complicate collateral calls and may lead to collateral disputes. If trades include potentially problematic assets, it may be optimal to only focus on a subset of trades that make up the majority of credit exposure and leave out asset classes that are hard to value either due to complexity (e.g., exotic options) or illiquidity (e.g., credit derivatives). Global considerations are also important, especially as counterparties trade with each other over many time zones and geographical locations. It may be optimal to handle trades separately with regions that are problematic and make up only a small portion of trades. Finally, if an entity expects one of its counterparties to have difficulty valuing certain trades or assets, it may be preferred to leave those trades uncollateralized rather than face potential and frequent disputes. Given that collateral agreements typically require that undisputed amounts be transferred immediately, it is generally advantageous to collateralize the majority of products.

If disputes do arise, they can relate to the trade population, trade valuation, netting rules, market data and market closing time, and valuing collateral that was previously posted. If the disputed amount or valuation difference is small, counterparties may simply split the difference. If the disputes involve larger differences, the exposure will remain uncollateralized until the dispute is resolved. Disputes include the following steps: (1) the disputing party notifies the counterparty of its intent to dispute the exposure by the end of the day following the collateral call; (2) all undisputed amounts are transferred, and the reason for the dispute is identified; and (3) for unresolved disputes, the parties will request quotes from several market makers (usually four) for the MtM value.

Reconciling trades minimizes the chance of disputes. Parties may also find it beneficial to perform dummy (practice) reconciliations prior to trading and periodic reconciliations during trading (weekly or monthly) to preempt future disputes.

MODULE QUIZ 34.1

1. Which of the following features is least likely a benefit of collateralization?
   A. Reduces capital requirements.
   B. Allows for more competitive pricing of counterparty risk.
   C. Reduces market, operational, and liquidity risk.
   D. Reduces credit exposure.

2. Which of the following statements is least accurate regarding a credit support annex (CSA) and/or an ISDA Master Agreement?
   A. ISDA Master Agreements help standardize collateral management.
   B. CSAs must define all collateralization parameters in order to work as intended.
   C. Compared to the ISDA Master Agreement, CSAs were first to establish collateral standards.

D. CSAs are incorporated into an ISDA Master Agreement.

MODULE 34.2: COLLATERAL AGREEMENTS

Collateral Agreement Features

LO 34.g: Explain the features of a collateralization agreement.

Collateral agreements are typically negotiated prior to any trading, and they are often updated prior to an increase in trading. Parameters must be clearly defined, and parties must balance the work involved in calling and returning collateral with the benefits of risk mitigation.

Terms of a collateral agreement may be linked to the credit quality of counterparties in order to minimize operational workload while maintaining the ability to tighten collateral terms when a party's credit quality declines. Counterparties most commonly link a tightening of collateral terms to changes in credit rating (e.g., to a downgrade in rating to below investment grade). While this approach is easy to set up, it can lead to issues by requiring the downgraded counterparty to post collateral exactly at a time when it is experiencing credit issues. This can lead to a "death spiral" of the affected counterparty, as the counterparty faces multiple collateral calls. As a result, it may be preferable to link collateral terms not to the credit rating of entities, but to credit spreads, the market value of equity, or net asset values.

Margin calls should be done at least daily. Products like repos and swaps that are cleared via central counterparties most often have intraday margining. While longer margin frequencies likely reduce operational workloads, daily margining has, more or less, become the market norm.

Threshold in margining refers to the level of exposure below which collateral will not be called. As a result, threshold represents the level of uncollateralized exposure, and only the incremental amount above the threshold would be collateralized. Thresholds generally aim to reduce the operational burden of calling collateral too frequently. A threshold of zero means any exposure is collateralized, while a threshold of infinity means all exposure is uncollateralized. Thresholds are most often linked to credit ratings in a tiered manner, with lower credit ratings corresponding to lower or zero threshold amounts.

Initial margin is the collateral amount that is posted upfront and is "independent" of any subsequent collateralization. It is often used to mitigate the widening of credit spreads or declines in equity values. Initial margin is typically required by stronger credit quality counterparties or by the counterparty more likely to have positive exposures and represents a level of **overcollateralization**. Initial margins are also typically linked to the credit rating of counterparties in a tiered manner; however, as opposed to thresholds, the level of initial margin *increases* with lower ratings. Initial margins can be thought of as converting counterparty risk into gap risk, ensuring that the less risky counterparty always remains overcollateralized by this amount without incurring losses, even when the risky counterparty defaults. Initial margins should,

therefore, be large enough to minimize the gap from large value movements of trades should the risky counterparty default.

A **minimum transfer amount** represents the smallest amount of collateral that can be transferred. A minimum transfer amount is used to reduce the operational workload of frequent transfers for small amounts of collateral, which must be balanced against the benefits of risk mitigation. It is important to note that the threshold and minimum transfer amount are additive; that is, exposure must exceed the sum of *both* before a collateral call can be made. Minimum transfer amounts are also typically tied to credit ratings, with higher ratings corresponding to higher amounts.

Collateral amounts typically use **rounding** (e.g., to the nearest thousand) to avoid transferring very small amounts during collateral calls or returns.

A **haircut** is essentially a discount to the value of posted collateral. In other words, a haircut of x% means that for every unit of collateral posted, only (1 − x)% of credit will be given. This credit is also referred to as valuation percentage. Cash typically has a haircut of 0% and a valuation of 100%, while riskier securities have higher haircut percentages and lower corresponding valuation percentages.

For example, if a particular sovereign bond has a haircut of 2% and a collateral call of $100,000 is made, only 98% of the collateral's value is credited for collateral purposes. That is, in order to satisfy a $100,000 collateral call, $102,041 ($100,000 / 0.98) of the sovereign bond must be posted (or $100,000 in cash).

It is easy to see that riskier securities have greater haircuts to account for their volatility, which may lead to a decline in their value. In the order of increasing riskiness and higher haircuts, cash typically has no haircuts, followed by high-quality government bonds, AAA-rated corporate bonds, structured notes or products, and, finally, equities and commodities. Key factors to consider when assessing haircuts are time to liquidate collateral, volatility of the collateral's underlying market, and the default risk, maturity, and liquidity of the security. Assessing haircuts will often depend on current market conditions using sophisticated value at risk (VaR) calculations.

Entities usually pay interest, coupons, dividends, and other cash flows to counterparties posting collateral as long as the counterparty is not in default. Interest on cash collateral is paid at an overnight market rate. During times of high volatility and illiquid markets, cash collateral is generally preferred, and entities may pay higher-than-market interest rates as an incentive to the entity posting collateral.

LO 34.i: Explain aspects of collateral including funding, rehypothecation, and segregation.

We will now look at substitution, reuse, rehypothecation, and segregation of collateral. Counterparties sometimes require that the original posted collateral be returned to them for various reasons, including meeting certain delivery commitments. In this case, they can make a **substitution** request by posting an equivalent value of some other eligible collateral. Substitution requests cannot be refused by the other party if the

substituted collateral meets all eligibility criteria. Noncash collateral may also be sold, used in repo transactions, or rehypothecated.

Rehypothecation refers to transferring posted collateral to other counterparties as collateral. While widespread, rehypothecation carries two related risks. Consider a scenario where Party A pledges collateral to Party B; Party B rehypothecates this collateral to Party C. If Party C defaults, then Party B will not only have a loss from not receiving the collateral from Party C, it will also have a liability to Party A for not returning its collateral. The practice of rehypothecation was relatively widespread prior to the 2007–2009 credit crisis; however, it has been significantly less popular following the crisis. Parties now increasingly prefer cash collateral.

In the event of default, there is a risk that collateral may not be retrieved even when it is not rehypothecated. If the counterparty receiving the collateral becomes insolvent, for example, **segregation** of collateral can be used to reduce counterparty risk by legally protecting the posted collateral. This practice establishes legal actions that will return all collateral that is not required. Thus, segregation works contrary to rehypothecation. Note, however, that segregation may result in funding problems when replacing collateral that could have been rehypothecated.

CSA Agreements

LO 34.h: Differentiate between a two-way and one-way CSA agreement and describe how collateral parameters can be linked to credit quality.

There may be instances when CSAs are not used. Institutions may be unable or unwilling to post collateral. This may be because their credit quality is far superior to their counterparty or they cannot commit to the operational and liquidity requirements that arise from committing to a CSA.

A **two-way CSA** is often established when two counterparties are relatively similar, as it will be beneficial to both parties involved. It is important to note that the two sides may not be treated equally, as certain key parameters (like threshold and initial margin) may differ depending on the respective risk levels of each party.

A **one-way CSA** differs from a two-way CSA in that the former only requires that one counterparty post collateral (either immediately or after a specific event, such as a ratings downgrade). As a result, the CSA will be beneficial to the receiver of the collateral and at the same time will present additional risk for the counterparty posting the collateral. These types of CSAs are established when two counterparties are significantly different in size, risk levels, et cetera.

The terms of a collateral agreement are usually linked to the credit quality of the counterparties in a transaction. This is beneficial when a counterparty's credit quality is strong because it minimizes operational workload. However, it is also beneficial when a counterparty's credit quality is weak as it allows the other party to enforce collateralization terms triggered by a quality downgrade. Although credit ratings are the most common quality linked, others include market value of equity, net asset value, and traded credit spread. The benefits of linking to credit ratings must be weighed

against the costs associated with the requirement of collateral when a ratings downgrade occurs.

CSA Calculations

LO 34.c: Calculate the credit support amount (margin) under various scenarios.

ISDA documentation specifies that, at any point in time, the credit support amount is equal to the amount of the requested margin. This amount will not be equal to the value of the portfolio due to parameters such as thresholds, initial margins, and minimum transfer amounts.

Assume a counterparty is only receiving the margin amount. In this case, the credit support amount (margin) calculation when only considering the threshold and initial margin is:

$$\max(\text{value} - K_A, 0) + IM_A$$

where:
value = current value of applicable transactions
K_A = threshold (fixed amount)
IM_A = initial margin (dynamic amount)

This equation shows that thresholds and initial margins work in opposite directions. As a result, it is typically the case that when initial margins are present, the threshold will be set to zero.

When considering both counterparties, the equation for computing the credit support amount (for variation margin) is:

$$\max(\text{value} - K_A, 0) - \max(-\text{value} - K_B, 0) - CSB$$

where:
K_B = threshold for the counterparty generating the margin calculation
CSB = credit support balance (margin previously held)

If this equation results in a positive amount, then margin can be called; if it results in a negative amount, then margin is required to be posted. These conditions hold as long as the margin amount is greater than the minimum transfer amount.

Note that initial margin is not a factor in the previous calculation. It is typically the case that the credit support amount captures variation margin, but not initial margin. The initial margin will be computed independently and, thus, it is sometimes referred to as the independent amount. In the event that both counterparties post initial margin, those amounts will not be netted, and initial margins will be paid separately. Figures 34.1 and 34.2 illustrate example margin calculations without and with initial margins, respectively.

Figure 34.1: Margin Calculation Example (Without Initial Margin)

	Time 1	Time 2
Portfolio value	250	225
Threshold	100	100
Credit support balance	0	150
Credit support amount	150	–25

At Time 1, the portfolio value is not fully collateralized. At Time 2, the portfolio is uncollateralized by 75 (= 225 – 150), but the credit support amount is negative 25, which is the amount of margin that needs to be posted up to the threshold amount of 100.

Figure 34.2: Margin Calculation Example (With Initial Margin)

	Time 1	Time 2
Portfolio value	250	275
Threshold (set to zero)	0	0
Credit support balance	0	250
Credit support amount	250	25
Initial margin (independent amount)	40	35

At Time 1, the addition of initial margin means that the portfolio is overcollateralized. At Time 2, the portfolio value increase results in a margin deficit of 25, but this move is within the initial margin amount. Note that despite the increase in variation margin, the initial margin is independent and will not be netted with the increase.

Collateral Agreement Risks

LO 34.j: Explain how market risk, operational risk, and liquidity risk (including funding liquidity risk) can arise through collateralization.

Collateralization may improve asset recovery in the event of a counterparty default, but it should be viewed as a supplement to, not a replacement for, ongoing due diligence review of credit quality and exposure. Use of collateral may be viewed as a double-edged sword. When managed properly, it can mitigate risks, but when managed poorly, it may well give rise to additional risks. Collateral agreements could potentially cause the following risks.

Market Risk

Market risk relates to the degree of market movements that have occurred since the last posting of collateral. It is relatively small compared to the risk of an uncollateralized situation, but market risk is a challenge to hedge and to quantify.

Even though collateral is in place to mitigate counterparty risk, there will always be some residual risk due to parameters such as minimum transfer amounts and thresholds that delay the collateral process. In addition, even when collateral is called, there will be a normal delay in sending/receiving the collateral. This delay is

represented as the margin period of risk, which is the effective time between a collateral call and the receipt of the collateral.

Operational Risk

Potential pitfalls in the handling of collateral include missed collateral calls, failed deliveries, computer error, human error, and fraud. Proper controls must be in place to reduce the likelihood of the occurrence of any one of the foregoing items. Examples of proper controls would be the existence of accurate and enforceable legal agreements, robust IT systems capable of automating many steps in the process, timely and accurate valuation of the collateral, current information on initial margins, minimum transfer amounts, rounding, a requirement that collateral types and currencies must be available for each counterparty, and careful observation of the failure to deliver collateral.

Liquidity and Liquidation Risk

Transaction costs may result when having to liquidate collateral to mitigate counterparty risk. These are often in the form of a bid-ask spread or selling costs. Liquidating a security in an amount that is large relative to its typical trading volume may negatively impact its price, leading to a substantial loss. The alternative is to liquidate a position slowly. With this approach, the counterparty is exposed to market volatility during the period of liquidation. Additional considerations regarding liquidity risk include:

- How large is the market capitalization of the issue posted as collateral?
- Is there a link between the value of the collateral and the counterparty's credit quality? This would be an example of wrong-way risk (when credit exposure and default risk both increase at the same time).
- Would the liquidity of the collateral change due to a default by the counterparty?

Funding Liquidity Risk

Funding liquidity risk refers to the ability of an institution to settle its obligations quickly when they become due, which results from the funding needs established in a CSA. For various reasons, collateral agreements are not in place for many OTC derivatives transactions. When a counterparty does not have the operational capacity or liquidity to handle frequent collateral calls (required under a CSA), the counterparty will be vulnerable to funding implications. This risk is relatively small when markets are liquid and funding costs are low. However, when markets are illiquid, the risks become higher because funding costs can increase considerably.

Default Risk

The default of a security posted as collateral will lower its value (when the loss in value is unlikely to be covered by a haircut). Cash or high-quality fixed-income securities are usually the preferred type of collateral. Should the collateral's credit rating fall below what the collateral agreement specifies, then it would need to be replaced. Poor collateral may fail to mitigate counterparty risk.

Foreign Exchange Risk

Foreign exchange risk occurs when counterparties have different currencies. Collateral carrying foreign exchange risk can be hedged in spot and forward markets. The process must be done carefully due to the dynamic and changing value of the collateral.

Regulatory Requirements

LO 34.k: Describe the various regulatory capital requirements.

Non-clearable over-the-counter (OTC) transactions require banks to hold higher capital requirements compared to standardized OTC transactions. In 2011, the G20 established bilateral collateral requirements for non-clearable OTC derivatives. These regulatory requirements cover both variation and initial margins with the goal to minimize systemic risk and reduce potential regulatory arbitrage between clearable and non-clearable OTC transactions. However, these newer rules require additional collateralization, which forces banks to either find additional funding sources or leave the OTC derivatives market all together. In addition, in a stressed market, funding liquidity risk will most likely increase.

Covered entities, which are financial and systemically important non-financial entities, are required to exchange both variation and initial margin. Variation margin must: (1) be exchanged frequently, (2) use full collateral, (3) not exceed $650,000, and (4) be posted in its entirety for any transactions after implementation. Initial margin should: (1) be highly liquid, (2) be exchanged without netting, (3) be protected by bankruptcy, (4) be based on extreme but possible portfolio movements, (5) use a 10-day time horizon, (6) be based on regulatory tables or internal models, and (7) follow a phased-in implementation.

It was also established that variation margin and initial margin be segregated. In case of any disagreements, strong resolutions should be set. Covered counterparties will most likely agree to new CSAs. These new or updated CSAs will address the following features: (1) thresholds, (2) minimum transfer amounts, (3) eligibility of collateral, (4) haircuts, (5) initial margin calculations, (6) deliveries and schedules, (7) resolutions for disputes, and (8) segregation approaches.

MODULE QUIZ 34.2

1. Collateral agreements could potentially create multiple risks, including liquidity and liquidation risks. Which of the following is most accurate regarding liquidity and liquidation risk?
   A. Liquidation risk occurs when the amount of a security sold is large relative to its outstanding volume, which may affect the price of that security.
   B. Liquidity risk must be hedged in spot and forward markets.
   C. Liquidation risk embodies a transaction cost when collateral is liquidated in accordance with initial margin.
   D. Liquidity risk occurs when there are potential pitfalls in the handling of collateral, including human error.

2. When dealing with a hedge fund, a bank would most likely negotiate a:

A. one-way agreement in the bank's favor given the bank's stronger credit rating.
B. one-way agreement in the bank's favor agreeing to post collateral to the hedge fund.
C. two-way agreement given the relatively small difference in credit quality between the two entities.
D. two-way agreement where both parties agree to post collateral.

3. Assume a sovereign bond has a haircut of 5% and is used for a collateral call of $100,000. What amount is credited if a $100,000 bond is submitted, and what amount of bond is needed for $100,000 to be credited, respectively?
A. $100,000; $106,263.
B. $95,000; $100,000.
C. $95,000; $105,263.
D. $105,263; $95,000.

KEY CONCEPTS

LO 34.a

Collateral is an asset supporting a risk in a legally enforceable way. Collateral management is often bilateral, where either side to a transaction is required to post or return collateral to the side with the positive exposure.

LO 34.b

A credit support annex (CSA) allows parties to mitigate credit risk through the posting of collateral. The CSA provides governance on many issues related to the collateral itself, including what may be used, when and how it should be valued and transferred, and any changes that must be made upon the occurrence of certain events. A CSA will also define key parameters such as the threshold, minimum transfer amount, and initial margin.

LO 34.c

The credit support amount (for variation margin) is computed as:

$$\max(\text{value} - K_A, 0) - \max(-\text{value} - K_B, 0) - \text{CSB}$$

where:
K_A = threshold for Counterparty A
K_B = threshold for Counterparty B
CSB = credit support balance (margin previously held)

If this equation results in a positive amount, then margin can be called; if it results in a negative amount, then margin is required to be posted (up to the threshold amount). The credit support amount captures variation margin, but not initial margin, which is computed independently.

LO 34.d

The role of the valuation agent is to call for the delivery of collateral and handle any collateral-related calculations, including credit exposure, market values, credit support amounts, and the delivery/return of collateral. One or both parties to an agreement may be the valuation agent, or alternatively, a third-party agent may be used.

LO 34.e

Collateralization involves the party with the negative exposure posting collateral in the form of cash or securities to the party with the positive exposure. Collateral can include cash, government and government agency securities, mortgage-backed securities, corporate bonds and commercial paper, letters of credit, and equity. The most common type of collateral is cash.

LO 34.f

Collateral disputes may arise due to the valuation and population of trades, market data and market closing time, netting rules, and valuing collateral previously posted. Managing disputes include the following steps: (1) the disputing party notifies the counterparty of its intent to dispute the exposure by the end of the day following the collateral call; (2) all undisputed amounts are transferred and the reason for the dispute is identified; and (3) for unresolved disputes, the parties will request quotes from several market makers (usually four) for the MtM value. Reconciling trades on a regular basis can minimize potential disputes.

LO 34.g

Threshold is the level of exposure below which collateral will not be called and represents the level of uncollateralized exposure.

Initial margin is the collateral amount that is posted upfront and is independent of any subsequent collateralization. It represents a level of overcollateralization and can be thought of as converting counterparty risk into gap risk to always maintain an overcollateralized position by the stronger credit quality party.

A minimum transfer amount represents the smallest amount of collateral that can be transferred and is used to reduce operational workload. The threshold and minimum transfer amounts are additive.

A haircut is a discount to the value of posted collateral, with cash having the lowest discount (highest credit given). The riskier the security, the higher the haircut and the lower the credit given.

Substitution refers to posting an equivalent value of other eligible collateral. Rehypothecation refers to transferring posted collateral to other counterparties as collateral.

LO 34.h

A one-way CSA requires one counterparty to post collateral, while a two-way CSA requires both sides to post collateral. For a two-way CSA, certain key parameters may differ if the parties' have different risk levels.

Collateral agreements are often linked to the credit quality of the counterparties in a transaction, in particular credit ratings. While this linking can be beneficial to one party if the other party's credit rating declines, there are costs associated with requiring collateral when a ratings downgrade occurs.

LO 34.i

Substitution refers to posting an equivalent value of other eligible collateral. Rehypothecation refers to transferring posted collateral to other counterparties as collateral. Segregation refers to legally protecting posted collateral.

LO 34.j

Key risks involved as a result of entering into a collateral agreement include the following: market risk (unfavorable market movements since the last collateral posting), operational risk (operational issues in the handling of collateral transactions), liquidity and liquidation risk (the ability to liquidate collateral without an unexpected or substantial loss in value), and funding liquidity risk (the ability to meet funding obligations as they come due).

LO 34.k

Non-clearable OTC transactions require banks to hold higher capital requirements. In 2011, the G20 established bilateral collateral requirements for non-clearable OTC derivatives. These regulatory requirements cover both variation and initial margins with the goal to minimize systemic risk and reduce potential regulatory arbitrage between clearable and non-clearable OTC transactions.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 34.1

1. **C** Collateralizing trades reduces credit exposure (credit risk) and capital requirements, and allows for more competitive pricing of counterparty risk. However, collateralization also creates other risks including market risk (negative equity leaving exposures partially or fully uncollateralized), operational risk (legal obstacles to take possession of collateral), and liquidity risk (difficulty in selling collateral at a fair market value). (LO 34.a)

2. **C** The purpose of a credit support annex (CSA) incorporated into an ISDA Master Agreement is to allow the parties to the agreement to mitigate credit risk through the posting of collateral. A CSA is created to govern issues such as collateral eligibility, interest rate payments, timing and mechanics associated with transfers, posted collateral calculations, haircuts to collateral securities (if applicable), substitutions of collateral, timing and methods for valuation, reuse of collateral, handling disputes, and collateral changes that may be triggered by various events. In order to work as they are intended to work, CSAs must define all collateralization parameters and account for any scenarios that may impact both the counterparties and the collateral they are posting. (LO 34.b)

Module Quiz 34.2

1. **A** Liquidating a security in an amount that is large relative to its typical trading volume may negatively impact its price, leading to a substantial loss. (LO 34.i)

2. **A** The bank would most likely negotiate a one-way agreement in its own favor given the higher credit quality of the bank. This type of negotiation is typical when there are large differences in credit quality between two entities. (LO 34.h)

3. **C** A haircut is essentially a discount to the value of posted collateral. In other words, a haircut of x% means that for every unit of collateral posted, only (1 − x)% of credit will be given. This credit is also referred to as valuation percentage. If a particular sovereign bond has a haircut of 5% and a collateral call of $100,000 is made, only 95% of the collateral's value is credited for collateral purposes. That is, in order to satisfy a $100,000 collateral call, $105,263 (= $100,000 / 0.95) of the sovereign bond must be posted. (LO 34.g)

The following is a review of the Credit Risk Measurement and Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Gregory, Chapter 8.

READING 35

CENTRAL CLEARING

Study Session 6

EXAM FOCUS

This topic discusses the structure of a central counterparty (CCP) as well as the advantages and disadvantages of central clearing though a CCP. For the exam, understand the fundamental issues related to multilateral offset, over-the-counter (OTC) derivatives clearing, wrong-way risk (WWR), loss mutualization, and margin requirements. Multilateral offset offers the benefits of reduced counterparty and systemic risks. However, there are challenges related to standardization, complexity, liquidity, and WWR that make it difficult to centrally clear OTC derivatives. Also, understand the structure of the CCP loss waterfall as a way to manage the default of a CCP member. Be prepared to explain how setting adequate initial and variation margins plays a key role in ensuring that loss mutualization is efficiently obtained through the CCP loss waterfall.

MODULE 35.1: CENTRAL COUNTERPARTIES

LO 35.a: Define a central counterparty (CCP) and describe the mechanics of central clearing.

A **central counterparty (CCP)** has become a solution for systemic risk mitigation. CCPs provide clearing services for many different types of financial transactions between member firms. They are involved in "complete clearing," which means they essentially stand in the middle of previously bilateral over-the-counter (OTC) transactions and operate as the buyer for every seller and vice versa. Through this process, the original counterparty is no longer a direct risk as the CCP conceptually becomes the new counterparty. Figure 35.1 shows a traditional bilateral counterparty structure where default risk is directly borne by the individual counterparties.

Figure 35.1: Bilateral Structure

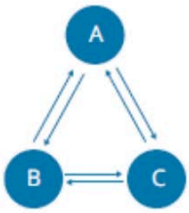
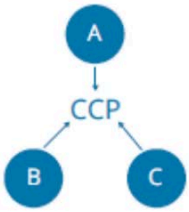


Figure 35.2 shows how a CCP structure changes the traditional risk landscape with the CCP acting as the middleman in all risk transactions. Through this new structure, a CCP can reduce market interconnectedness because Party A is no longer directly exposed to the full losses of Party B or Party C, for example. There is greater transparency because the CCP is aware of all member positions.

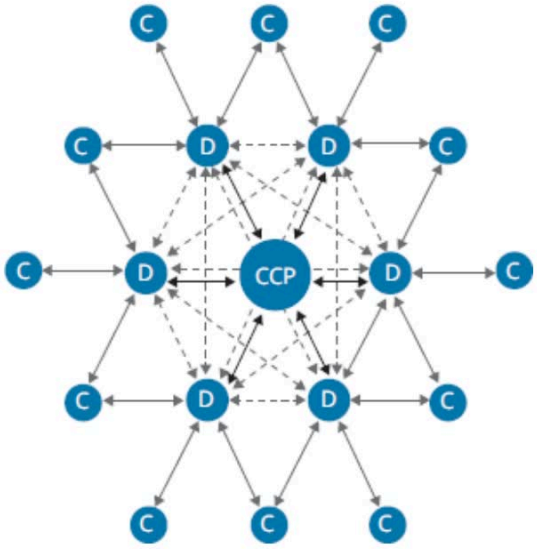
However, there is some potential added complexity as some counterparties do not access a CCP directly but rather through a backchannel using one of the member firms. For example, there might be a Party D who is a nonmember firm within a given CCP, but Party D might still clear financial transactions using Party C, who is a member firm, as a conduit. This may add an additional layer of complexity regarding margin transfer and default scenarios, for example.

Figure 35.2: CCP Structure



To get a fuller picture, Figure 35.3 shows a centrally cleared market with bilateral transactions (dotted lines), directly-cleared transactions (black lines), and nonclearing members (C) who must clear with the assistance of clearing members (D) (gray lines). Note that there will always be some OTC derivatives that cannot be centrally cleared and, therefore, can only exist as bilateral transactions.

Figure 35.3: Centrally Cleared Market



Source: Jon Gregory, *The xVA Challenge: Counterparty Credit Risk, Funding, Collateral, and Capital*(West Sussex, UK: John Wiley & Sons, 2020). Chapter 8.

To elaborate on Figure 35.3, the existence other CCPs and their interconnectedness must be considered because members of one CCP may also be members of another CCP. Although there are clear advantages of central clearing, there is a significant form of *concentration risk* in that a major error or failure at the CCP level could prove to be disastrous for all members involved.

Mechanics of Central Clearing

CCPs operate primarily by charging fees on all trades and to a lesser extent by earning income on the assets in their possession. The total number of CCPs in a global market must be small enough to be efficient but large enough to mitigate concerns of severe systemic risk or political issues. There are some advantages of allowing fewer CCPs to have monopolistic control over clearing. Competition between CCPs could lead to concerns regarding the credit quality of the CCPs, which supports a monopolistic structure. However, that also increases the risk of severe systemic risk which could result from the collapse of a CCP when there are too few to absorb the impact. Multilateral netting benefits such as reducing risk exposures and gaining economies of scale support the argument for a small number of CCPs.

However, jurisdictional fragmentation, the variety of products, the need for competition, and the risk of severe systemic risk are all factors suggesting that the number of CCPs should be greater. In the context of jurisdictional fragmentation, it may be necessary for clearing to occur for trades in a certain local currency (e.g., USD, EUR) and some regulators may insist that financial institutions clear their transactions only through a national or regional CCP. In terms of products, a single CCP often focuses on specific products and, therefore, will not be able to clear all OTC derivatives. The existence of a wide range of OTC derivatives would require multiple CCPs.

CCP ownership and logistics can be roughly divided into two categories: vertical and horizontal. With a vertical scheme, an exchange owns the CCP and the CCP operates as a unit within the exchange by only clearing products associated with that exchange. With a horizontal scheme, the clearing members usually own the CCP collectively, and without being tied to a specific exchange, the CCP is able to transact in a much wider range of markets and asset classes. In practice, the horizontal scheme works best for bilateral OTC derivatives and allows for greater competition than the vertical scheme, which is viewed favorably by regulators. In short, greater competition is likely to result in lower costs and a higher standard of clearing services.

Many OTC derivatives are currently cleared through CCPs, and the volume will continue to grow in the future. New products are more problematic as it takes time for them to develop the characteristics needed for clearing. When examining derivative products clearing in a CCP setting, the following characteristics must be considered: (1) standardization, (2) complexity, (3) liquidity, (4) wrong-way risk, and (5) market volume.

- *Standardization.* Because the clearing process means that the CCP is legally liable for all cash flows associated with the product, OTC derivative products such as credit default swaps (CDSs) must be standardized before they can be cleared through a CCP. Standardization also facilitates the netting process for the same or similar contracts.
- *Complexity.* Exotic or more complex derivatives are problematic for CCPs because their unique features make them difficult to value (even if they are standardized). Therefore, only nonexotic and less complex derivatives are clearable by CCPs because those derivatives can be easily, reliably, and quickly valued. The valuation is important for initial and variation margin computations and to avoid the risk associated with under-margining or the opportunity costs associated with over-margining.
- *Liquidity.* CCPs can only clear products that are liquid. In that regard, CCPs face pricing issues for illiquid products, which have less information and historical data that can be used for calculating initial and variation margins. Furthermore, the illiquidity and complexity of products makes it difficult to calibrate valuation models, which increases the risk for CCPs in the event of default. Illiquid products will also increase the time horizon needed for replacing defaulted trade positions.
- *Wrong-way risk (WWR).* Products with WWR are not optimal for CCPs. WWR introduces complexity and creates additional problems for CCPs in the event of default (i.e., WWR is the positive correlation between default risk and credit exposure to a counterparty). The presence of WWR can lead to an increase in risk exposures resulting from the default of a CCP member.
- *Market volume.* Sufficient market volume for a specific product is necessary in order for a CCP to clear that product given the upfront costs involved in developing the expertise to do so.

Novation

LO 35.b: Explain the concept of novation under central clearing.

In the event of a default, a CCP must replace nonperforming contracts through a process formally known as novation. **Novation** involves closing out the nonperforming side of a bilateral contract with a new counterparty (i.e., the CCP) that is capable of meeting the contractual obligations. Essentially, the CCP takes on the counterparty risk upon novation as the original parties no longer have contractual obligations to each other.

The transaction is guaranteed once buyers and sellers are matched. In that regard, the CCPs remain market neutral by netting all buy-side transactions with offsetting sell-side transactions (i.e., with the matched book). However, market risk will be introduced upon default by either party because the matched book will no longer be in place. The CCP may attempt to sell off the defaulting party's positions to restore the matched book. Additionally, the CCP may require default fund contributions by all member firms so that losses are mutualized and spread over a larger number of market participants rather than concentrating them with a single party. Further details on default funds will be discussed shortly.

Netting, Multilateral Offset, and Compression

LO 35.c: Define netting, multilateral offset, and compression and provide examples of each.

The bilateral derivatives market, by its nature, likely has a significant number of redundant transactions that raise the level of counterparty risk. **Netting** and **multilateral offset** are used to reduce the number of transactions. These two concepts are closely related as demonstrated in Figure 35.4. The use of CCPs is desirable because it can achieve multilateral offsets for cash flows and margins, for example.

Figure 35.4: Multilateral Netting

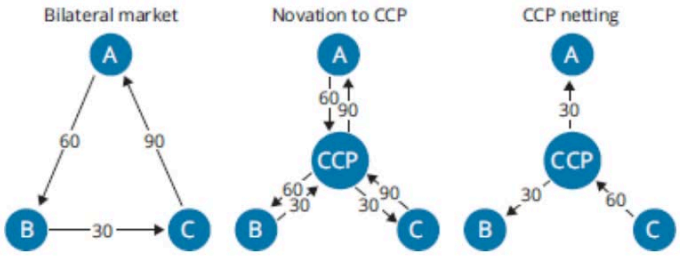


Figure 35.4 shows the liabilities between parties based on the directions of the arrows. With the bilateral market, the total liabilities are 180 (= 30 + 60 + 90). Here, Party A owes Party B an amount of 60. At the same time, Party C owes Party A an amount of 90. If Party C defaults and does not pay Party A the amount of 90, then it is quite possible

that Party A will also default because it does not have sufficient funds to pay Party B the amount owing of 60.

As an alternative, when considering novation in the second component of Figure 35.4, the CCP steps into the middle of all the parties, which allows for the netting of the transactions, which then leads to the third component of Figure 35.4. For example, the two transactions between Party A and the CCP (60 and 90) would net out to 30. Overall, risk is reduced as shown by the lower liability of Party C (previously 90 but reduced to 60 with netting) and Party A no longer owes 60 to Party B but instead is owed 30 by the CCP.

Compression involves the cancellation of real transactions on an absolute or gross basis, without relying on the offsetting benefits of multilateral offsets. In general terms, with compression, multiple offsetting contracts are canceled and substituted with fewer contracts to lower the gross exposures of both parties but maintaining the net exposures. For example, assuming there are 10 offsetting transactions between Parties A and B with a gross exposure of $1 million and a net exposure of $250,000 to Party A. Compression may allow the reduction of the number of transactions to, say five, and reduce the gross exposure to, say $350,000, while maintaining the net exposure of $250,000.

In comparing the compression example (e.g., compressing transactions and/or cash flows) to multilateral offset, the latter is able to compress risk without having to cancel any transactions. Compression can be used in conjunction with central clearing. From an efficiency standpoint, it makes sense to have fewer transactions and to have lower notional amounts cleared by a CCP. Specifically, there could be reductions in initial margin requirements, regulatory capital, and administrative work relating to margin calculations and reporting.

In practice, although the amount of notional cleared continues to increase for interest rates swaps, for example, the amount of notional outstanding remains virtually the same. Compression techniques are becoming more sophisticated including the ability to compress positions that have the same cash flow dates but different fixed rates.

MODULE QUIZ 35.1

1. There are numerous challenges when clearing over-the-counter (OTC) derivative products through a central counterparty (CCP). Which of the following lists best summarizes the key challenges for central clearing of OTC derivative products?
   A. Illiquid products, jurisdictional fragmentation, presence of wrong-way risk, and legal concerns.
   B. Lack of standardization, increased counterparty risk, increased dependency risk, and less transparency.
   C. Jurisdictional fragmentation, increased counterparty risk, less transparency, and standardization.

D. Product complexity, illiquid products, presence of wrong-way risk, and lack of standardization.

MODULE 35.2: CCP RISK MANAGEMENT

LO 35.d: Describe the application and estimation of margin and default funds under central clearing.

With central clearing, initial and variation margins play important roles to mitigate the risk of member default or bankruptcy. **Initial margin** is the beginning deposit required from all members to cover future potential default losses in a worst-case scenario. **Variation margin** is the additional margin required to account for daily price changes in asset positions; intraday margin calls are used during periods with large market movements. Similar to variation margin, initial margin depends primarily on market risk rather than the credit quality of the clearing member.

The time period in which a CCP could be exposed to a position as well as the required confidence level (i.e., the percentage of default scenarios the margin will cover) for the CCP are important factors in determining the initial margin level. The idea is to have a sufficient provision for losses for a given member to a high enough level of confidence (usually 99% or more) so that losses do not have to be covered by other members.

In a perfect world, each member would contribute enough money to the CCP to pay for 100% of their potential losses but that amount could be prohibitively high. Instead of such a high standard, loss mutualization occurs whereby members are required to contribute money into the CCP's **default fund** at a level that would cover potential losses with a high degree of confidence.

Within the CCP structure, a member's liability for default losses may occur indirectly. For example, the loss allocation process may result in a member being liable for a share of the default losses even though that member had no direct dealings with the defaulting member or no net position with the CCP.

LO 35.e: Discuss the risks faced by a CCP and the ways it manages its exposures.

Membership Requirements

CCPs face general risks from their clearing members; therefore, CCPs impose membership requirements to manage those risks. The membership requirements focus on creditworthiness (e.g., low likelihood of default), liquidity (e.g., ability to cover margin calls quickly), and likelihood of compliance with CCP rules. Upon acceptance as clearing members, CCPs manage the risk of clearing members by imposing requirements pertaining to minimum capital base, default fund contributions, and default management participation.

Margin

As discussed earlier, margin is used as the main form of risk mitigation by a CCP in the event of member default. Typically, only cash is accepted as variation margin, and

netting in a single currency is possible but not in different currencies. In contrast, cash and highly liquid (government) securities are accepted as initial margin. Initial margin is a complex computation that uses various scenarios of price changes during a specified trade horizon.

CCPs hold a significant amount of margin on which they usually pay interest on excess cash deposited as initial margin. As a result, it necessary for the CCP to conservatively invest the margin funds in low-risk investments to generate sufficient income to pay interest.

Member Default

Member default is the CCP's overwhelmingly main risk. Default results in an unmatched book because the defaulting member (who is assumed to have incurred a loss) is not making the required variation margin payment to the members who have a gain. Therefore, the CCP must make the variation margin payment instead. In a default, the CCP reduces its risk through macro-hedging and auctions.

Through the default management group, **macro-hedging** aims to significantly reduce portfolio exposure to major market risks (e.g., interest rate volatility).

With a member default, the CCP's goal is to quickly liquidate the defaulted member's portfolio to minimize realized losses. This is done by **auctioning** the portfolio (by subportfolios) to members. Clearing members have an incentive to participate in this auction to work out the smallest possible loss for the CCP's collective member group and avoid going down the loss waterfall (see next section). In this way, the CCP structure may yield a higher auction price for defaulted assets than would be achieved in the open market. Also, because the macro-hedges were already in place, the defaulted subportfolios will have little or no market risk, which should increase their attractiveness and help ensure sufficiently high bid prices offered by surviving members.

From an efficiency standpoint, it makes the most sense to port the defaulted member's trades to a surviving member who must accept everything on an "as is" basis. If porting does not work, then the trades and the defaulted member's portfolio are taken to the default management process. As a first step, the initial margins are taken to cover the losses.

Margin Period of Risk

The **margin period of risk (MPoR)** is also known as the liquidation period. CCPs can lower the MPoR through very frequent (e.g., at least daily) cash collateral calls; cash does not result in any settlement delays. Additionally, CCPs can close out positions quite rapidly because it is quite easy for them to declare a member in default and then work through the steps of an efficient default management process without challenge.

The MPoR can be subdivided into three distinct periods:

1. *Predefault.* This begins from the time of the member's most recent margin posting until the time the CCP declares the member in default.

2. *Macro-hedging.* The most important market risks are reduced substantially and quickly using liquid hedges.
3. *Auctions.* The defaulting member's portfolio is sold off and risk will decrease to zero with the wrap-up of each auction and closing of positions.

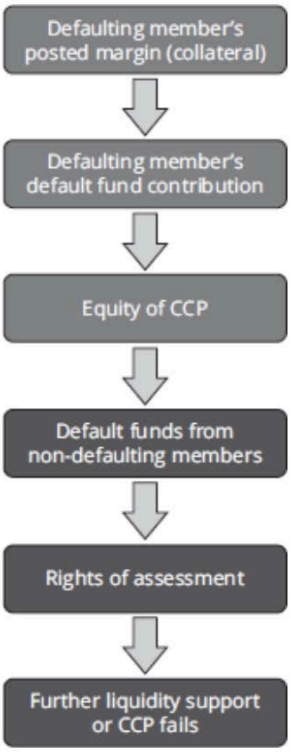
CCP Loss Waterfall

LO 35.f: Provide examples of a loss waterfall.

LO 35.g: Explain the different methods of managing the default of one or more members of a CCP.

Figure 35.5 illustrates how CCP member defaults are absorbed in a **loss waterfall**.

Figure 35.5: CCP Loss Waterfall



In the event of a CCP member default, the macro-hedging and auction costs are initially covered by the member's initial margin and default fund contributions (see Stage 1 and 2 of Figure 35.5). In other words, the first stage in the loss waterfall is for the defaulting member to sacrifice the collateral that they posted when their transaction was initiated and when daily marking-to-market occurred.

After the collateral and the default fund contributions from a defaulting member have been exhausted to remedy a realized loss, Stage 3 of Figure 35.5 indicates that the CCP will dip into its own equity capital to a point where the CCP would still be able to

function normally. This is an equity contribution from the CCP (i.e., “skin in the game”); such a potential cash outflow means that the CCP may want to make careful assessments to set the initial margins and default fund contributions sufficiently high for members so that the CCP is able to avoid equity contributions.

If a loss still remains after Stage 3, then the **loss mutualization** process takes over whereby the “surviving” members pay. The first layer of this process (Stage 4 of Figure 35.5) is to use contributions to the CCP’s default fund from nondefaulting members. Loss allocation could be done on a pro rata basis or in a way that allocates fewer losses to those who bid successfully in the auction.

Rights of Assessment

In rare and extreme loss situations that liquidate a sizable portion of the CCP’s default fund (e.g., 25%), member firms may need to make additional contributions to the default fund to restore it and prevent the CCP from total liquidation and collapse. These additional contributions are known as **rights of assessment** (see Stage 5 of Figure 35.5) and are usually limited to a specific amount per period. Limits are desirable to ensure that members are not faced with onerous cash outflows especially during an economic downturn when they are least able to make additional contributions.

Variation Margin Gains Haircutting

Variation margin gains haircutting (VMGH) is an alternative solution which assumes that losses incurred by defaulting members would have corresponding gains accrued by other members. VMGH involves the CCP “discounting” the incremental margin paid to the members who have gains so that they only receive a partial amount of what they otherwise would have received. At the same time, amounts owed to the CCP must be satisfied in full. Assuming a CCP is able to transact at midmarket prices for the defaulted portfolio, the VMGH will be successful. However, if the CCP is forced to transact at a large premium above midmarket prices, then the VMGH may fail.

Tear-Up

If the auction does not work, the CCP may cancel (or complete a **tear-up**) of unmatched contracts with clearing members. The tear-up simply strives to restore the CCP to a matched book by canceling trades that were opposite to those of the defaulting member. A key distinction between tear-up and VMGH is that the CCP will not need to pay risk premiums that could otherwise occur with an auction. Partial or complete tear-ups are possible; the latter of which is favorable for the CCP, but the clearing members will incur losses and residual market risk.

Forced Allocation

Forced allocation requires members to take specific positions for amounts specified by the CCP. The end effect is close to that of tear-up, but unlike a tear-up, the existing trade is not canceled. Instead, the member may be forced to transact in a reverse trade, for example. Tear-ups demand that the member already has the relevant trades in place whereas forced allocation does not require it. Additionally, tear-ups could allow the

clearing member to pass financial impacts to their clients but the same cannot be done with forced allocation.

Further Liquidity Support

In short, loss allocation methods such as tear-up and forced allocation are very onerous (e.g., liability could be infinite). In that regard, if the needs of a CCP are excessive, then it could be detrimental to the survival of the member firms. In this case, the CCP will either fail or require external liquidity support from a well-capitalized entity like a central bank (see Stage 6 of Figure 35.5). Some CCPs may have other (costly) sources of liquidity not listed in Figure 35.5 such as bank lines of credit or guarantees from insurance companies. Ultimately, it is important to remember that full movement down the loss waterfall is an extremely low probability event.

It is also noteworthy that CCPs are not permitted to touch the initial margin of nondefaulting members despite the potential to use initial margin haircutting as a form of loss allocation. However, loss allocation methods such as tear-up and forced allocation may impose infinite liability on a member so the "safety" of the initial margin of nondefaulting members may ultimately be irrelevant.

MODULE QUIZ 35.2

1. Which of the following statements regarding risk management by central counterparties (CCPs) is most accurate?
   A. Netting in different currencies is possible.
   B. Only cash is accepted as variation margin.
   C. An important source of returns for CCPs is the interest earned on held assets.
   D. During the margin period of risk (MPoR), most of the risk is reduced with auctions where the defaulting member's portfolio is sold off.

2. Given the following three events, what is the proper order of the CCP loss waterfall?
   I. Nondefaulting member's default fund contributions are exhausted.
   II. Defaulting member's collateral and default fund contributions are exhausted.
   III. CCP taps an amount of its equity that enables them to function normally.
   A. I, II, III.
   B. II, I, III.
   C. II, III, I.
   D. III, II, I.

MODULE 35.3: CENTRAL CLEARING MARKET IMPACT

Bilateral vs. Central Clearing

LO 35.h: Compare bilateral and central clearing.

The notion of a centrally cleared OTC derivatives market is best evaluated by contrasting it against a bilateral market.

Key characteristics of **bilaterally cleared markets** include the following:

- *Counterparty*. In a bilateral market, the original counterparty remains in effect as long as the contract remains in effect.
- *Available products*. There are no limitations to products that can be used in bilateral markets. As long as the two parties agree to the terms of a contract, then it is able to be created.
- *Eligible participants*. Participation in bilateral markets is open to any and all market actors. The only exclusion would be if someone has such weak credit that no counterparty would be willing to take the opposite side of their trade.
- *Contract netting*. Any netting of contracts to offset risks will need to be manually and intentionally arranged by players in bilateral markets. Typically, trades are not offset as market participants are placing bets on specific events, which means they do not wish to be market neutral.
- *Margining*. Two bilateral counterparties are able to negotiate customized collateral arrangements. New regulatory rules are trying to standardize this factor, but for now, there is a great deal of flexibility.
- *Close-out of default positions*. Close-out of a default position can be messy in a bilateral market. This process is entirely between two bilateral counterparties and may quickly result in a default scenario for the entire counterparty and not just the isolated transaction.
- *Loss absorbency cost*. Loss absorption is mostly through capital although increasingly through initial margins.

Key characteristics of **centrally cleared markets** include the following:

- *Counterparty.* In a centrally cleared market, the original counterparty is effectively replaced when the CCP steps into the middle of the transaction. Through the CCP structure, the CCP becomes the new counterparty and the other CCP members become secondary counterparties.
- *Available products*. Financial products traded in centrally cleared markets must be standardized, plain-vanilla (nonexotic), and liquid. This helps to limit loss potential from specialized contracts, but it also limits the flexibility of types of contracts that can be used within the CCP structure.
- *Eligible participants*. Centrally cleared markets are only open to clearing members, which are typically large financial institutions. Other entities may clear transactions by using a clearing member as a conduit only if they are willing and able to post the necessary collateral and a clearing member is willing to sponsor them.
- *Contract netting*. CCPs naturally try to remain market neutral by netting financial transactions. This process helps to further spread out risks.
- *Margining*. A centrally cleared market has transparent collateral requirements and margin rules with daily or intra daily posting. These rules are static and nonnegotiable for member firms.
- *Close-out of default positions*. A coordinated default process is one of the hallmarks of a centrally cleared market. The loss waterfall is the heart of this process, and it has the potential to not let a default on a single asset result in the complete default of an

individual member firm. This coordinated close-out structure helps to minimize internal costs due to operational efficiencies and also minimize legal risk because the member firms are already engaged in a rules-based transactional relationship.

- *Loss absorbency cost.* Loss absorption is mostly through initial margin and through funds provided by clearing members to the default fund.

Initial Margin and Default Fund Requirements

LO 35.i: Compare initial margin and default fund requirements for clearing members in relation to loss coverage, cost of clearing, and moral hazard.

In simplified terms, initial margin is designed to provide very high likelihood (e.g., 99%) of sufficient coverage of any losses suffered by a CCP due to a member default. Despite such strong assurances, there is always the possibility that losses will occur when the initial margin is insufficient.

The default fund covers losses not covered by the initial margin. Given the nature of the loss distributions, if the margin is insufficient then there are likely extreme losses. The amount of coverage required would also be extreme and, therefore, the default fund uses a risk pooling system that shares a large loss from one CCP member with all other members. Because the default fund is mutualized, it means that default fund contributions by each member are relatively small, and the default fund will have much more loss absorbency compared to initial margin.

The split between initial margin and default fund is subjective and there are multiple approaches. Larger initial margins and smaller default funds have a higher clearing cost but are more consistent with the defaulter paying for the losses it causes. This encourages better behavior, so, as a result, moral hazard is lower. This, in turn, encourages clearing members to provide portability (i.e., allow clients to move their portfolio to another clearing member).

In contrast, smaller initial margins and larger default funds have a lower clearing cost but elevate moral hazard. This is because there is greater likelihood of losses being covered by default funds and less consistency with the defaulter paying for the losses it causes. This discourages clearing members from providing portability as there may not be enough initial margin, thereby requiring the clearing members to pay additional amounts into default funds.

The default fund serves to lower clearing costs through a process of loss mutualization to absorb potentially large losses exceeding those covered by the initial margins. An accurate computation of the optimal default fund size is problematic due to extreme complexities, therefore, CCPs must estimate the default fund size using stress tests. The size would likely be expressed in terms of how many defaults the CCP can absorb (e.g., one or two). From there, the loss allocation process can be done in a straightforward manner (e.g., pro rata based on position size or initial margin).

Advantages and Disadvantages of Central Clearing

LO 35.j: Describe the advantages and disadvantages of central clearing.

While the central clearing process does not fully eliminate counterparty risk, it does greatly reduce it from a traditional bilateral model. The advantages and disadvantages of the CCP structure are summarized here.

The advantages of a CCP include the following:

- *Transparency.* Unlike bilateral markets, a CCP can see aggregate risk concentrations because they are aware of many of the transactions of their member firms. This enables the CCP to take mitigating actions to potentially offset risks that it notices early on.
- *Multilateral offset.* The transparency of the CCP structure enables risk to be offset. The offsetting process eliminates the need for members to monitor the creditworthiness of other members. This process also lowers margin costs for member firms.
- *Loss mutualization*. In the event that a CCP member defaults, the CCP will manage the default using the loss waterfall where realized losses may be shared by all members of the CCP. This reduces the market impact of a default scenario and reduces systemic risk.
- *Legal and operational efficiency.* Both netting and the collateral policies of a CCP increase operational efficiency and lower costs. Legal costs are also minimized due to the rules-based structure of a CCP.
- *Liquidity.* Greater ability for members to trade and use multilateral offset leads to enhanced market transparency and, therefore, improved market liquidity.
- *Default management.* The CCP also manages default scenarios with an orderly auction of the defaulted member's position. This brings stability to the market and secures the best price possible for the market.

The disadvantages of a CCP include the following:

- *Moral hazard.* This well-known insurance industry concept can be applied to the CCP structure because there is little incentive for member firms to vet the creditworthiness of other member firms. The netting, collateralization, and loss mutualization process contribute to this view.
- *Adverse selection.* Most CCP member firms specialize in derivative contracts. As such, they may have superior knowledge on pricing and risk compared to the CCP. This creates an environment where the member firms may choose to trade with CCPs that offer the best prices due to incomplete information.
- *Bifurcations.* The fact that CCPs are required to only clear standard contracts has created a bifurcated market where some trades are processed through clearing firms, and some are not. This reduces the benefit of multilateral offset.
- *Procyclicality.* Procyclicality refers to a positive correlation between an event and the state of the economy. As the market and economy become more volatile, CCPs

generally increase collateral requirements, which can further exacerbate a potential default scenario.

MODULE QUIZ 35.3

1. Which of the following statements is not an improvement that centrally cleared markets offer relative to bilateral markets? Centrally cleared markets:
   A. remain market neutral by netting trades.
   B. formalize the default workout process by using a loss waterfall structure.
   C. offer more flexibility in contract selection because of their collateral collecting process.
   D. improve the counterparty risk picture by replacing the original counterparty with a series of counterparties.

2. Following the financial crisis of 2007–2009, the roles of central counterparties (CCPs) were increased to reduce systemic risk through a centralized clearing process. Which of the following actions is not an advantage of the CCP in the centralized clearing process?
   A. Increase transparency.
   B. Manage loss mutualization.
   C. Eliminate counterparty risk.
   D. Improve operational efficiency.

KEY CONCEPTS

LO 35.a

A central counterparty (CCP) has become a solution for systemic risk mitigation. CCPs essentially stand in the middle of previously bilateral over-the-counter (OTC) transactions and operate as the buyer for every seller and vice versa. When examining derivative products clearing in a CCP setting, the following characteristics must be considered: standardization, complexity, liquidity, wrong-way risk, and market volume.

Multilateral netting benefits such as reducing risk exposures and gaining economies of scale suggest that there should be a small number of CCPs. However, jurisdictional fragmentation, the variety of products, the need for competition, and the risk of severe systemic risk are all factors suggesting that there should be a greater number of CCPs.

LO 35.b

Novation involves closing out the nonperforming side of a bilateral contract with a new counterparty (i.e., the CCP) that is capable of meeting the contractual obligations. Essentially, the CCP takes on the counterparty risk upon novation as the original parties no longer have contractual obligations to each other.

LO 35.c

The bilateral derivatives market, by its nature, likely has a significant number of redundant transactions that raise the level of counterparty risk. Netting and multilateral offset are used to reduce the number of transactions. The use of CCPs is desirable because it can achieve multilateral offsets for cash flows and margins, for example.

Compressing portfolios involves the cancellation of real transactions on an absolute or gross basis, without relying on the offsetting benefits of multilateral offsets. In general terms, with compression, multiple offsetting contracts are canceled and substituted with fewer contracts to lower the gross exposures of both parties while maintaining the net exposures.

LO 35.d

Initial margin is the beginning deposit required from all members to cover future potential default losses in a worst-case scenario. Variation margin is the additional margin required to account for daily price changes in asset positions; intraday margin calls are used during periods with large market movements. Similar to variation margin, initial margin depends primarily on market risk rather than the credit quality of the clearing member.

LO 35.e

CCPs impose membership requirements, which focus on creditworthiness, liquidity, and likelihood of compliance with CCP rules.

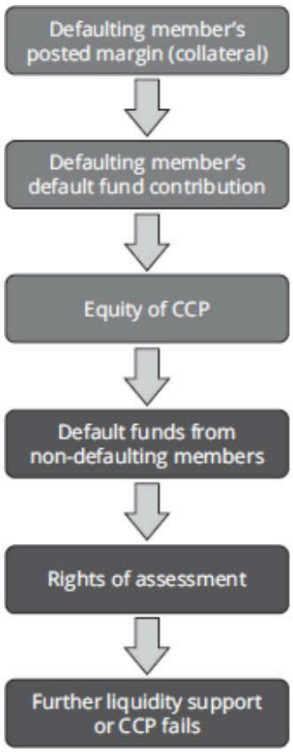
Margin is used as the main form of risk mitigation by a CCP in the event of member default. Typically, only cash is accepted as variation margin, and cash and highly liquid (government) securities are accepted as initial margin.

Member default is the CCP's main risk. In a default, the CCP reduces its risk through macro-hedging and auctions.

The margin period of risk (MPoR) is the liquidation period, and it can be subdivided into three distinct periods: predefault, macro-hedging, and auctions.

LO 35.f

The loss waterfall summarizes how CCP member defaults are absorbed. A typical loss waterfall is illustrated as follows:



LO 35.g

In rare and extreme loss situations that liquidate a sizable portion of the CCP's default fund, member firms may need to make additional contributions (rights of assessment) to the default fund to restore it and prevent the CCP from total liquidation and collapse.

Variation margin gains haircutting (VMGH) involves the CCP "discounting" the incremental margin paid to the members who have gains so that they only receive a partial amount of what they otherwise would have received. At the same time, amounts owed to the CCP must be satisfied in full.

Assuming the auction does not work, the CCP may cancel (or tear-up) unmatched contracts with clearing members. The tear-up simply strives to restore the CCP to a matched book by canceling trades that were opposite to those of the defaulting member.

Forced allocation requires members to take specific positions for amounts specified by the CCP. The end effect is close to that of tear-up, but unlike a tear-up, the existing trade is not canceled. Instead, the member may be forced to transact in a reverse trade, for example.

If the needs of a CCP are excessive, then it could be detrimental to the survival of the member firms. In this case, the CCP will either require external liquidity support from

a well-capitalized entity like a central bank or face failure.

LO 35.h

Key characteristics of bilaterally cleared markets are as follows:

- The original counterparty remains in effect as long as the contract remains in effect.
- There are no limitations to products that can be used in bilateral markets.
- Participation in bilateral markets is generally open to any and all market actors.
- Any netting of contracts to offset risks will need to be manually and intentionally arranged by players in bilateral markets.
- Two bilateral counterparties are able to negotiate customized collateral arrangements.
- Close-out of a default position is entirely between two bilateral counterparties and may quickly result in a default scenario for the entire counterparty and not just the isolated transaction.
- Loss absorbency cost is mostly through capital.

Key characteristics of centrally cleared markets are as follows:

- The original counterparty is effectively replaced when the CCP steps into the middle of the transaction.
- Financial products traded in centrally cleared markets must be standardized, plain-vanilla (nonexotic), and liquid.
- Centrally cleared markets are generally only open to clearing members, which are typically large financial institutions.
- CCPs naturally try to remain market neutral by netting financial transactions.
- Transparent collateral requirements and margin rules with daily or intradaily posting. These rules are static and nonnegotiable for member firms.
- A coordinated default process is one of the hallmarks of a centrally cleared market. The loss waterfall is the heart of this process, and it has the potential to not let a default on a single asset result in the complete default of an individual member firm.
- Loss absorbency cost is mostly through initial margin and through funds provided by clearing members to the default fund.

LO 35.i

The strengths and weaknesses of using different amounts of initial margin and default fund contributions are summarized as follows:

	Higher Initial Margin/ Lower Default Fund	Lower Initial Margin/ Higher Default Fund
Cost	Higher	Lower
Client clearing	Clients pay for their own risk using initial margin.	Clients do not directly pay for their own risk.
	Portability is encouraged.	Portability is a challenge.
Moral hazard	Lower	Higher

LO 35.j

The advantages of a CCP include transparency, multilateral offset, loss mutualization, legal and operational efficiency, liquidity, and default management.

The disadvantages of a CCP include moral hazard, adverse selection, bifurcations, and procyclicality.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 35.1

1. **D** Lack of standardized products, complexity, illiquid products, and the presence of wrong-way risk are characteristics of OTC derivative products that make CCP clearing challenging. OTC derivative products need to be standardized before they can be cleared through a CCP. More complex and illiquid derivative products are problematic for CCPs because their unique features make them difficult to value. Products with wrong-way risk are also more complex and create additional concerns for CCPs in the event of default. (LO 35.a)

Module Quiz 35.2

1. **B** Usually, only cash is accepted as variation margin. Netting in a single currency is possible but not in different currencies. CCPs operate primarily by charging fees on all trades and to a lesser extent by earning income on the assets in their possession. The most important risks are reduced substantially and quickly using liquid hedges via macro-hedging. (LO 35.e)

2. **C** The first layer in the loss waterfall is for the defaulting member's collateral and default fund contributions to be exhausted. The next layer is for the CCP to tap into its own equity to the point where it could still function normally. Nondefaulting members will then have their default funds exhausted before moving to the rights of assessment. (LO 35.f)

Module Quiz 35.3

1. **C** Bilateral markets permit any type of customized financial contract and customized collateral that is freely negotiated between the two bilateral parties. In a centrally cleared market, flexibility is reduced because contracts must be standardized, and collateral rules are fixed and nonnegotiable. (LO 35.h)

2. **C** CCPs reduce counterparty risk, but they do not eliminate this risk. Improved legal and operational efficiencies, increased transparency, and loss mutualization are major advantages of the CCP central clearing process. (LO 35.j)

The following is a review of the Credit Risk Measurement and Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Gregory, Chapter 11.

READING 36

FUTURE VALUE AND EXPOSURE

Study Session 6

EXAM FOCUS

In this reading, we describe credit exposures for various security positions. For the exam, understand credit exposure metrics and their application. Be prepared to identify potential future exposure (PFE) for the various asset classes discussed. Understand how credit exposure and VaR methods compare, and be able to explain credit exposure factors. Know how payment frequencies and exercise dates impact exposure profiles. Also, be familiar with netting tables and be able to calculate the netting factor. Understand the impact of collateral attributes on credit exposure reduction and know the steps in computing the margin period of risk (MPoR). Finally, be able to explain the difference between risk-neutral and real-world parameters in arbitrage models and risk management applications.

MODULE 36.1: CREDIT EXPOSURE

Credit Exposure Metrics

LO 36.a: Describe and calculate the following metrics for credit exposure: expected mark-to-market, expected exposure, potential future exposure, expected positive exposure and negative exposure, effective expected positive exposure, and maximum exposure.

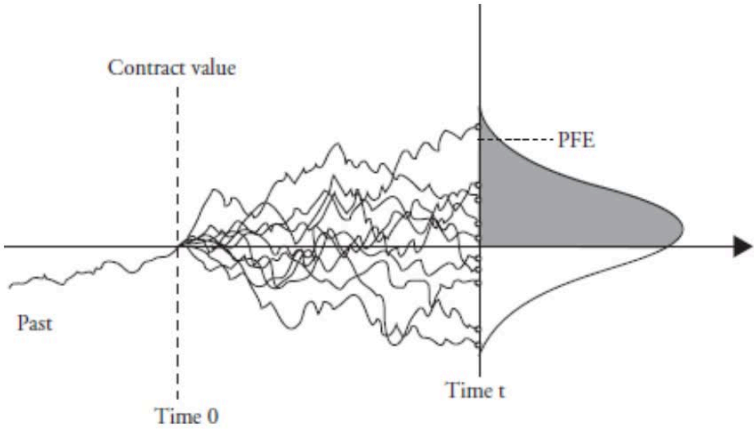
Expected mark to market (MtM) is the expected value of a transaction at a given point in the future. Long measurement periods as well as the specifics of cash flows may cause large differences between current MtM and expected MtM.

Expected exposure (EE) is the amount that is expected to be lost if there is positive MtM and the counterparty defaults. Expected exposure is larger than expected MtM because the latter considers both positive and negative MtM values.

Potential future exposure (PFE) is an estimate of MtM value at a specific point in the future. It is usually based on a high confidence level, taking into account the worst-case scenario. The current MtM may follow a number of different possible paths into the

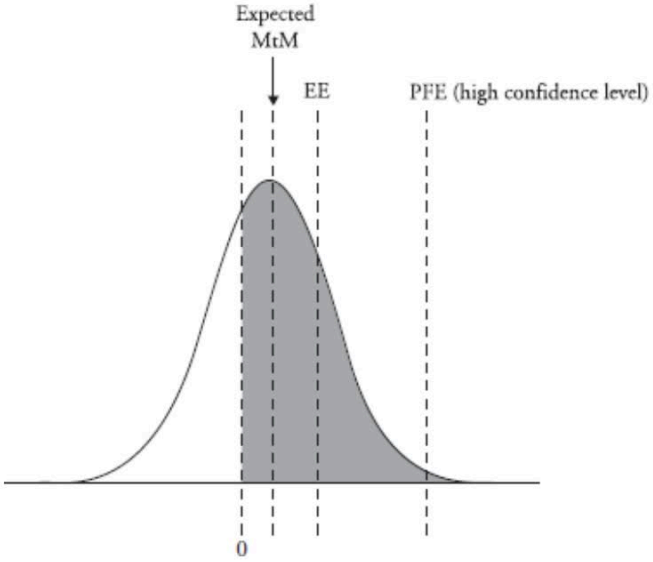
future, so a probability distribution of PFE can be derived, similar to the one shown in Figure 36.1. Positive MtM (the shaded area in Figure 36.1) is the part of the exposure that is at risk. Any points in this shaded area can represent PFE.

Figure 36.1: Potential Future Exposure



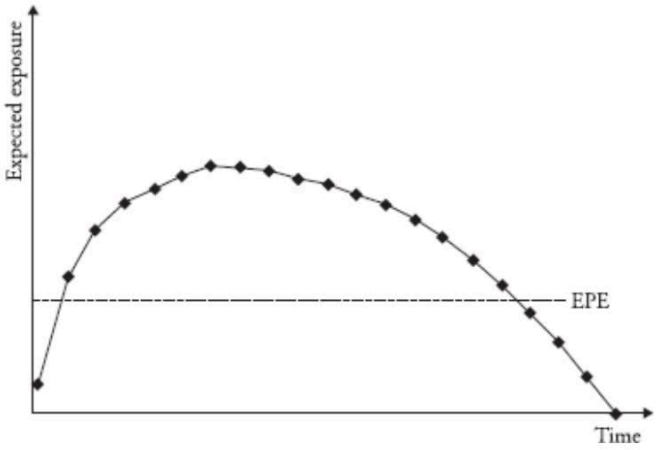
In other words, PFE is the worst exposure that could occur at a given time in the future at a given confidence level. Potential future exposure represents a "gain" amount because it is the amount at risk if the counterparty defaults. **Maximum PFE** is the highest PFE value over a stated time frame.

Figure 36.2: Credit Exposures



Expected positive exposure (EPE) is the average EE through time. Expected positive exposure is a useful single amount to quantify exposure.

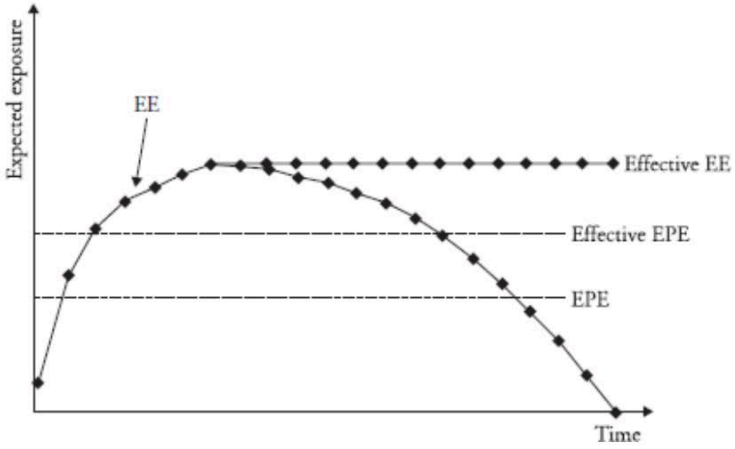
Figure 36.3: Expected Positive Exposure



Negative exposure, which is the exposure from the counterparty's point of view, is represented by negative future values. The expected negative exposure (ENE) is the exact opposite of EPE.

The **effective EE** and **effective EPE** measures are meant to properly capture rollover risk for short-term transactions (under one year). Effective EE is equal to nondecreasing EE. Effective EPE is the average of the effective EE.

Figure 36.4: Effective EE and Effective EPE



Comparing Credit Exposure to VaR Methods

LO 36.b: Compare the characterization of credit exposure to VaR methods and describe additional considerations used in the determination of credit exposure.

Value at risk (VaR) is a measure used to estimate the risk of loss on a portfolio of financial/investment assets (e.g., stocks, bonds, derivatives, etc.). For example, if an asset portfolio has a one-day 10% VaR of $100,000, there is a 10% probability that the market value of the portfolio will fall by more than $100,000 over a period of one day.

The characterization of credit exposure is similar to the characterization of VaR, although additional considerations are relevant to credit exposure, described as follows:

- *Application*: Credit exposure is defined for both pricing and risk management, whereas VaR is just for risk management. As a result, quantifying credit exposure is more difficult and may result in different calculations for both pricing and risk management purposes.
- *Time horizon*: VaR models are based on a relatively short time horizon, whereas credit exposure must be defined over many time horizons. The trend (i.e., drift) of market variables, their underlying volatility, and their levels of co-dependence become relevant for credit exposure, whereas for VaR, these elements are irrelevant due to the short time horizon. Also, while VaR tends to ignore future contractual payments and changes such as exercise decisions, cash flows, and cancellations, credit exposure must take these elements into account because they tend to create path dependency (i.e., credit exposure in the future depends on an event occurring in the past).
- *Risk mitigants*: Netting and collateral are examples of risk mitigants, designed to reduce the level of credit exposure. In order to estimate future levels of credit exposure, these mitigants need to be taken into account. Netting requires that the proper rules be applied, which may add a level of complexity. Future collateral adds a significant element of subjectivity, as the type of collateral and time to receive collateral must all be modeled even though they may be unknown.

Credit Exposure Factors

LO 36.c: Identify factors that affect the calculation of the credit exposure profile and summarize the impact of collateral on exposure.

The credit exposure profile is impacted by several factors, including:

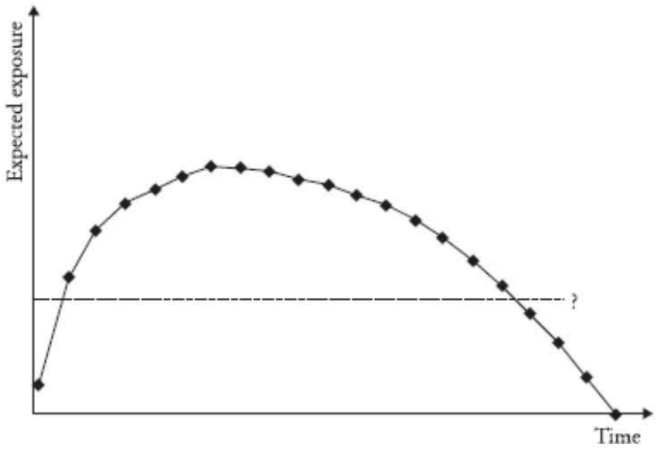
- *Future uncertainty*: In situations where there is a single payout at the end of the life of a contract, uncertainty regarding the value of the final exchange increases over time. Foreign exchange forwards and FRAs often have single payouts at the end of their contract lives.
- *Periodic cash flows*: Unlike the situation where there is a single payout, when cash flows occur regularly, the negative impact of the future uncertainty factor is reduced. However, additional risk exists when periodic cash flows are not equal in each period and are based on variables that may change as is often the case in an interest rate swap with variable interest rates.
- *Combination of profiles*: This exists when the credit exposure of a product results from the combination of multiple underlying risk factors. A cross-currency swap (which combines a foreign exchange forward trade with an interest rate swap) is a good example of this factor.
- *Optionality*: Exercise decisions (e.g., a swap-settled interest rate swaption) will have an impact on credit exposure.

Collateral will also have a significant impact on credit exposure, as it typically reduces the level of credit exposure. However, determining the true level of risk reduction must take into account key parameters (e.g., minimum transfer amounts, thresholds, etc.); the margin period of risk; and other risks associated with collateral such as liquidity, operational risk, and legal risk.

In addition, the reality is that risk is not removed entirely even with collateral due to factors such as delays in receiving collateral, variations in collateral value (i.e., when the collateral is something other than cash), the granularity effect (i.e., key parameters prevent asking for all of the collateral actually required), and the path dependency of collateral (i.e., the amount called for depends on the amount collected in the past).

MODULE QUIZ 36.1

1. Which metric for credit exposure is represented by the "?" in the following graph?



A. Expected positive exposure (EPE).
B. Potential future exposure (PFE).
C. Effective expected exposure (EE).
D. Effective expected positive exposure (EPE).

MODULE 36.2: SECURITY EXPOSURE PROFILES

LO 36.d: Identify typical credit exposure profiles for various derivative contracts and combination profiles.

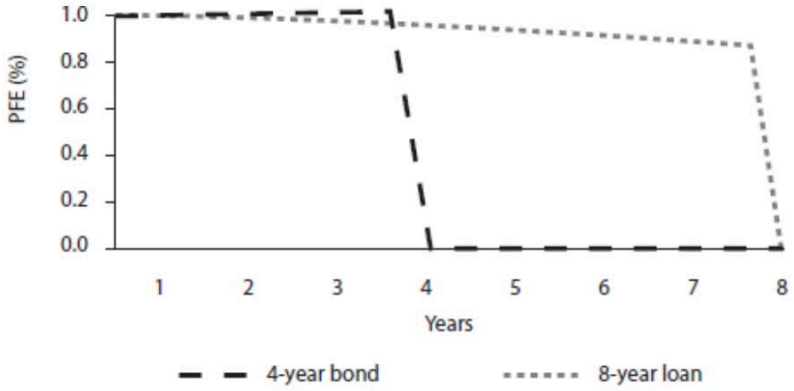
Potential future exposure (PFE) is defined as the maximum expected credit risk exposure for a specified period of time at a prespecified level of confidence. PFE is a measure of counterparty and credit risk exposures. Thus, the maximum credit risk exposure indicated by a PFE analysis is the upper bound on a confidence interval for future credit risk exposure. The ability to quantify counterparty credit exposure is impacted by time to maturity. There is more uncertainty related to market variables further into the future.

Examples of PFE are used to illustrate the credit exposure profile of various security types that result from different sources (e.g., maturity, option exercise, payment

frequencies, default risk, and roll-off risk). In this section, a 99% confidence level is used to create the PFEs.

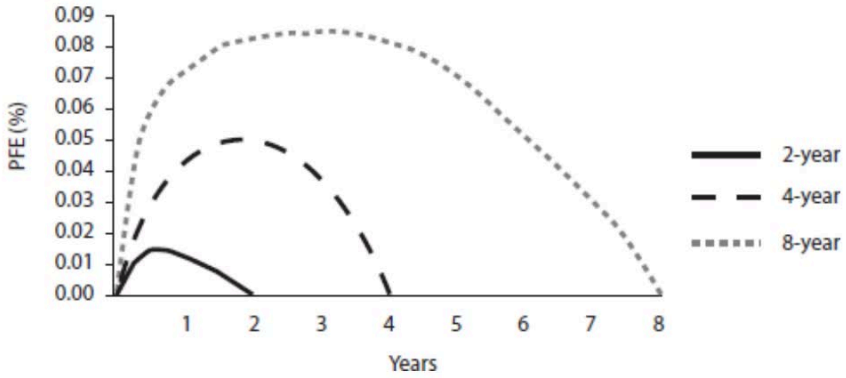
The PFE of bonds, loans, and repos are approximately equal to the notional value. The additional exposure of a four-year bond, as shown in Figure 36.5, is the result of interest rate risk. Bonds typically pay a fixed interest rate. If interest rates decline, then the exposure may increase. Figure 36.5 also illustrates the exposure for an eight-year loan. Loans typically have variable interest rates, and the exposure over time may decrease as a result of prepayments.

Figure 36.5: Loan and Bond PFE



Exposure profiles of swaps are typically characterized by a peak shape, as illustrated in Figure 36.6. This peaked shape results from the balancing of future uncertainties over payments and the roll-off risk of swap payments over time.

Figure 36.6: Interest Rate Swap PFE



The high volatility of FX rates, long maturities, and large final payments of notional value result in monotonically increasing exposures for foreign exchange products. Figure 36.7 illustrates that there is some exposure associated with interest rate risk (IR); however, the majority of the exposure results from the uncertainty regarding the final notional value payment associated with FX rate risk.

Figure 36.7: Three-Year Cross-Currency Swap PFE (Exposure Impact of Interest

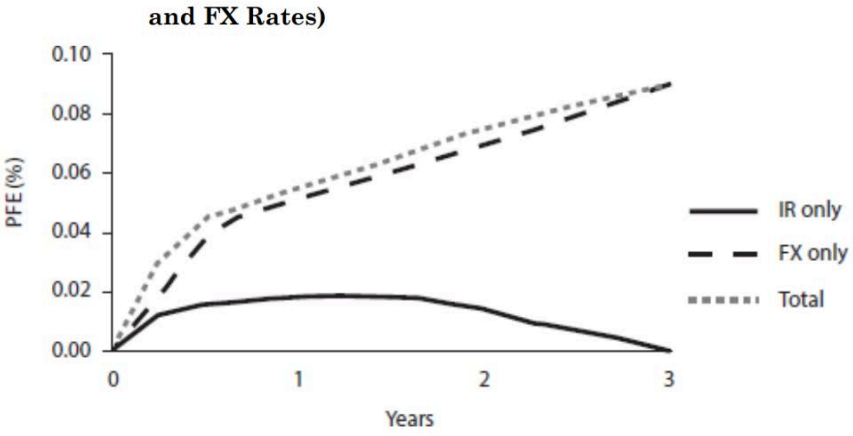
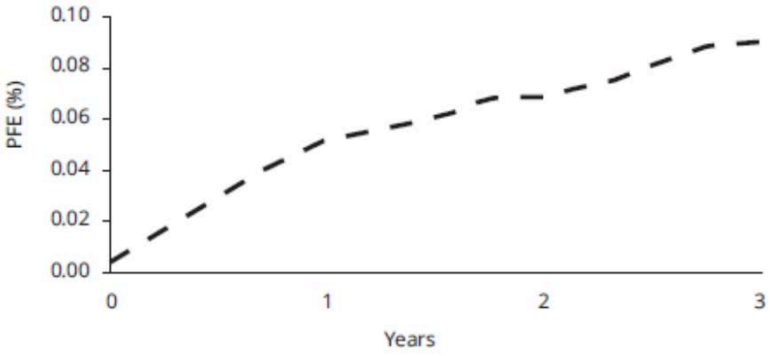


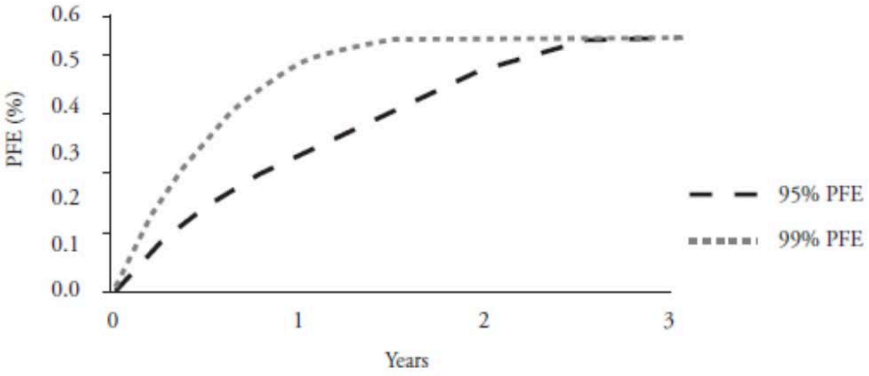
Figure 36.8 provides an exposure profile for a long option position (with up-front premium) and illustrates the increase over time of the exposure until the option is exercised. The exact shape of the graph can change when the option is near, in, or out of the money. However, the increase over time is similar for all options due to the fact that the option can be deep in the money.

Figure 36.8: Option PFE



The effect of **wrong-way risk** leads to considerable counterparty risk for credit derivatives. Figure 36.9 illustrates the exposures for a long-protection credit default swap (CDS) at the 95% and 99% confidence levels. The increase in exposures in early years is the result of the CDS premium (or credit spread) widening. The maximum exposure for the CDS occurs at a credit event where the notional value is paid less the recovery value. The 55% final exposure in this example is the result of a 45% recovery rate.

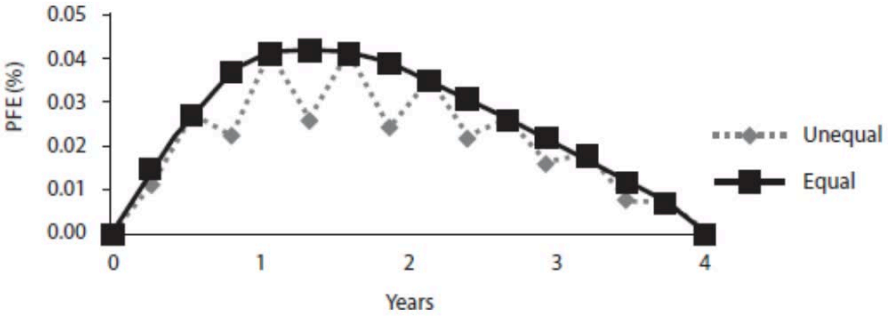
Figure 36.9: Credit Derivative PFE



LO 36.e: Explain how payment frequencies and exercise dates affect the exposure profile of various securities.

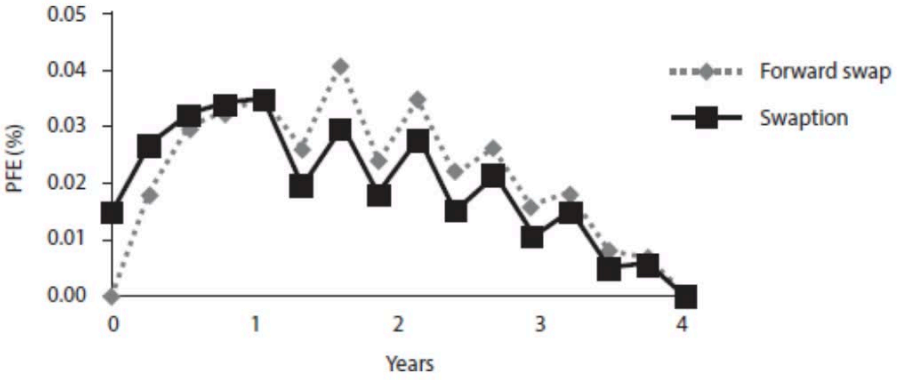
To illustrate the impact of payment frequencies, we can compare interest rate swap PFEs, assuming semiannual fixed payments are made and floating quarterly payments are received. Figure 36.10 illustrates that with unequal payments there is reduced exposure when payments are received more frequently than payments are made. Conversely, if a PFE were created for an interest rate swap where interest payments made were more frequent than interest payments received, it would have the reverse effect. In that case, the unequal payment PFE would show greater exposure than the equal payment PFE.

Figure 36.10: PFE for Swap With Equal and Unequal Interest Payments



Exercise dates result in more complex exposure profiles as illustrated in Figure 36.11, which shows an exposure profile for an interest rate swaption and forward swap with an exercise date of one year. The swaption in this example is swap-settled (as opposed to cash-settled) on the expiration date. The payment frequencies also differ for the swaps in this example. When compared to a forward swap, notice that the exposure is greater for the swaption prior to the one-year exercise date. This relationship reverses after the exercise point and the exposure for the forward swap is greater than the exposure for the swaption. This greater exposure is due to the fact that in some scenarios the forward swap has a positive value and the swaption is not exercised.

Figure 36.11: PFE for Interest Rate Swaption and Forward Swap



Modeling Netting Agreements

LO 36.f: Explain the general impact of aggregation on exposure, and the impact of aggregation on exposure when there is correlation between transaction values.

Netting agreements allow two parties to net a set of positions should one of the parties default. This type of risk is effectively modeled in Monte Carlo simulations. The benefits of netting are realized when MtM values have opposite signs for two trades. Thus, the netting calculation is done at the individual level prior to calculating the total expected exposure (EE). A single time horizon netting factor is defined by EE, and a weighted average EE over time defines the expected positive exposure (EPE).

It is also important to consider the relationship between netting and correlation. Positive correlations have lower netting benefits than negative correlations, with perfect positive correlation providing the least netting benefit. High positive correlations likely result in trades that are of the same sign, resulting in a small or zero netting benefit.

Figure 36.12: Netting With Positive Correlations

	MtM		Total Exposure		
	Trade 1	Trade 2	No Netting	Netting	Netting Benefit
Scenario 1	15	5	20	20	0
Scenario 2	5	−5	5	0	5
Scenario 3	−5	−15	0	0	0
EE			8.3	6.7	1.7

PROFESSOR'S NOTE
EE, or expected exposure, is the average of the netting figures assuming equal weight.

We can, therefore, easily see that negative correlations provide stronger netting benefits, with perfect negative correlation leading to the greatest netting benefit. In this

case, trades are perfectly offsetting, and the netting benefit is 100% because there is zero overall risk.

Figure 36.13: Netting With Negative Correlations

	MtM		Total Exposure		
	Trade 1	Trade 2	No Netting	Netting	Netting Benefit
Scenario 1	15	−5	15	10	5
Scenario 2	5	5	10	10	0
Scenario 3	−5	15	15	10	5
EE			13.3	10.0	3.3

Overall, we can derive the following netting formula for the **netting factor** for any set of jointly distributed random variables across different asset classes:

$$\text{netting factor} = \frac{\sqrt{n + n(n-1)\bar{\rho}}}{n}$$

where:
n = number of exposures
$\bar{\rho}$ = average correlation

The netting factor will, therefore, be 100% when there is no netting benefit (correlation is 1) and 0% if the netting benefit is maximized. We also see that the netting benefit improves (i.e., netting factor declines) with a larger number of exposures and a lower correlation. If correlation is zero, the formula simplifies to $1 / \sqrt{n}$, implying that the netting factor for two independent exposures will be reduced to 71%, and for four exposures the netting factor declines to 50%.

PROFESSOR'S NOTE
There is a restriction on the correlation level in the netting factor equation. The maximum negative correlation must be bounded by $[-1 / (n - 1)]$ in order to prevent the expression under the square root from becoming negative.

Finally, it is important to note that the netting benefit also depends on the initial MtM of transactions. For example, a trade with strong overall negative MtM under all scenarios will have a strong netting benefit by offsetting some or all of the positive MtM of other trades. Similarly, a trade with strong overall positive exposure under all scenarios will reduce the netting benefit by offsetting some or all of the negative MtM of other trades.

MODULE QUIZ 36.2

1. Miven Corp. has two trades outstanding with one of its counterparties. Which of the following scenarios would result in the greatest netting advantage for Miven?
   A. The two trades have strong positive correlation.
   B. The two trades have weak positive correlation.
   C. The two trades are uncorrelated with each other.
   D. The two trades have strong negative correlation.

2. Which of the following security types will most likely result in a peaked shape for the exposure profile represented by potential future exposure (PFE)?

A. Long option position.
B. Foreign exchange product.
C. 10-year loan with a floating rate payment.
D. Swap.

3. Which of the following statements best describes the benefit of netting risk exposures? The benefits of netting are realized when:
A. marked-to-market (MtM) values have high structural correlations for two trades.
B. marked-to-market (MtM) values have opposite signs for two trades.
C. expected exposure (EE) values are minimal.
D. expected future exposure (EFE) values have zero correlation.

MODULE 36.3: COLLATERAL AND CREDIT EXPOSURE

LO 36.h: Explain the impact of collateralization on exposure and assess the risk associated with the remargining period, threshold, and minimum transfer amount.

When Party A has a positive exposure (e.g., receives cash flows in a swap transaction from Party B), Party A is said to have credit exposure because Party B could default. When exposure (i.e., mark-to-market value) is negative, Party A must post collateral to Party B to minimize the credit risk exposure.

When calculating an exposure profile, a risk manager should understand the factors that affect the collateral's ability to reduce risk. Specifically, factors that affect the calculation of exposure include thresholds, minimum transfer amounts, rounding, initial margin, and the margin period of risk. These factors will be discussed later in this section.

The **margin period of risk (MPoR)**, also known as the remargin period, is the period from which a collateral call takes place to when collateral is actually delivered. It is a period of extreme exposure to the counterparty seeking collateral. A prudent risk analyst will assume default of the counterparty that must post collateral during the MPoR. Steps that enter into the calculation of the number of days in the MPoR are as follows:

Step 1: Valuation/margin call: How long it takes to calculate current exposure to the counterparty and the market value of the collateral. These calculations help to determine if a valid call may be made.

Step 2: Receiving collateral: The period between when the counterparty receives the request and when it releases the collateral.

Step 3: Settlement: The time it takes to sell the collateral for cash. The type of security being settled determines the time necessary. Cash may be posted on an intraday basis, whereas government and corporate bonds may need one- and three-day settlement periods, respectively.

Step 4: Grace period: The amount of time afforded to the counterparty obligated to deliver the collateral in the event that the collateral is not received by the requesting counterparty after the call. This may be a short window of time before the delivering counterparty would be considered in default for a failure-to-pay credit event.

Step 5: Liquidation/close-out and re-hedge: The time needed to liquidate the collateral, close out, and re-hedge positions.

An example of a MPoR time line is found in Figure 36.14, along with the minimum period lengths that must be assumed according to Basel II. Over-the-counter (OTC) derivatives and repurchase agreements (repos) are separated as they are governed by different documentation. The length of a MPoR is a function of the collateral agreement, the counterparty in question, legal considerations, and the management structure of the institution in question. Also, the counterparty requesting the collateral could show leniency toward certain counterparties in the interest of maintaining harmonious business relationships.

Figure 36.14: MPoR Time Line

	OTC Derivatives	Repos
Valuation/margin call	2 days	_
Receiving collateral	1 day	1 day
Settlement	2 days	1 day
Grace period	3 days	_
Liquidation/close-out and re-hedge	2 days	1 day
Total	10 days	3 days
Basel II minimum period	10 days	5 days

Measuring Exposure During the MPoR

Both expected exposure and potential future exposure measure the volatility of exposure over a given period of time. **Expected exposure (EE)** is the expected value of an exposure at a given point in time. During the MPoR, it is calculated as:

$$EE = \frac{1}{\sqrt{2\pi}} \times \sigma_E \times \sqrt{T_M} \approx 0.4 \times \sigma_E \times \sqrt{T_M}$$

where:
σ_E = volatility of collateralized exposure
$\sqrt{T_M}$ = MPoR frequency (in years)

Potential future exposure (PFE) is what the value of the marked-to-market exposure might be at some future point in time. During the MPoR, it is calculated as:

$$PFE = k \times \sigma_E \times \sqrt{T_M}$$

where:
k = constant that is a function of the confidence level
(e.g., k = 2.33 for a 99% confidence level)

> **EXAMPLE: Computing PFE**
>
> **Calculate** the worst-case change in the value of an exposure with 7% annual volatility perfectly collateralized by cash over a 10-day MPoR. Assume 250 trading days in the year and a 99% PFE confidence level.

Answer:

$$\text{PFE} = -2.33 \times 7\% \times \sqrt{10/250} = -3.3\%$$

Potential disadvantages of PFE calculations include:

- It assumes a strongly collateralized position. PFE fails to work under a large threshold or minimum transfer amount, which produces a partially uncollateralized exposure.
- The analysis fails to account for the uncertainty of collateral volatility.
- Liquidity and liquidation risks are not considered.
- Volatility may differ from expected or implied volatility at the time of the collateral call and may not assume counterparty default.
- Wrong-way risk is not taken into account.

Collateral volatility must be calculated when a decline in the value of noncash collateral has the potential to create undercollateralization. The PFE formula is used for this calculation.

When there is no correlation between the volatility of the underlying exposure and that of the collateral, overall volatility is calculated as follows:

$$\sqrt{\text{variance of noncash collateral} + \text{variance of underlying exposure}}$$

For example, if the volatility of the noncash collateral was 8% and the volatility of the underlying exposure was 5%, the overall volatility would be computed as:

$$\sqrt{8\%^2 + 5\%^2} = 9.4\%$$

This volatility measure would be used in the PFE formula to reflect the additive exposure of the collateral and volatility of the underlying exposure. In this example, collateral lessens exposure but increases the volatility of the position due to the volatility inherent in the collateral itself.

There are also situations where there is a negative or positive correlation, ρ, between the trade and the collateral. For example, assume a 10-year swap is collateralized with a 15-year government bond that is interest rate–sensitive. The volatilities are 4% for the swap and 6% for the bond. The effective volatility of this position is calculated as follows:

$$\text{effective volatility} = \sqrt{4\%^2 + 6\%^2 - 2 \times 4\% \times 6\% \times \rho}$$

The overall risk of the position as a function of correlation is then calculated as:

$$k \times \text{effective volatility} \times \sqrt{T_M}$$

Modeling Collateral

Quantifying how much collateral reduces credit exposure is important. The risks that arise during the process of collateralizing exposure are discussed in the following.

Collateralization may be deficient due to terms in the collateral agreement, such as threshold, minimum transfer amount, and rounding. These factors may result in less than full collateralization. The following expression represents imperfect collateralization:

$$\text{exposure}_{t-\Delta} > \text{collateral}_{t-\Delta}$$

where:
t = time
Δ = time since collateral was last received (MPoR)

Exposure could increase between margin calls. The increased amount of exposure may not be collateralized. The following expression represents the portion of exposure not collateralized:

$$\text{exposure}_{t} > \text{exposure}_{t-\Delta}$$

Collateral is path-dependent. This means that the amount of collateral requested depends on how much was requested in the past.

Certain parameters impact the effectiveness of collateral in lessening credit exposure. These parameters are as follows:

1. **Margin period of risk**: the time between the call for collateral and its receipt.
2. **Threshold**: an exposure level below which collateral is not called. It represents an amount of uncollateralized exposure.
3. **Minimum transfer amount**: the minimum quantity or block in which collateral may be transferred. Quantities below this amount represent uncollateralized exposure as well.
4. **Initial margin**: an amount posted independently of any subsequent collateralization. This is also referred to as the initial margin.
5. **Rounding**: the process by which a collateral call amount will be adjusted (rounded) to a certain increment.

Differences Between Funding and Credit Exposure

LO 36.g: Describe the differences between funding exposure and credit exposure.

Funding costs and benefits are associated with positive and negative credit exposures, respectively. If a counterparty defaults, it creates the potential for positive credit exposure, which results in a funding cost to the firm. If the firm itself defaults, it creates the potential for negative credit exposure, which results in a funding benefit. Posting margin against a positive exposure will decrease both funding costs and counterparty risk, while posting margin against negative exposure will decrease both funding benefits and exposure from the counterparty's point of view.

Despite these connections, there are some differences between funding and credit exposure that should be recognized. Differences include:

- *Defining value*: How value is defined for credit exposure is subjective and depends on assumptions related to close-out procedures. For funding exposure, value is objective since it is also present in non-defaulting situations.
- *Margin period of risk*: This measure considers counterparty default and is used when computing credit exposure. For funding exposure, the associated funding delay does not necessarily assume counterparty default. Thus, the funding value adjustment could be zero even if the associated credit value adjustment is non-zero.
- *Aggregation*: Credit exposure arises in default; therefore, it is concerned with netting values. With funding exposure, the entire portfolio may be considered since margin from different counterparties can be reused.
- *Wrong-way risk*: This concept is associated with the measurement of credit exposure and not a key consideration for funding.
- *Segregation*: This concept restricts the use of margin, so it impacts credit and funding exposure differently.

Impact of Collateral on Counterparty Risk and Funding

LO 36.i: Assess the impact of collateral on counterparty risk and funding, with and without segregation or rehypothecation.

Counterparty risk and funding costs can be reduced by posting certain types of collateral. Counterparty risk can be mitigated by taking ownership of collateral in the event of counterparty default, and funding costs can be mitigated by posting collateral against other transactions. In order to maximize both counterparty risk mitigation and funding benefits, the collateral posted must not exhibit wrong-way risk and it must be reusable (i.e., not segregated). The impact of different types of collateral on counterparty risk and funding costs can be examined under the following scenarios:

- *Cash that is not segregated*. This mitigates both counterparty risk and funding costs.
- *Securities that can be rehypothecated*. This mitigates both counterparty risk and funding costs, given that the haircuts are sufficient.
- *Cash and securities that must be segregated and cannot be rehypothecated*. This mitigates counterparty risk but does not provide funding benefits because the collateral cannot be reused under a non-default scenario.
- *Counterparty bonds that can be rehypothecated*. This mitigates funding costs but is problematic for counterparty risk mitigation because bonds will be in default when required.

MODULE QUIZ 36.3

1. Time steps that enter into the calculation of the number of days in the margin period of risk include all of the following except:
   A. valuation/margin call.
   B. posting collateral.
   C. settlement.

D. close-out and re-hedge.

KEY CONCEPTS

LO 36.a

Important metrics for credit exposure include the following: expected MtM, expected exposure (EE), potential future exposure (PFE), expected positive exposure (EPE), expected negative exposure (ENE), effective EE, effective EPE, and maximum PFE.

LO 36.b

Although value at risk (VaR) and credit exposure are similarly used to estimate the risk of loss, additional considerations related to credit exposure that must be accounted for include how it is applied (exposure is defined for pricing and risk management), the time horizon (exposure has a much longer time horizon than VaR), and risk mitigants (netting and collateral).

LO 36.c

The credit exposure profile is impacted by factors such as future uncertainty, periodic cash flows, profile combinations, and optionality. Collateral will also impact exposure, typically in a favorable way. However, risk reduction may be limited by the existence of key parameters (thresholds, minimum transfer amounts), characteristics of collateral (delays, value variations, granularity, path dependency), and other risks (liquidity, operational, legal) associated with collateral.

LO 36.d

The PFE of bonds, loans, and repos are approximately equal to the notional value or 100%. PFEs of swaps have a peaked shape. PFEs of long option positions or FX products monotonically increase. The maximum PFE for credit default swaps occurs at a credit event where the notional value less the recovery value is paid.

LO 36.e

With unequal payments, there is reduced exposure that results when payments are received more frequently than payments are made. Exercise dates result in more complex exposure profiles.

LO 36.f

Positive correlations between contract mark-to-market values have lower netting benefits than negative correlations, with perfect positive correlation providing the least netting benefit and perfect negative correlation the most benefit.

LO 36.g

Funding costs and benefits are associated with positive and negative credit exposures, respectively. Despite some connections, differences between funding and credit exposure are present in defining value, the margin period of risk, aggregation of exposures, wrong-way risk, and segregation.

LO 36.h

The margin period of risk (MPoR) is the period from which a collateral call takes place to when collateral is actually delivered.

Factors that affect the calculation of the exposure profile when taking collateral into account include:

- MPoR: creates exposure.
- Minimum transfer amount (≠ threshold amount): creates exposure below the minimum transfer amount.
- Threshold (≠ minimum transfer amount): creates exposure below the threshold.
- Initial margin: may reduce exposure, depending on its size.
- Rounding: may create a small amount of exposure, depending on the direction of the rounding.

Assumptions and parameters in modeling collateral include (1) terms of the collateral agreement, (2) risk of increased exposure between margin calls, and (3) path dependency of collateral.

LO 36.i

Counterparty risk and funding costs can be reduced by posting certain types of collateral. The impact of the type of collateral can be examined with and without segregation or rehypothecation.

ANSWER KEY FOR MODULE QUIZZES

Module Quiz 36.1

1. **A** EPE is equal to average EE over time. It is a useful single amount to quantify exposure. (LO 36.a)

Module Quiz 36.2

1. **D** The greatest netting benefit among the scenarios presented occurs when the two trades have a strong negative correlation. In this case, a large portion of the negative exposures will offset positive exposures. (LO 36.f)
2. **D** Exposure profiles of swaps are typically characterized by the peaked shape that results from balancing future uncertainties over payments and roll-off risk of swap payments over time. (LO 36.e)
3. **B** The benefits of netting are realized when MtM values have opposite signs for two trades. (LO 36.f)

Module Quiz 36.3

1. **B** The time period from which the request for collateral is received to which it is released refers to the receipt of collateral, but it does not involve its actual posting. All of the remaining items are part of the MPoR. (LO 36.h)

The following is a review of the Credit Risk Measurement and Management principles designed to address the learning objectives set forth by GARP®. Cross-reference to GARP assigned reading—Gregory, Chapter 17.

READING 37

CVA

Study Session 6

EXAM FOCUS

The pricing of counterparty risk is a function of the credit exposure and default probability of a counterparty. For the exam, know how to calculate a credit value adjustment (CVA) in the presence of unilateral contracts. Also, understand the concepts of incremental and marginal CVA, and know how to estimate CVA as a spread. Finally, be able to explain both wrong-way risk and right-way risk as well as identify these risks in transactions such as put options, call options, credit default swaps, foreign currency transactions, interest rate and currency swaps, and commodities.

MODULE 37.1: CREDIT VALUE ADJUSTMENT

LO 37.a: Explain the motivation for and the challenges of pricing counterparty risk.

The pricing of counterparty risk (i.e., how much to charge a counterparty for the risk that it may default) is a function of the credit exposure and default probability of a counterparty. Accurate pricing of a counterparty's risk generates reserves to absorb potential losses due to that counterparty's default. Pricing counterparty risk needs to account for risk mitigants (e.g., netting, collateralization).

The price of counterparty risk approximates to the value of the risk of all outstanding positions with a counterparty and exists in addition to the price of the financial instrument itself that the counterparties use (e.g., a swap). Best practices will organize responsibilities as to who should calculate counterparty risk within the financial institution. The challenge in pricing this type of risk arises with bilateral derivatives contracts (e.g., swaps with fixed and floating components) rather than one-way payment instruments such as bonds.

LO 37.b: Describe credit value adjustment (CVA).

LO 37.c: Calculate CVA and CVA as a spread with no wrong-way risk, netting, or collateralization.

The **credit value adjustment (CVA)** is defined as the expected value or price of counterparty credit risk. The CVA represents a *cost* to the counterparty that bears a greater propensity to default. A risky security transaction has a risk-free price with no counterparty risk and an adjustment for counterparty risk (i.e., risky value = risk-free value − CVA). The adjustment for counterparty risk is the credit value adjustment. CVA is calculated as follows:

$$\text{CVA} = -\text{LGD} \times \sum_{i=1}^{m} \text{EPE}(t_i) \times \text{PD}(t_{i-1}, t_i)$$

where:

LGD = loss given default or how much of the exposure one expects to lose in the event of a counterparty default; equal to 1 minus the recovery rate $(1 - \text{RR})$

EPE = discounted expected positive exposure for future dates

PD = marginal default probability

Speed and simplicity are the hallmarks of this calculation, which aggregates components from different departments of the risk management organization. The resulting amount may be expressed as a percentage of the notional value of the transaction on which it is based. Additionally, the formula assumes no wrong-way risk and does not require simulation default events, which simplifies the calculation.

PROFESSOR'S NOTE

Remember that CVA is a cost to the counterparty that bears a greater propensity to default; therefore, the equation begins with a negative sign to represent CVA as a loss.

CVA Spread

To approximate the CVA as a spread, divide the CVA by the unit premium of a risky annuity (e.g., credit default swap [CDS]) for the contract in question, producing an annual spread in basis points. This would be a charge to the weaker counterparty. The left-hand side of the following calculation represents the CVA as a running spread:

$$\frac{\text{CVA}(t,T)}{\text{CDS}_{\text{premium}}(t,T)} = -X^{\text{CDS}} \times \text{average EPE}$$

where:

$\text{CDS}_{\text{premium}}(t, T)$ = unit premium value of a credit default swap

X^{CDS} = CDS premium at maturity date T; this amount can be thought of as a credit spread

EPE = expected positive exposure that is the average of the expected exposure over a preset time period, typically from the present to the maturity date of the transaction

Assumptions for this calculation include (1) EPE is constant over the entire profile, (2) default probability is constant over the entire profile, and (3) EE or default probability

is symmetric over the entire profile.

> **EXAMPLE: Computing CVA spread**
>
> A trader needs a quick approximation of the CVA spread on a swap. The exposure management group comes up with an EPE of 6%. The counterparty's credit spread is around 375 basis points (bps) per year. **Calculate** the CVA as a running spread.
>
> **Answer:**
>
> The CVA as a running spread would be computed as:
>
> $-6\% \times 3.75\% = -23$ bps
>
> This is the amount the trader may subtract from the leg of the trade as the CVA or credit charge, and it is a common way to represent CVA as a risk charge to the client in a swap transaction.

Impact of Changes in Credit Spread and Recovery Rates

LO 37.d: Evaluate the impact of changes in the credit spread and recovery rate assumptions on CVA.

When evaluating the impact of the probability of default and recovery on CVA, the following factors must be considered: credit spread levels, the shape of the credit spread curve, the impact of the recovery rate, and the basis risk that arises between different recovery rate assumptions.

Regarding the impact of changes in the credit spread, the CVA will most often increase given an increase in the credit spread. However, the impact will not be linear because default probabilities are limited to 100%. If a counterparty is very close to default, the CVA will actually decrease slightly, and in default the CVA will fall to zero. When considering the shape of the credit spread curve, the CVA will be lower for an upward-sloping curve compared to a flat and a downward-sloping curve, and the CVA will be higher for a downward-sloping curve compared to a flat and an upward-sloping curve.

Regarding the impact of changes in recovery rate assumptions, increasing the recovery rate will increase the implied probability of default but reduce the resulting CVA. Differences in settled versus actual recovery rates may also be considered. The settled recovery is the recovery at default, while the actual recovery is the claim amount that will be received. As an example, consider a settled recovery rate of 10% and an actual recovery rate of 40%. In this situation, the higher actual recovery rate will produce a lower CVA compared to a 40% recovery assumption for both settled and actual recovery rates.

Incorporating Netting and Collateralization

LO 37.h: Explain how netting can be incorporated into the CVA calculation.

LO 37.j: Explain the impact of incorporating collateralization into the CVA calculation, including the impact of margin period of risk, thresholds, and initial margins.

Netting reduces the CVA price as it nets (i.e., reduces) exposure when trades are settled. One must evaluate the change in CVA before and after a trade has been executed. The new trade should be sufficiently profitable to offset any increase in CVA at a minimum. This expression is shown as follows:

$$V(i) = \Delta CVA_{NS,i} = CVA(NS, i) - CVA(NS)$$

where:

$V(i)$ = risk-free value of new trade i
$CVA(NS, i)$ = CVA included in new trade in the netting set
$CVA(NS)$ = CVA on all current trades within the netting set

Collateralization reduces the CVA, changing only the counterparty's expected exposure (EE), but not its default probability. Inclusion of minimum transfer and threshold amounts would correspondingly increase the CVA as they increase exposure linearly. On the other hand, an increase in initial margin, which is a negative threshold amount, would decrease the CVA.

The **margin period of risk (MPoR)** defines the number of calendar days over which the CVA is measured. As MPoR increases, the CVA will gradually move toward the uncollateralized CVA. At an MPoR of 40 days, the CVA is about half the size of the uncollateralized CVA. Once the CVA for a specific date is known, it can be scaled by using the square root of time rule. For example, compared to the 10-day MPoR, the approximation for the CVA of 20 calendar days would be $\sqrt{20/10} = 1.41$ times larger (i.e., bigger negative).

MODULE QUIZ 37.1

1. Which of the following statements is not a motivation for pricing counterparty risk?
   A. Accurate pricing should only account for the cost of the trade.
   B. Counterparty risk pricing should account for risk mitigants.
   C. Best practices organize pricing responsibilities in the organization.
   D. Pricing bilateral derivatives contracts.

2. A trader wants to know the approximate CVA for a counterparty in a swap transaction. The counterparty's expected potential exposure (EPE) is 7%, and its credit spread is 475 basis points. What is the CVA as a running spread?
   A. −0.33%.
   B. −1.48%.
   C. −2.25%.
   D. −9.75%.

3. Regarding the impact of changes in the credit spread and recovery rate assumptions on the CVA, which of the following statements is true?
   A. A decrease in the credit spread will most often increase the CVA.

B. For an upward-sloping curve, the CVA will be higher compared to a downward-sloping curve.
C. Increasing the recovery rate will reduce the CVA.
D. If the actual recovery rate is higher than the settled recovery rate, the CVA will most likely be higher compared to a situation where both recovery assumptions are the same for both rates.

4. When incorporating netting and collateralization into the CVA calculation, which of the following statements is incorrect?
   I. Netting increases the CVA price because it reduces exposure when trades are settled.
   II. Collateralization does not change the CVA because it only changes the counterparty's expected exposure.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

MODULE 37.2: INCREMENTAL AND MARGINAL CVA, AND CVA FOR A BILATERAL CONTRACT

Incremental and Marginal CVA

LO 37.i: Define and calculate incremental CVA and marginal CVA and explain how to convert CVA into a running spread.

The practicality of CVA lies in its ability to take into account risk mitigation provided by collateralization and netting. The usefulness of standalone CVA is limited to giving the risk manager a quick appraisal of the CVA charge.

Incremental CVA is the change (or increment) in CVA that a new trade will create, taking netting into account (i.e., the difference between CVA with and without the new trade). The formula differs from the original CVA only in the change in expected exposure. The ΔEE is the incremental change in EE at each point in time caused by the new trade, which impacts the original exposure.

Incremental CVA is important for pricing a new trade with respect to existing ones. CVA with netting will never be higher than CVA without netting because netting cannot increase exposure. The benefits of netting are a function of the transaction size. The larger the transaction, the smaller the benefit to the point where the value of incremental CVA will approach standalone CVA.

Marginal CVA enables the risk manager to break down netted trades into trade level contributions that sum to the total CVA. The calculation is identical to that for the standalone CVA, except for the substitution of marginal EE for initial EE. This metric allows for more rigorous analysis, as it is useful for better understanding which trades have the greatest impact on a counterparty's CVA. It provides an ex-post view of the trades.

Converting CVA Into a Running Spread

Converting an upfront CVA into a running spread CVA is also worth considering. Given an interest rate swap, the rate paid on the swap would need to change when charging a CVA to a client. This transformation would occur by dividing the CVA by the risky duration for the maturity under consideration. For example, assuming a five-year payer interest rate swap with a notional amount of 100M, a risky duration of 3.75, and a standalone CVA of −90,000, the additional spread would be calculated as:

$$-90{,}000 / (3.75 \times 100{,}000{,}000) = -2.40 \text{ bps}$$

However, the addition of this spread will also impact the CVA. Therefore, the correct value should be computed in a recursive fashion until the risky MtM value declines to zero. This is accomplished by solving the following equation: $V_{C'} = CVA_{C'}$, where $V_{C'}$ is the contract value given the adjusted rate C'. This method ensures that the CVA is offset by the initial value and allows the adjusted rate (C') to become the hurdle rate for profitability.

Applying CVA to Exotic Products and Path Dependency

Applying CVA to exotic products and in the presence of path dependency presents special challenges.

Regarding **exotic products**, valuation may require techniques such as Monte Carlo simulation. Thus, value approximations to such products may be necessary to estimate their CVA values given the complexity in pricing the products themselves (e.g., swaptions may be treated as forward swaps, Bermudan option payoffs may be treated as European option payoffs).

Regarding **path dependency**, in order to assess future exposure at a given point in time, one must have information on the entire path from the present to that future date. As with exotic products, approximation of the probability calculation of path-dependent events will suffice when dealing with exotic derivative prices.

CVA for a Bilateral Contract

LO 37.e: Describe debt value adjustment (DVA) and bilateral CVA (BCVA).

LO 37.f: Explain the distinctions between unilateral CVA (UCVA) and BCVA, and between unilateral DVA (UDVA) and BCVA.

LO 37.g: Calculate DVA, BCVA, and BCVA as a spread.

Given a charge for counterparty risk that favors a stronger counterparty (typically a bank), CVA historically did not take into account that both counterparties could be subject to default risk. The 2007–2009 financial crisis changed risk parameters and perceptions drastically.

Counterparty risk is now viewed as *bilateral*. Bilateral counterparty risk assumes that both counterparties may default. The formula for the credit value adjustment for a bilateral contract derives from the original CVA formula and assumes no simultaneous default (e.g., wrong-way risk).

The CVA expression in the following **bilateral credit value adjustment (BCVA)** formula represents the CVA of the counterparty, C, and the DVA expression represents the CVA of the financial institution, I. The CVA of the institution is also known as the **debt value adjustment (DVA)**. The two terms in this expression are mirror images of one another. If the financial institution defaults first, it books a gain when the marked-to-market (MtM) exposure is negative. This is the case because the institution in default will only pay the counterparty the recovery amount of what they owe, which is a fraction of what they would have otherwise owed had they not defaulted. That difference is a gain to the defaulting party.

$$\text{BCVA} = \text{CVA} + \text{DVA}$$

$$\text{CVA} = -\text{LGD}_{\text{C}} \times \sum_{i=1}^{m} \text{EPE}(t_i) \times \text{PD}_{\text{C}}(t_{i-1}, t_i)$$

$$\text{DVA} = -\text{LGD}_{\text{I}} \times \sum_{i=1}^{m} \text{ENE}(t_i) \times \text{PD}_{\text{I}}(t_{i-1}, t_i)$$

where:

ENE = expected negative exposure (EPE from the counterparty's perspective); DVA is positive given the negative value of ENE

Implications of the BCVA model include:

1. BCVA can be positive if DVA is larger than CVA, implying that the risk value of a derivative is greater than its risk-free value. Standalone CVA may only be negative.
2. Two counterparties in agreement on the parameters of the BCVA equation will settle up owing to the equation's symmetry. For example, Party 1 has BCVA of +X, then Party 2 has BCVA of –X. Party 2 owes Party 1 +X due to Party 2's counterparty risk.
3. Netting with BCVA may be a disadvantage when the DVA expression dominates, implying that the financial institution is riskier than its counterparty. Without netting, the institution may select contracts with a positive MtM settlement, discarding those with a negative MtM value as bankruptcy liabilities.
4. If both parties agree on the parameters of the BCVA calculation, then counterparty risk in the marketplace (the sum of all BCVAs) is zero. However, this holds more in theory than in practice.

PROFESSOR'S NOTE

This BCVA formula excludes a survival probability, which considers the possibility that a financial institution may default before its counterparty. If this is the case, the institution will not suffer a loss from the counterparty. The survival probability will be included in the BCVA equation in Reading 38, when we discuss stress testing the debt value adjustment.

BCVA Spread

BCVA may be expressed as a spread or basis point charge to the weaker counterparty as follows: