

# 17 Introduction to counterparty risk

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## 17.2 Credit value adjustments

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- A substantial part of all derivative transactions is carried out over the counter and there is no central clearing counterparty to guarantee fulfilment of the contractual obligations.
- These trades are subject to the risk that a contracting party defaults during the transaction, thus affecting the cash flows that are actually received by the other party. This is known as **counterparty credit risk**.
- Counterparty risk received a lot of attention during the financial crisis of 2007-2009 as some of the institutions heavily involved in derivative transactions experienced worsening credit quality or—in the case of Lehman Brothers—even a default event.
- **Counterparty risk management** is now a key issue for all financial institutions and the focus of many new regulatory developments.

## Example of Interest-Rate Swap

- Two parties  $A$  and  $B$  agree to exchange a series of interest payments on a given nominal amount of money for a given period.
- $A$  receives payments at a fixed interest rate and makes floating payments at a rate equal to the three-month LIBOR rate.
- Suppose that  $A$  defaults at time  $\tau_A$  before the maturity of the contract.
- If interest rates have risen relative to their value at inception of contract:
  - ▶ The fixed interest payments have decreased in value and the value of the contract has increased for  $B$ .
  - ▶ The default of  $A$  constitutes a loss for  $B$ ; the loss size depends on the term structure of interest rates at  $\tau_A$ .
- If interest rates have fallen relative to their value at  $t = 0$ :
  - ▶ The fixed payments have increased in value so that the swap has a negative value for  $B$ .

- ▶  $B$  will still have to pay the value of the contract into the bankruptcy pool, and there is **no upside for  $B$**  in  $A$ 's default.
- If  $B$  defaults first the situation is **reversed**: falling rates lead to a counterparty-risk-related loss for  $A$ .

## Management of counterparty risk

- Counterparty risk has to be taken into account in pricing and valuation. This has led to the notion of **credit value adjustments (CVA)**.
- Counterparty risk needs to be controlled using risk-mitigation techniques such as **netting** and **collateralization**.
- Under a **netting agreement** the value of all derivatives transactions between  $A$  and  $B$  is computed and only the aggregated value is subject to counterparty risk; since offsetting transactions cancel each other out, this has the potential to reduce counterparty risk substantially.

- Under a **collateralization agreement** the parties exchange collateral (cash and securities) that serves as a pledge for the receiver. The value of the collateral is adjusted dynamically to reflect changes in the value of the underlying transactions.

## 17.2 Credit value adjustments

**General definition.** The price (for the protection buyer ) satisfies

$$\begin{aligned}\text{True price} = & \text{(counterparty) risk-free price} \\ & - \text{adjustment for default of seller (CVA)} \\ & + \text{adjustment for default of buyer (DVA) ,}\end{aligned}$$

where CVA and DVA stand for Credit Value Adjustment and Debt Value Adjustment respectively.

## General adjustment formulas

Denote by  $V_t$  the market value of the CDS (assuming that  $B$  and  $S$  are default-free), by  $\tau = \min\{\tau_R, \tau_S, \tau_B\}$  the first default time and by  $\xi \in \{R, S, B\}$  the identity of first defaulting firm. Recall that  $x^+ = \max(x, 0)$  and  $x^- = -\min(x, 0)$  and denote by  $D(0, t)$  the discount factor over the period  $[0, t]$  (with constant interest rate,  $D(0, t) = e^{-rt}$ ).

It can be shown that

$$\begin{aligned}\text{CVA} &= \mathbb{E}^{\mathbb{Q}}(I_{\{\tau < T\}} I_{\{\xi=S\}} D(0, \tau) \delta^S V_{\tau}^+) \\ \text{DVA} &= \mathbb{E}^{\mathbb{Q}}(I_{\{\tau < T\}} I_{\{\xi=B\}} D(0, \tau) \delta^B V_{\tau}^-)\end{aligned}$$

## Comments.

- CVA gives **loss of B** due to **premature default of S**; DVA gives **loss of S** due to **premature default of B**.
- The value adjustments involve an option on the market value  $V = (V_t)_{t \leq T}$  of the swap with strike  $K = 0$  (a call for the CVA and a put for the DVA).
- Similar formula holds if  $V$  is the market value of another derivative such as an interest swap or even a reinsurance contract.
- DVA is a bit problematic: a **worsening credit quality of B** leads to an **accounting profit for B**.

## A simplified formula

In order to evaluate the CVA and DVA formulas one needs a model with stochastic credit spreads that takes **dependence** between the default of S, B and the **market value**  $V$  of the CDS into account (a **dynamic portfolio credit risk model**). Markets often work with a simpler formula that assumes that the default of S and B and  $V$  are **independent**:

$$\begin{aligned}\text{CVA}^{\text{indep}} &= \delta^S \int_0^T \bar{F}_B(t) D(0, t) \mathbb{E}^{\mathbb{Q}}(V_t^+) f_S(t) dt, \\ \text{DVA}^{\text{indep}} &= \delta^B \int_0^T \bar{F}_S(t) D(0, t) \mathbb{E}^{\mathbb{Q}}(V_t^-) f_B(t) dt.\end{aligned}$$

Here  $f_S$  is the density of  $\tau_S$  and  $\bar{F}_B$  resp  $\bar{F}_S$  is the survival function of  $\tau_B$  resp  $\tau_S$ .



## Comments.

- In order to evaluate the simplified formula one only needs to determine the marginal distribution of  $\tau_S$  and  $\tau_B$  and the so-called **expected exposures**  $\mathbb{E}^{\mathbb{Q}}(V_t^+)$  and  $\mathbb{E}^{\mathbb{Q}}(V_t^-)$ .
- The independence assumption underlying the simplified value adjustment formula between the price of the CDS on  $R$ , that is  $V_t$ , and the default event of  $S$  and  $B$  is often unrealistic; in practice this is known as **wrong way risk**.

Examples:

- ▶ CDS on a financial institution: given that  $S$  defaults it is quite likely that credit quality of  $R$  is low.
- ▶ Reinsurance.

For further reading on counterparty risk see Gregory (2012).

# References

Gregory, J. (2012), Counterparty Credit Risk and Credit Value Adjustment: A Continuing Challenge for Global Financial Markets, Chichester: John Wiley and Sons Ltd.