form of cash or securities. This way, if they default, the bank keeps the collateral as compensation. This of course works both ways in the event that the bank has a negative MTM.

The details of collateral posting as well as credit events are located in the CSA (Credit Support Annex) section of the ISDA Master Agreement. The CSA specifies the following:

- What type of financial instruments can be posted as collateral, which usually includes cash and non-cash (securities) collateral
- The rate at which the bank will pay interest to the counterparty who is posting collateral to us, as well as the interest rate the bank receives from posting collateral
- Haircuts which may be applied to non-cash collateral. A haircut is a discount on the price of the underlying asset tied to its risk and volatility of changing its value. E.g. stock options may have a 20% haircut meaning that \$1000 worth of options will cover \$800 of collateral. For treasury bonds the haircut would of course be much less
- The collateral may be non-rehypo or available for rehypothecation. Rehypothecation means that the bank can use its counterparty's collateral to post as collateral with other counterparties
- Triparty which means the collateral is not posted to the issuing bank but to a third party in escrow
- Concentration limits, which specifies how much of a certain kind of collateral can be used
- Threshold grids specify at what point, in terms of MTM movement the counterparty or the bank starts to post collateral and how much of it is posted

The current proposed project for CDM is that it is capable of delivering the following after a user enters the CoPeR ID, Legal Entity and Product Type:

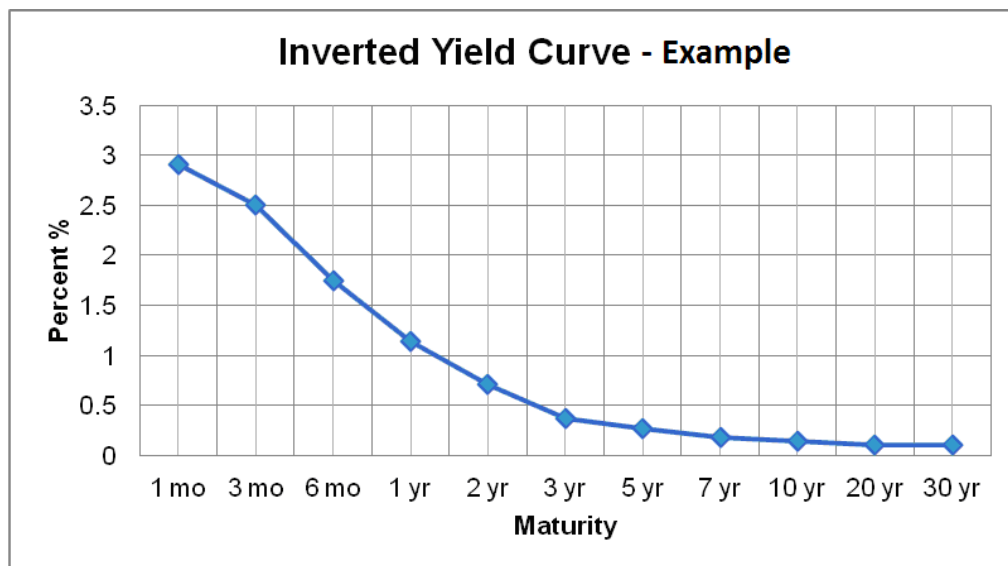
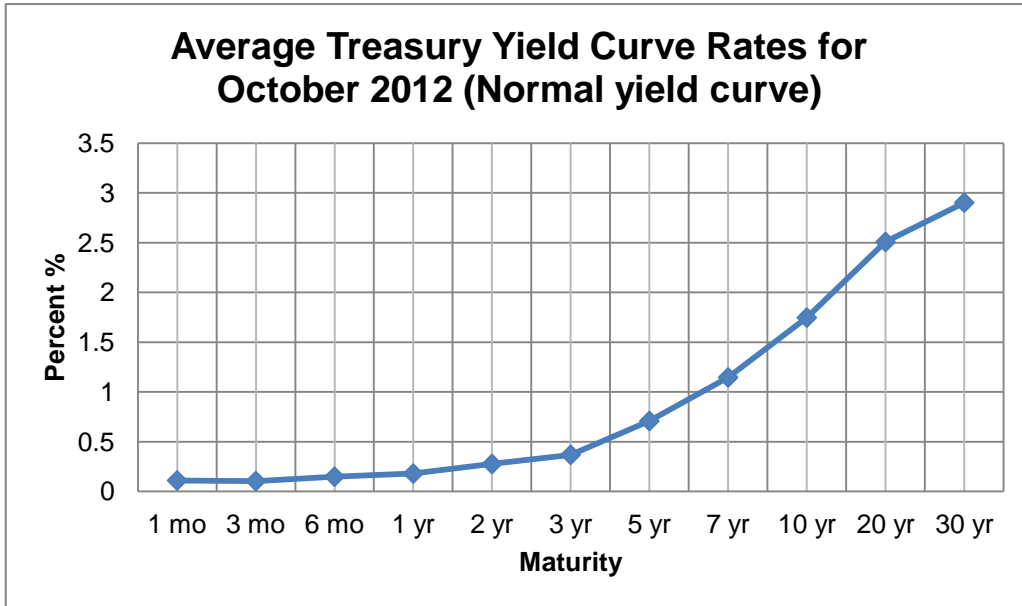
- CSA Master ID
- Jurisdiction (US, UK, etc.)

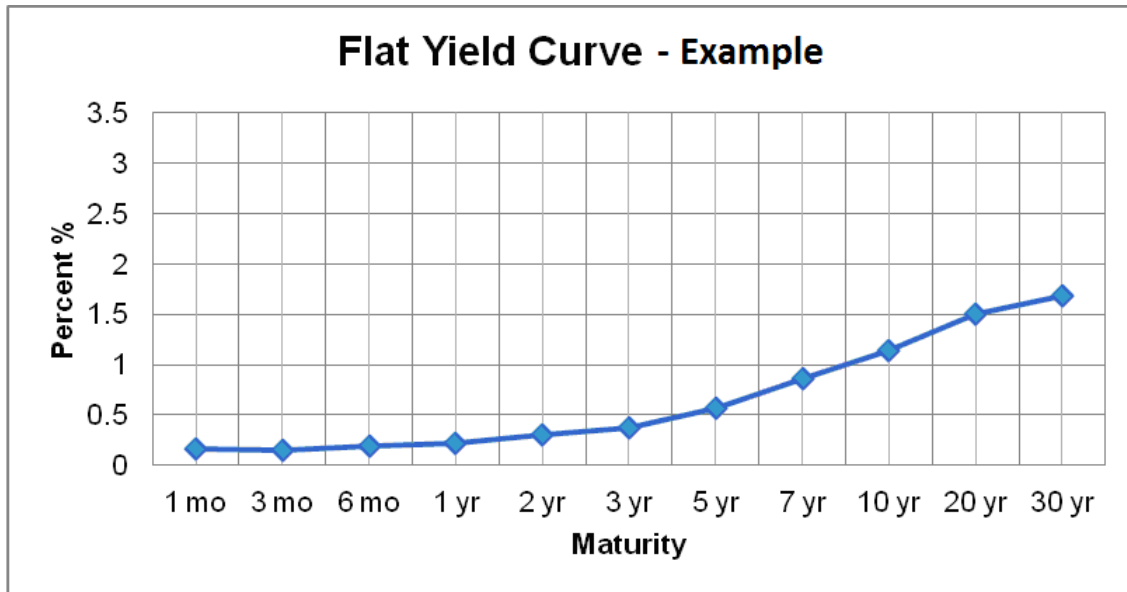
- Summary of Rehyppo flag
- Triparty flag
- CSA Rating from collateral desk
- Discount curve
- Threshold grid
- Eligible collateral table
- Total MTM exposure
- Postings table
- Additional CSA Info
  - Termination events
  - Downgrade provisions

## **g. Yield curves**

A yield curve is a line that plots the changing interest rates at a specific set point in time of bonds having equal credit quality but different maturity dates. The most common yield curve is the one comparing the 3-months, 2-years, 5-years and 30-years U.S. Treasury debt. It is used as a benchmark for other debt products such as bank lending rates and mortgage rates. It can also be used to predict changes in economic output and growth. The diagram below shows a normal yield curve, where the yield increases with maturity because of the risk associated with time. An inverted yield curve means short-term yields will be higher than long-term yields and could be a

sign of upcoming recession. The third type is a flat yield curve which is when the short-term and long-term yields are close to each other and may predict an economic transition.





#### h. Mark to Market (MTM)

Mark to market is an accounting method that enables a more accurate depiction of the value of assets and liabilities. Instead of looking at the book value, one looks at the market value. Obviously this perspective subjects the value to change over time; in some cases this can be a rapid change, as was the case during the financial crisis of 2008.

In this scenario, MTM actually caused the holdings of many banks to be much less than a realistic value, because the market demand vanished in a time of financial panic. As a direct result of this, the Financial Accounting Standards Board now allows mark to market accounting to use the price that would be had outside of a financial crisis, rather than forced liquidation regardless of circumstances. Mark to market is very important in assuring that collateral for derivatives can be properly posted – otherwise the purpose of collateral in mitigating credit risk would be nullified as the true market value would not be accounted for and the collateral could not be accurately posted.

## **i. Discount rates**

A discount rate is an interest rate used when eligible institutions borrow money from central banks on a short term basis. It is determined by the average rate which banks are willing to charge each other for overnight funds. This valuation method can be very helpful when dealing with investments that contain high risk such as derivatives; it allows estimating the present value of what you'd receive from an investment by adjusting for the time value of money. In the case of credit default swaps, the potential for the reference equity defaulting is a risk which can be taken into account using discount rates.

### ***i. London Interbank Offered Rate (LIBOR)***

The London Interbank Offered Rate, or Libor, is a common measure of the average interest rate of lending between banks. It is calculated from the daily Libor bids of several member banks of the British Banker's Association by dropping the four highest and four lowest bids and averaging the remaining. Libor is calculated every day for ten different currencies and time periods ranging from overnight to annual. This rate is used in over \$300 trillion worth of financial derivatives, especially swaps. In the last few years, there has been a repeated discovery of member banks manipulating their bids in order to profit from a subsequent movement (or lack thereof) in Libor, which further encouraged a switch to OIS.

### ***ii. Overnight Indexed Swap (OIS)***

An overnight indexed swap, or OIS, is a specific type of interest rate swap in which the floating rate is set to the overnight rate's geometric average. An advantage of OIS over Libor-



based swaps is that the former only involves a payment of the net difference between floating and fixed rates.

In the United States, the overnight index swaps are called *Federal Funds* and they are excess reserves that commercial banks deposit at the “Federal Reserve”. They are borrowings that banks keep at the Federal Reserve to meet their reserve requirements and also to clear financial transactions. They can be lent to other commercial banks with insufficient reserves to help them meet their requirements as well. Banks are also required to keep a level of reserves in correlation to the amount of customer deposits they are responsible for. What makes them different is the fact that they hold relatively lower interest rates; the “federal fund rates”. These are extremely short, overnight rates and are not subject to collateral. They are therefore considered unsecured interbank loans.

In Europe, just like the Libor, the *Euro OverNight Index Average (EONIA)* is a common measure of the average interest rate of lending between banks in the euro market. Eonia reference rates are calculated by the European Central Bank.

Similar to the Eonia, the *Sterling Overnight Index Average (SONIA)*, which was created in 1997 by the Wholesale Markets Brokers’ Association, is the measure of the average rate of lending between banks in the United Kingdom.

### ***iii. LIBOR-OIS Spread***

The Libor-OIS spread is the difference between the Libor and the OIS discount rates. The spread between OIS rates and Libor is an important economic indicator which is a possible gauge for stress in the money markets. A much higher Libor indicates banks’ unwillingness to lend to each other, while the opposite shows a high liquidity. Historically Libor is around 10 basis points

higher than OIS rates, but during the most recent financial crisis, this reached a record high of 365 basis points after the collapse of Lehman Brothers. As of October 29<sup>th</sup> 2012, the three month Libor – OIS spread is standing at 16 basis points, which suggests that it is within the same range as it was pre-crisis. We can see from the chart below that the recovery has a decreasing trend in the last year and is approaching its stable historic value.

## US Libor OIS Spread



Source: <http://www.bloomberg.com/quote/BICLOISS:IND/>

## j. Swaps

Swaps are a financial derivative in which the two parties are involved in a contract in which they agree to exchange cash flows, usually one side at a fixed rate and the other at a floating rate. These cash flows can be based on commonly used interest rates (such as LIBOR), commodities (such as oil), or even the condition of certain events like the case of a credit default swap (which as its name suggests pays off based upon a specified default's occurrence). In the case of an interest rate swap, the “payer” pays the fixed rate to the “receiver” and the “payer”

receives the floating rate from the “receiver.” Floating rates can also be exchanged. Essentially, when the time of payment comes, the two interest rates assigned to each party are compared at the time, and the net amount is then transferred to the party with the higher interest.

### **i. Cross-Currency Swap**

As opposed to a swap, where the two parties exchange cash flows in the same currency, a cross-currency swap introduces the concept of exchange rates and its main purpose is for the counterparties to benefit from comparative advantage. In general the cross-currency swap involves the exchange of a flow of payments in one currency for a flow of payments in a different currency. This can easily be applied to something like an interest rate swap, exchanging for example Libor +30bps in USD for 50bps in EUR.

In the case of a CDS, where before the default there are only periodic payments in one direction, there can still be cross currency issues if the CSA allows collateral to be posted in more than one type of currency, where the counterparty posting the collateral would effectively enter a cross currency swap in order to change from one currency to the other one.

#### ***1. Cross currency basis***

Cross Currency basis refers to the difference or spread between the Euro and Dollar OIS rates. Currently it is negative, meaning that there is more demand for dollar funding than there is for euro funding.

## ii. Swaptions

A swaption (or a swap option), is an option that gives the owner the right to enter into an interest rate swap. In exchange for a premium, the buyer is given the right (but not the obligation) to enter into a specific swap agreement with the issuer on a specified future date.

There are two types of swaption contracts:

- A payer swaption: the owner enters a swap where they pay the fixed leg and receive the floating leg.
- A receiver swaption: the owner enters a swap in which they receive the fixed leg and pay the floating leg.

The two parties, the buyer and the seller, agree on the premium, the strike rate, length of the option, the notional amount, and the frequency of settlement payments. There exist three major categories for swaptions:

- Bermudan swaption → the owner is allowed to enter the swap on different specified dates.
- European swaption → the owner is allowed to enter the swap only on the maturity date.
- American swaption → the owner is allowed to enter the swap on any day within the range of two days.

These can be physically settled, when an option is actually entered into upon exercise, or, they can be cash settled in which case the market value of the underlying swap changes hands upon exercise.

## k. Differential Discounting

Differential discounting is the practice of valuing derivative contracts using discount rates that are specific to the terms of the governing collateral agreements. In other words, derivatives are valued depending on the governing CSA terms. The general consensus is that the discount factor that should be used to discount the future cash flows should be based on the OIS curve instead of the currently used Libor curve. The reason behind this is that with the events that took place during the crisis as well as the post-crisis era, we have found that the OIS reveals the true funding costs tied to credit derivatives. During the crisis, banks were not willing to lend money as much as the government, which leads to an increased Libor - OIS spread. Recall from the previous sections that the OIS is based on government rates and Libor is set by major banks.

For credit derivatives that involve two currencies instead of one, such as a EUR denominated CDS where the counterparty wishes to post collateral in USD, the cross currency basis has to be accounted for in the derivative pricing. This arises because the counterparty who is posting the USD collateral will be effectively entering a cross currency swap to turn the USD into EUR and post the collateral in the designated currency. Currently the EURUSD cross currency basis is negative therefore the counterparty will have a funding advantage. This has to be accounted for in the valuation of the derivative. In practice, the cross currency basis would be factored into the discount curve that is used to value the contract.

As more market participants recognize the funding impact of collateral agreements, the credit derivative market will move to a standard, as has already occurred in interest rate markets, where the collateral arrangements underlying the transaction are incorporated into pricing and valuing contracts.

## **I. Bank of America CSA Project**

Bank of America is currently undergoing a project to implement the switch of valuing credit derivatives using OIS instead of LIBOR. The reason behind this is because collateral agreements pay rates closer to the OIS rather than the LIBOR, meaning that derivatives are funded at OIS rates. The project has two phases, Standard CSA and Actual CSA. The overall requirements of the CSA project are to implement OIS discounting based on CSA collateral agreements through books and records; and to establish the necessary business processes to support OIS discounting.

### ***1. Standard CSA***

The Standard CSA phase assumes the adoption of local currency discounting for seven major currencies as well as USD. OIS discounting will be used for the remaining currencies.

### ***2. Actual CSA***

The Actual CSA phase, which follows the Standard CSA phase, assumes that non-collateralized trades are valued using local LIBOR curves while collateralized trades are valued based on the individual CSA rules and a cheapest to deliver logic (meaning the counterparty will deliver the cheapest currency) governing the Bank's relationship with a particular client. When determining the most appropriate discount regime, it will incorporate pledge type, cheapest to deliver currency and thresholds.

### **m. Counterparty Valuation Adjustment (CVA)**

Counterparty valuation adjustment (sometimes referred to as credit valuation adjustment, abbreviated CVA) is the difference between the risk-free portfolio value and the true portfolio value that takes into account the possibility of the counterparty defaulting. In other words, CVA is a measure of the market value of counterparty credit risk. CVAs depend mainly on interest rates and default risks. Only privately negotiated over the counter derivatives are subject to counterparty risk. There are two characteristics that make CVA different from traditional credit risk: the uncertainty of exposure and the bilateral nature of credit risk. It is important to measure CVA when entering into a credit derivative transaction with a counterparty that has some credit risk, especially to value the derivative properly. In Bank of America, CVA also refers to the team in charge of counterparty valuation adjustments.

### **n. Funding Valuation Adjustment (FVA)**

Funding Valuation Adjustment refers to the present value of the lifetime expected funding accrual difference between Actual CSA terms and 3 Month USD Libor or the Standard CSA conditions. The reason for FVA comes from the fact that many CSA's permit more than one currency to be posted as collateral, which essentially means that the cheapest currency to post for collateral can vary over the life of a trade. In Bank of America, FVA also refers to the team in charge of funding valuation adjustments.

## **III. Methodology**

This section of the paper will explain the methods used by the credit derivatives back and middle office desks, specifically some of the systems we interacted with and were relevant to our project.

### **1. ATS - Agreement Term Sheet**

The agreements term sheet (ATS) is an interface originally designed to store the agreements between counterparties. Today it is also used to model and capture data in these. With the unplanned use of this interface, a number of problems occur such as:

- Missing data, specifically eligible securities for collateral
- Inconsistent securities mapping
- Slow turnaround time on change request
- Multitude of unresolved data quality issues
- Inadequacies and inflexibility in the ATS model

### **2. CDM - CVA Data Manager**

The CVA Data Manager or CDM is a centralized database interface that provides bank employees with a variety of services such as:

- Viewing and quoting trades that require CVA quoting



- Viewing any CSA issues with the bank's counterparties
- Viewing counterparty thresholds and overrides
- Viewing hypothetical trade data
- Consistent input data such as credit curves, collateral terms and credit mitigation

The goals of the CDM project are:

- To provide CVA pricing models with correct input data
- To manage data with appropriate levels of control
- To eliminate potential bottlenecks in feeds to CVA pricing models
- To minimize the CVA team's external dependencies
- To deliver a scalable and extensible data management solution
- To deliver a unified CDM API for the Scenario Tool and CVA Pricing Spreadsheet

Some of the calculations and computations CDM will do are:

- Calculate correlations and volatilities needed for CVA pricing
- Act as repository for historical time series CVA Data
- Receive raw data from ATS which validates, cleans and normalizes it
- Produce an end of day report of different CDS indices including families of the Markit CDX index (North America) as well as the iTraxx (EMEA)

- House normalized inflation volatilities for their use in pricing inflation-linked derivatives.
- Provide netting flag and information (netting will allow counterparties to offset collateral exposure depending on their sum of their MTM).

CVA Data Manager



View prod v1.37.8 NBK7KU0

Query Metadata Query Diff Thresholds CSA Issues **Counterparties** Counterparty Overrides

Manage Counterparties Export

Coper Id 
  GCI Id 
  Name 
 Non-Provisioned

Name	Coper Id	GCI Id	Legal Entity	Data Layer	Curve Source	Curve Identifier	Provisioning Status
GOLDMAN SACHS & CO.	4844	006984561	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
THE GOLDMAN SACHS GROUP, INC.	4851	998924906	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS INTERNATIONAL	4852	998901656	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS (ASIA) FINANCE	21720	337423745	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS (ASIA) LLC	45597	999420334	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS JAPAN CO., LTD.	160603941	998918759	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS INTERNATIONAL BANK (SEOUL BRANCH)	161631301	335556318	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS ASSET MANAGEMENT, L.P. O/B/O THE TRUSTEES OF THE OPSEU PENSION PLAN TRUST FUND	161679344	337437361	DEFAULT		CAMDEN	USD/GS/Senior unsecured/3 month/scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS BANK, USA	163657219	998925184	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS FOREIGN EXCHANGE (SINGAPORE) PTE	163868703	998923395	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS CREDIT PARTNERS LP	212182598	998929939	DEFAULT		CAMDEN	USD/GS/Senior Unsecured/3 month/Scenario 4	<input checked="" type="checkbox"/>
GOLDMAN SACHS (INDIA) CAPITAL MARKETS PRIVATE LIMITED	212268389	338566658	DEFAULT		CAMDEN	usd/GS/senior unsecured/3 month/scenario 4	<input checked="" type="checkbox"/>

For example, in the screen above the user goes to the Counterparties tab and searches ‘Goldman’ to find all of the counterparties that start with that name, he then finds the CoPeR ID of the appropriate name which in this case would be 4844.

Query Metadata Query Diff **Thresholds** CSA Issues Counterparties Counterparty Overrides

Perform a Threshold Grid Query

As Of Date: Nov 30, 2012

Master Id Coper Id GCI Id

Coper Id: 4844

Legal Entity: BKNA

**Threshold Grid:**

asOfDate	coperid	gcild	legalEntity	masterid	xdocsAgreementId	rating	bankThresholdAmount	bankThresholdAmountCurrency	cpThresholdAmount	cpThresholdAmo
2012-11-30	4844	006984561	BKNA	238185		AAA	25,000,000	USD	25,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		AA+	25,000,000	USD	25,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		AA	20,000,000	USD	20,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		AA-	20,000,000	USD	20,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		A+	15,000,000	USD	15,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		A	5,000,000	USD	5,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		A-	5,000,000	USD	5,000,000	USD
2012-11-30	4844	006984561	BKNA	238185		BBB+	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		BBB	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		BBB-	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		BB+	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		BB	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		BB-	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		B+	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		B	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		B-	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		CCC+	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		CCC	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		CCC-	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		CC	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		C	0	USD	0	USD
2012-11-30	4844	006984561	BKNA	238185		NR	0	USD	0	USD

The user then makes his way to the Threshold tab to find specific information about this counterparty. He types the CoPeR ID and the Legal Entity and receives back all the threshold information he was looking for.

As-Of Date: **Nov 30, 2012**

Collateral
As-Of Date: **Nov 30, 2012**

**Query**

**Counterparty**

**Coper Id**

**Legal Entity**

**Counterparty Details**

**Counterparty** GOLDMAN SACHS & CO.

**Master Id** 238185

**Rating** A-

**CSA Details**

**Pledge Type** Bilateral **Bank Substitution**

**Counterparty** Coper: 4844 Legal Entity: BKNA  
DataLayer:

**Last Modified** 2012-05-14 **CP Substitution**

**Entry Price** FF +5.890 **Tri-Party**

**Exit Price** FF **Rehyppo**

**Rating** B **Governing Law** NY

**Current Thresholds**

**Counterparty**

**Currency** USD

**Threshold Amount** 5,000,000

**Min Transfer Amount** 500,000

**Independent Amount** 0

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**Eligible Collateral** Thresholds Posted Collateral

**Eligible Cash**

Post To	Identifier	Rehyppo	CSA Rate	Currency	Type	Non FTP	Curve	Price Rate	Adjustment To OIS	Ranking Rate	Price
Counterparty	USD-CASH	<input checked="" type="checkbox"/>	FEDEFF D +0.000	USD	TRSY	<input checked="" type="checkbox"/>	FF	16	0	16	FF
Bank	USD-CASH	<input checked="" type="checkbox"/>	FEDEFF D +0.000	USD	TRSY	<input checked="" type="checkbox"/>	FF	16	0	16	FF

**Eligible Securities**

Post To	Identifier	Rehyppo	Haircut	Type	Non FTP	Curve	Price Rate	RWA BS	Ranking Rate	Cash Rate	Price	Inv. LE	Inv. Other
Counterparty	FHLMC-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Counterparty	GA-FNMA-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Counterparty	GNMA-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Counterparty	FHLMC-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Counterparty	GA-FNMA-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670	<input checked="" type="checkbox"/>	
Counterparty	GNMA-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Counterparty	UST-BONDS RE 1<x<=10	<input checked="" type="checkbox"/>	98.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Counterparty	UST-NOTES RE 1<x<=10	<input checked="" type="checkbox"/>	98.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Counterparty	UST-BILLS RE x<=1	<input checked="" type="checkbox"/>	99.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.89	16	FF +5.890	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Counterparty	UST-BONDS RE x<=1	<input checked="" type="checkbox"/>	99.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.89	16	FF +5.890		
Counterparty	UST-NOTES RE x<=1	<input checked="" type="checkbox"/>	99.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.89	16	FF +5.890		
Bank	FHLMC-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Bank	GA-FNMA-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Bank	GNMA-NACN RE 5<x<=999	<input checked="" type="checkbox"/>	95.0	AGY	<input checked="" type="checkbox"/>	FF	22	0	20.9	16	FF +4.900		
Bank	FHLMC-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Bank	GA-FNMA-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Bank	GNMA-NACN RE x<=5	<input checked="" type="checkbox"/>	98.5	AGY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		
Bank	UST-BONDS RE 1<x<=10	<input checked="" type="checkbox"/>	98.5	TRSY	<input checked="" type="checkbox"/>	FF	22	0	21.67	16	FF +5.670		

The screen above shows other information that the user can attain from the CDM using the CoPeR ID and Legal Entity. It can be seen that information such as the credit rating, pledge type, CSA Rating, rehypothecation and eligible types of collateral are available.

### 3. GDA-Global Derivatives Analytics

GDA is a three letter acronym that has grown to have more than one meaning during the past decade at Bank of America. It is considered to refer to the core quantitative analytics library that is used widely throughout the organization for pricing and risk management purposes.

When the GDA project first began in 2001 within Merrill Lynch, its primary aim was to unify quantitative analytics across the organization. Merrill Lynch had many distinct analytics libraries when the project started but each one's coverage was limited to either one or two asset classes. GDA now covers all main asset classes and almost all of the legacy analytics libraries from before. Users and developers now have access to a one-stop shop for all their quantitative requirements, and are able to build solutions with a single unified library and programming interface.

### 4. Quartz Funding Adapter

The Quartz Funding Adapter (FA) allows clients to compute funding curves used for Funding Value Adjustments (FVA) calculations. The funding adapter consists of a funding ID calculation API (application programming interface).

The FA calculator uses an Excel algorithm to compute the funding ID, but it is in need of some certain set of trade details. The Excel formula is:

```
getFundingID(coperID, legalEntity, tradetype, product, cptyBranch='UNKNOWN',  
dealCcy=None, isMultiCcy=True, forceUSDOIS=False, forceRehypo=None, forceTriparty=None,  
asofdate=None, forceBilateral=None, forceCsalsExecuted=None, fidType=None)
```

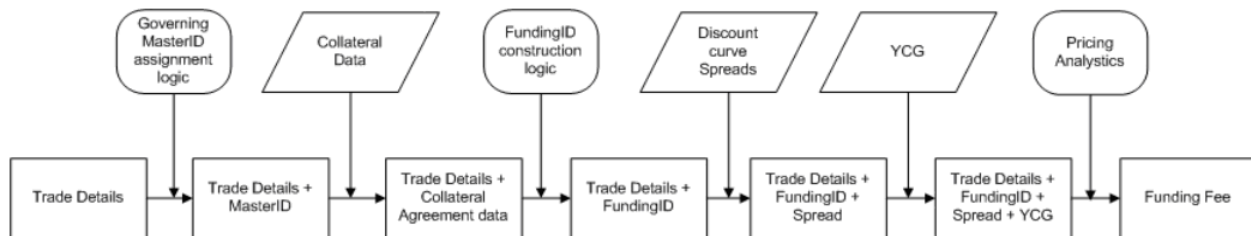
And the attributes needed are:

- CoPer ID (integer): The CoPeR ID of the counterparty to the deal
- LegalEntity (string): The legal entity acronym (e.g. MLI, BKNA..) of the bank side of the deal
- TradeType (string): The trade type
- Product (string): The ATS product code of the trade

Once the funding ID is generated, the funding adapter will retrieve the collateral agreement details for that specific ID with another Excel algorithm based on the given trade attributes.

The formula for that is:

**retrieveCollInfo**(*counterParty, legalEntity, tradeType, productType, counterPartyBranch='UNKNOWN', asOfDate=None*)



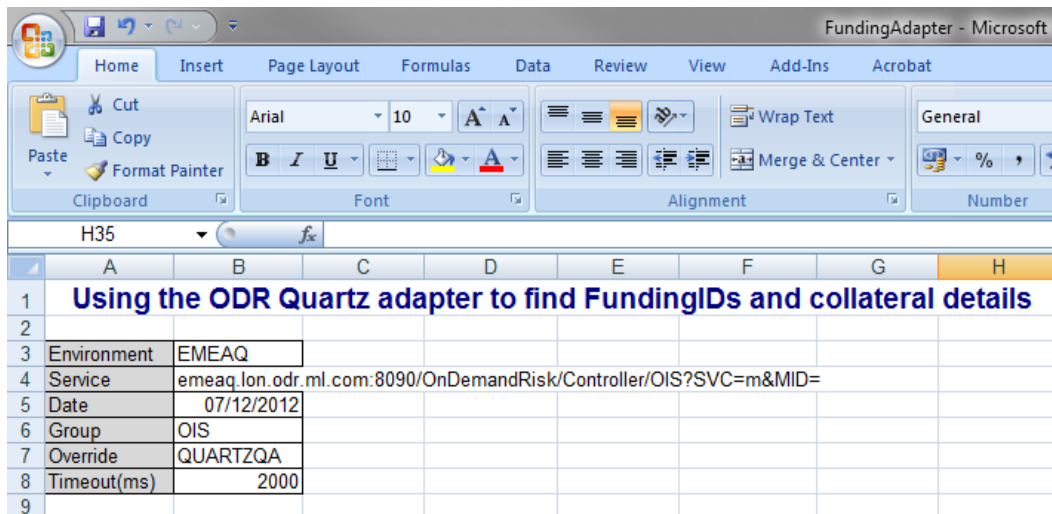
The figure above shows a diagram displaying the basic system logic when finding a Funding ID for a trade detail.

In the screenshot below, we can see the funding adapter spreadsheet and mainly, the ‘Lookup Details’ section of it:

Using the ODR Quartz adapter to find FundingIDs and collateral details													
												Support:	DG FVA Support
Environment	EMEAQ												
Service	emeaq.lon.odr.ml.com:8090/OnDemandRisk/Controller/OIS?SVC=m&MID=												
Date	07/12/2012												
Group	OIS												
Override	QUARTZQA												
Timeout(ms)	2000												
CopierID	Entity	Product Type	Trade Type	Deal CCY	Multi Currency	Funcor	Delivery	MaxTenor	SettleType	CashSettleType	ODR ID	Result	Funding ID
13	150 BKNA	FFS	SWAP	JPY	No						x-odrlloc.em	#NAME?	
14	32997 BKNA	FXS	FX_FWD	ZAR	Yes						x-odrlloc.em	#NAME?	
15	211648718 BKNA	FFS	Swap	NZD	No						x-odrlloc.em	#NAME?	
16	160532219 BKNA	FFS	SWAP	CAD	Yes						x-odrlloc.em	#NAME?	
17	211773939 BKNA	CDP	CREDIT_DERIV	EUR	No						x-odrlloc.em	#NAME?	
18	154426012 MLC1	FFS	Swap	CAD	No						x-odrlloc.em	#NAME?	
19	214235328 MLIL	FFS	Swap	USD	No						x-odrlloc.em	#NAME?	
20	1116 BCML	FFS	Swap	BRL	No						x-odrlloc.em	#NAME?	
21	52718 MLCS	XXC	SWAP	SGD	No						x-odrlloc.em	#NAME?	
22	1116 BCML	FFS	Swap	USD	Yes						x-odrlloc.em	#NAME?	
23	163646532 BKNA	CDP	CREDIT_DERIV	USD	No						x-odrlloc.em	#NAME?	
24	1402 MLC1	FFS	Swap	AUD	No	SwaptionFlow	Swap	1Y	PHYSICAL	NONE	x-odrlloc.em	#NAME?	x-o
25	18412 MLC1	FFS	Swap	EUR	Yes	SwaptionFlow	Swap	3Y	PHYSICAL	NONE	x-odrlloc.em	#NAME?	x-o
26	28079 MLC1	FFS	Swap	KRW	Yes	SwaptionFlow	Swap	1Y	PHYSICAL	NONE	x-odrlloc.em	#NAME?	x-o
27	186294711 MLCS	FFS	Swap	HKD	No	CMSFloatSidi	CashYCAadj	3M	Cash	CashYCAadj	x-odrlloc.em	#NAME?	x-o
28	211332625 BKNA	FFS	Swap	USD	Yes	SwaptionFlow	Swap	5Y	PHYSICAL	NONE	x-odrlloc.em	#NAME?	x-o
29	1192 BMUB	FFS	Swap	INR	Yes	CMSFloatSidi	CashYCAadj	1Y	Cash	CashYCAadj	x-odrlloc.em	#NAME?	x-o
30				CHF	Yes								
31				CHF	No								
32				INR	No								
33													
34													
35													
36													
37													
38													
39													
40													
41													
42													
43													
44													
45													
46													

On the top part, there are some options that the user can specify. Those are environmental variables. They are:

- Environment: which is specific to the location of the user (e.g. in London, the EMEA directory is used)
- Service: is the domain from which the information is looked up
- Date: shows the today's date
- Group: it looks up which discount rate should be used, in this case it is OIS
- Override: refers to the Quartz Desktop
- Timeout(ms): the program stops running after the specified amount of milliseconds has passed

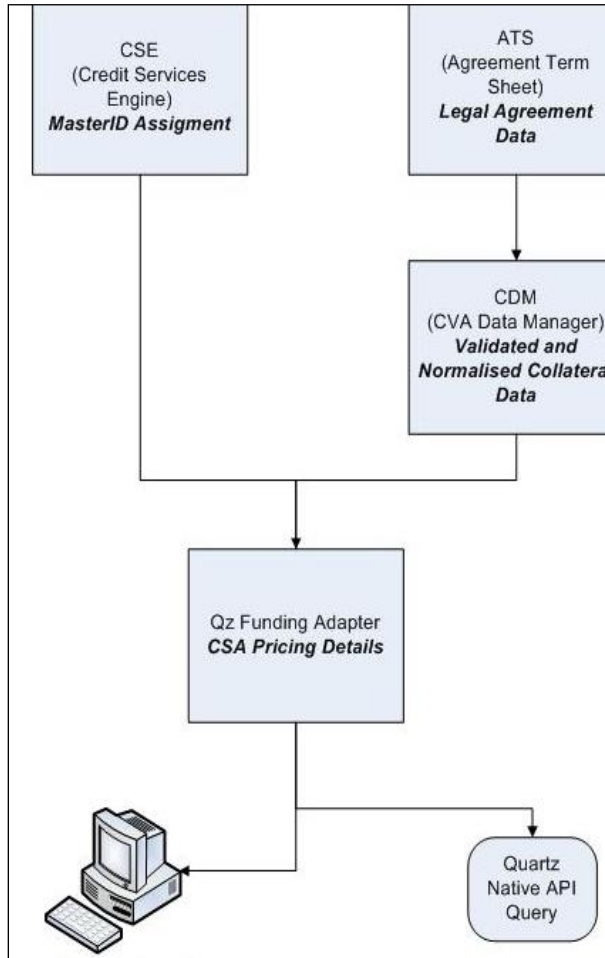


The screenshot shows a Microsoft Excel spreadsheet titled "FundingAdapter - Microsoft E". The ribbon includes Home, Insert, Page Layout, Formulas, Data, Review, View, Add-Ins, and Acrobat. The active cell is H35. The spreadsheet content is as follows:

	A	B	C	D	E	F	G	H	
1	<b>Using the ODR Quartz adapter to find FundingIDs and collateral details</b>								
2									
3	Environment	EMEAQ							
4	Service	emeaq.lon.odr.ml.com:8090/OnDemandRisk/Controller/OIS?SVC=m&MID=							
5	Date	07/12/2012							
6	Group	OIS							
7	Override	QUARTZQA							
8	Timeout(ms)	2000							
9									



Finally, in the figure below we can see the overall mapping of the systems, specifically the data streaming flow.



## IV. Results

### 1. Business Requirements Document

At Bank of America, BRDs (short for business requirements document) are used commonly to describe and propose an upcoming project. They are documents structured in such way that the summary of it is displayed in the first page in a table, giving the reader an insight on the project. For our application, we prepared a BRD for our manager, to be distributed to traders.

Version no	Date	Author	Summary of changes
<b>0.1</b>	29 Nov 2012	Burak Birand Francisco Amador Jack DeWeese	Initial draft
<b>0.2</b>	30 Nov 2012	Burak Birand Francisco Amador Jack DeWeese	Made clarification changes

## i. Project Description

Problem Statement	Traders do not have a good interface to use to check for counterparty and collateral information.
Goal statement	To create a user friendly interface to unify all relevant counterparty and collateral information in a spreadsheet. If the interface is working appropriately, it will be integrated to Quartz.
Scope	All of the counterparties that have been traded with so far will be covered in this GUI.
Key benefits	<ol style="list-style-type: none"><li>1. A single spreadsheet which is designed to give the most information with less inputs → easier for FO to use.</li><li>2. A reliable program with proper documentation → with this, inquiries about the UI will be solved by the user.</li><li>3. Eventually move it to Quartz and reduce dependencies on other systems that are being migrated to Quartz.</li></ol>
Line of business	EMEA
Project Sponsor	William Carroll

## ii. Introduction

The front office does not currently have a properly working interface to look for any counterparty information or collateral postings. Traders' queries are sent to the Credit Technology desk which causes delays and work overload.

### iii. Background

#### Current Issues faced by the Front Office

The FO is facing problems finding information and Standard CSA Funding ID in the funding adapter (FA). This is due to the fact that the FA requires the trader to type in some information, these include:

- CoPeR ID
- Entity
- Product Type (3 letter code to be found from a disorganized 12 page Word document)
- Trade Type

Sometimes, these are not even enough and inputting the 'Deal Currency' and 'Multi Currency' is necessary.

The real problem is the fact that the FO employees have difficulties finding all these inputs, especially the CoPeR ID's. The CVA Data Manager (CDM) currently contains counterparty information such as CoPeR ID, Master ID. It is not a completely user friendly tool and not entirely accurate hence takes time. This forces traders to send queries to the Credit Technology desk, resulting in major delays.

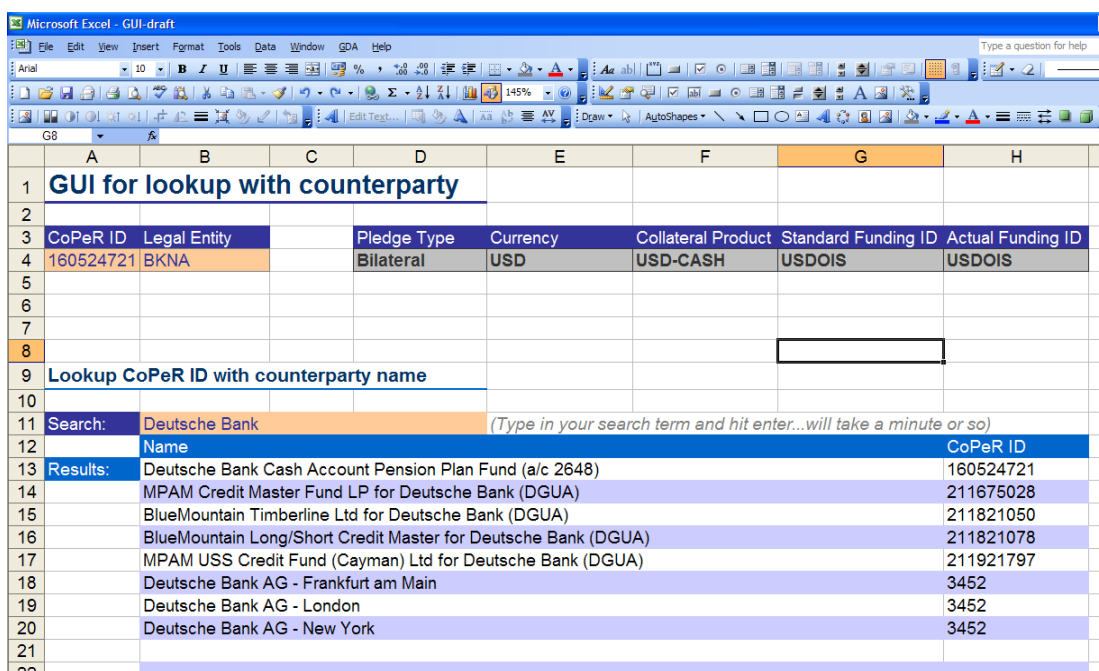
#### Proposed Graphical User Interface

The goal of this new spreadsheet interface is to put everything together in one place. All the counterparties, GDA, and other parameters will be present in separate sheets in Excel, in the same

file. The one main sheet will have a “smart search” tool which will allow the user to type in key words of counterparties and get out the CoPeR ID.

Once the CoPeR ID is given, all there is to do is to copy and paste it to the “CoPeR ID” field on top and hit ‘Enter.’

We can see in the example below that the CoPeR ID is inserted to the field on top, and the information is given automatically.



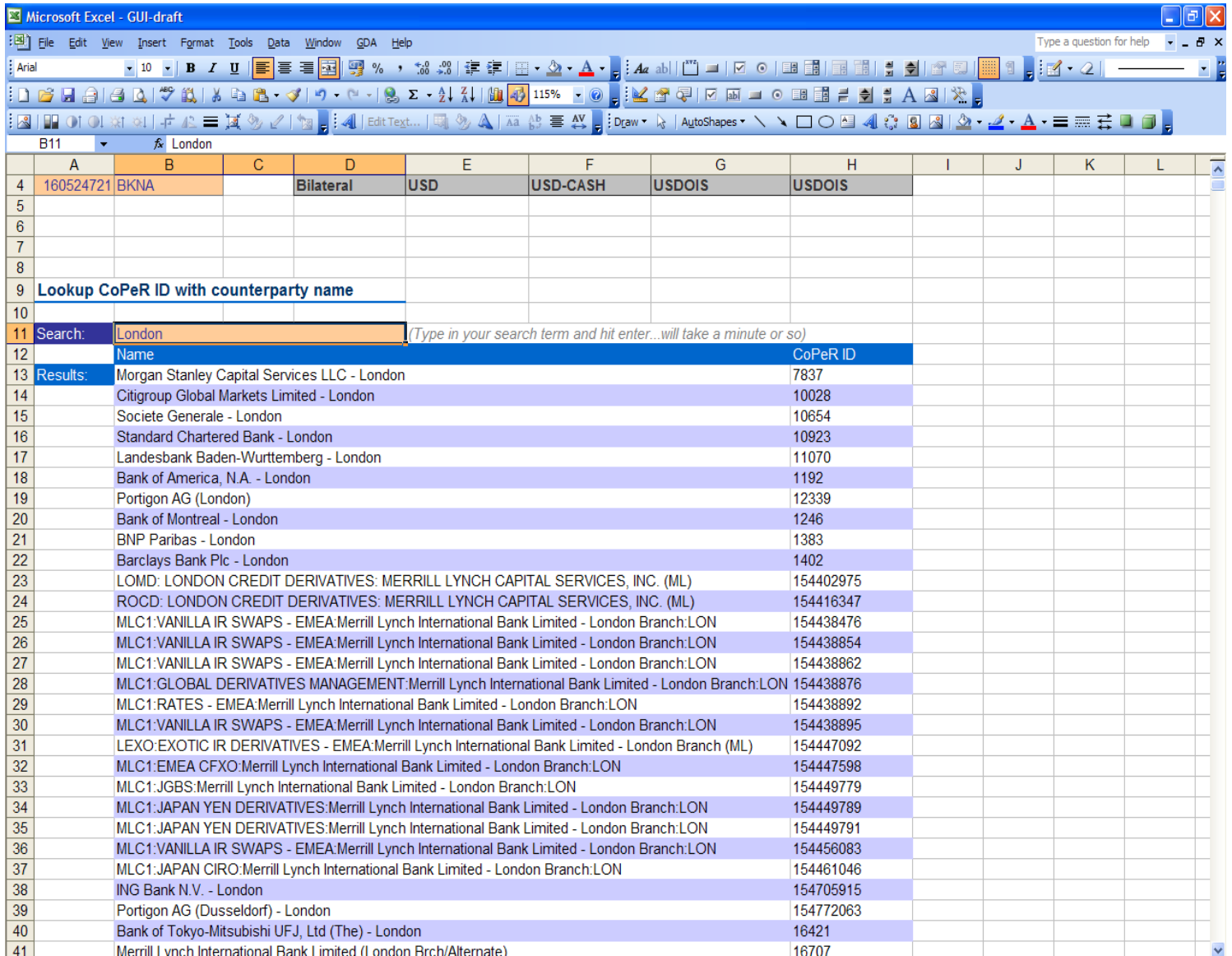
The information put out by the GUI includes:

- Pledge Type
- Currency
- Collateral Product
- Standard Funding ID

- Actual Funding ID

This new UI will be better presented and user friendly.

As shown in the screenshot below (UI still in development), one can type in “London” and the search engine will look for ‘all’ the counterparties with the name London in them and show them respectively with their CoPeR IDs.

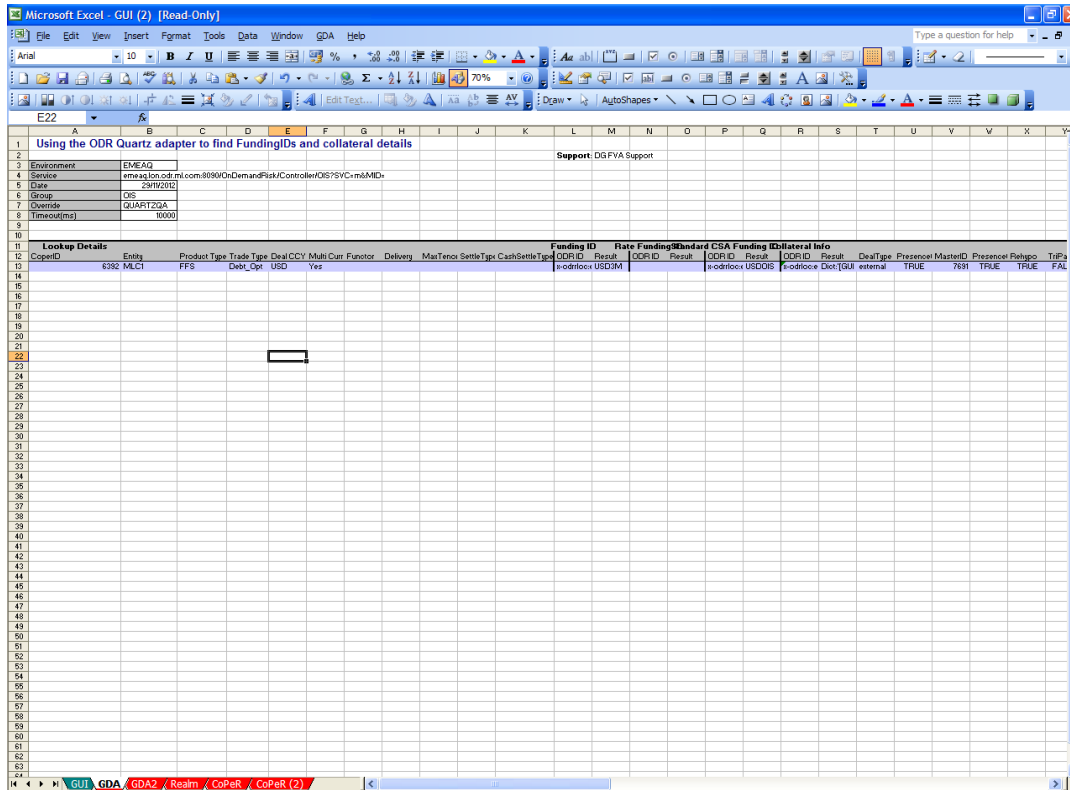


#### iv. Business Requirements

For someone to use this new ‘graphical user interface’ (GUI), all they need is to have the GDA plug-in installed in their Windows Excel (2003 or higher). That is something that can be easily done via ARM (Access Request Management) over the Bank of America secure connection. The request is completed within a couple of days, and bulk requests can be done upon need.

- What is the Graphical User Interface made of?

The existing funding adapter is integrated in the GUI:



This means that it can do everything the FA could in a more presentable way.

The list of all the counterparties traded is also included in another sheet. This list of counterparty – CoPeR ID is the same one used in the CDM database, so the new UI has all the *relevant* information the CDM has.

A screenshot of that list is below.

1	Ctpy	Ctpy Coper				
2	Morgan Stanley Capital Services LLC - London	7837	Search:	London		Ctpy
3	Morgan Stanley Capital Services LLC - New York	7837				"London"
4	Citigroup Financial Products Inc	10026	Results:	Morgan Stanley Capital Services LLC - London		
5	Citigroup Financial Products Inc. - New York	10026				
6	Citigroup Global Markets Limited - London	10028	Results:	Morgan Stanley Capital Services LLC - London	7837	
7	Accident Compensation Committee (A/C 2176)	100318		Citigroup Global Markets Limited - London	10028	
8	PIMCO Banner Health Fund 989	101123		Societe Generale - London	10654	
9	PIMC-J Sainsbury Pension Scheme tite Sainsburys Pens Scheme 2109	101369		Standard Chartered Bank - London	10923	
10	PIMCO Winchester Cayman U S Bond Fund 2725	101390		Landesbank Baden-Wuerttemberg - London	11070	
11	PIMC-Brown Bro Hariman Cayman Tr PIMCO Cayman Frgn Bd Fd 2726	101393		#NUM!	#NUM!	
12	PIMCO Winchester Cayman Global Ex Japan Yen Hd Bd Fd 2732	101460		#NUM!	#NUM!	
13	Banca Popolare dell Emilia Romagna	1019		#NUM!	#NUM!	
14	Genworth Life and Annuity Insurance Company	102091		#NUM!	#NUM!	
15	Banco Bilbao Vizcaya Argentaria SA (Madrid)	1042		#NUM!	#NUM!	
16	PIMCO Winchester Glo Tr Co Ltd P Cayman Tr PI C Gl Aggregated Bd Fd 2733	105351		#NUM!	#NUM!	
17	Skandinaviska Enskilda Banken - Stockholm	10599		#NUM!	#NUM!	
18	Societe Generale	10654		#NUM!	#NUM!	
19	Societe Generale - London	10654		#NUM!	#NUM!	
20	Societe Generale - New York	10654		#NUM!	#NUM!	
21	S.N.C.B. Holding	10664		#NUM!	#NUM!	
22	KeyBank National Association (Cleveland)	10669		#NUM!	#NUM!	
23	PIMCO Employees Retirement System of the City of Norfolk (A/C 801)	108481		#NUM!	#NUM!	
24	PIMCO Frank Russell Investment Co plc - The U.S. Bd Fd (a/c 1627)	108611		#NUM!	#NUM!	
25	Banco Espirito Santo SA - Lisbon	1088		#NUM!	#NUM!	
26	Standard Bank PLC	10919		#NUM!	#NUM!	
27	Standard Bank of South Africa Ltd.	10920		#NUM!	#NUM!	
28	Standard Chartered Bank - London	10923		#NUM!	#NUM!	
29	Standard Chartered Bank - Singapore	10923		#NUM!	#NUM!	
30	Banco Finantia SA	1093		#NUM!	#NUM!	
31	Agilent Ltd. Retirement Benefits Plan (A/C 1898)	110367		#NUM!	#NUM!	
32	Landesbank Baden-Wuerttemberg - London	11070		#NUM!	#NUM!	
33	Landesbank Baden-Wuerttemberg - New York	11070		#NUM!	#NUM!	
34	Landesbank Baden-Wuerttemberg - Stuttgart	11070		#NUM!	#NUM!	
35	Sumitomo Mitsui Banking Corporation - Tokyo	11083		#NUM!	#NUM!	
36	Boeing Company Employee Retirement Plan Master Trust A/C 158	110928		#NUM!	#NUM!	
37	Svenska Handelsbanken AB (PUBL) - Stockholm	11165		#NUM!	#NUM!	
38	Swedbank AB (Stockholm) - Stockholm	11169		#NUM!	#NUM!	
39	PIMCO Absolute Return Strategy IV Master Fund LDC (A/C 3199)	111912		#NUM!	#NUM!	

## v. Additional Notes

- The interface is still in the design process. Once complete, it will list counterparties in an order (alphabetical or CoPeR ID number order).
- Copying and pasting the IDs to the necessary fields will be streamlined.



- The GUI will be able to list more than one line of counterparty information at a time.
- A documentation/manual of the process will also be available for users.
- If testing goes appropriately, the next step will be to integrate it to the Quartz desktop.

## 2. FB & J Counterparty Lookup Tool Description

In order to assist traders with the day-to-day collection of information, we created the FB&J Collateral Information Lookup. This tool, created in a macro-enabled Excel spreadsheet, allows a trader to search for a counterparty by its name, and display relevant information on the collateral agreement for said counterparty.

The spreadsheet has a static list of all counterparties for the search function. One of the problems encountered with the GDA Funding Adapter is that the specific CoPeR ID was required to lookup information, but since there was no easy way to lookup the counterparty's CoPeR ID and it would have to be repeated for each counterparty, it was not convenient for traders. As a way around this, a search function was added to the tool, so the trader can simply type in a search term(s) and have a list of matching counterparties with their respective CoPeR IDs appear below.

Because the user of course does not want the inconvenience of having to retype each CoPeR into the new section, the program allows the user to simply select a counterparty and click the "Add" button. The legal entity may have to be changed, in which case there is a drop down menu to select from.

The rest of the process is completely automatic, as the CoPeR IDs and legal entities selected are used to query the collateral information and then display it in an easy to read table. The pertinent information displayed is counterparty name, pledge type (whether it is bilateral or one way, and if so, which party is posting, or if there is no collateral posted), currency(ies) of the collateral, collateral product, and standard and actual funding IDs.

The final objective of this project for Bank of America is to have the tool available in Quartz, but due to time constraints, we were not able to complete the Quartz version. We did however leave a very well commented version in Excel to help the Quartz programmers finish the process of porting over the tool.

## V. Project Impact and Conclusion

The primary objectives of this project were two-fold. We helped bridge the gap between the front and back offices and the development team at Bank of America, and we created an Excel tool (which will eventually be moved to Quartz) for traders to streamline the process of looking up collateral information for specific counterparties.

During the first few weeks, we gave several presentations to both several members from the front and back offices and several members from the development team. Our first presentation was to discuss the details of differential discounting and the purposes behind it. We gave this first to the back office and then repeated the presentation for the development side so they were able to better understand the purpose of the upcoming changes in software that would be needed. Later we did a lot of research into the various software packages (e.g. CDM, Quartz) and their respective documentation and gave detailed presentations to front and back office members on what was available, its functionality, and our goals for the new tool. This type of education process is vital to the financial industry as all too often there is a large disconnect between business and development sides and very few individuals able to communicate across the gap effectively.

Our final product for our project here was the FB&J Excel tool. While very simple in nature, it very effectively streamlines a common lookup process for the traders that is extremely important with the changing nature of collateral due to differential discounting. While spending time coding VBA just for items such as a button to copy one cell to another in a spreadsheet may not seem very important, it is these minute details that make the program easy to use and thus desirable to traders in their constantly busy days. For the tool, user's guides were made for both traders and developers. The former is simply a step-by-step on how to use the program, while the developer's

guide details how the tool works cell-by-cell. Its purpose is primarily to help its integration into Quartz after we leave.

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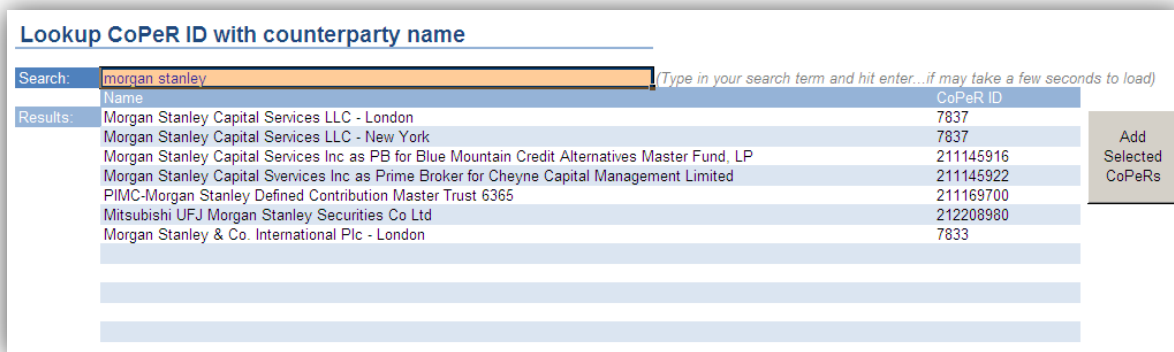
# VII. Appendix

## 1. FB&J Collateral Info Lookup Guide

### Step 1

#### Action: Search for counterparty

In the cell highlighted below, type your search term for the counterparty you are looking for and hit enter.



#### Result

The list below should populate with any matches from the list of counterparties as shown above.

### Step 2

#### Action: Copy CoPeR IDs

Select counterparty(ies) to lookup collateral information for, and then click the button “Add Selected CoPeRs.”



## FB&J: GUI for lookup via counterparty



CoPeR ID	Legal Entity	Counterparty Name	Pledge Type	Currency	Collateral Product	Standard Funding ID	Actual Funding ID
7837	BKNA	Morgan Stanley Capital Services LLC - London					
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						

Clear CoPeRs

### Lookup CoPeR ID with counterparty name

Search:  (Type in your search term and enter...if may take a few seconds to load)

Name	CoPeR ID
Morgan Stanley Capital Services LLC - London	7837
Morgan Stanley Capital Services LLC - New York	7837
Morgan Stanley Capital Services Inc as PB for Blue Mountain Credit Alternatives Master Fund, LP	211145916
Morgan Stanley Capital Services Inc as Prime Broker for Cheyne Capital Management Limited	211145922
PIMC-Morgan Stanley Defined Contribution Master Trust 6365	211169700
Mitsubishi UFJ Morgan Stanley Securities Co Ltd	212208980

Add Selected CoPeRs

## Result

The counterparty you have selected will be copied to the next free cell in the upper table under CoPeR ID and the collateral information in the cells to the right will fill in automatically.

CoPeR ID	Legal Entity	Counterparty Name	Pledge Type	Currency	Collateral Product	Standard Funding ID	Actual Funding ID
7837	BKNA	Morgan Stanley Capital Services LLC - London	Bilateral	USD	T-STRP	USDOIS	USDOIS
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						
	BKNA						

Clear CoPeRs

The columns give the following information (from left to right):

- Counterparty name
- Pledge Type (i.e. bilateral, one way counterparty posts, one way bank posts, or no collateral)
- Collateral currencies
- Collateral product type
- Standard Funding ID

- Actual Funding ID

### Step 3 (optional)

#### *Action: Change legal entity*

If BKNA (or whichever legal entity is currently selected) is not the desired legal entity, you can select the cell and either simply type the correct legal entity or select one from the dropdown menu.

#### *Result*

The collateral data to the right will automatically refresh to reflect the change in legal entity. If the legal entity given does not match any on the list of all legal entities, a warning will appear.

### Step 4 (optional)

#### *Action: Clear CoPeR IDs*

If the list of CoPeR IDs is full, you can clear the list by either clicking the button “Clear CoPeRs” or by selecting the cell and pressing delete.

#### *Result*

The list will now have room for additional CoPeRs to be added.

NOTE: All cells other than the input cells in the workbook are protected and thus cannot be edited (there is no password to unlock cells).

## 2. List of Acronyms

*ATS*: Agreement Term Sheet

*GCM*: Global Capital Markets

*CDM*: CVA Database Management

*CDS*: Credit Default Swap

*CSA*: Credit Support Annex. It is a document that defines the terms or rules under which collateral is posted or transferred between swap counterparties to mitigate the credit risk

*CSE*: Credit Services Engine, new Quartz based system.

*CVA*: Counterparty Valuation Adjustment. An adjustment to the market value of a derivative reflects the market's assessment of credit risk of the parties involved

*Unilateral CVA*: CVA assuming that only the counterparty can default and Bank of America will never default

*Bilateral CVA*: CVA assuming that either Bank of America or the counterparty could default

*FVA*: Funding value adjustment

*GDA*: Global Derivative Analytics, in house Microsoft Excel plug-in

*IR*: Interest rate

*ISDA*: International Swap and Derivative Association

*OTC*: Over the Counter

*RC* –Rates and Currencies

<b>Field name</b>	<b>Description</b>
CoPeR ID	Counterparty ID
LegalEntity	ATS Legal Entity Acronym (Bank side counterparty)
MasterID	ATS ID for Master Agreement
DealType	Whether the Counterparty is internal or external
PresenceOfExecutedAgreement	If the agreement has a contract statue of 'Executed'
PresenceOfCsa	If the agreement has a CSA attached to it
PledgeType	Who will post collateral under the agreement
Triparty	Will the collateral be held by a third party
Rehypo	Can the collateral be rehypothecated
CollateralCurrency	CSA eligible collateral type

### 3. List of Major Currency Acronyms

*USD*: United States Dollar

*EUR*: Euro

*GBP*: British Pound

*JPY*: Japanese Yen

*CHF*: Swiss Franc

*AUD*: Australian Dollar

*HKD*: Hong Kong Dollar

*CAD*: Canadian Dollar

*NOK*: Norwegian Krone

*SEK*: Swedish Krona