The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Basel I, Basel II, and Solvency II

Topic 59

Exam Focus

This topic provides an overview of the international capital standards put in place by the Basel Committee on Banking Supervision. Basel I (1988) contained the first steps toward risk-weighting bank activities on- and off-balance sheet to relate required capital to risk. Basel I was the first to set a capital to risk-weighted assets requirement, but it only considered credit risk, not market or operational risk. Basel II took a more sophisticated approach to measuring bank credit risk, market risk, and operational risk. For the exam, understand the contribution Basel II makes to risk measurement, and know the differences between the methods used to calculate various risks. Also, know the difference between Basel II and Solvency II, a similar international standard for insurance companies, and the likely repercussions a firm will face if it breaches the standards. In addition, be able to calculate a bank's required capital under the various regimes. One of the recurring themes in this topic is the difference between a standardized approach for measuring risk, used by less sophisticated banks (and insurance companies), and an internal approach that is firm specific and more complex but often lowers required capital because it allows banks to use their own model inputs and considers the correlations between assets.

LO 59.1: Explain the motivations for introducing the Basel regulations, including key risk exposures addressed, and explain the reasons for revisions to Basel regulations over time.

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. Requirements were stated as minimum ratios of capital to total assets or as maximum ratios of total assets to capital. Some countries and/or regulatory authorities were more diligent in their enforcement of capital regulations than others. As banks became increasingly global, banks operating in countries with more lax standards were perceived to have a competitive advantage over banks operating in countries with strict enforcement of capital regulations.

There were additional problems with the existing regime. First, high risk loans from international banks to lesser developed countries such as Mexico and Brazil raised questions about the adequacy of existing capital to cover potential losses. Second, banks used "accounting games" to record some of these transactions, masking risk. Third, bank transactions were becoming more complex. Off-balance sheet transactions in over-the-counter (OTC) derivatives like interest rate swaps, currency swaps, and options were growing. These off-balance sheet deals did not affect total assets, and thus did not affect the amount of capital a bank was required to keep, providing fuel to the growing belief that total assets did not reflect a bank's total risk. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards, called the 1988 BIS Accord, now commonly known as Basel I.

Basel I

LO 59.2: Explain the calculation of risk-weighted assets and the capital requirement per the original Basel I guidelines.

Basel I put forth two capital requirements:

1. The bank's total assets to capital ratio had to be less than 20 (i.e., capital to total assets had to be greater than 1/20 or 5%). This capital requirement was similar to the requirements in many countries prior to 1988.

2. The bank's on- and off-balance sheet items had to be used to calculate **risk-weighted assets** (RWA). RWA is intended to measure a bank's total credit exposure. The ratio of capital to risk-adjusted assets is called the **Cooke ratio**, after Peter Cooke from the Bank of England. Basel I stipulated that the Cooke ratio must exceed 8%.

Most banks met the first requirement. However, the risk-based capital requirement (i.e., the second requirement) was the key change to capital regulation. The process for calculating risk-weighted assets includes assigning a risk weight that reflects the bank's credit risk exposure, to each of the on- and off-balance sheet items. A sample of some of the risk weights assigned to various asset categories is shown in Figure 1.

Figure 1: Risk Weights for On-Balance Sheet Items

Risk Weight (%)	*Asset Category*
0%	Cash, gold, claims on Organisation of Economic Co-operation and Development (OECD) countries such as U.S. Treasury bonds and insured residential mortgages
20%	Claims on OECD banks and government agencies like U.S. agency securities or municipal bonds
50%	Uninsured residential mortgages
100%	Loans to corporations, corporate bonds, claims on non-OECD banks

Example: Risk-weighted assets

The assets of Blue Star Bank consist of $20 million in U.S. Treasury bills, $20 million in insured mortgages, $50 million in uninsured mortgages, and $150 million in corporate loans. Using the risk weights from Figure 1, **calculate** the bank's risk-weighted assets.

Answer:

$$(0.0 \times \$20) + (0.0 \times \$20) + (0.5 \times \$50) + (1.0 \times \$150) = \$175 \text{ million}$$

Off-balance sheet items are expressed as a **credit equivalent amount**. The credit equivalent amount is, in essence, the loan principal that is considered to have the same credit risk. This means the bank "converts" off-balance sheet items into on-balance sheet equivalents for the purpose of calculating risk-based capital. The weight is then multiplied by the principal amount (i.e., the credit equivalent amount) of the item to arrive at a risk-weighted value. A **conversion factor** is applied to the principal amount of the instrument for non-derivatives. Off-balance sheet items that are similar, from a credit perspective, to loans (e.g., banker's acceptances), have a conversion factor of 100%. Other off-balance sheet items, such as note issuance facilities, have lower conversion factors.

For interest rates swaps and other over-the-counter (OTC) derivatives, the credit equivalent amount is calculated as:

$$\max(V, 0) + a \times L$$

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

The first term in the equation [max(V, 0)] reflects the bank's current exposure. If the counterparty defaults and *V*, the current value of the derivative, is positive, the bank will lose *V*. If the counterparty defaults and *V* is negative, the exposure is 0 (i.e., no gain or loss to the bank). The **add-on amount** (a × L) allows for the possibility that the bank's exposure may increase in the future. Add-on factors are higher for higher risk derivatives (e.g., longer maturities, riskier underlying assets). A sample of add-on factors is shown in Figure 2.

Figure 2: Add-on Factors as a Percent of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Exchange Rate and Gold*	*Equity*	*Other Commodities*
< 1 year	0.0	1.0	6.0	10.0
1 to 5 years	0.5	5.0	8.0	12.0
> 5 years	1.5	7.5	10.0	15.0

Example: Credit equivalent amounts for off-balance sheet items

Blue Star Bank has entered a $175 million interest rate swap with a remaining maturity of three years. The current value of the swap is $2.5 million. Using the add-on factors in Figure 2, **calculate** the swap's credit equivalent amount.

Answer:

The add-on factor is 0.5% of the interest rate swap principal.

credit equivalent amount = $2.5 + (0.005 × $175) = $3.375 million

The credit equivalent amount is multiplied by the risk weight for the counterparty to calculate risk-weighted assets. Risk weights are similar to those shown in Figure 1 with the exception of corporate counterparties. If the counterparty is a corporation, the risk weight is 50%. If the counterparty is an OECD bank, the risk weight is 20%.

Example: Calculating risk-weighted assets for an off-balance sheet item

In the previous example, Blue Star Bank entered an interest rate swap that had a credit equivalent amount of $3,375,000. **Calculate** the risk-weighted assets assuming (1) the counterparty is an OECD bank and (2) the counterparty is a corporation.

Answer:

RWA assuming counterparty is an OECD bank: $3,375,000 × 0.2 = $675,000

RWA assuming counterparty is a corporation: $3,375,000 × 0.5 = $1,687,500

The total RWAs of the bank are calculated by summing the on- and off-balance sheet risk-weighted items as follows:

$$\sum_{i=1}^{N} w_i L_i + \sum_{j=1}^{M} w_j C_j$$

where:
w_i = the risk weight of the counterparty of the ith on-balance sheet item
L_i = principal of the ith on-balance sheet item
w_j = the risk weight of the counterparty of the jth off-balance sheet item
C_j = credit equivalent amount of the jth off-balance sheet item

The bank must maintain at least 8% capital to risk-weighted assets.

Example: Calculating risk-based capital

Using the information from the previous three examples, **calculate** Blue Star Bank's required capital, assuming the swap counterparty is a corporation.

Answer:

($175 million + $1.6875 million) × 0.08 = $14.135 million

According to Basel I, capital has two components, Tier 1 capital and Tier 2 capital.

Tier 1 capital (or core capital) consists of items such as:

- Equity (subtract goodwill from equity).
- Non-cumulative perpetual preferred stock.

Tier 2 capital (or supplementary capital) consists of items such as:

- Cumulative perpetual preferred stock.
- Certain types of 99-year debentures.
- Subordinated debt with an original maturity greater than five years (where the subordination is to depositors).

Equity capital (i.e., Tier 1) absorbs losses. Supplementary capital (i.e., Tier 2) is subordinate to depositors and thus protects depositors in the event of a bank failure. At least 50% of capital must be Tier 1. This means there is a 4% Tier 1 capital to risk-weighted assets requirement (i.e., 8% × 0.5). Half of the Tier 1 requirement has to be met with common equity. Under Basel I, some countries required banks to have more capital than required by The Accord.

Professor's Note: Basel I had a number of shortcomings that were remedied over the coming years with new capital accords. For example, Basel I treats all corporate loans the same in terms of capital requirements. The creditworthiness of the borrower is ignored. Also, Basel I did not include a model of default correlation.

Market Risk Capital Requirements

LO 59.3: Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk:
- **Standardized Measurement Method**
- **Internal Models Approach**

The goal of the **1996 Amendment** to the 1988 Basel Accord was to require banks to measure market risks associated with trading activities and maintain capital to back those risks. Banks must **mark-to-market** (i.e., *fair value accounting*) bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading (referred to as the *trading book*). Banks do not have to use fair value accounting on assets they intend to hold for investment purposes (referred to as the *banking book)*. This includes loans and some debt securities. The 1996 Amendment proposed two methods for calculating market risk:

1. Standardized Measurement Method.
2. Internal Model-Based Approach.

Standardized Measurement Method. This method assigns a capital charge separately to each of the items in the trading book. It ignores correlations between the instruments. Banks with less sophisticated risk management processes are more likely to use this approach.

Internal Model-Based Approach. This method involves using a formula specified in the amendment to calculate a value at risk (VaR) measure and then convert the VaR into a capital requirement. Capital charges are generally lower using this method because it better reflects the benefits of diversification (i.e., correlations between the instruments). As such, banks with more advanced risk management functions prefer the internal models approach.

Risks covered by the VaR model include movements in broad market variables such as interest rates, exchange rates, stock market indices, and commodity prices.

The VaR model does not incorporate company-specific risks such as changes in a firm's credit spread or changes in a company's stock price. The **specific risk charge** (SRC) captures company-specific risks. For example, a corporate bond has interest rate risk, captured by VaR, and credit risk, captured by the SRC. Tier 3 capital consisting of short-term subordinated, unsecured debt with an original maturity of at least two years could be used to meet the market risk capital requirement at the time of the amendment. Tier 3 capital has subsequently been eliminated under Basel III.

LO 59.4: Calculate VaR and the capital charge using the internal models approach, and explain the guidelines for backtesting VaR.

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading day time horizon and a 99% confidence level. The market risk capital requirement is calculated as:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

The multiplicative factor must be at least three, but may be set higher by bank supervisors if they believe a bank's VaR model has deficiencies. This means the capital charge will be the higher of either the previous day's VaR or three times the average of the daily VaR plus a charge for company specific risks (i.e., the SRC).

Banks calculate a 10-day, 99% VaR for SRC. Regulators then apply a multiplicative factor (which must be at least four) similar to m_c to determine the capital requirement. The total capital requirement for banks using the internal model-based approach must be at least 50% of the capital required using the standardized approach.

The bank's total capital charge, according to the 1996 Amendment, is the sum of the capital required according to Basel I, described in LO 59.2, and the capital required based on the 1996 Amendment, described in this LO. For simplicity, the RWAs for market risk capital was defined as 12.5 times the value given in the previous equation. The total capital a bank has to keep under the 1996 Amendment is:

$$\text{total capital} = 0.08 \times (\text{credit risk RWA} + \text{market risk RWA})$$

where:

$$\text{market RWA} = 12.5 \times (\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC)$$

$$\text{credit RWA} = \Sigma(\text{RWA on-balance sheet}) + \Sigma(\text{RWA off-balance sheet})$$

Example: Market risk capital charge

A bank calculates the previous day's market risk VaR as $10 million. The average VaR over the preceding 60 trading days is $8 million. The specific risk charge is $5 million. Assuming a multiplicative factor of three, **calculate** the market risk capital charge.

Answer:

$$\text{market risk capital charge} = 0.08 \times \{12.5 \times [(3 \times \$8 \text{ million}) + \$5 \text{ million}]\}$$
$$= \$29 \text{ million}$$

Backtesting

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. A bank calculates the VaR using its current method for each of the 250 trading days and then compares the calculated VaR to the actual loss. If the actual loss is greater than the estimated loss, an **exception** is recorded. The multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to 3.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to 4.

The bank supervisor has discretion regarding the multiplier. If the exception is due to changes in the bank's positions during that day, the higher multiplier may or may not be used. If the exception is due to deficiencies in the bank's VaR model, higher multipliers are likely to be applied. There is no guidance to supervisors in terms of higher multipliers if an exception is simply the result of bad luck.

Credit Risk Capital Requirements

LO 59.5: Describe and contrast the major elements of the three options available for the calculation of credit risk:
- **Standardized Approach**
- **Foundation IRB Approach**
- **Advanced IRB Approach**

LO 59.8: Define in the context of Basel II and calculate where appropriate:
- **Probability of default (PD)**
- **Loss given default (LGD)**
- **Exposure at default (EAD)**
- **Worst-case probability of default**

Basel II specifies three approaches that banks can use to measure credit risk:

1. Standardized approach.

2. Foundation internal ratings based (IRB) approach.

3. Advanced IRB approach.

The Standardized Approach

The **standardized approach** is used by banks with less sophisticated risk management functions. The risk-weighting approach is similar to Basel I, although some risk weights were changed. Significant changes include:

- OECD status is no longer considered important under Basel II.
- The credit ratings of countries, banks, and corporations are relevant under Basel II. For example, sovereign (country) risk weights range from 0% to 150%, and bank and corporate risk weights range from 20% to 150%.
- Bank supervisors may apply lower risk weights when the exposure is to the country in which the bank is incorporated.
- Bank supervisors may choose to base risk weights on the credit ratings of the countries in which a bank is incorporated rather than on the bank's credit rating. For example, if a sovereign rating is AAA to AA–, the risk weight assigned to a bank is 20%. The risk weight increases to 150% if the country is rated below B– and is 100% if the country's bonds are unrated.
- Risk weights are lower for unrated countries, banks, and companies than for poorly rated countries, banks, and companies.
- Bank supervisors who elect to use the risk weights in Figure 3 are allowed to lower the risk weights for claims with maturities less than three months. For example, the risk weights for short-maturity assets may range from 20% if the rating is between AAA to BBB–or unrated, to 150% if the rating is below B–.
- A 75% risk weight is applied to retail loans, compared to 100% under Basel I. A 100% risk weight is applied to commercial real estate loans. The uninsured residential mortgage risk weights are 35% under Basel II, down from 50% under Basel I.

A sample of risk weights under the standardized approach is presented in Figure 3.

Figure 3: Risk Weights (as a Percent) Under Basel II's Standardized Approach

	AAA to AA–	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*B+ to B–*	*Below B–*	*Unrated*
Country	0	20	50	100	100	150	100
Bank	20	50	50	100	100	150	50
Corporation	20	50	100	100	150	150	100

Collateral Adjustments

Banks adjust risk weights for collateral using the **simple approach**, similar to Basel I, or the **comprehensive approach**, used by most banks. Under the simple approach, the risk weight of the collateral replaces the risk weight of the counterparty. The counterparty's risk weight is used for exposure not covered by collateral. Collateral must be revalued at least every six months. A minimum risk weight of 20% is applied to collateral. Using the comprehensive approach, banks adjust the size of the exposure upward and the value of the collateral downward, depending on the volatility of the exposure and of the collateral value.

Example: Adjusting for collateral using the simple approach

Blue Star Bank has a $100 million exposure to Monarch, Inc. The exposure is secured by $80 million of collateral consisting of AAA-rated bonds. Monarch has a credit rating of B. The collateral risk weight is 20% and the counterparty risk weight is 150%. Using the simple approach, **calculate** the risk-weighted assets.

Answer:

$(0.2 \times 80) + (1.5 \times 20) = \$46$ million risk-weighted assets

Example: Adjusting exposure and collateral using the comprehensive approach

Blue Star Bank assumes an adjustment to the exposure in the previous example of +15% to allow for possible increases in the exposures. The bank also allows for a –20% change in the value of the collateral. **Calculate** the new exposure using the comprehensive approach.

Answer:

$(1.15 \times 100) - (0.8 \times 80) = \$51$ million exposure

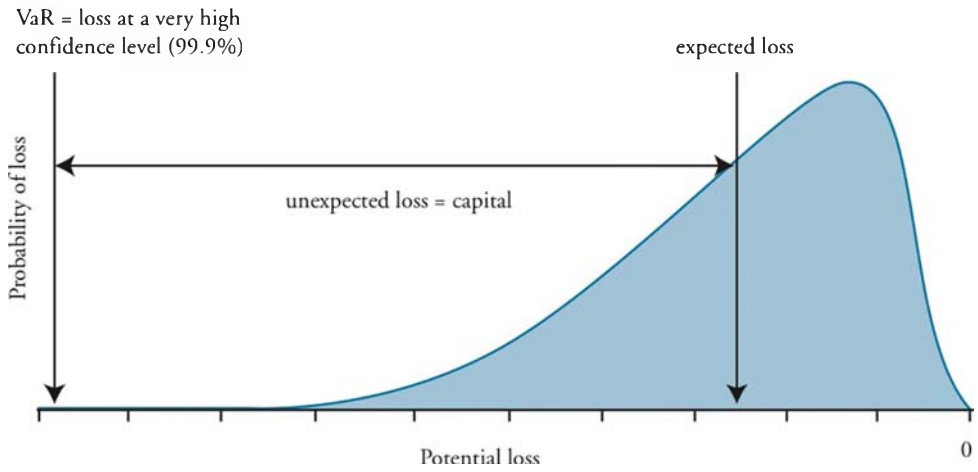
Applying a risk weight of 150% to the exposure:

$1.5 \times 51 = \$76.5$ million risk-weighted assets

The Internal Ratings Based (IRB) Approach

United States regulators applied Basel II to large banks only. As such, regulatory authorities decided that the **IRB approach** must be used by U.S. banks. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The model underlying this approach is shown in Figure 4.

Figure 4: Capital Requirement



The goal of the IRB approach is to capture unexpected losses (UL). Expected losses (EL) should be covered by the bank's pricing (e.g., charging higher interest rates on riskier loans to cover EL). The capital required by the bank is thus VaR minus the bank's EL. The VaR can be calculated using a Gaussian copula model of time to default. That is:

$$\text{WCDR}_i = \text{N}\left[\frac{\text{N}^{-1}(\text{PD}_i) + \sqrt{\rho}\,\text{N}^{-1}(0.999)}{\sqrt{1-\rho}}\right]$$

In this equation, WCDR_i is the **worst case probability of default**. The bank can be 99.9% certain that the loss from the ith counterparty will not exceed this amount in the coming year. PD is the one-year **probability of default** of the i^{th} obligor given a large number of obligors, and ρ is the **copula correlation** between each pair of obligors.

Professor's Note: WCDR is called the worst case probability of default in the assigned reading. It is also called the worst case default rate, hence the acronym WCDR.

Assuming the bank has a large portfolio of instruments such as loans and derivatives with the same correlation, the one-year, 99.9% VaR is approximately:

$$\text{VaR}_{99.9\%,\ 1-\text{year}} \approx \sum_i \text{EAD}_i \times \text{LGD}_i \times \text{WCDR}_i$$

EAD_i is the **exposure at default** of the i^{th} counterparty or the dollar amount the i^{th} counterparty is expected to owe if it defaults. For example, if the counterparty has a loan outstanding, EAD would likely be the principal amount outstanding on the loan at the time of default. LGD_i is the **loss given default** for the i^{th} counterparty or the proportion of the EAD_i that is expected to be lost in the event of default. For example, if the bank expected to collect (i.e., recover) 40% in the event of default, the LGD_i would be 60% (i.e., 1 – 0.4 = 0.6).

Recall from Book 2 that the expected loss (EL) from default is computed as:

$$EL = \sum_i EAD_i \times LGD_i \times PD_i$$

The capital the bank is required to maintain is the excess of the worst-case loss over the bank's expected loss defined as follows:

$$\text{required capital} = \sum_i EAD_i \times LGD_i \times (WCDR_i - PD_i)$$

Note that WCDR, PD, and LGD are expressed as decimals while EAD is expressed in dollars.

Figure 5 shows the dependence of the one-year WCDR on PD and correlation, ρ.

Figure 5: Dependence of One-Year, 99.9% WCDR on PD and ρ

	PD = 0.1%	*PD = 0.5%*	*PD = 1%*	*PD = 1.5%*	*PD = 2.0%*
ρ = 0.0	0.1%	0.5%	1.0%	1.5%	2.0%
ρ = 0.2	2.8%	9.1%	14.6%	18.9%	22.6%
ρ = 0.4	7.1%	21.1%	31.6%	39.0%	44.9%
ρ = 0.6	13.5%	38.7%	54.2%	63.8%	70.5%
ρ = 0.8	23.3%	66.3%	83.6%	90.8%	94.4%

It is clear from Figure 5 that WCDR increases as the correlation between each pair of obligors increases and as the probability of default increases. If the correlation is 0, then WCDR is equal to PD.

Basel II assumes a relationship between the PD and the correlation based on empirical research. The formula for correlation is:

$$\rho = 0.12 \times (1 + e^{-50 \times PD})$$

Note that there is an inverse relationship between the correlation parameter and the PD. As creditworthiness declines, the PD increases. At the same time, the PD becomes more idiosyncratic and less affected by the overall market, thus the inverse relationship.

The relationship between WCDR and PD, as shown in Figure 6, is obtained by combining the previous equation with the calculation of WCDR. The WCDR increases as the PD increases, but not as fast as it would if the correlation were assumed to be independent of PD.

Figure 6: Relationship Between WCDR and PD for Firm, Sovereign, and Bank Exposures

PD	0.1%	0.5%	1.0%	1.5%	2.0%
WCDR	3.4%	9.8%	14.0%	16.9%	19.0%

From a counterparty's perspective, the capital required for the counterparty incorporates a maturity adjustment as follows:

$$\text{required capital} = \text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}$$

where:
MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(PD)]^2$

The **maturity adjustment**, MA, allows for the possibility of declining creditworthiness and/or the possible default of the counterparty for longer term exposures (i.e., longer than one year). If M = 1.0, then MA = 1.0 and the maturity adjustment has no impact. The risk-weighted assets are calculated as 12.5 times capital required:

$$\text{RWA} = 12.5 \times [\text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}]$$

The capital required is 8% of RWA. The capital required should be sufficient to cover unexpected losses over a one-year period with 99.9% certainty (i.e., the bank is 99.9% certain the unexpected loss will not be exceeded). Expected losses should be covered by the bank's product pricing. Theoretically, the WCDR is the probability of default that happens once every 1,000 years. If the Basel Committee finds the capital requirements too high or too low, it reserves the right to apply a scaling factor (e.g., 1.06 or 0.98) to increase or decrease the required capital.

Professor's Note: On the exam, if you begin with RWA, multiply by 0.08 to get the capital requirement. If instead you begin with the capital requirement, multiply by 12.5 (or divide by 0.08) to get RWA. In other words, these percentages are simply reciprocals (i.e., 1/0.08 = 12.5).

Foundation IRB Approach vs. Advanced IRB Approach

The **foundation IRB approach** and the **advanced IRB approach** are similar with the exception of who provides the estimates of LGD, EAD, and M. The key differences between the two approaches are outlined by the following.

Foundation IRB Approach

- The bank supplies the PD estimate. For bank and corporate exposures, there is a 0.03% floor set for PD.
- The LGD, EAD, and M are supervisory values set by the Basel Committee. The Basel Committee set LGD at 45% for senior claims and 75% for subordinated claims. If there is collateral, the LGD is reduced using the comprehensive approach described earlier.
- The EAD is calculated similar to the credit equivalent amount required under Basel I. It includes the impact of netting.
- M is usually set to 2.5.

Advanced IRB Approach

- Banks supply their own estimates of PD, LGD, EAD, and M.
- PD can be reduced by credit mitigants such as credit triggers subject to a floor of 0.03% for bank and corporate exposures.
- LGD is primarily influenced by the collateral and the seniority of the debt.
- With supervisory approval, banks can use their own estimates of credit conversion factors when calculating EAD.

Foundations IRB Approach and Advanced IRB Approach for Retail Exposures

- The two methods are merged for retail exposures. Banks provide their own estimates of PD, EAD, and LGD.
- There is no maturity adjustment (MA) for retail exposures.
- The capital requirement is EAD × LGD × (WCDR – PD).
- Risk-weighted assets are 12.5 × EAD × LGD × (WCDR – PD).
- Correlations are assumed to be much lower for retail exposures than for corporate exposures.

Example: RWA under the IRB approach

Assume Blue Star Bank has a $150 million loan to an A-rated corporation. The PD is 0.1% and the LGD is 50%. Based on Figure 6, the WCDR is 3.4%. The average maturity of the loan is 2.5 years. **Calculate** the RWA using the IRB approach and compare it to the RWA under Basel I.

Answer:

$$b = [0.11852 - 0.05478 \times \ln(0.001)]^2 = 0.247$$

$$MA = 1/ (1 - (1.5 \times 0.247)) = 1.59$$

$$\text{risk-weighted assets} = 12.5 \times 150 \times 0.5 \times (0.034 - 0.001) \times 1.59 = \$49.19 \text{ million}$$

Under Basel I, the RWA for corporate loans was 100% or $150 million in this case. Thus, the IRB approach lowers the RWA for higher rated corporate loans, in this case from $150 million to $49.19 million.

Operational Risk Capital Requirements

LO 59.6: Describe and contrast the major elements of the three options available for the calculation of operational risk: basic indicator approach, standardized approach, and the Advanced Measurement Approach.

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire, are also considered operational risks.

Under Basel II, there are three approaches banks may use to calculate capital for operational risk:

1. Basic indicator approach.
2. Standardized approach.
3. Advanced measurement approach.

Basic Indicator Approach (BIA). This is the simplest approach and is used by banks with less sophisticated risk management functions. The required capital for operational risk is equal to the bank's average annual gross income (i.e., net interest income plus non-interest income) over the last three years multiplied by 0.15.

The Standardized Approach (TSA). This method is similar to the basic indicator approach. The primary difference between the two approaches is that a different multiplier is applied to the bank's gross income for different lines of business.

Advanced Measurement Approach (AMA). Like the IRB approach discussed for credit risk, the capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss (i.e., VaR) calculated over a one-year time horizon with a 99.9% confidence level. The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts (e.g., fire insurance).

Professor's Note: While Basel II generally lowered credit risk capital requirements for most banks, requiring banks to hold capital for operational risks had the effect of raising overall capital requirements back to (approximately) Basel I levels.

Basel II Pillars of Sound Bank Management

LO 59.7: Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review, and market discipline.

While Basel I improved the way capital requirements were determined for banks worldwide, it had some major limitations. First, all corporate loans were treated the same (i.e., a risk

weight of 100%) regardless of the creditworthiness of the borrower. A firm with an AAA credit rating was treated the same as a borrower with a C rating. Basel I also ignored the benefits of diversification (i.e., there was no model of default correlation). Basel II, proposed in June 1999 and after multiple revisions was published in 2004 and implemented in 2007, corrected a number of the deficiencies in Basel I. The rules applied to "internationally active" banks and thus many small regional banks in the United States were not subject to the requirements but fell under Basel IA, similar to Basel I, instead. All European banks are regulated under Basel II.

There are three pillars under Basel II: (1) minimum capital requirements, (2) supervisory review, and (3) market discipline.

Pillar 1: Minimum Capital Requirements

The key element of Basel II regarding capital requirements is to consider the credit ratings of counterparties. Capital charges for market risk remained unchanged from the 1996 Amendment. Basel II added capital charges for operational risk. Banks must hold total capital equal to 8% of risk-weighted assets under Basel II, as under Basel I. Total capital under Basel II is calculated as:

$$\text{total capital} = 0.08 \times (\text{credit risk RWA} + \text{market risk RWA} + \text{operational risk RWA})$$

Pillar 2: Supervisory Review

Basel II is an international standard, governing internationally active banks across the world. A primary goal of Basel II is to achieve overall consistency in the application of capital requirements. However, Pillar 2 allows regulators from different countries some discretion in how they apply the rules. This allows regulatory authorities to consider local conditions when implementing rules. Supervisors must also encourage banks to develop better risk management functions and must evaluate bank risks that are outside the scope of Pillar 1, working with banks to identify and manage all types of risk.

Pillar 3: Market Discipline

The goal of Pillar 3 is to increase transparency. Banks are required to disclose more information about the risks they take and the capital allocated to these risks. The key idea behind Pillar 3 is that if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions. Banks have discretion in determining what is relevant and material and thus what should be disclosed. According to Basel II, banks should disclose:

- The entities (banks and other businesses such as securities firms in Europe) to which Basel II rules are applied.
- A description of the characteristics, terms, and conditions of all the capital instruments held by the bank.
- A list of the instruments comprising the bank's Tier 1 capital. The amount of capital provided by each instrument should also be disclosed.
- A list of the instruments comprising the bank's Tier 2 capital.

- The capital requirements for each type of risk covered under Basel II: credit, market, and operational risks.
- Information about other bank risks.
- Information about the bank's risk management function, how it is structured, and how it operates.

Solvency II Framework

LO 59.9: Differentiate between solvency capital requirements (SCR) and minimum capital requirements (MCR) in the Solvency II framework, and describe the repercussions to an insurance company for breaching the SCR and MCR.

There are no international standards to regulate insurance companies. In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. While Solvency II was expected to be implemented in 2013, the date has been postponed. Solvency II has three pillars, analogous to Basel II.

Pillar 1 specifies a **solvency capital requirement** (SCR). The SCR may be calculated using the standardized approach or the internal models approach (discussed in the next LO). Repercussions for breaching the SCR are less severe than if the firm breaches a minimum capital requirement (MCR). If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount. Specific measures, determined by regulators, may be required.

Pillar 1 also specifies a **minimum capital requirement** (MCR), which is an absolute minimum of capital. There are at least two methods for calculating the MCR under consideration. First, MCR may be set as a percentage of the SCR. A second possibility is to calculate MCR the same way as SCR, but with a lower confidence level. The repercussions for breaching the MCR are severe. If a firm's capital falls below the MCR, regulators will likely prohibit the company from taking new business. Regulators can also force the insurance company into liquidation and transfer the company's insurance policies to another firm.

LO 59.10: Compare the standardized approach and the internal models approach for calculating the SCR in Solvency II.

The two approaches an insurance firm can use to calculate the SCR under Solvency II are:

1. Standardized approach.

2. Internal models approach.

Standardized Approach. Analogous to Basel II, the standardized approach to calculating SCR under Solvency II is intended for less sophisticated insurance firms that cannot or do not want to develop their own firm-specific risk measurement model. It is intended to capture the risk profile of the average firm and is more cost efficient for smaller firms with less fully developed risk management functions.

Internal Models Approach. This approach is similar to the IRB approach under Pillar 1 of Basel II. A VaR is calculated with a one-year time horizon and a 99.5% confidence level. There is a capital charge for the following three types of risk:

1. *Underwriting risk*: divided into risks arising from life insurance, non-life insurance (such as property and casualty insurance), and health insurance.

2. *Investment risk*: divided into market risk and credit risk.

3. *Operational risk*.

Regulators have implemented quantitative impact studies (QISs) to examine whether capital is sufficient to weather significant market events. For example, QISs have considered large declines (i.e., 32%) in global stock markets, large declines (20%) in real estate prices, large increases (10%) or decreases (25%) in mortality rates, and so on.

Internal models developed by insurance companies must satisfy the following three tests:

1. **Statistical quality test:** This tests the quality of the data and the methodology the firm uses to calculate VaR.

2. **Calibration test:** This tests whether risks are measured in agreement with an industry-wide SCR standard.

3. **Use test:** This test determines if the model is relevant and used by risk managers.

Key Concepts

LO 59.1

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards known as Basel I.

Basel I was originally developed to cover credit risk capital requirements. It was amended in 1996 to also include market risk capital requirements. Basel II was introduced in 2004 and addressed not only credit and market risk capital but also operational risk capital.

LO 59.2

Under Basel I, banks calculated risk-weighted assets for on- and off-balance sheet items. Capital was required as a percentage of risk-weighted assets. For example, cash and Treasury securities received a 0% risk weight while commercial loans received a 100% risk weight. Off-balance sheet items were expressed as credit equivalent amounts and were "converted" into risk-weighted assets. Capital could be Tier 1 or Tier 2 but at least half of the capital requirement (4%) had to be met with Tier 1 capital (equity and non-cumulative perpetual preferred).

LO 59.3

Banks were required to measure market risk in addition to credit risk under the 1996 Amendment to the 1988 Basel Accord. The 1996 Amendment proposed two methods for calculating market risk including the standardized measurement method and the internal model-based approach. The standardized method assigns a capital charge separately to each of the items in the trading book. This method ignores correlations between the instruments. The internal model-based approach uses a formula specified in the amendment to calculate a value at risk (VaR) measure used to determine the capital requirement. Capital charges are generally lower using this method because it considers correlations between the instruments.

LO 59.4

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading-day time horizon and a 99% confidence level. The capital requirement for market risk is:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 days
m_c = multiplicative factor, minimum value of three
SRC = specific risk charge

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. If the actual loss is greater than the estimated loss, an exception is recorded. The

multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to three.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to four.

The bank supervisor has discretion regarding the multiplier.

LO 59.5

Basel II improves on Basel I in at least two ways. First, counterparty credit ratings are considered in calculating risk-weighted assets. Second, a model of default correlation is included. Basel II specifies three approaches banks can use to measure credit risk, including the standardized approach, the foundation internal ratings based (IRB) approach, and the advanced IRB approach. The standardized approach is the least complicated and the risk-weighting approach is similar to Basel I, although some risk weights were changed. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The foundation IRB approach and the advanced IRB approach are similar. The key difference is who supplies the input variables. Banks supply their own estimates of probability of default (PD), loss given default (LGD), exposure at default (EAD), and the maturity adjustment (M) if using the advanced approach. Under the foundation approach, banks supply PD estimates, while the Basel Committee supplies the estimates of LGD, EAD, and M.

LO 59.6

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire that destroys bank assets or information, are also considered operational risks. Under Basel II, there are three approaches banks may use to calculate capital for operational risk including the basic indicator approach (the simplest), the standardized approach (similar to the basic indicator approach but with different multipliers applied to different lines of business), and the advanced measurement approach (the most complex). The capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss calculated over a one-year time horizon and a 99.9% confidence level (i.e., VaR). The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts.

LO 59.7

Basel II is an international standard, governing "internationally active banks." There are three pillars under Basel II as follows:

1. Minimum capital requirements. This pillar involves calculating capital based on the riskiness of the bank, taking into consideration credit risk, market risk, and operational risk.

2. Supervisory review. A primary goal of Basel II is to achieve overall consistency in the application of the capital requirements across countries while, at the same time, giving supervisors discretion to consider market conditions in their own countries.

3. Market discipline. Banks are required to disclose more information about the risks they take and the capital allocated to those risks. According to Basel II, if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions.

LO 59.8

In the context of Basel II, the worst case probability of default (WCDR) is the amount the bank can be 99.9% certain the loss will not exceed (from a specific counterparty) in the coming year. The one-year probability of default (PD) is the probability that an obligor, given a large number of obligors, will default. The exposure at default (EAD) is the dollar amount a counterparty is expected to owe if it defaults. The loss given default (LGD) is the proportion of the EAD that is expected to be lost in the event the counterparty defaults. For example, if the bank expected to collect 40% in the event of default by a counterparty, the LGD is 60%.

LO 59.9

In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. Pillar 1 of Solvency II specifies:

- Minimum capital requirement (MCR). The repercussions for breaching the MCR will likely include a prohibition from taking new business. Regulators may also force the insurance company into liquidation and transfer the company's insurance policies to another firm.
- Solvency capital requirement (SCR). Repercussions for breaching the SCR are less severe than if the firm breaches the MCR. If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount.

LO 59.10

There are two approaches an insurance firm can use to calculate the SCR under Solvency II. They are the standardized approach and the internal models approach. The standardized approach is least complicated and is meant to capture the risk of the average firm. The internal models approach is similar to the IRB approach under Basel II. It involves calculating a VaR with a one-year time horizon and a 99.5% confidence level.

Concept Checkers

1. Michigan One Bank and Trust has entered a $200 million interest rate swap with a corporation. The remaining maturity of the swap is six years. The current value of the swap is $3.5 million. Using the table below to find the add-on factor for the interest rate swap, the equivalent risk-weighted assets (RWA) under Basel I is closest to:

Add-on Factors as a Percentage of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Equity*
< 1 year	0.0	6.0
1 to 5 years	0.5	8.0
> 5 years	1.5	10.0

A. $3,000,000.
B. $3,250,000.
C. $3,500,000.
D. $6,500,000.

2. Saugatuck National Bank uses the internal model-based approach to set market risk capital as prescribed by the 1996 Amendment to the 1988 Basel Accord. The bank has backtested its 99%, one-day VaRs against the actual losses over the last 250 trading days. Based on the results of the backtesting, the bank recorded 11 exceptions. Based on these results, the multiplicative factor (m_c) in the model should be set:
A. less than 3.
B. equal to 3.
C. between 3.1 and 3.9.
D. equal to 4.

3. Bank Macatawa has a $150 million exposure to Holland Metals Co. The exposure is secured by $125 million of collateral consisting of AA+-rated bonds. Holland Metals Co. is unrated. The collateral risk weight is 20%. Bank Macatawa assumes an adjustment to the exposure of +15% to allow for possible increases in the exposure and allows for a –25% change in the value of the collateral. Risk-weighted assets for the exposure are closest to:
A. $78.75 million.
B. $93.75 million.
C. $118.13 million.
D. $172.50 million.

4. Which of the following accords first required banks to hold capital for operational risk?
A. Basel I.
B. The 1996 Amendment to Basel I.
C. Basel II.
D. Solvency II.

5. Which of the following statements is correct regarding capital requirements for insurance companies?
   A. Basel II includes the regulation of banks and insurance companies in the three pillars.
   B. The minimum capital requirement is likely to be higher than the solvency capital requirement for insurance companies.
   C. The repercussion for violating the solvency capital requirement is likely liquidation and the transfer of company insurance policies to another firm.
   D. The internal models approach to calculating the solvency capital requirement is similar to internal ratings based approach under Basel II in that the firm must calculate a VaR with a one-year time horizon.

Concept Checker Answers

1. B The add-on factor is 1.5% of the interest rate swap principal for swaps with a maturity greater than five years.

   credit equivalent amount = max(V,0) + a × L

   where:
   V = current value of the derivative to the bank
   A = add-on factor
   L = principal amount

   credit equivalent amount = $3.5 + (0.015 × $200) = $6,500,000

   The risk-weight factor for a corporate counterparty under Basel I is 50% for derivatives and 100% for corporate loans. This means the risk-weighted assets (RWA) are:

   RWA = 0.50 × $6,500,000 = $3,250,000

2. D Saugatuck National Bank must compare the VaR calculated using its current method for each of the 250 trading days to the actual loss over the same period to determine the multiplicative factor. If the actual loss is greater than the estimated loss, an exception is recorded. If, over the previous 250 days, the number of exceptions is:
   - Less than 5, m_c is usually set equal to three.
   - 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
   - Greater than 10, m_c is set equal to four.

   Therefore, with 11 exceptions recorded, m_c should be set equal to four.

3. A Exposure = (1.15 × 150) – (0.75 × 125) = 172.5 – 93.75 = $78.75

   The risk weight for an unrated corporate counterparty based on Figure 3 in the topic is 100%. Applying the 100% risk weight, risk-weighted assets are:

   risk-weighted assets = 1.0 × 78.75 = $78.75 million

4. C Basel II requires banks to maintain capital for operational risks. Banks can use three methods to measure operational risk. They are the basic indicator approach, the standardized approach, and the advanced measurement approach.

5. D Solvency II, not Basel II, establishes capital requirements for insurance companies. The minimum capital requirement (MCR) is just that, a true floor and is thus likely to be lower than the solvency capital requirement (SCR). The repercussion for violating the MCR is likely the prohibition of taking new business and possible liquidation. The repercussion for violating the SCR is the requirement of a plan to remedy the situation and bring the capital back to the required level. The internal models approach is similar to the internal ratings based approach under Basel II in that the insurance company must calculate a one-year VaR with a 99.5% confidence level (versus 99.9% confidence for banks under Basel II).

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Basel II.5, Basel III, and Other Post-Crisis Changes

Topic 60

Exam Focus

Following the 2007–2009 financial crisis, the Basel Committee on Banking Supervision implemented reforms to shore up bank capital. This topic describes the measures taken in Basel II.5 and Basel III to increase capital and tighten the definition of what constitutes capital in normal periods, create buffers to protect banks against loss in stress periods, and encourage banks to better manage liquidity risks by requiring banks to maintain liquidity coverage and net stable funding ratios. It also describes the major reforms in the Dodd-Frank Act that impact banks and bank regulation. For the exam, know the major changes to capital regulation, including the incremental risk charge, the comprehensive risk measure, the stressed VaR, the capital conservation buffer, and the countercyclical buffer. Understand why banks may use less mainstream funding sources, such as contingent convertible bonds, as a result of higher capital requirements. In addition, be able to calculate the leverage ratio, liquidity coverage ratio, and net stable funding ratio given a bank's balance sheet. Finally, be able to recognize and describe major changes imposed on U.S. banks by Dodd-Frank, including the creation of the Financial Stability Oversight Council, the Office of Financial Research, and the Bureau of Financial Protection.

Stressed VaR

LO 60.1: Describe and calculate the stressed value-at-risk measure introduced in Basel 2.5, and calculate the market risk capital charge.

The implementation of Basel II coincided with the financial crisis of 2007–2009. Some people blamed Basel II because banks using the advanced internal ratings based (IRB) approach to calculate credit risk were allowed to use their own estimates of probability of default (PD), loss given default (LGD), and exposure at default (EAD). Some believed Basel II was a move toward self-regulation and allowed banks to underestimate risks. As a result, the Basel Committee on Banking Supervision implemented a series of changes to the calculation of market risk capital. These changes were part of Basel II.5, implemented December 31, 2011. There were three primary changes, including:

1. The calculation of a stressed value-at-risk (SVaR).
2. The implementation of a new incremental risk change (IRC).
3. A comprehensive risk measure (CRM) for instruments sensitive to correlations between default risks of various instruments.

In the past, banks used the historical simulation method to calculate the VaR in order to find the market risk capital charge. The assumption in the historical simulation method

is that percentage changes in market variables the next day are random samples of the percentage changes over the previous one to four years. Volatilities of most market variables were low in the pre-crisis period (i.e., 2003–2006). As such, market risk VaRs were also low during this period and continuing for a time following the start of the financial crisis. To remedy the problem of low VaRs, Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a **stressed VaR**, using a 250-day period of stressed market conditions. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their actual portfolios performed poorly. This means the stressed period may be different across banks.

The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. The formula for the total capital charge is:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + \max(SVaR_{t-1}, m_s \times SVaR_{avg})$$

where:

VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level
VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_c = multiplicative factor, determined by supervisor, minimum value of three
$SVaR_{t-1}$ = previous day's stressed VaR, 10-day time horizon, 99% confidence level
$SVaR_{avg}$ = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

Example: Total market risk capital charge

Spartan State Bank has calculated a market risk VaR for the previous day equal to $15.6 million. The average VaR over the last 60 days is $4.8 million. The bank has calculated a stressed VaR for the previous day equal to $17.7 million and an average stressed VaR equal to $18.4 million. Spartan State Bank has an accurate risk measurement model and recorded only two exceptions while backtesting actual losses against the calculated VaR. As such, the multiplicative factors, both m_c and m_s, are set to 3. **Calculate** the total market risk capital charge.

Answer:

total capital charge = $15.6 million + ($18.4 × 3) = $70.8 million

Professor's Note: Because the stressed VaR will be equal to or, more likely, greater than, VaR, the capital charge for market risk under Basel II.5 will be at least double the capital charge under Basel II.

Incremental Risk Capital Charge

LO 60.2: Explain the process of calculating the incremental risk capital charge for positions held in a bank's trading book.

Prior to the financial crisis, the capital charge for exposures in the bank's trading book (i.e., bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading) was generally lower than the capital charge for exposures in the banking book (i.e., instruments the bank intends to hold for investment purposes including loans and some debt securities). A one-year, 99.9% confidence level VaR was required for calculating capital for the banking book while a multiplier was applied to a 10-day, 99% VaR for capital to back the trading book.

The Basel Committee proposed an **incremental default risk charge** (IDRC) in 2005 to correct the problem. The proposal required a 99.9% confidence level, one-year time horizon VaR for instruments in the trading book that are sensitive to default risk. This change had the affect of requiring roughly the same capital for trading book instruments as banking book instruments. However, because much of the 2007–2009 losses in the financial sector were due not to defaults but instead to downgrades, widening credit spreads, and losses of liquidity, the Basel Committee revised the IDRC to become an **incremental risk charge** (IRC). Instead of instruments sensitive to default, it is now credit-sensitive instruments. Banks must consider ratings change sensitivities in addition to default sensitivity. Banks are expected to rebalance the portfolio through the year to lessen default risk.

As part of the IRC calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA-rated bond in the portfolio has a liquidity horizon of 6 months. If at the end of 6 months the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each six-month period (or three months, nine months, etc., depending on the estimated liquidity horizon). The Basel Committee set the minimum liquidity horizon at three months.

This assumption of rebalancing to the beginning of the period position is known as the **constant level of risk** assumption. Small losses occur as bonds are downgraded and the portfolio is rebalanced, but the likelihood of default is lessened. Generally this assumption reduces the one-year, 99.9% VaR. As discussed in the previous topic, the specific risk charge (SRC) captures changing credit spreads.

Comprehensive Risk Measure

LO 60.3: Describe the comprehensive risk measure (CRM) for positions that are sensitive to correlations between default risks.

The **comprehensive risk measure** (CRM) is a single capital charge for correlation-dependent instruments that replaces the **specific risk charge** (SRC) and the IRC. The measure accounts for risks in the "correlation book." Instruments that are sensitive to the correlation between the default risks of different assets include asset-backed securities (ABS)

and collateralized debt obligations (CDOs). In normal periods, there is little risk of loss for highly rated tranches of these instruments. However, in times of stress, as in the 2007–2009 financial crisis, correlations with other instruments increase and even the highest-rated tranches can be vulnerable to loss.

The committee has specified a standardized approach for rated instruments. Due to the experience of the financial crisis, *resecuritizations*, such as CDOs of ABSs, have higher capital requirements than normal securitizations such as mortgage-backed securities.

Figure 1: Standardized Capital Charge for Correlation-Dependent Instruments

Type of Instrument	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*Below BB– or Unrated*
Securitization	1.6%	4%	8%	28%	Deduction
Resecuritization	3.2%	8%	18%	52%	Deduction

For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital. This is equivalent to a 100% capital charge; banks must hold dollar-for-dollar capital against the tranche. For unrated tranches banks are allowed, with supervisory approval, to use an internal model to calculate the CRM. If a bank is allowed to use an internal model, it must routinely perform rigorous stress tests. Internal models must be sophisticated and capture the cumulative effects of several factors including:

- Credit spread risk.
- Multiple defaults.
- The volatility of implied correlations.
- The relationship between implied correlations and credit spreads.
- The costs of rebalancing hedges.
- The volatility of recovery rates.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) does not allow ratings to be used in setting capital requirements. As such, the United States is trying to devise its own CRM rules that do not use ratings.

Professor's Note: For unrated and low rated (below BB–) instruments or tranches, the deduction of the principal amount of the exposure from capital is in essence assigning a 1250% risk weight to the asset class. Think about a $100 corporate loan that has a 100% risk weight. The capital charge is $8, or $100 × 100% × 0.08 (the asset value times the risk weight times the capital requirement). If instead you have a $100 unrated ABS CDO, the capital charge is $100. Another way to look at it is $100 × 1250% × 0.08. This lets you see the difference in the way that these low or unrated correlation dependent instruments are treated in terms of capital requirements, compared to traditional assets like loans.

Basel III Capital Requirements

LO 60.4: Define in the context of Basel III and calculate where appropriate:
- **Tier 1 capital and its components**
- **Tier 2 capital and its components**
- **Required Tier 1 equity capital, total Tier 1 capital, and total capital**

Basel III increased capital for credit risk and tightened the definition of capital in response to the 2007–2009 financial crisis. The proposals were published in December 2010 and will be implemented gradually between 2013 and 2019. Basel III eliminated Tier 3 capital.

Tier 1 capital (or core capital) includes:

- Common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital).
- Non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1 capital).

Tier 1 capital does not include:

- Goodwill.
- Deferred tax assets.
- Changes in retained earnings arising from securitized transactions.
- Changes in retained earnings arising from the bank's credit risk, called debit (debt) value adjustment (DVA).

Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). In addition, there are rules governing capital issued by consolidated subsidiaries and also for the inclusion of minority interests.

Tier 2 capital (or supplementary capital) includes:

- Debt subordinated to depositors with an original maturity of five years or more.
- Some preferred stock, such as cumulative perpetual preferred.

Common equity is known as going-concern capital. It absorbs losses when the bank has positive equity (i.e., is a going concern). Tier 2 capital is known as gone-concern capital. When the bank has negative capital and is no longer a going concern, Tier 2 capital absorbs losses. Depositors are ranked above Tier 2 capital in liquidation so theoretically, as long as Tier 2 capital is positive, depositors should be paid in full.

Capital requirements for each tier and for total capital are:

- Tier 1 equity capital must be 4.5% of risk-weighted assets at all times.
- Total Tier 1 capital (i.e., equity capital plus additional Tier 1 capital such as perpetual preferred stock) must be 6% of risk-weighted assets at all times.
- Total capital (Total Tier 1 capital plus Tier 2 capital) must be at least 8% of risk-weighted assets at all times.

By comparison, under Basel I the equity capital requirement was 2% of risk-weighted assets and the total Tier 1 capital requirement was 4% of risk-weighted assets. The new requirements are significantly more rigorous both because the percentages are higher and because the definition of what qualifies as equity capital has been tightened. The 8%

total capital requirement is the same as under Basel I and Basel II, but again, the stricter definition of equity capital applies under Basel III.

The timeline for implementation for new capital requirements is shown in Figure 2.

Figure 2: Implementation Dates for New Capital Requirements

Regulatory Change	*1/1/13*	*1/1/14*	*1/1/15*	*1/1/18*
Tier 1 Equity Capital	3.5%	4.0%	4.5%	4.5%
Tier 1 Total Capital	4.5%	5.5%	6.0%	6.0%
New Capital Definitions	Phased in	Phased in	Phased in	New definitions fully in place

Capital Conservation Buffer and Countercyclical Buffer

LO 60.5: Describe the motivations for and calculate the capital conservation buffer and the countercyclical buffer introduced in Basel III.

The **capital conservation buffer** is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1 equity capital ratio (i.e., 4.5% + 2.5% = 7.0%). Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Banks need an extra cushion against loss during stress periods. The idea behind the buffer is that it is easier for banks to raise equity capital in normal periods than in periods of financial stress. The buffer will be phased in between January 1, 2016, and January 1, 2019.

Dividend payments are constrained when the buffer is wholly or partially used up. For example, if a bank's Tier 1 equity capital ratio is 6%, the bank must retain a minimum of 60% earnings, thus dividends cannot exceed 40% of earnings. See Figure 3 for the restrictions on dividend payments as they relate to the capital conservation buffer.

Figure 3: Dividend Restrictions Resulting from the Capital Conservation Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.000% to 5.125%	100%
5.125% to 5.750%	80%
5.75% to 6.375%	60%
6.375% to 7.000%	40%
> 7.0%	0%

Professor's Note: While the buffer requires the ratios to be 7% (Tier 1 equity), 8.5% (Total Tier 1 capital), and 10.5% (total capital) of risk-weighted assets, the ratios are expected to decline in times of market stress due to losses. At that point, the ratio requirements described in LO 60.4 are in force (i.e., 4.5%, 6.0%, and 8.0%, respectively). However, once financial markets stabilize, banks will face pressure to increase the ratios again. Given the higher equity requirements under Basel III, it will likely be difficult for banks to achieve the high returns on equity (ROE) that they enjoyed in the 15 years leading up to the financial crisis (i.e., 1990 – 2006).

While left to the discretion of individual country supervisors, Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the **countercyclical buffer**. The countercyclical buffer can range from 0% to 2.5% of risk-weighted assets. Like the capital conservation buffer, it must be met with Tier 1 equity capital. The buffer will be phased in between January 1, 2016, and January 1, 2019.

For countries that require the countercyclical buffer, dividend restrictions may apply. See Figure 4 for the restrictions on dividend payments as they relate to the countercyclical buffer (when set to the maximum 2.5% of risk-weighted assets), keeping in mind that the ratios are higher because the capital conservation buffer is also included. In other words, Figure 4 is a revised Figure 3, taking the additional buffer into account.

Figure 4: Dividend Restrictions Resulting from the Capital Conservation Buffer and a 2.5% Countercyclical Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.50% to 5.75%	100%
5.75% to 7.00%	80%
7.00% to 8.25%	60%
8.25% to 9.50%	40%
> 9.5%	0%

Liquidity Risk Management

LO 60.6: Describe and calculate ratios intended to improve the management of liquidity risk, including the required leverage ratio, the liquidity coverage ratio, and the net stable funding ratio.

In the wake of the 2007–2009 financial crisis, one of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III specifies a minimum **leverage ratio** (capital / total exposure) of 3%. As of the 2010 Basel III publication date, the type of capital required to calculate the ratio was not decided. Total exposure includes all items on the balance sheet, in their entirety (i.e., not risk-weighted). It also includes some off-balance sheet items such as loan commitments.

Banks often finance long-term obligations with short-term funds such as commercial paper or repurchase agreements. This is fine during normal economic periods. However,

in times of financial stress, this mismatched financing gives rise to liquidity risk. Banks find it difficult to roll over the short-term financing when they have, or are perceived to have, financial problems. During the 2007–2009 financial crisis, liquidity risk, not a lack of capital, was the real problem for many banks (e.g., Lehman Brothers). Basel III requires banks to meet the following two liquidity ratios: (1) liquidity coverage ratio and (2) net stable funding ratio.

Liquidity Coverage Ratio (LCR): The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The severe stress considered could be a three-notch downgrade (e.g., AA to A), a loss of deposits, a complete loss of wholesale funding, a devaluation of the value of collateral for funding agreements like repurchase agreements (i.e., increased "haircuts"), and potential drawdowns on lines of credit. The ratio is computed as:

$$\text{high quality liquid assets / net cash outflows in a 30-day period} \geq 100\%$$

Liquid assets need to be at least as great as potential net cash outflows such that the bank can withstand one or more of the pressures described earlier.

Net Stable Funding Ratio (NSFR): The NSFR focuses on the bank's ability to manage liquidity over a period of one year. The ratio is computed as:

$$\text{amount of available stable funding / amount of required stable funding} \geq 100\%$$

To calculate the numerator, each source of funding (such as retail deposits, repurchase agreements, capital, and so on) is multiplied by a factor that reflects the relative stability of the funding source. See Figure 5 for the **available stable funding** (ASF) factors and types of funding available.

Figure 5: ASF Factors in NSFR

ASF Factor	*Category*
100%	Tier 1 and Tier 2 capital, preferred stock, debt with remaining maturity greater than one year.
90%	"Stable" demand and term deposits from individuals and small businesses with maturities less than one year.
80%	"Less stable" demand and term deposits from individuals and small businesses with maturities less than one year.
50%	Wholesale funding (demand and term deposits) from nonfinancial corporations, sovereigns, central banks, multi-lateral development banks, and public sector entities with maturities less than one year.
0%	All other liability and equity categories.

To calculate the denominator, each required amount of stable funding is multiplied by a factor that reflects the relative permanence of the funding required. See Figure 6 for the **required stable funding** (RSF) factors and the types of assets requiring the funding.

Figure 6: RSF Factors in NSFR

RSF Factor	*Category*
0%	Cash and short-term instruments, securities, and loans to financial entities with residual maturities of less than one year.
5%	Marketable securities with maturities of greater than one year, if claim is on a sovereign with 0% risk weight (e.g., U.S. Treasury securities).
20%	Corporate bonds with rating of AA– or higher and residual maturity greater than one year. Claims on sovereigns or similar bodies with risk-weight of 20%.
50%	Gold, equities, bonds rated A+ to A–.
65%	Residential mortgages.
85%	Loans to small businesses or retail customers with remaining maturities less than one year.
100%	All other assets.

Example: Calculating the NSFR

Bank of the Bluegrass has the following balance sheet:

Cash (coins and banknotes)	10	Retail deposits (less stable)	100
Central bank reserves	10	Wholesale deposits	75
Treasury bonds (> 1 yr)	10	Tier 2 capital	2
Mortgages	30	Tier 1 capital	18
Retail loans (< 1 yr)	30		
Small business loans (< 1 yr)	90		
Fixed assets	15		
Total assets	195	Total liabilities and equity	195

Using the information in Figures 5 and 6 to find the corresponding ASF and RSF factors, **calculate** the bank's net stable funding ratio.

Answer:

ASF = (100 × 0.8) + (75 × 0.5) + (2 × 1.0) + (18 × 1.0) = $137.50

RSF = (10 × 0) + (10 × 0) + (10 × 0.05) + (30 × 0.65) + (30 × 0.85) + (90 × 0.85) + (15 × 1.0) = $137.00

NSFR = 137.50 / 137.00 = 1.0036 = 100.36%

With an NSFR greater than 100%, Bank of the Bluegrass satisfies the new liquidity requirement.

These new rules represent a significant change for banks and will impact bank balance sheets. The LCR is scheduled to be implemented January 1, 2015, and the NSFR is scheduled to be implemented January 1, 2018.

Contingent Convertible Bonds

LO 60.7: Describe the mechanics of contingent convertible bonds (CoCos) and explain the motivations for banks to issue them.

Contingent convertible bonds (CoCos), unlike traditional convertible bonds, convert to equity automatically when certain conditions are met. These bonds typically convert to equity when the company or bank is experiencing financial strains. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not drag down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss, which helps prevent insolvency. The needed capital is provided by private sector bondholders rather than the government, allowing the bank to avoid a bailout.

Potential triggers that activate conversion are:

- The ratio of Tier 1 equity capital to risk-weighted assets. For example, Credit Suisse issued CoCos in 2011. Conversion is triggered if Tier 1 equity capital to risk-weighted assets falls below 7%.
- Supervisors' judgment about the issuing bank's solvency prospects. For example, the Credit Suisse CoCos automatically convert if bank supervisors determine that the bank needs public sector aid (i.e., equity capital) to avoid insolvency.
- A minimum ratio of a bank's market capitalization to its assets. Market value triggers may reduce balance sheet manipulations (as one might see if the ratio of capital to risk-weighted assets is used as a trigger) but might instead introduce stock price manipulation.

Because of the increased pressure on banks to maintain higher capital levels under Basel III, it is estimated that more than $1 trillion of CoCos will be issued between 2010 and 2020.

Dodd-Frank Wall Street Reform

LO 60.8: Explain the major changes to the U.S. financial market regulations as a result of Dodd-Frank.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has several provisions aimed at regulating banks. Some of the major changes include:

- The establishment of the **Financial Stability Oversight Council** (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system. The body monitors systemic risks.
- The establishment of the **Office of Financial Research** (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States. The bodies seek to maintain investor confidence and promote market discipline.
- The FSOC and the OFR are charged with identifying **systemically important financial institutions** (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. The FSOC can impose extra capital requirements on SIFIs. In the United States, a bank with more than $50 billion in assets qualifies as a SIFI. The definition is less clear for non-banks.
- The elimination of the Office of Thrift Supervision, a former supervisory body that regulated savings and loan institutions.
- The expansion of the Federal Deposit Insurance Corporation's (FDIC's) powers to liquidate banks. For example, the FDIC is allowed to take over large firms that are failing and sell their assets, even at a loss to shareholders and creditors. The financial industry, not taxpayers, should bear the costs of failures.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- Greater reporting requirements for large hedge funds and similar firms. These firms must now register with the SEC.
- The establishment of **Federal Insurance Office** that will work with state insurance regulators and monitor the insurance industry.
- The establishment of the **Volcker Rule**, intended to curtail proprietary trading by institutions (like banks) that accept insured deposits as a source of funding. One of the problems with this rule is that it can be difficult to distinguish between a bank's speculative trading and hedging activities.
- The requirement that some financial firms spin off high-risk trading operations into separately capitalized subsidiaries.

- Increased regulation and improved transparency of over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs). To facilitate OTC trading, swap execution facilities (SEFs) were mandated. The Commodity Futures Trading Commission (CFTC) was given responsibility to monitor CCPs and SEFs. A trade repository of all derivatives transactions will be established, improving transparency. A new Legal Entity Identifier (LEI) system will be created to assist with this goal. An LEI is a reference code that identifies a legally distinct entity engaging in a financial transaction.
- The Federal Reserve must set risk management standards for systemically important financial institutions engaged in clearing, settlement, and payment functions.
- The requirement that rating agencies be more transparent in their assumptions and methods used to rate firms. An **Office of Credit Ratings** was created to monitor rating agencies. The potential legal liabilities of rating agencies were also increased under Dodd-Frank.
- The use of external credit ratings in the regulation of banks and other financial institutions was banned. This is in direct conflict with the Basel Committee, which uses external credit ratings to set some capital requirements.
- Individual protections were increased, both for investors and consumers. The **Bureau of Financial Protection** was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Firms are required, with some exceptions, to keep a minimum of 5% of the assets they securitize.
- Changes in compensation. Compensation packages that encourage short-term performance goals that may lead to increased risk taking are discouraged. Shareholders were given a non-binding vote on executive compensation packages. Board compensation committees must be made up of independent directors.
- Banks are required to assess a mortgage borrower's ability to repay. Foreclosures may be disallowed if a bank does not make a good faith effort to determine that the borrower can repay the loan.
- At least one board member should have risk management experience at large, complex organizations.

Key Concepts

LO 60.1

Basel II.5 requires banks to calculate two market risk VaRs. The first is the usual VaR required in Basel II, using the historical simulation method. The second is a stressed VaR, using a 250-day period of stressed market conditions. To calculate the stressed VaR, banks must identify a one-year period when their portfolios performed poorly. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR.

LO 60.2

The Basel Committee proposed an incremental default risk charge (IDRC) in 2005 to correct for the fact that the banking book was attracting more capital than the trading book in most banks. For instruments in the trading book that are sensitive to default risk, the IDRC requires the bank to calculate a 99.9% confidence level, one-year time horizon VaR. This was altered to account for ratings change sensitivities in addition to default sensitivities following the 2007–2009 financial crisis and became known as the incremental risk charge (IRC). Banks must estimate a liquidity horizon for each instrument and rebalance the portfolio if credit quality declines.

LO 60.3

The comprehensive risk measure (CRM) accounts for risks in the correlation book. Asset-backed securities (ABS) and collateralized debt obligations (CDOs) are sensitive to the default risk of other assets. For example, they are sensitive to the default risk of the securitized assets that collateralize the instruments. The committee has specified a standardized approach to assign capital charges for rated instruments. Resecuritizations, such as CDOs of ABSs, have higher risk weights than normal securitizations, such as mortgage-backed securities. For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital which is equivalent to a 100% capital charge.

LO 60.4

Basel III increased capital requirements for credit risk and tightened the definition of what qualifies as Tier 1 and Tier 2 capital. Basel III eliminated Tier 3 capital. Under Basel III, a bank's total capital consists of Tier 1 equity capital (primarily common stock plus retained earnings), additional Tier 1 capital (primarily non-cumulative perpetual preferred), and Tier 2 capital (primarily debt subordinated to depositors with an original maturity of at least five years). By January 1, 2015, Tier 1 equity capital must be at least 4.5% of risk-weighted assets, total Tier 1 capital must be 6% of risk-weighted assets, and total capital (Tier 1 plus Tier 2) must be at least 8% of risk-weighted assets.

LO 60.5

The capital conservation buffer protects banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1equity capital ratio. Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Dividend restrictions apply when capital ratios fall below required levels.

Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the countercyclical buffer. This requirement is left to the discretion of individual country supervisors and can range from 0% to 2.5% of risk-weighted assets.

LO 60.6

One of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III requires banks to meet the following three liquidity ratios:

1. A minimum leverage ratio (capital / total exposure) of 3%. Total exposure includes all items on the balance sheet in their entirety (i.e., not risk-weighted) and some off-balance sheet items, such as loan commitments.

2. A minimum liquidity coverage ratio (high quality liquid assets / net cash outflows in a 30-day period) of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity.

3. A minimum net stable funding ratio (amount of stable funding / required amount of stable funding) of 100%. The NSFR focuses on the bank's ability to manage liquidity over a period of one year.

LO 60.7

Contingent convertible bonds (CoCos) convert to equity automatically when certain conditions are met, usually when the company or bank is experiencing financial stresses. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not weigh down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss and preventing insolvency and potentially allowing the bank to avoid a bailout.

LO 60.8

Dodd-Frank was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has many provisions aimed at regulating banks. Some of the more important provisions are as follows:

- The establishment of the Financial Stability Oversight Council (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system.
- The establishment of the Office of Financial Research (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States.
- The FSOC and the OFR are charged with identifying systemically important financial institutions (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. SIFIs may also be required to hold additional capital.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- The establishment of the Volcker Rule, intended to curtail proprietary trading by banks.
- The Bureau of Financial Protection was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Increased regulation and improved transparency for over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs).

Concept Checkers

1. Which of the following statements about a stressed VaR, required under Basel II.5, is correct?
   A. Basel II.5 has established the year 2008 as the "stress" period. All banks use data from 2008 to calculate the stressed VaR.
   B. The stressed VaR replaces the "normal" VaR for the purpose of calculating capital for credit risks.
   C. Market risk capital under Basel II.5 should be at least double that of market risk capital under Basel II due to the addition of the stressed VaR.
   D. The stressed VaR must be calculated using a 99.9% confidence interval.

2. Banks are required to rebalance their portfolios as the creditworthiness of bonds decline, leading to losses over time but generally not to outright default. This requirement to specify a liquidity horizon for each instrument in the portfolio and rebalance at the end of the liquidity horizon is part of the:
   A. incremental risk charge calculation.
   B. net stable funding charge formula.
   C. countercyclical buffer estimation.
   D. comprehensive risk measure calculation.

3. Which form of capital must be adjusted downward to reflect deficits in defined benefit pension plans under Basel III?
   A. Tier 1 capital.
   B. Tier 2 capital.
   C. Tier 3 capital.
   D. There is no requirement under Basel III to adjust capital downward to reflect deficits in defined benefit pension plans.

4. The capital conservation buffer:
   A. is intended to protect banks from the countercyclical nature of bank earnings.
   B. can be set between 0.0% and 2.5% of risk-weighted assets, and is at the discretion of the regulators in individual countries.
   C. causes the Tier 1 equity capital ratio requirement to increase to 7% of risk-weighted assets in normal economic periods.
   D. requires that total capital to risk-weighted assets must be 10.5% at all times.

5. Highlands Bank has estimated stable funding in the bank to be $100 million. The bank estimates that net cash outflows over the coming 30 days will be $137 million. The bank has capital of $5 million and a total exposure of $140 million. The bank estimates that it has high-quality liquid assets of $125 million. What is the bank's liquidity coverage ratio (LCR)?
   A. 89.3%.
   B. 91.2%.
   C. 73.0%.
   D. 3.6%.

Concept Checker Answers

1. C Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a stressed VaR, using a 99% confidence level, 250-day period of stressed market conditions. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their portfolios performed poorly. This means the stressed period may be different across banks.

2. A As part of the incremental risk charge (IRC) calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA+-rated bond in the portfolio has a liquidity horizon of three months. If, at the end of three months, the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA+-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each three-month period (or six months, nine months, etc., depending on the estimated liquidity horizon). Rebalancing allows banks to take losses as instruments are downgraded but generally allows the bank to avoid defaults.

3. A Tier 1 includes common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital) and non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1capital). Tier 1 capital does not include goodwill, deferred tax assets, changes in retained earnings arising from securitized transactions, or changes in retained earnings arising from the bank's credit risk. Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). Tier 2 or supplementary capital includes debt subordinated to depositors with an original maturity of five years or more. Tier 3 capital was eliminated under Basel III.

4. C The capital conservation buffer is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times, a bank should have a minimum 7% Tier 1equity capital to risk-weighted assets ratio, an 8.5% total Tier 1 capital to risk-weighted assets ratio, and a 10.5% Tier 1 plus Tier 2 capital to risk-weighted assets ratio. The capital conservation buffer is a requirement and is not left to the discretion of individual country regulators. It is not a requirement at all times but is built up to that level in normal economic periods and declines in stress periods.

5. B Basel III requires a minimum liquidity coverage ratio of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The formula is computed as follows:

   high-quality liquid assets / net cash outflows in a 30-day period

   LCR = $125 million / $137 million = 0.912 or 91.2%.

   In this case, Highlands Bank does not meet the minimum 100% requirement and is in violation of the rule.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Fundamental Review of the Trading Book

Topic 61

Exam Focus

The new banking capital requirements, as specified in this topic, will profoundly change the way that capital for market risk is calculated. There are several key innovations that will cause this change. First, banks will be required to forgo using the 99% confidence interval VaR measure in favor of the 97.5% confidence interval expected shortfall measure. This change will better capture the potential dollar loss (i.e., tail risk) that a bank could sustain in a given window of time. Many risk managers have already begun using expected shortfall in practice for internal audits. Second, risk assets will be divided into liquidity horizons that better reflect the volatility in specific asset categories. The third innovation is a rules-based criteria for an asset being categorized as either a trading book asset or a banking book asset. This step will help mitigate the potential for regulatory arbitrage.

Market Risk Capital Calculation

LO 61.1: Describe the proposed changes to the Basel market risk capital calculation and the motivations for these changes, and calculate the market risk capital under this method.

In May 2012, the Basel Committee on Banking Supervision began considering the next round of changes to market risk capital calculations for banks. This process is known as the **Fundamental Review of the Trading Book** (FRTB). After receiving comments on proposals and seeing the results of a formal study, the rules were further refined in December 2014. It is important for risk managers to understand the nature of the proposed changes and the new calculation methodology.

In order to properly understand the changes, it is necessary to first understand the previous market risk requirements. The Basel I calculations for market risk capital involved a 10-day **value at risk** (VaR) calculated with a 99% confidence interval. This process produced a very current result because the 10-day horizon incorporated a recent period of time, which typically ranged from one to four years. The Basel II.5 calculations required banks to add a stressed VaR measure to the current value captured with the 10-day VaR. The stressed VaR measures the behavior of market variables during a 250-day period of stressed market conditions. Banks were required to self-select a 250-day window of time that would have presented unusual difficulty for their current portfolio.

The FRTB researched if the 10-day VaR was really the best measurement for a bank's true risk. The value at risk measure has been criticized for only asking the question: "How bad can things get?" VaR communicates, with a given level of confidence, that the bank's

losses will not exceed a certain threshold. Consider a bank that uses a 10-day VaR with a 99% confidence interval and finds that losses will only exceed $25 million in 1% of all circumstances. What if the 1% chance involves a $700 million loss? This could be a catastrophic loss for the bank. Therefore, the FRTB has proposed an alternate measure using **expected shortfall** (ES), which is a measure of the impact on the profit and loss statement (P&L) for any given shock of varying lengths. The expected shortfall asks the question: "If things get bad, what is the estimated loss on the bank's P&L?"

Consider the following example that illustrates the difference between value at risk and expected shortfall. A bank has a $950 million bond portfolio with a 2% probability of default. The default schedule appears in Figure 1.

Figure 1: Example Default Schedule for $950 Million Bond Portfolio

Confidence Level	*Default*	*Loss*
95%	No	$0
96%	No	$0
97%	No	$0
98%	No	$0
99%	**Yes**	**$950 million**
99.9%	**Yes**	**$950 million**

At the 95% confidence interval, there is still no expected loss, so the 95% VaR would imply a $0 of loss. However, the expected shortfall measure accounts for the potential dollar loss conditional on the loss exceeding the 95% VaR level. In this case, three out of five times the expected loss is still $0, but two out of five times the expectation is for a total loss of the $950 million bond portfolio's value due to default. This means that 40% of the tail risk would yield a loss, so the expected shortfall is $380 million (i.e., 40% × $950 million). This presents a very different risk perspective than using the VaR measure alone.

Instead of using a 10-day VaR with a 99% confidence interval, the FRTB is proposing the use of expected shortfall with a 97.5% confidence interval. For a normal distribution, with mean of μ and standard deviation of σ, these two measures yield approximately the same result. The 99% VaR formula is $\mu + 2.326\sigma$, and the 97.5% expected shortfall formula is $\mu + 2.338\sigma$. However, if distributions have fatter tails than a normal distribution, then the 97.5% expected shortfall can be considerably different from the 99% VaR.

Under this FRTB proposal, banks would be required to forgo combining a 10-day, 99% VaR with a 250-day stressed VaR, and instead calculate capital based on expected shortfall using a 250-day stressed period exclusively. Just as with the 250-day stressed VaR, banks would be charged with self-selecting a 250-day window of time that would be exceptionally difficult financially for the bank's portfolio.

Professor's Note: There are approximately 250 trading days in a 12-month time period. This is why 250-day time windows are used. Following the same logic, a 120-day window equates to six months, a 60-day window equates to one quarter (three months), a 20-day window equates to one month, and a 10-day window is essentially two weeks.

Liquidity Horizons

LO 61.2: Compare the various liquidity horizons proposed by the Fundamental Review of the Trading Book (FRTB) for different asset classes and explain how a bank can calculate its expected shortfall using the various horizons.

According to the Basel Committee, a **liquidity horizon** (LH) is "the time required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The standard 10-day LH was not deemed appropriate given the actual variations in liquidity of the underlying transactions. Five different liquidity horizons are now in use: 10 days, 20 days, 60 days, 120 days, and 250 days. Consider the 60-day horizon, which is essentially three months worth of trading days. The calculation of regulatory capital for a 60-day horizon is intended to shelter a bank from significant risks while waiting three months to recover from underlying price volatility.

Under FRTB proposals, every risk factor is assigned a liquidity horizon for capital calculations. For example, investment grade sovereign credit spreads are assigned a 20-day horizon, while non-investment grade corporate credit spreads are assigned a 120-day horizon and structured products have a 250-day horizon. See Figure 2 for a sample listing of liquidity horizons.

Figure 2: Allocation of Risk Factors to Liquidity Horizons

Risk Factors	*Horizon (in Days)*
Interest rate (EUR, USD, GBP, AUD, JPY, SEK, and CAD)	10
Interest rate (other)	20
Interest rate at-the-money (ATM) volatility	60
Credit spread: sovereign, investment grade	20
Credit spread: sovereign, non-investment grade	60
Credit spread: corporate, investment grade	60
Credit spread: corporate, non-investment grade	120
Credit spread: structured products	250
Equity price: large cap	10
Equity price: small cap	20
Equity price: large cap ATM volatility	20
Equity price: small cap ATM volatility	120
FX rate (liquid currency pairs)	10
FX rate (other currency pairs)	20
FX volatility	60
Energy price	20
Precious metal price	20
Energy price ATM volatility	60
Precious metal ATM volatility	60

The Basel committee's original idea was to utilize overlapping time periods for stress testing. They initially wanted to find a time period's expected shortfall (ES) by scaling smaller time periods up to longer time periods using a series of trials. Consider a bank that has a 10-day risk asset, like large-cap equity, and a 120-day risk asset, like a non-investment grade corporate credit spread. In the first trial, they would measure the stressed P&L changes from Day 0 to Day 10 for the large-cap equity and also the value change from Day 0 to Day 120 for the non-investment grade corporate credit spread. The next trial would measure the change from Day 1 to Day 11 on the large-cap equity and from Day 1 to Day 121 for the credit spread. The final simulated trial would measure Day 249 to Day 259 for the large-cap equity and Day 249 to Day 369 for the credit spread. The ES used would then be the average loss in the lower 2.5% tail of the distribution of the 250 trials.

After the initial idea was submitted for comments, it was revised in December 2014 to incorporate five categories. The rationale was to reduce implementation costs. The updated categories are as follows:

- Category 1 is for risk factors with 10-day horizons.
- Category 2 is for risk factors with 20-day horizons.
- Category 3 is for risk factors with 60-day horizons.
- Category 4 is for risk factors with 120-day horizons.
- Category 5 is for risk factors with 250-day horizons.

Using this revised, categorical process attempts to account for the fact that risk factor shocks might not be correlated across liquidity horizons.

This proposed new process is formally known as the **internal models-based approach** (IMA). In the internal models-based approach, expected shortfall is measured over a base horizon of 10 days. The expected shortfall is measured through five successive shocks to the categories in a nested pairing scheme using ES_{1-5}. ES_1 is calculated as a 10-day shock with intense volatility in all variables from category 1–5. ES_2 is calculated as a 10-day shock in categories 2–5, holding category 1 constant. ES_3 is calculated as a 10-day shock in categories 3–5, holding category 1 and 2 constant. ES_4 is calculated as a 10-day shock in categories 4–5, holding categories 1–3 constant. The final trial, ES_5, is calculated as a 10-day shock in category 5, holding categories 1–4 constant. The idea is to measure the hit to the bank's P&L for ES_{1-5}. The overall ES is based on a waterfall of the categories, as described above, and is scaled to the square root of the difference in the horizon lengths of the nested risk factors. This relationship is shown in the following formula:

$$ES = \sqrt{ES_1^2 + \sum_{j=2}^{5}\left(ES_j\sqrt{\frac{LH_j - LH_{j-1}}{10}}\right)^2}$$

Until the internal models-based approach has been formally approved, banks must continue to use what is known as the **revised standardized approach**. This process groups risk assets with similar risk characteristics into "buckets," which are essentially just organized around

liquidity horizons. The standardized risk measure for each bucket is then calculated using the following formula:

$$\sum_i w_i^2 v_i^2 + 2\sum_i \sum_{j<i} \rho_{ij} w_i w_j v_i v_j$$

where:
v_i = the value of the ith risk factor
w_i = a weighting factor established by the Basel Committee
ρ_{ij} = the correlation established by the Basel Committee

In order to find the regulatory capital, the standardized risk measures are then combined for each bucket. Regulators may require that capital calculated using the new internal models-based approach be at least some set percentage of the revised standardized approach.

Proposed Modifications to Basel Regulations

LO 61.3: Explain proposed modifications to Basel regulations in the following areas:

- **Classification of positions in the trading book compared to the banking book**
- **Treatment of credit spread and jump-to-default risk, including the incremental default risk charge**

The FRTB also addressed regulatory modifications. One modification is to clarify if a risk asset should be considered part of the trading book or the banking book. Historically, the trading book consisted of risk assets that the bank intended to trade. **Trading book** assets have been periodically marked-to-market. The banking book has consisted of assets that are intended to be held until maturity, and they are held on the books at cost. **Banking book** assets are subject to more stringent credit risk capital rules, while trading book assets are subject to market risk capital rules. Using different rules has enabled a form of regulatory arbitrage where banks will hold credit-dependent assets in the trading book to relax capital requirements.

In an attempt to mitigate this regulatory arbitrage, the FRTB makes a specific distinction between assets held in the trading book and those held in the banking book. To be allocated to the trading book, the bank must prove more than an intent to trade. They must meet dual criteria of: (1) being able to trade the asset, and (2) physically managing the associated risks of the underlying asset on the trading desk. If these two criteria are met, then an asset can be allocated to the trading book, but the day-to-day price fluctuations must also affect the bank's equity position and pose a risk to bank solvency.

Another important distinction was made in terms of reclassification between a banking book asset and a trading book asset. Once an asset has been acquired and initially assigned to either the trading book or the banking book, it cannot be reclassified except for extraordinary circumstances. This roadblock has been established to minimize the act of switching between categories at will, based on how capital requirements are calculated.

An example of an extraordinary circumstance is if the bank changes accounting practices that is a firm-wide shift. Another caveat is that any benefit derived from calculating capital requirements under a post-shift category is disallowed. The capital requirement of the original method must be retained.

Basel II.5 also introduced the **incremental risk charge** (IRC) to further mitigate this regulatory arbitrage. The IRC recognizes two different types of risk created by credit-dependent risk assets: (1) credit spread risk, and (2) jump-to-default risk.

Credit spread risk is the risk that a credit risk asset's credit spread might change and thus cause the mark-to-market value of the asset to change. This risk can be addressed by using the expected shortfall calculation process discussed earlier. The IRC process allows banks to assume a constant level of risk. This means that it is assumed that positions that deteriorate are replaced with other risk assets. For example, if a bank has an A-rated bond with a three-month liquidity horizon that suffers a credit-related loss, then it is assumed that the bank replaces this risk asset with another A-rated bond at the end of the three-month liquidity horizon. This is clearly a simplifying assumption, which is being replaced with incremental marking-to-market without assuming replacement under the FRTB proposals.

Jump-to-default risk is the risk that there will be a default by the issuing company of the risk asset. A default would lead to an immediate and potentially significant loss for the bank that holds the defaulted issuer's risk asset. This risk is subject to an **incremental default risk** (IDR) charge. The IDR calculation applies to all risk assets (including equities) that are subject to default. It is calculated based on a 99.9% VaR with a one-year time horizon.

Key Concepts

LO 61.1

The Fundamental Review of the Trading Book (FRTB) is changing the historical reliance on 10-day value at risk (VaR) with a 99% confidence interval combined with a 250-day stressed VaR. The new calculation will require the use of expected shortfall with a 97.5% confidence interval. This switch will better capture the value of capital at risk below a certain confidence interval.

LO 61.2

The FRTB is establishing various liquidity horizons, which are the length of time "required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The expected shortfall will then be calculated by structuring risk assets into categories and solving for an overall value of expected shortfall for a bank's risk assets.

LO 61.3

Some banks have engaged in regulatory arbitrage by actively switching assets between the trading book and the banking book depending on which category would show their capital requirements in a more favorable light. The FRTB is mitigating this arbitrage opportunity by deploying a rules-based standard for classification into these categories and a roadblock for easily switching between them.

Concept Checkers

1. Which of the following statements regarding the differences between Basel I, Basel II.5, and the Fundamental Review of the Trading Book (FRTB) for market risk capital calculations is incorrect?
   A. Both Basel I and Basel II.5 require calculation of VaR with a 99% confidence interval.
   B. FRTB requires the calculation of expected shortfall with a 97.5% confidence interval.
   C. FRTB requires adding a stressed VaR measure to complement the expected shortfall calculation.
   D. The 10-day time horizon for market risk capital proposed under Basel I incorporates a recent period of time, which typically ranges from one to four years.

2. What is the difference between using a 95% value at risk (VaR) and a 95% expected shortfall (ES) for a bond portfolio with $825 million in assets and a probability of default of 3%?
   A. Both measures will show the same result.
   B. The VaR shows a loss of $495 million while the expected shortfall shows no loss.
   C. The VaR shows no loss while the expected shortfall shows a $495 million loss.
   D. The VaR shows no loss while the expected shortfall shows a $395 million loss.

3. Which of the following statements best describe how the internal models-based approach (IMA) incorporates various liquidity horizons into the expected shortfall calculation?
   A. A rolling 10-day approach is used over a 250-day window of time.
   B. Smaller time periods are used to extrapolate into larger time periods.
   C. A series of weights are applied to the various liquidity horizons along with a correlation factor determined by the Basel Committee.
   D. The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. Which of the following statements represents a criteria for classifying an asset into the trading book?
   I. The bank must be able to physically trade the asset.
   II. The risk of the asset must be managed by the bank's trading desk.

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

5. Which of the following risks is specifically recognized by the incremental risk charge (IRC)?
   A. Expected shortfall risk, because it is important to understand the amount of loss potential in the tail.
   B. Jump-to-default risk, as measured by 99% VaR, because a default could cause a significant loss for the bank.
   C. Equity price risk, because a change in market prices could materially impact mark-to-market accounting for risk.
   D. Interest rate risk, as measured by 97.5% expected shortfall, because an increase in interest rates could cause a significant loss for the bank.

Concept Checker Answers

1. C Basel I and Basel II.5 use VaR with a 99% confidence interval and the FRTB uses the expected shortfall with a 97.5% confidence interval. Basel I market risk capital requirements produced a very current result because the 10-day horizon incorporated a recent period of time. The FRTB does not require adding a stressed VaR to the expected shortfall calculation. It was Basel II.5 that required the addition of a stressed VaR.

2. C The VaR measure would show a $0 loss because the probability of default is less than 5%. Having a 3% probability means that three out of five times, in the tail, the portfolio will experience a total loss. The potential loss is $495 million (= 3/5 × $825 million).

3. D The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. C The criteria for classification as a trading book asset are: (1) the bank must be able to physically trade the asset, and (2) the bank must manage the associated risks on the trading desk.

5. B The two types of risk recognized by the incremental risk charge are: (1) credit spread risk, and (2) jump-to-default risk. Jump-to-default risk is measured by 99% VaR and not 97.5% expected shortfall.

Self-Test: Operational and Integrated Risk Management

10 Questions: 30 Minutes

1. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing. Which of the following actions is(are) suggested by the Basel Committee for controlling risks related to outsourcing?

   I. An agreement detailing termination rights and other rights and responsibilities of the two parties involved.
   II. Established policies for restitution in the event of failure on the part of an outside service provider.

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

2. There are five major factors that could lead to a poor or fragmented IT infrastructure at an organization. Which of the following factors is least likely to result in a poor or fragmented IT infrastructure?
   A. Moderate turnover of key IT staff.
   B. Participating in merger and acquisition activities.
   C. Management of a firm that is focused primarily on long-term projects.
   D. Allowing each business line the autonomy to upgrade their IT systems based on the best available resources.

3. The generalized Pareto distribution is used for modeling extreme losses. The model requires the choice of a threshold. Which of the following best describes the tradeoffs in setting the threshold level?
   A. The threshold must be high enough so that the tail index indicates a heavy tail.
   B. The threshold must be high enough so that the tail index indicates a light tail.
   C. The threshold must be high enough so that convergence to the generalized Pareto distribution occurs.
   D. The threshold must be high enough so that there are enough observations to estimate the parameters.

4. Given the following data for a project, which of the following statements is most accurate regarding the use of the risk-adjusted return on capital (RAROC)?

- Equity beta: 1.2
- Market return: 13%
- Variance of returns: 5%
- RAROC: 16%
- Risk-free rate: 4%

I. Using the adjusted RAROC, the project should be rejected because the RAROC is less than the market return plus the risk-free rate.
II. Using the adjusted RAROC, the project should be accepted because its adjusted RAROC is higher than the risk-free rate.

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

5. You are holding 100 SkyTrek Company shares with a current price of $30. The daily mean and volatility of the stock return are 2% and 3%, respectively. VaR should be measured relative to initial wealth. The bid-ask spread of the stock varies over time, and the daily mean and volatility of this spread are 0.5% and 1%, respectively. Both the return and spread are normally distributed. What is the daily liquidity-adjusted VaR (LVaR) at a 99% confidence level assuming the confidence parameter of the spread is equal to 3?

A. $103.50.
B. $172.62.
C. $193.15.
D. $202.20.

6. A recently published article on issues with value at risk (VaR) estimates included the following statements.

Statement 1: Differences in the use of confidence intervals and time horizon can cause significant variability in VaR estimates as there is lack of uniformity in practice.
Statement 2: Standardization of confidence interval and time horizon would eliminate most of the variability in VaR estimates.

This article's statements are most likely correct with regard to:

A. Statement 1 only.
B. Statement 2 only.
C. Both statements.
D. Neither statement.

7. Global Transportation, Inc., recently traded at an ask price of $45 and a bid price of $44.50. The sample standard deviation of the bid-ask spread was 0.0001. The 99% spread risk factor for a purchase of Global Transportation is closest to:

A. 0.0057.
B. 0.2541.
C. 25.41.
D. 0.1111.

8. The Basel Committee has provided guidelines on bank supervision. Which of the following statements is not consistent with their guidelines?
   A. Regulatory capital is used for unexpected, not expected losses.
   B. Banks do not need to maintain reserves for defaulted loans.
   C. Loss given default estimates are calculated using historical default rates.
   D. The term portfolio invariance refers to the fact that risk weights do not incorporate the correlation of the asset with other assets in the portfolio.

9. The standardized model for market risk charges differs from the internal model-based approach in that the standardized model:
   A. sums up market risks across market risk categories, whereas the internal model-based approach uses a multiplicative factor on the average VaR.
   B. sums up market risks across market risk categories, whereas the internal model-based approach focuses solely on specific risk charges.
   C. focuses solely on specific risk charges, whereas the internal model-based approach sums up market risks across market-risk categories.
   D. uses a multiplicative factor on the average VaR, whereas the internal model-based approach sums up market risks across market risk categories.

10. Given the following information, what is Bank X's net stable funding ratio (NSFR)?

- High-quality liquid assets: $100
- Required amount of stable funding: $200
- Cash outflows over the next 30 days: $130
- Net cash outflows over the next 30 days: $90
- Available amount of stable funding: $210

A. 65%.
B. 89%.
C. 105%.
D. 125%.

Self-Test Answers: Operational and Integrated Risk Management

1. A Outsourcing policies should include:
   - Processes and procedures for determining which activities can be outsourced and how the activities will be outsourced.
   - Processes for selecting service providers (e.g., due diligence).
   - Structuring the outsourcing agreement to describe termination rights, ownership of data, and confidentiality requirements.
   - Monitor risks of the arrangement including the financial health of the service provider.
   - Implement a risk control environment and assess the control environment at the service provider.
   - Develop contingency plans.
   - Clearly define responsibilities of the bank and the service provider.

   The Basel Committee does not explicitly suggest establishing policies for restitution in the event of failure on the part of the outside service provider although this could be detailed in the outsourcing agreement.

   (See Topic 38)

2. C Management of a firm that is focused less on short-term financial issues and more on long-term survival is much less likely to encounter problems with poor or fragmented IT infrastructures. Moderate turnover in IT staff, especially key staff, will likely contribute to the problem. Merger and acquisition activity will often result in multiple systems running at the same time so that data aggregation across products and business lines becomes a significant new challenge. Allowing autonomy to each business line will likely result in inconsistency across business lines and could be costly if the systems end up being incompatible due to the inconsistency.

   (See Topic 40)

3. C The threshold must be high enough so that convergence to the generalized Pareto distribution occurs. Choices A and B are incorrect because the tail index is chosen by the researcher. Heavy tails are indicated by a tail index greater than zero. Choice D is incorrect because the threshold must be low enough so that there are enough observations to estimate the parameters.

   (See Topic 46)

4. **B** The adjusted RAROC (ARAROC) compares the adjusted RAROC to the risk-free rate. So Statement I is incorrect.

   The project should be accepted because the ARAROC of 5.2% is greater than the risk-free rate of 4%. So Statement II is correct.

   ARAROC = 0.16 – 1.2(0.13 – 0.04) = 0.052.

   (See Topic 49)

5. **D** At the 99% confidence level, you would use an alpha statistic of 2.33 since VaR is a one-tailed test. The liquidity-adjusted VaR = normal VaR + adjustment for liquidity.

   Normal VaR = portfolio value × (mean – 2.33 × standard deviation)

   Normal VaR = 100 × $30 × (2% – 2.33 × 3%)

   Normal VaR = $149.70 (Note that a negative sign is implied here since we are dealing with the value at risk.)

   Liquidity adjustment = 0.5 × portfolio value (spread mean + 3 × spread volatility)

   Liquidity adjustment = 0.5 × $3,000 × (0.5% + 3 × 1%) = $52.5

   LVaR = $149.70 + $52.5 = $202.20

   (See Topic 53)

6. **A** Statement 1 is correct as variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Statement 2 is incorrect as other factors can also cause variability, including length of the time series under analysis, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

   (See Topic 54)

7. **A** The formula for the expected transactions cost confidence interval is:

   $+/- P \times \frac{1}{2}(s + 2.33\sigma_s)$

   where:
   P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation.
   s = expected or typical bid-ask spread calculated as (ask price – bid price) / midprice
   σ_s = sample standard deviation of the spread

   The $\frac{1}{2}(s + 2.33\sigma_s)$ component of the confidence interval is referred to as the 99% spread risk factor.

   Midprice = (45 + 44.50) / 2 = 44.75

   s = (45 – 44.5) / 44.75 = 0.0112

   spread risk factor = ½[0.0112 + 2.33(0.0001)] = 0.0057

   (See Topic 55)

8. **C** Regulatory capital is used for unexpected losses. Expected losses should be covered by a bank's normal course of business (i.e., loan loss provisions and write-offs). Banks do not need to maintain reserves for defaulted loans because they are covered by the loss given default. Loss given default estimates cannot be calculated using historical default rates. They should be estimated conservatively, assuming economic downturns. Portfolio invariance refers to the fact that risk weights do not explicitly incorporate the correlation of the asset with other assets in the portfolio.

   (See Topic 59)

9. **A** The standardized model approach simply sums the market risks across the market-risk categories. The internal model-based approach applies a multiplicative factor to the average VaR.

   (See Topic 59)

10. **C** The longer-term funding ratio is equal to the available amount of stable funding divided by the required amount of stable funding. Under Basel III, this ratio must equal or exceed 100%. Bank A's net stable funding ratio = $210 / $200 = 105%.

    (See Topic 60)

Formulas

Topic 44

basic indicator approach:

$$K_{BIA} = \frac{\left(\sum_{i=1}^{n} GI_i \times \alpha\right)}{n}$$

where:
GI = annual (positive) gross income over the previous three years
n = number of years in which gross income was positive
α = 15% (set by Basel Committee)

the standardized approach:

$$K_{TSA} = \frac{\left\{\sum_{3\ Years} \max\left[\sum (GI_{1-8} \times \beta_{1-8}), 0\right]\right\}}{3}$$

where:
GI_{1-8} = annual gross income in a given year for each of the eight business lines
β_{1-8} = beta factors (fixed percentages for each business line)

Topic 45

business indicator:

$$BI = ILDC_{avg} + SC_{avg} + FC_{avg}$$

where:
ILDC = interest, lease, dividend component
SC = services component
FC = financial component

internal loss multiplier:

$$\text{internal loss multiplier} = \ln\left(e^1 - 1 + \frac{\text{loss component}}{\text{BI component}}\right)$$

where:
loss component =
7 × average total annual loss
+ 7 × average total annual loss only including loss events above €10 million
+ 5 × average total annual loss only including loss events above €100 million

Topic 46

generalized extreme value (GEV) distribution:

$$F(X \mid \xi,\mu,\sigma) = \exp\left[-\left(1+\xi\times\frac{x-\mu}{\sigma}\right)^{-1/\xi}\right] \text{ if } \xi \neq 0$$

$$F(X \mid \xi,\mu,\sigma) = \exp\left[-\exp\left(\frac{x-\mu}{\sigma}\right)\right] \text{ if } \xi = 0$$

generalized Pareto distribution:

$$1-\left[1+\frac{\xi x}{\beta}\right]^{-1/\xi} \text{ if } \xi \neq 0$$

$$1-\exp\left[-\frac{x}{\beta}\right] \text{ if } \xi = 0$$

Topic 49

economic capital:

economic capital = risk capital + strategic risk capital

RAROC:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

$$\text{RAROC} = \frac{\left(\begin{array}{l}\text{expected revenues} - \text{costs} - \text{expected losses}\\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{array}\right)}{\text{economic capital}}$$

hurdle rate:

$$h_{AT} = \frac{\left[(CE \times R_{CE}) + (PE \times R_{PE})\right]}{(CE + PE)}$$

where:
CE = market value of common equity
PE = market value of preferred equity
R_{CE} = cost of common equity [could be derived from the capital asset pricing model (CAPM)]
R_{PE} = cost of preferred equity (yield on preferred shares)

adjusted RAROC:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$

Topic 53

$$\text{spread} = \frac{(\text{ask price} - \text{bid price})}{(\text{ask price} + \text{bid price}) / 2}$$

liquidity-adjusted VaR (constant spread):

$$\text{LVaR} = (V \times z_\alpha \times \sigma) + [0.5 \times V \times \text{spread}]$$

$$\text{LVaR} = \text{VaR} + \text{LC}$$

where:
V = asset (or portfolio) value
z_α = confidence parameter
σ = standard deviation of returns

lognormal VaR: $\text{VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{spread}}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

elasticity: $E = \frac{\Delta P/P}{\Delta N/N}$

where:
$\Delta N/N$ = size of the trade relative to the entire market

$$LVaR = VaR \times \left(1 - \frac{\Delta P}{P}\right) = VaR \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

$$\left.\frac{LVaR}{VaR}\right|_{combined} = \left.\frac{LVaR}{VaR}\right|_{exogenous} \times \left.\frac{LVaR}{VaR}\right|_{endogenous}$$

Topic 55

leverage ratio: $\bar{L} = \frac{A}{E} = \frac{(E+D)}{E} = 1 + \frac{D}{E}$

leverage effect: ROE = (leverage ratio × ROA) – [(leverage ratio – 1) × cost of debt]

transactions cost confidence interval: +/– $P \times \frac{1}{2}(s + 2.33\sigma_s)$

where:
P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation
s = expected or typical bid-ask spread
σ_s = sample standard deviation of the spread

spread risk factor: $\frac{1}{2}(s + 2.33\sigma_s)$

Topic 59

credit equivalent amount:

$\max(V, 0) + a \times L$

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

market risk capital requirement:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + SRC$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

expected loss:

$$EL = \sum_i EAD_i \times LGD_i \times PD_i$$

required capital = EAD × LGD × (WCDR – PD) × MA

where:
MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(PD)]^2$

total capital = 0.08 × (credit risk RWA + market risk RWA + operational risk RWA)

Topic 60

stressed VaR:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + \max(SVaR_{t-1}, m_s \times SVaR_{avg})$$

where:
VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level
VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_c = multiplicative factor, determined by supervisor, minimum value of three
$SVaR_{t-1}$ = previous day's stressed VaR, 10-day time horizon, 99% confidence level
$SVaR_{avg}$ = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

liquidity coverage ratio:

high quality liquid assets / net cash outflows in a 30-day period $\geq$ 100%

net stable funding ratio:

amount of available stable funding / amount of required stable funding $\geq$ 100%

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