White Paper

TALANTON TECHNOLOGIES

Understanding Credit Risk and Tackling It Cost Effectively

Credit risk management is an important part of risk management for which significant resources are dedicated to computing credit risk measures. Such teams generally consist of technologists, financial and quantitative analysts. Credit risk measures help the senior management in financial institutions make calculated decisions to mitigate risk and enhance returns.

Table of Contents

The significance of counterparty credit risk management

Let us start with a simple example by assuming that there are two financial institutions A and B respectively where A lends an amount of USD 1 million to institution B at an interest of 10% per annum. Institution A ideally will receive an amount of USD 1.1 million from B after a year, however we consider the alternative scenario where institution B defaults on its obligation of paying USD 1 million plus the 10% interest.

This unpredictable situation wherein institution B defaults on its obligation to institution A is the counterparty credit risk for institution A.

In the event that institution B defaults, then institution A will lose all its money. The above is a basic demonstration of what credit risk is to financial institutions, and how does it arise from the counterparty in any given transaction, and hence the name counterparty credit risk. Due to such uncertain events, financial institutions have credit risk measurement teams wherein the exposure of the institution with respect to each transaction entered is measured thoroughly as per the prescribed regulatory standards. In most cases, transactions are complex and contain more exotic products.

Say we have two institutions entering into an interest rate swap transaction, wherein both parties exchange a certain amount of payment periodically as per the contract. In this case the counterparty credit risk for both institutions are the events that the counterparty will fail to meet its contractual obligations, which is an example of a bilateral risk.

However, not all trades have counterparty risk involved. The risk is non-existent for an exchange, hence exchange traded contracts such as futures do not have counterparty risk as the counterparty in Exchange Traded contracts is the Exchange itself. Although exchanges being the counterparty do carry credit risk, nevertheless they have a very low probability of default and thus can be considered credit risk-less.

The risk in a general transaction mainly stems from OTC derivatives and securities financing, and is computed for the individual portfolio (assessing the exposure to the trade), the trade itself, as well as the trading counterparty.

Counterparty Credit Risk Measurement

Valuation Adjustments are financial risk modelling such as funding (FVA), credit risk (CVA), regulatory capital costs (KVA), and more. Where the "x" in xVA to denote an entire collection of valuation adjustments to meet individual needs. These values represent price correction at a portfolio level and therefore can only be computed once price distribution of each trade over portfolio lifetime is known. This means thousands of price valuations are needed for each trade to accurately determine CVA and Debit Valuation Adjustment (DVA) values. Adding to the challenges, computing fine grade sensitivities for these adjustments using traditional bump-and-revalue methods has become computationally infeasible or they demand a hefty cloud computing cost.

Credit risk measures are used to make calculated decisions. These decisions help organizations manage their risk exposure better. To start with, the existing transactions are priced as the initial step in measuring credit risk. Once the value of trades is known then the credit risk is measured. The possibility that the counterparty may default forms the core of this exercise. Moreover, counterparties may as well have a very low probability of default. Examples of low default probability entities are Exchanges or Central Clearing Houses. Whereas lowest rated counterparties (such as below BB+/Ba1 i.e. non-investment grade speculative) have a higher degree of default.

Understanding the types of risk measure: Risk measures are classified into two categories;

- **Scalar Risk Measure**: It measures that represent risk as a single value i.e. one value to represent exposure for entire life of contracts with a counterparty.
- **Profile Risk Measure**: It represents risk over a time period i.e. one value for each time point.
- **Counterparty Credit Risk Measures**: To accurately price the transactions we use mathematical finance computations based on the current state of the market and thus is based on the current market data. We will discuss in brief the credit risk measures prescribed by the regulatory bodies and compliance organizations.

Due to the changing market data the price computations for the transactions vary as well over time. In addition, prescribed regulations require computations of credit risk exposure for future dates. Thus, sophisticated mathematical modelling techniques are used for pricing transactions over the lifetime of a portfolio, which includes various sampling and forecasting techniques. Therefore, montecarlo simulation techniques are used in credit risk computations to simulate market data over a range of scenarios which mimic future time points. These scenario generated market data points are known as simulated paths, which are part of an n number of montecarlo simulations. The probability distribution of relevant variables such as the interest rate curves affects the generated data points, on which the trades are then priced with respect to.

List of common credit list measures.

The price of any given trade is the Market To Market (MtM). MtMs are calculated across scenarios and time points and then used to calculate relevant number of risk measures. Other inputs such as probability of counterparty default, recovery rate of getting money back from the counterparty are combined with these computed risk measures, along with a range of other statistical measures to compute credit risk measures:

- **Expected Market To Market (EMtM):** The transaction price is computed from its cashflows during the lifetime of a contract. EMtM considers both positive and negative amounts. EMtM profile is one MtM value for each timepoint
- **Expected Exposure(EE)**:EE amount indicates the positive amount that the trading party will lose if the counterparty defaults. Negative MtMs are capped to 0. EE is a profile risk measure and is the average of MtM distribution. EE is usually greater than MtM.
- **Negative Expected Exposure (NEE):** This is a mirror image of how EE is calculated. Positive MtMs are floored to 0. NEE tells trading entity how much counterparty is exposed to it. NEE is a profile risk measure.
- **Expected Potential Exposure (PEE):** Once EE is calculated, an average value of EE is computed. EPE is a scalar risk measure.
- **Expected Negative Exposure (ENE):** Mirror image of EPE. It is the average value of NEE. ENE is a scalar risk measure.
- **Effective Expected Exposure (EEE):** For each time, maximum of (current EE value and maximum EEE) is selected. This then results in increasing EE profile. EE is a profile risk measure.
- **Effective Expected Positive Exposure (EEPE):** EEPE is the average of EEE profile. EEPE is a scalar risk measure.
- **Potential Future Exposure (PFE):** Based on a confidence level (e.g. 97.5 percentile or 99 percentile), the distribution of MtM is computed and a value is taken from the distribution for each time point. We can think of PFE as the worst-case scenario exposure to a counterparty. PFE is usually greater than EE. PFE is a profile risk measure.
- **Potential Exposure (PE):** As PFE is calculated over a number of time points, PE is the maximum value of PFE across all time points. PE is greater than PFE. PE is a scalar risk measure. I have also seen PE as a risk measure profile whereby maximum PFE of each timepoint is selected to create a peak exposure profile.

- **Exposure At Default (EAD):** EAD is a scalar risk measure. It is calculated as EEPE x 1.4.
- **Credit Value Adjustment (CVA):** CVA is the market price of a counterparty. This amount indicates how much a trading entity should charge the counterparty. Refer appendix for equations.
- **Funding Value Adjustment (FVA):** Amount banks need to keep if they are trading in OTC derivatives.
- **Default Value Adjustment (DVA):** Market price of a trading entity to the counterparty. Refer appendix for equations
- **Bilateral Credit Value Adjustment (BCVA):** It calculates net effect of CVA and DVA and is calculated as CVA + DVA.
- **Capital Value Adjustment (KVA):** To support uncollateralized OTC derivatives.
- **Margin Value Adjustment (MVA):** Amount required to support posting of collateral. Note, netting and collateral can reduce counterparty credit risk measures.

Reducing exposure to counterparty risk

The three ways to reduce exposure to credit counterparty risk is by diversification, collateral, and netting set; each of which we will explain in the following.

- **Diversification**: Counterparty credit risk can be transferred by diversifying and entering contracts with a large number of counterparties with different probabilities of default. For example, a trading party can enter into some of its contracts with an Exchange. This is known as Diversification and Hedging Risk by entering trades with a range of counterparties to reduce the counterparty credit risk. There are several rating agencies such as Fitch and Moody's, S&P etc. that gather valuable information on counterparties to provide counterparty credit ratings.
- **Netting, Closeouts and Collateral**: There are several other ways to mitigate counterparty credit risk too. These methods include netting, closeouts and collateral.

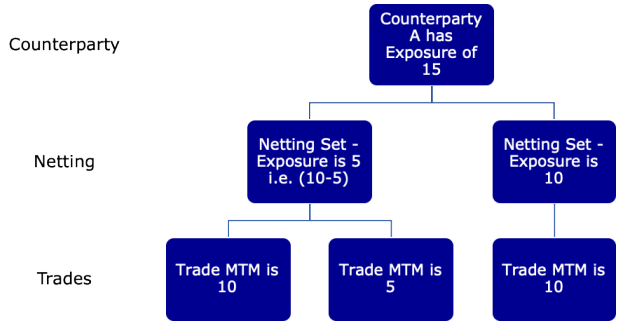

Figure 1. Exposure without netting set presence is USD 20.MtMs of all trades is summed to give us exposure of USD 20.

Basics of Netting

Derivative trades are priced and their value is calculated. This is known as calculating transaction mark to market (MtM). Each transaction is priced using its own mathematical model. In general, cashflows are calculated and summed across the maturity of the trade to calculate price of a trade.

The price can either be negative or positive. Negative amount implies what you owe your counterparty whereas positive amount reflects the money that you require from your counterparty.

Trades can be grouped together if they belong to the same legal agreement such as ISDA. If a group of trades belong together then their grouping is known as a netting agreement. It is also known as a netting set. Netting agreements can be bilateral (involves trading party and the counterparty) or multi-lateral where a group of counterparties are involved to reduce the credit exposure.

Prices of grouped trades are summed to produce a single value. As a result, positive and negative prices end up netting or cancelling each other off. If a group of trades do not belong to a netting agreement then the negative MtMs are ignored and negatives are capped to 0. As a result, without netting sets, negatives are ignored whereas netting sets reduce exposure because a positive amount is offset by a negative amount in a netting set.

Overall, the reduction in exposure reduces the counterparty credit risk.

How Netting Works

The diagram below illustrates a set of trades in a portfolio and how total exposure is reduced due to netting sets, We can reduce the credit risk exposure by introducing netting sets.

For netting across different asset classes, a netting factor is calculated as:

$$Netting\ Factor = \frac{\sqrt{Number\ of\ Exposures + (Number\ of\ Exposures - 1)}}{Number\ of\ Exposures}$$

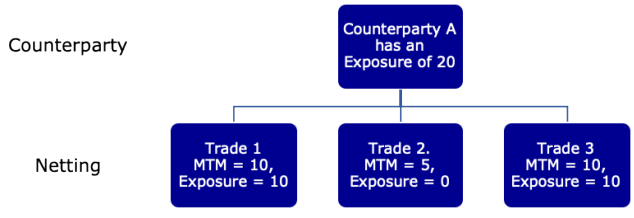

Figure 2. Exposure is USD 15 at counterparty level. This reduction is due to grouping of trades within the netting sets.Without being set, it would have been USD 20. Netting set therefore reduces counterparty credit risk.

Higher Netting factor implies lower netting benefits. Netting factor decreases with larger number of exposures.

Closeout: When counterparty defaults, all of its contracts are closed. Closing out is the process of immediate transfer of the netted amount to the trading party. If a trading party owes a counterparty money then the feature that allows a trading party to terminate the contracts when counterparty defaults is known as walkout. Credit risk can also be reduced by posting and receiving collateral.

Collateral: Collateral is also known as margining. Two parties can enter into a collateral agreement. A collateral agreement outlines the collateral amount that the parties need to post to reduce counterparty exposure. Collateral agreement is also known as Collateral Support Annex (CSA) which is a document associated with a netting agreement. CSA document outlines col- lateral rules. When a CSA exists between two counterparties then firstly trades between trading party and counterparty are netted together and then collateral calculation is applied.

Not only collateral reduces counterparty credit risk, it also reduces capital required to trade with a counterparty. It's Important to Understand Collateral Support Annex (CSA). When a CSA is part of a netting agreement then parties are required to post collateral on periodic basis.

CSA

Presence of CSA can reduce counterparty credit risk as counterparties are obliged to post collateral. Posting of collateral has administrative and transactional costs associated with it therefore collateral is only posted on timely basis. Collateral amount can reduce the exposure to 0. If the netted amount is negative then the trading party posts collateral amount to the counterparty. If the netted amount is positive then the trading party receives collateral amount from the counterparty.

CSA outlines a number of important legal details, for example how to resolve dispute, timing of collateral, rounding of collateral and credit quality etc.

In this section, we will highlight a number of useful parameters that are stated in a CSA:

- **Initial Margin (IM) or Independent Amount (IA):** Amount required to enter into a contract. It is mainly dependent on the credit quality of a counterparty and not on the exposure level.
- **Minimum Transfer Amount (MTA):** Amount that can be recalled by a counterparty at any time.
- **Threshold:** MtM of a netting agreement can alter on daily basis and can result in 0, positive or negative value. As negative MtM implies posting collateral amount, posting of collateral has its own administrative costs associated with it. Threshold is the minimum MtM amount that needs to be exceeded before collateral can be posted.
- **Collateral Amount:** Collateral amount that counterparties can call.
- **Haircut Amount:** Amount to reduce the value of collateral.

It accounts for the possibility

- that the collateral amount can fall between previous collateral call and a counterparty de- fault. Haircut "cuts" the collateral amount that is required to be posted. Collateral can be posted in cash, government bonds, MBS, equity etc. The discount (haircut) is expressed in percentage and is dependent on the type of collateral posted.
- For example, haircut of 2% implies 2% of collateral amount needs to be posted. Riskier assets have greater haircut per- centage. Cash has least haircut percentage.

In the following section, we will discuss on how users can avail the services offered by Talanton Technologies and tackle counterparty credit risk cost effectively.

Going the Open-Source Way

Given the increased costs of regulations on financial institutions, it has become a difficult tradeoff to keep paying for the hefty license fees for proprietary software. These costs keep rising for institutions in developing and under-developed nations, as they have no control whatsoever over not only the software but also the data. In addition, majority of these software originate from OECD nations where the software developer has to pay multiple levels of taxes, including personal income tax as well as corporate tax. These third-party costs are then transferred upon to the consumers and thus we see them bearing the brunt of increasing costs due to factors outside their control.

Our areas of expertise

- Interfacing of low-level routines to languages like Python, Java and .Net/CLR (e.g., with SWIG, PyBind11, JNI, etc).
- Reproducible builds with complete software supply chain control.
- Deployment to serverless/cloud facilities.
- Data models to integrate numerical algorithms with business logic.
- Applications to financial markets and engineering.

Numerical algorithms integrated securely, efficiently and durably into your business

We interface, wrap, build, package, deploy and integrate open-source numerical algorithms and implementations in a way that works for front-line business and engineering. We can offer fixed prices for suitable projects and license the full source code setting you up for the long term and reducing your risks.

The need for open-source programs

There are plenty of numerical computing problems that require not only processing of input values into output values, but also require measures of how outputs change with respect to small variations in inputs. These measures are called gradients, derivatives, sensitivity, or risk in finance applications.

Applications in Finance are wide and include computation of risk sensitivities of financial derivative instruments, calibration of model parameters, and pricing, and hence we need to keep a tab on the costs for developing and maintaining these applications.

Cost Considerations

The costs associated with developing and maintaining the solution in line with business requirements are a major concern for most users, these are:

- **License Cost:** Open-source costs are zero as there is no proprietary license. Also, customers can use open-source solution as per their requirements. Talanton can make tailored solutions based on open-source elements for our clients.
- **Maintenance Cost:** Licensed software are not only occupying a hefty storage space, but are also very difficult to keep up to date. This is due to the fact that proprietary vendors' primary source of revenue is the license fee, and hence any update / path or other technical fix must go through a large bureaucratic legal validation. Not to mention the restrictions placed on the clients' use of these software.
- **Configuration Cost:** Proprietary software are extremely inflexible as the user has no access to the build method of the software. As a result, the user is unable to configure the software as per need. Any tampering with the build is considered illegal as per the signed contract and thus the user could face potential lawsuits if any attempts are made to customize the software as needed. This problem ceases to exist when using open-source solutions.

A key driver nowadays is flexibility and speed of delivery. In recent years, firms have been adjusting to constantly changing regulations. Firms are now looking to implement solutions that are flexible and agile enough to quickly react to new regulatory changes; taking active steps to upgrade their technology architecture by:

- Implementing an integrated end-to-end platform supported by a single data structure;
- Removing manual inefficiencies through automation; and
- Designing API driven architecture.

Such platforms not only support the flexibility and speed of delivery requirement, but are expected to support active cost management.

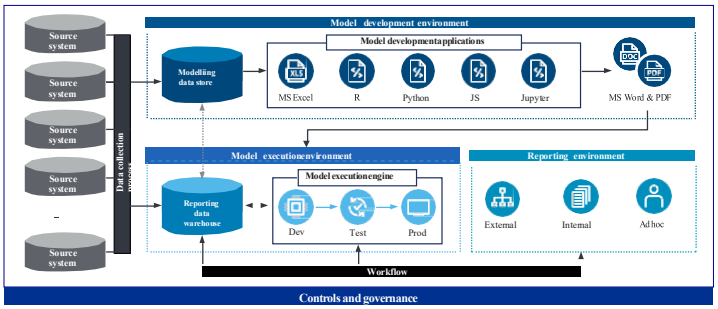

Figure 3. Credit Risk Architecture Overview

Despite this clear potential, many organizations are yet to get started with open-source adoption. As enterprises look to begin their open-source journeys, the more common use cases exist around the Jupyter notebook.

Example opportunities for using open-source software in your organization are:

- **Spreadsheet**: Many organizations are comfortable using spreadsheets for their computations. Here the computations are executed via a VBA code and the output is displayed in a different spreadsheet, where the data can be transformed into graphs and charts.
- **Jupyter**: With the increased availability of free visualization libraries online which can be called using a single command, institutions nowadays feel comfortable in creating Jupyter notebooks for their computational needs.
- **Frontend JS**: Organizations with substantial financial resources at their disposal create their own internal dashboard systems, however it takes a good dozen member team to maintain it. Not to mention an average of USD 600,000 per year. Even single user proprietary software costs a low end USD 3000 and high end USD 10,000.

Modelling the right way

Talanton Technologies help firms establishing a proper modelling resource. We will service the firm's analytical needs and manage/maintain all models used by the firm. We use a common framework to develop, implement, and maintain models. These models will then be made available to model consumers in the bank through various forms such as the APIs.

- Contact us info@talantontechnologies.io or at Contact Page with outline of your requirements.
- Most of our work involves combination of open-source modules, our existing library of proprietary modules and custom work. We will at this stage give you rough indication of likely cost and timescales
- We together agree on definitive scope of work and testing to be done on the components.
- A contract is agreed with a firm fixed price. For larger projects there may be a multiple stage contract.
- The required development and testing work is the carried out by us at our facilities

- We demonstrate the software and install at your (cloud) facilities if needed
- Usually a payment on account will be made at this stage but this may not be necessary for smaller projects or for well-established counterparties.
- Final delivery of software, the source code and scripts to reproduce the installation. You confirm to us everything is as agreed in contract
- We invoice for the full amount
- Any extended support agreement begins after final delivery, terms can be negotiated separately or during the original contract drawing up stage

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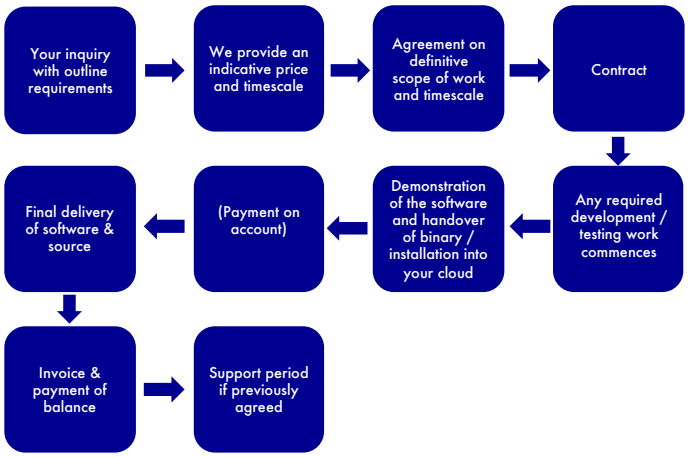

Figure 4. Talanton Technologies engagement process

Significant performance leaps, from Talanton Technologies

Substantial performance improvements are possible for xVAPricing and Greeks applications, using nothing more than standard Processors along with innovative easy-to-integratesoftware from Talanton Technologies.

Post financial crises regulations have made it mandatory for institutions to report their sensitivities to multiple scenarios, requiring banks to recalculate their trade portfolios thousandsof times. These regulations push banks to calculate risks to even finer risk granularities, making regulatory adherence an even larger burden in terms of costs for implementation, running, and maintenance.

For this reason, utilizing open-source resources becomes a highly desirable method to implement robust risk management in current markets and comply with current andfuture regulatory requirements.

More efficient methods to support xVA computations can yieldimportant benefits for a wide range of business groups including sales, trading, risk management, product management, enterprise risk, and treasury.

Summary

Counterparty Credit Risk is a big area in risk management. This topic introduced counterparty credit risk and highlighted common terminology used in risk management. It also explained how credit risk can be measured, reduced and mitigated:

- **Solutions** – Talanton Technologies develop, apply and share financial engineering solutions to expedite your journey of risk management.
- **Platforms** – Talanton offers several turnkey, full stack and user-friendly systems that can be quickly deployed to accelerate your risk cycle.
- **Frameworks** – Talanton is optimizing the most popular open- source community frameworks for xVA pricing to deliver peak performance across a range of processor platforms.
- **Libraries** – Talanton is researching on accelerating applications by optimizing primitives and creating a Compiler to enable frameworks to use any target hardwarewith peak performance. Our resultant library will be much more affordable than any other international competitor.

Talanton is enabling its strong ecosystem and partner network to accelerate xVA progress through wide industry collaboration.

Like the organizations we serve, we are on a journey, pushing the forefront of xVA computing through cutting-edge R&D into areas for optimizing high performance computing.

Learn More

- **More Information at:** talantontechnologies.io
- **Explore - Use Talanton's performance:** optimized libraries & frameworks
- **Engage -** Contact your Talanton representative for help and POC opportunities

References and Resources

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