Counterparty Credit Risk Project

OUTLINE

Financial Risk overview.

The importance of Counterparty Credit Risk.

Important Financial Products

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Financial Risk Overview

Market Risk: Arises from the (short-term) movement of market prices. market risk has led to the birth of the **value-at-risk.**

Operational risk: Arises from people, systems, internal and external events. For example, human error, fraud, failed processes and etc.

Counterparty Credit Risk: Arises the counterparty will not be able to meet its contractual obligations if the credit event occur.

The Importance of Counterparty Credit Risk.

Financial Crisis:

In 2007 we started to experience what would be the worst financial crisis since the 1930s. The crisis spread from origins in the United States to become a global crisis. It also spread rapidly from the financial markets to have a significant impact on the real economy. Some financial institutions failed including the extremely high profile bankruptcy of the investment bank **Lehman Brothers** founded in 1850. In order to avoid global financial crisis happen again, Counterparty Credit Risk become more and more important.

Regulator:

Canada: OSFI (Office of the Superintendent of Financial Institutions).

America: Federal Reserve, OCC (Office of the Comptroller of the Currency)

China: China Banking Regulatory Commission

Important Financial Products

Over-The-Counter (OTC) Products: Foreign Currency Forward, Interest Rate Swap, Interest Rate Swaption, Commodity Swap, Equity Option, Total Return Swap.

Exchange Traded Market: Future, Future Options.

Repo Market: Repurchase agreement, Reverse Repurchase agreement.

Project of measuring Counterparty Credit Risk

Background: Starting from January, 2019, OSFI requires all financial institutions measure Counterparty Credit Risk by new model called **Standardised Approach (SACCR).** Compare to previous model, SACCR is more risk sensitive and ability to capture risk during the financial crisis – Therefore SACCR produces more exposure.

Principal: In general, SACCR risk (exposure) is captured by **Replacement Cost (RC)** and **Potential Future Exposure (PFE)**

- $Counterparty\ Credit\ Risk\ Exposure = 1.4 * (RC + PFE)$
- RC is current Counterparty Credit Risk faced by financial institution
- PFE is future Counterparty Credit Risk faced by financial institution

Project Task #1: Financial Concept

Model Related

- What is Mark to Market and Potential Future Exposure?
- What is Exposure at Default?
- What is Option? e.g. Describe a transaction, where you **buy** a **Call** Option.
- What is Option Delta?

Products Related

- What is forward? e.g. Describe a transaction, where you **buy** a cotton forward.
- What is the difference between future and forward?
- What is interest rate swap?
- What is Equity Total Return Swap?

Project Task #1: Model Preparation

Read the answer the following questions.

- What is the difference between margined and unmargined transactions?
- How to calculate Replacement Cost for margined and unmargined transactions?
- How to calculate PFE multiplier and why the SACCR model needs it?
- How to calculate supervisory duration? And which asset classes it applies to?
- How to calculate delta for options?
- How to calculate Maturity Factor for margined and unmargined transactions?
- How to calculate effective notional and Addon for interest rate products?
- How to calculate Potential Future Exposure by using multiplier and addon?

Python

- Need to know how to use Pandas to read CSV/Excel and save as Data Frame
- Need to know how to write function in Python.
- Need to know how to calculate group dataset.
- Need to well organized code and let other people read/debug easily.

The standardised model for measuring counterparty credit risk exposure

Introducing the SA-CCR

The exposures under the SA-CCR consist of two components: replacement cost (RC) and potential future exposure (PFE). Mathematically:

$$Counterparty\ Credit\ Risk\ Exposure = 1.4 * (RC + PFE)$$

where alpha equals 1.4, which is carried over from the alpha value set by the Basel Committee for the Internal Model Method (IMM). The PFE portion consists of a multiplier that allows for the partial recognition of excess collateral and an aggregate add-on, which is derived from add-ons developed for each asset class.

Methodologies:

1. For unmargined transactions, the *RC* intends to capture the loss that would occur if a counterparty were to default and were closed out of its transactions immediately. The *PFE* add-on represents a potential conservative increase in exposure over a one-year time horizon from the present date (i.e. the calculation date).

2. For margined trades, the *RC* intends to capture the loss that would occur if a counterparty were to default at the present or at a future time, assuming that the closeout and replacement of transactions occur instantaneously. However, there may be a period (the margin period of risk) between the last exchange of collateral before default and replacement of the trades in the market. The *PFE* add-on represents the potential change in value of the trades during this time period.

3. For unmargined transactions (that is, where variation margin (VM) is not exchanged, but collateral other than VM may be present), *RC* is defined as the greater of: (i) the current market value of the derivative contracts less net haircut collateral held by the bank (if any), and (ii) zero. This is consistent with the use of replacement cost as the measure of current exposure, meaning that when the bank owes the counterparty money it has no exposure to the counterparty if it can instantly replace its trades and sell collateral at current market prices. Mathematically:

$$RC = max(V - C, 0)$$

4. For margined trades, the replacement cost is:

$$RC = max(V - C, TH + MTA - NICA, 0)$$

where *V* and *C* are defined as in the unmargined formulation, *TH* is the positive threshold before the counterparty must send the bank collateral, and *MTA* is the minimum transfer amount applicable to the counterparty.

5. The *PFE* add-on consists of (i) an aggregate add-on component, which consists of add-ons calculated for each asset class and (ii) a multiplier that allows for the recognition of excess collateral or negative mark-to-market value for the transactions. Mathematically:

$$PFE = multiplier * AddOn^{aggregate}$$

149. This multiplier will also be activated when the current value of the derivative transactions is negative. This is because out-of-the-money transactions do not currently represent an exposure and have less chance to go in-the-money. Mathematically:

$$multiplier = \min\left\{1; Floor + (1 - Floor) * \exp\left(\frac{V - C}{2 * (1 - Floor) * AddOn^{aggregate}}\right)\right\}$$

where exp(...) equals to the exponential function, *Floor* is 5%, *V* is the value of the derivative transactions in the netting set, and *C* is the haircut value of net collateral held.

6. For interest rate and credit derivatives, the trade-level adjusted notional is the product of the trade notional amount, converted to the domestic currency, and the **supervisory duration** which is given by the following formula:

$$SD = \frac{\exp(-0.05 * S) - \exp(-0.05 * E)}{0.05}$$

where S and E are the start and end dates, respectively, of the time period referenced by the interest rate or credit derivative.

7. Delta Calculation for option products.

δ_i	*Bought*	*Sold*
Call Options[13]	$+\Phi\left(\frac{\ln(P_i / K_i) + 0.5 * \sigma_i^2 * T_i}{\sigma_i * \sqrt{T_i}}\right)$	$-\Phi\left(\frac{\ln(P_i / K_i) + 0.5 * \sigma_i^2 * T_i}{\sigma_i * \sqrt{T_i}}\right)$
Put Options[7]	$-\Phi\left(-\frac{\ln(P_i / K_i) + 0.5 * \sigma_i^2 * T_i}{\sigma_i * \sqrt{T_i}}\right)$	$+\Phi\left(-\frac{\ln(P_i / K_i) + 0.5 * \sigma_i^2 * T_i}{\sigma_i * \sqrt{T_i}}\right)$

With the following parameters that banks must determine appropriately:

P_i : Underlying price (spot, forward, average, etc)

K_i : Strike price

T_i : Latest contractual exercise date of the option

8. **Unmargined transaction maturity factor.**

$$MF_i^{(unmargined)} = \sqrt{\frac{\min\{M_i; 1year\}}{1year}}$$

Unmargined transaction maturity factor.

$$MF_i^{(margined)} = \frac{3}{2}\sqrt{\frac{MPOR_i}{1year}}$$

where $MPOR_i$ is the margin period of risk appropriate for the margin agreement containing the transaction *i*.

9. Effective Notional and Addon for interest rate products.

168. In the first step, the effective notional $D_{jk}^{(IR)}$ is calculated for time bucket k of hedging set (ie currency) j according to:

$$D_{jk}^{(IR)} = \sum_{i \in (Ccy_j, MB_k)} \delta_i * d_i^{(IR)} * MF_i^{(type)}$$

where notation $i \in (Ccy_j, MB_k)$ refers to trades of currency j that belong to maturity bucket k. That is, the effective notional for each time bucket and currency is the sum of the trade-level adjusted notional amounts (cf. paragraphs 157-158) multiplied by the supervisory delta adjustments (cf. paragraph 159) and the maturity factor (cf. paragraph 164).

169. In the second step, aggregation across maturity buckets for each hedging set is calculated according to the following formula:[18]

$$EffectiveNotional_j^{(IR)} = \left[\left(D_{j1}^{(IR)}\right)^2 + \left(D_{j2}^{(IR)}\right)^2 + \left(D_{j3}^{(IR)}\right)^2 + 1.4 * D_{j1}^{(IR)} * D_{j2}^{(IR)} + 1.4 * D_{j2}^{(IR)} * D_{j3}^{(IR)} + 0.6 * D_{j1}^{(IR)} * D_{j3}^{(IR)} \right]^{\frac{1}{2}}$$

[18] Banks may choose not to recognise offset across maturity buckets. In this case, the relevant formula is: $EffectiveNotional_j^{(IR)} = \left|D_{j1}^{(IR)}\right| + \left|D_{j2}^{(IR)}\right| + \left|D_{j3}^{(IR)}\right|$

The hedging set level add-on is calculated as the product of the effective notional and the interest rate supervisory factor:

$$AddOn_j^{(IR)} = SF_j^{(IR)} * EffectiveNotional_j^{(IR)}$$