
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:

ASSESSING THE QUALITY OF RISK MEASURES

Topic 54

EXAM FOCUS

This topic focuses primarily on model risk and model errors, with specific criticisms of the value at risk (VaR) model. It is important to understand model risk and the factors that could result in variability in VaR estimates. It is also important to understand the challenges associated with mapping risk factors to positions in making VaR calculations. Be ready to explain how incorrect mapping factors can underestimate certain risks including reputational, liquidity, market, and basis risk. The second part of this topic focuses on two specific case studies on the failures in strategies during 2005 and 2007–2009 related to modeling errors and the underestimation of key risks.

MODEL RISK

LO 54.1: Describe ways that errors can be introduced into models.

Models are highly useful in simulating real-life scenarios; however, they can suffer from several risks. **Model risk** is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and give rise to legal, reputational, accounting, and regulatory risk. Biases in models themselves do not necessarily cause model risk; however, inaccurate or inappropriate inputs can create distortions in the model.

There are several ways in which errors can be introduced into models. These include bugs in the programming of model algorithms, securities valuations or hedging, variability of value at risk (VaR) estimates, or inaccurate mapping of positions to risk factors.

For example, bugs in programming occurred in May 2008 when Moody's used flawed programming to incorrectly assign AAA ratings to certain structured credit products. It happened again in October 2011 when bugs in the quant programming used by AXA Rosenberg¹ led to investor losses. For Moody's, model risk was related to reputational and liquidity risk because the model errors had been discovered prior to being made public and coincided with a change in ratings methodology that resulted in no change to the ratings of certain products. As a result, Moody's was suspected of tailoring its model to the desired ratings, which damaged the company's reputation. For AXA Rosenberg, the discovery of the model error had not been made public in a timely manner, leading to both regulatory fines and considerable reputational damage to the firm.

1. AXA Rosenberg Group, LLC is a division of the French insurance company AXA.

Model errors in securities valuations or in hedging can create losses within a firm and lead to market risk and operational risk. *Market risk* is the risk of buying overvalued (or, at a minimum, fairly valued) securities in the market that are thought to be undervalued. *Operational risk* is the risk of recording unprofitable trades as profitable.

Relying on market prices rather than model prices through marking positions to market can theoretically avoid model errors and reduce valuation risk. A problem with this approach, however, is that certain positions, including long-term bank commercial loans, are difficult to mark-to-market due to infrequent trading and complexities in valuation.

VARIABILITY OF VaR ESTIMATES

LO 54.2: Describe how horizon, computational and modeling decisions can impact VaR estimates.

LO 54.3: Explain how model risk and variability can arise through the implementation of VaR models and the mapping of risk factors to portfolio positions.

Risk management is typically implemented via computer systems that help to automate gathering data, making computations, and generating reports. These systems can be made available commercially, and are typically used by smaller firms, while larger firms tend to use their own in-house systems, often in combination with commercial models. The implementation process for computing risk is usually referred to as the firm's *VaR model*, although the general computation process can apply to any risk measure other than VaR.

Data preparation is crucial in risk measurement systems. There are three types of data involved:

1. *Market data* is time series data (usually asset prices) that is used in forecasting the distribution of future portfolio returns. Market data involves obtaining the time series data, removing erroneous data points, and establishing processes for missing data. All of these steps can be costly but necessary.
2. *Security master data* is descriptive data on securities, including maturity dates, currency, and number of units. Building and maintaining data for certain securities, including equities and debt, can be challenging; however, it is critical from a credit risk management perspective.
3. *Position data* matches the firm's books and records but presents challenges as data must be collected from a variety of trading systems and across different locations.

Once the data is collected, software is used to compute the risk measures using specific formulas, which are then combined with the data. Results are then published in documents for reporting by managers. All of these steps can be performed in numerous ways and can lead to several issues within the risk measurement system. We focus on two of these issues: the variability of the resulting measures and the appropriate use of data.

Variability in risk measures, including VaR, is both a benefit and a problem. Managers have significant discretion and flexibility in computing VaR, and parameters can be freely used in many different ways. This freedom in measuring VaR leads to two significant problems in practice:

1. *Lack of standardization of VaR parameters.* Given the variability in VaR measurements and managers' discretion, parameters including confidence intervals and time horizons can vary considerably, leading to different measurements of VaR.
2. *Differences in VaR measurements.* Even if VaR parameters were standardized, differences in measuring VaR could lead to different results. These include differences in the length of the time series used, techniques for estimating moments, mapping techniques (discussed in the next section) and the choice of risk factors, decay factors in using exponentially weighted moving average (EWMA) calculations, and the number of simulations in Monte Carlo analysis.

Varying parameters can lead to materially different VaR results. For example, one study using different combinations of parameters, all within standard practice, of portfolios consisting of Treasury bonds and S&P 500 index options indicated that VaR results differed considerably by a factor of six or seven times. A simple read of the different VaR models published in the annual reports of some of the larger banks can give an indication of the variability in their measurements.

RISK FACTOR MAPPING FOR VAR CALCULATIONS

Mapping refers to the assignment of risk factors to positions. Mapping choices can also impact VaR results. These could include practical choices among alternatives where each alternative has its benefits and disadvantages. For example, managers have a choice between cash flow mapping and duration-convexity mapping for fixed income securities. *Cash flow mapping* leads to greater accuracy (each cash flow is mapped to a fixed income security with an approximately equal discount factor); however, *duration-convexity mapping* requires fewer and less complex computations, reducing costs and potential data errors as well as model risks.

It may also be difficult to locate data that addresses specific risk factors. One example is the previously widespread practice of mapping residential mortgage-backed securities (RMBS) or other securitized products to corporate credit spreads of the same rating. Because data on securitization spreads is typically not widely available, using a proxy risk factor of generic corporate bond spreads can be misleading, especially since previously lower spreads on securitizations widened considerably more during the recent financial crisis than did corporate spreads. This is an example of model risk and the inefficiency of VaR estimates in modeling large movements in market prices.

Incorrect mapping to risk factors can create risks such as liquidity risk and basis risk. Liquidity risk arises from divergences in model and market prices. For example, convertible bonds can be mapped to risk factors including implied volatilities, interest rates, and credit spreads based on the theoretical (model) price of the convertible bond using a replicating portfolio. However, significant divergences in model and market prices are difficult to capture with market data, and as a result, VaR estimates based on the replicating portfolio can considerably underestimate risk, creating liquidity risk.

Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors, which can be done when it is difficult to distinguish between two closely related positions. While this results in a measured VaR of zero, the positions have significant basis risk. Basis risk is also present in the risk modeling of securitization exposures where securitizations are hedged with corporate credit default swap (CDS) indices of similar ratings.

Other strategies can also lead to misleading VaR estimates. For example, event-driven strategies have outcomes that are close to binary and depend on a specific event occurring, including mergers or acquisitions, bankruptcy, or lawsuits. For these trades, the range of results cannot be measured based on historical return data. Dynamic strategies are another example, where risk is generated over time rather than at a specific point in time.

CREDIT MARKET IN EARLY 2005

LO 54.4: Identify reasons for the failure of the long-equity tranche, short-mezzanine credit trade in 2005 and describe how such modeling errors could have been avoided.

Credit Trade Description and Modeling Issues

Volatility in credit markets in the spring of 2005 caused significant modeling errors from both misinterpretation and incorrect application of models. Trades incurred losses as only certain dimensions of risks were hedged, while others were ignored.

A popular strategy in credit markets for hedge funds, banks, and brokerages was to sell protection on the equity tranche and buy protection on the junior (mezzanine) tranche of the CDX.NA.IG index, the investment-grade CDS index. As a result, the trade was long credit and credit spread risk on the equity tranche and short credit and credit spread risk on the mezzanine tranche. The trade was primarily executed on the IG3 and IG4 index series. The trade was designed to be default-risk neutral at initiation with equal credit spread sensitivities on the two legs. The motivation of the trade was to have a positively convex payoff profile with the two positions benefiting from credit spread volatility, while earning a positive net spread on the positions (positive carry). This allowed trades to have a position similar to delta-hedged, long option portfolios by receiving, rather than paying, time value.

The hedge ratio for the delta-hedged portfolio then determined the dollar amount of the mezzanine to be shorted for every dollar of the long equity. In other words, the hedge ratio was the ratio of the profit and loss impact of a 1 bp widening of the CDX index on the equity and mezzanine tranches. The proper hedge ratio then allowed for the creation of a portfolio based on the CDX index that, at the margin, was default-risk neutral. The CDX trade benefited from a large change in credit spreads and essentially behaved like an option straddle on credit spreads with an option premium paid to the owner of the option. The hedge ratio for the CDX index was around 1.5 to 2 in early 2005, which resulted in a net flow of spread income to the long equity/short mezzanine trade.

The critical error in the trade, however, was that it was set up at a specific value of implied correlation. A static correlation was considered a critical flaw as the deltas that were used in setting up the trade were partial derivatives that ignored any changes in correlation. With changes in credit markets, changing correlations doubled the hedge ratio to close to 4 by the summer of 2005. As a result, traders now needed to sell protection on nearly twice the notional value of the mezzanine tranche to maintain portfolio neutrality. Stated differently, as long as correlations remained static, the trade remained profitable. However, once correlations declined and spreads did not widen sufficiently, the trade became unprofitable.

Therefore, while the model did not ignore correlation, it assumed a static correlation and instead focused on anticipated gains from convexity. The error could have been corrected by stress testing correlation or by employing an overlay hedge of going long, single-name protection in high default-probability names.

Credit Market Example

Problems in credit markets were already evident by the spring of 2005. The problems were largely related to the automobile industry, specifically the original equipment manufacturers (OEMs), including Ford, Chrysler, and General Motors (GM), which had been experiencing troubles for some time. OEMs were particularly important in the U.S. investment-grade bond market, and the emerging threat of a downgrade to junk status rattled markets. Although the OEMs were not directly part of the CDX.NA.IG index, several of their related finance companies were. Outside of OEMs, several auto parts manufacturers were included in two series of the index, the IG3 and IG4 indices.

The immediate priority of the OEMs in early 2005 was to secure a relief from the United Auto Workers (UAW) union of health benefit commitments to retirees. When GM and the UAW were unable to reach an agreement in the spring of 2005, which coincided with the announcement of large losses for GM, GM and Ford were downgraded to junk status by S&P and Moody's. This created a sharp widening of corporate spreads, including the spreads on the automotive finance companies and other industry names. Several auto parts manufacturers filed for Chapter 11 bankruptcy protection. As a result, the market was now anticipating the possibility of defaults in the IG3 and IG4 indices, and the probability of extreme losses became real. In addition, the convertible bond market was also experiencing a selloff that resulted in widening of spreads. The IG indices widened in line with the credit spread widening of the index constituents. The mark-to-market value and the implied correlation of the equity tranche dropped sharply. The implied correlation fell given that (1) the auto parts supplier bankruptcies were in the IG4 series, which led to close to 10% of the portfolio now close to default, and (2) the widening of the IG4 series was constrained by hedging, which led to a fall in correlation. Participants could hedge short credit positions in the equity tranche by selling credit protection on the mezzanine tranche or the IG4 index series. Concurrently, the mezzanine tranche saw a small widening as market participants were covering their positions by selling protection on the mezzanine tranche (that is, they were taking on credit risk). These events led to the unwinding of the equity/mezzanine tranche trade with the relative value trade experiencing large losses.

RISK UNDERESTIMATION IN 2007–2009

LO 54.5: Explain major defects in model assumptions that led to the underestimation of systematic risk for residential mortgage backed securities (RMBS) during the 2007–2009 financial downturn.

The subprime RMBS valuation and risk models have been widely employed by credit rating agencies to assign bond ratings, by traders and investors in bond valuations, and by issuers in structuring RMBS. During the 2007–2009 financial downturn, two major defects in model assumptions became apparent:

1. *Assumption of future house price appreciation.* The RMBS risk model generally assumed that future house prices would rise, or at least not fall, based on relatively few historical data points. When house prices actually did drop beginning in 2007, this incorrect assumption led to a significant underestimation of the potential default rates and systematic risk in RMBS because the credit quality of the loans was dependent on borrowers' ability to refinance without additional equity.
2. *Assumption of low correlations.* The RMBS model assumed low correlations among regional housing markets, implying that loan pools from different geographical regions were well diversified. When house prices declined, correlations increased and loan defaults were much higher than previously expected under the model stress scenarios.

These two model errors led to a significant underestimation of systematic risk in subprime RMBS returns. When mortgage default rates began to increase, rating agencies were required to downgrade most issues, and by the end of 2009, approximately 45% of the initially AAA-rated U.S. RMBS had been downgraded. The downgrades of RMBS from their AAA-equivalent ratings shocked markets and exposed the degree to which systemic risk had been underestimated and mispriced.

There have been several explanations proposed for the inaccuracy of the rating models. First, the compensation of rating agencies by bond issuers led to a potential conflict of interest scenario that resulted in lower ratings standards. Second, an increase in demand for higher rated bonds with a modestly higher yield resulted in searching for yield. Finally, mapping problems led to misleading risk measurement results, as highly rated securitized products were frequently mapped to highly rated corporate bond spread indices. This resulted in incorrect VaR estimates, as incorrect mappings indicated it would be unlikely that bonds would decline significantly in value. In reality, the most highly rated RMBS lost a significant portion of their value, declining close to 70% during the subprime crisis, while lower investment-grade RMBS lost virtually all of their value.

KEY CONCEPTS

LO 54.1

Model risk is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and potential legal, reputational, accounting, liquidity, and regulatory risk. Errors can be introduced into models through programming bugs, securities valuations or hedging, VaR estimates, and position mappings.

LO 54.2

Firms use software to compute the risk measures from the data collected using specific formulas, which can be performed in a variety of ways and lead to potential issues. Variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Other factors can also cause variability, including length of time series, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

LO 54.3

Mapping refers to the assignment of risk factors to positions, and mapping choices can considerably impact VaR results.

Cash flow mapping results in greater accuracy of estimates. Duration-convexity mapping requires fewer risk factors and less complex computations, which reduces costs, data errors, and model risks. Locating data that addresses specific risk factors may also be difficult.

Liquidity risk arises from large divergences in model and market prices that are difficult to capture with market data, and as a result, VaR estimates based on replicating portfolios can underestimate risk and create liquidity risk.

Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors.

LO 54.4

Volatility in credit markets in the spring of 2005 fueled by company bankruptcies and losses led to defaults in the IG3 and IG4 index series of the CDX.NA.IG index, causing large selloffs that resulted in widening spreads. This also resulted in modeling errors from both misinterpretation and incorrect application of models, which led to trade losses.

LO 54.5

Two significant model errors in the RMBS valuation and risk models led to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009. First, the RMBS risk model assumed future house prices to rise or at least stay flat. The eventual decline in house prices starting in 2007 led to a significant underestimation of the potential default rates and systematic risk in RMBS. Second, the RMBS model assumed low correlations among regional housing markets. When house prices declined, correlations and loan defaults increased.

CONCEPT CHECKERS

1. Due to a recently discovered error in its valuation model, Samuelson, Inc. had previously recorded certain trades as profitable even though the positions were unprofitable. The risk that best characterizes this error is:
 - A. operational risk.
 - B. liquidity risk.
 - C. market risk.
 - D. hedge risk.

2. Duane Danning is a junior risk analyst at a large risk management firm. He has been asked to assess the firm's risk modeling practices and evaluate potential ways in which errors could be introduced into models. In his analysis, Danning indicates that errors can be introduced into models through programming bugs and errors in VaR estimates but rarely through incorrect position mappings. Danning's analysis is most accurate with regard to:
 - A. only programming bugs and incorrect position mappings.
 - B. only programming bugs and errors in VaR estimates.
 - C. only errors in VaR estimates.
 - D. only incorrect position mappings.

3. An advantage of duration mapping over cash flow mapping is that duration mapping:
 - A. is more accurate than cash flow mapping, thus reducing mapping errors.
 - B. uses cash flows that are mapped to specific fixed income securities without the use of approximations.
 - C. uses more complex computations, thus reducing data errors and model risk.
 - D. uses fewer risk factors, thus reducing data errors and model risk.

4. A common trade during 2004 and 2005 was to sell protection on the equity tranche and buy protection of the mezzanine tranche of the CDX.NA.IG index. Which of the following statements regarding this trade is least accurate?
 - A. The trade was set up to be default-risk neutral at initiation.
 - B. The trade was short credit spread risk on the equity tranche and long credit spread risk on the mezzanine tranche.
 - C. The main motivation for the trade was to achieve a positively convex payoff profile.
 - D. The trade was designed to benefit from credit spread volatilities.

5. Which of the following two model errors in the RMBS valuation and risk models are considered to have contributed the most to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009?
- A. The assumption of future house price appreciation and the assumption of high correlations among regional housing markets.
 - B. The assumption of future house price declines and the assumption of high correlations among regional housing markets.
 - C. The assumption of future house price appreciation and the assumption of low correlations among regional housing markets.
 - D. The assumption of future house price declines and the assumption of low correlations among regional housing markets.

CONCEPT CHECKER ANSWERS

1. A Recording trades as profitable that have, in fact, lost money is an example of operational risk.
2. B Danning's analysis is most accurate with regard to only programming bugs and errors in VaR estimates. Incorrect position mappings can also lead to material errors in risk models.
3. D Duration mapping (or duration-convexity mapping) requires the use of fewer risk factors and less complex computations, thus reducing costs, data errors, and model risks. Cash flow mapping results in greater accuracy of estimates, however, because cash flows are mapped to specific fixed income securities without the use of approximations.
4. B The trade was long credit and credit spread risk on the equity tranche and *short* credit and credit spread risk on the mezzanine tranche. The other statements are accurate.
5. C The two model errors considered to have contributed the *most* to a significant underestimation of systematic risk were (1) the assumption of future house price appreciation, and (2) the assumption of low correlations among regional housing markets.

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:

LIQUIDITY AND LEVERAGE

Topic 55

EXAM FOCUS

This topic analyzes the effects of liquidity and leverage on firm risk. For the exam, understand the distinction between transactions liquidity and funding liquidity, and the role banks play in providing liquidity. Also, be able to calculate a firm's leverage ratio and the leverage effect, and know how to construct the economic balance sheet given trades such as buying stock on margin, selling stock short, and taking positions in derivatives. Finally, be able to explain tightness, depth, and resiliency as they relate to liquidity risk.

SOURCES OF LIQUIDITY RISK

LO 55.1: Differentiate between sources of liquidity risk, including balance sheet/funding liquidity risk, systematic funding liquidity risk, and transactions liquidity risk, and explain how each of these risks can arise for financial institutions.

LO 55.9: Explain interactions between different types of liquidity risk and explain how liquidity risk events can increase systemic risk.

Liquidity is defined in many ways in financial markets. In general, an asset is liquid if it is “close to cash.” This means that the asset can be sold quickly, cheaply, and without moving the price “too much.” A market is liquid if positions can be unwound quickly, cheaply (i.e., at low transactions costs), and without undue price deterioration.

Liquidity has two essential properties, which relate to two essential forms of risk. **Transactions liquidity** deals with financial assets and financial markets. **Funding liquidity** is related to an individual’s or firm’s creditworthiness. Risks associated with liquidity include:

- **Transactions (or market) liquidity risk** is the risk that the act of buying or selling an asset will result in an adverse price move.
- **Funding liquidity risk or balance sheet risk** results when a borrower’s credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit (e.g., increase the required collateral for the loan). The position may, as a result, be unprofitable or may need to be unwound. Balance sheet risks are higher when borrowers fund longer term assets with shorter term liabilities. This is called a **maturity mismatch**. Maturity mismatching is often profitable for firms because short-term investors bear less risk and have a lower required rate of return. This means that short-term debt financing contributes less to the overall cost of capital of a borrowing firm. The incentive to maturity mismatch is even greater when the yield curve is upward sloping. However, funding long-term assets with short-term

financing exposes the borrower to **rollover risk** (sometimes called cliff risk), the risk that the debt cannot be refinanced or can only be refinanced at escalating rates.

- **Systemic risk** is the risk that the overall financial system is impaired due to severe financial stress. With this risk, credit allocation is impaired across the financial system.

Risks associated with liquidity are interrelated and can exacerbate problems. For example, if collateral requirements are increased, a counterparty may be forced to unwind a position early and at a potential loss. In this case, the increase in funding liquidity risk increases the transactions liquidity risk.

An important connection between funding and transactions liquidity is leverage. An investor with a long position may be forced to sell an asset if future funding for the asset dries up. This in turn would reduce the number of potential asset holders, leading to a reduction in asset valuation. It may be the case that this decline in price is temporary, however, the length of the depressed asset price could be long enough to adversely impact the solvency of the investor who initially purchased the asset. A rapid deleveraging of assets could lead to a “debt-deflation crisis.”

Transactions liquidity could also impair funding liquidity. For example, if a hedge fund is facing redemptions, it is forced to raise cash by selling assets and therefore must decide which assets to sell first. Selling highly liquid assets will lead to fewer adverse price impacts, but will leave the hedge fund with a more illiquid portfolio. On the other hand, selling highly illiquid assets will increase realized losses, which may put additional pressure on the portfolio from a funding liquidity standpoint.

The level of economy-wide liquidity directly impacts the level of systemic risk. When market conditions deteriorate, liquidity tends to become constrained just when investors need it the most. Liquidity risk events could potentially become systemic risk events through disruptions in payment, clearing, and settlement systems. Severe stress to the financial system would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may have a domino effect on other market participants throughout the system.

LIQUIDITY TRANSFORMATION BY BANKS

LO 55.2: Summarize the asset-liability management process at a fractional reserve bank, including the process of liquidity transformation.

Commercial bank assets are typically longer-term and less liquid than bank liabilities (e.g., deposits). Wholesale funding (i.e., non-deposit sources of funding like commercial paper, bonds, and so on) is generally longer term but deposits are “sticky.” Depositors generally change banks only if impelled to by a move or some other extenuating circumstance. Deposits make up approximately 60% of bank liabilities in the United States.

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all the deposits in liquid assets, but make loans with deposits instead. For example, a bank might take in \$100 of deposits, hold \$10 for redemptions, and lend the remaining \$90. This is known as a **fractional-reserve bank** and the process of using deposits to finance loans is known as **asset-liability management (ALM)**.

The bulk of banks in history have been fractional-reserve banks. The alternative to a fractional-reserve system is one in which the bank uses owners' money (i.e., equity) or money raised in capital markets to make loans, and keeps in reserve cash or highly liquid assets equal to its deposits.

If withdrawals are greater than the bank's reserves, the bank is forced into a **suspension of convertibility**. This means the bank will not be able to, as expected by depositors, convert deposits immediately into cash. In the extreme, there may even be a **run on the bank**. In the case of a bank run, depositors who are concerned about bank liquidity may attempt to get money out of the bank before other depositors and lenders. While rollover risk associated with other short-term financing is less extreme than bank runs, it does increase the fragility of banks. Higher capital reduces bank fragility.

Frozen commercial paper markets in the wake of the Lehman Brothers failure illustrated the fragility of bank funding. Commercial funding couldn't be placed and thus fell dramatically after the Lehman bankruptcy. It became nearly impossible to roll over longer term paper and very short-term paper rose to account for approximately 90% of the market. The Federal Reserve stepped in after the Lehman bankruptcy and created the Commercial Paper Funding Facility (CPFF) and the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF).

STRUCTURED CREDIT PRODUCTS AND OFF-BALANCE SHEET VEHICLES

Structured credit products, such as asset-based securities (ABSs) and mortgage-backed securities (MBBs), match investor funding needs with pooled assets. Because these products are maturity matched, they are not subject to funding liquidity issues. However, investor financing for structured credit products can create liquidity risk when investors rely on short-term financing. This type of financing was one of the main drivers of the recent subprime crisis and the increase in leverage in the financial system leading up to the crisis. Two types of short-term financing include: (1) securities lending (i.e., applying structured credit products as collateral to short-term loans), and (2) off-balance sheet vehicles.

Special-purpose vehicles (SPVs) serve as off-balance sheet vehicles by issuing secured debt in the form of asset-backed commercial paper (ABCP). ABCP conduits finance purchases of assets, such as securities and loans, with ABCP. They receive liquidity and credit support via credit guarantees. **Structured investment vehicles** (SIVs) differ slightly from ABCP conduits because they do not receive full liquidity and credit support.

Prior to the subprime crisis, both ABCP conduits and SIVs profited from the spread between funding costs and asset yields. The assets held by these vehicles typically had longer maturities than the ABCP that fund the assets. In addition to maturity transformation, these vehicles also provided liquidity transformation. This was accomplished by creating ABCP that was more liquid and had shorter terms than the assets held in the conduit and SIV. However, despite being off-balance sheet, which permitted firms to hold less capital, these vehicles did not entirely transfer risk. As a result, they still contributed to the leverage issues and fragility of the financial system during the recent subprime crisis.

SYSTEMATIC FUNDING LIQUIDITY RISK

LO 55.3: Describe specific liquidity challenges faced by money market mutual funds and by hedge funds, particularly in stress situations.

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. As loans become shorter term, lenders and borrowers are exposed to greater liquidity risks. Borrowers must be able to refinance in order to repay short-term loans. The risk is systematic in that it affects borrowers and lenders at the same time.

Liquidity issues arose during the recent financial crisis for a variety of investment strategies including:

- **Leveraged buyouts (LBOs).** Leveraged loans became the dominate type of syndicated bank loans as LBOs and private equity grew before the crisis. Leveraged loans accounted for a large part of collateralized loan obligations (CLOs) and collateralized debt obligations (CDOs), which provided funding for LBOs. During the subprime mortgage crisis, LBO deals fell apart as funding dried up. Some loans, called “hung loans,” had not been distributed to investors and demand dried up. Banks incurred significant losses as prices fell sharply.
- **Merger arbitrage hedge funds.** Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target’s stock price typically increases and the acquirer’s price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.
- **Convertible arbitrage hedge funds.** Convertible arbitrage strategies rely on leverage to enhance returns. Credit is extended by broker-dealers. When financing becomes unavailable due to market conditions, as experienced in the 2007–2009 financial crisis, convertible bond values drop precipitously. The funding liquidity problem was compounded by redemptions (i.e., a market liquidity problem). Also, because there is a limited clientele investing in convertible bonds, when the clientele develops a dislike for the product due to deteriorating market conditions, it is difficult to sell the assets without large price declines. The gap between convertible bond prices and replicating portfolios widened dramatically during the financial crisis, but it still did not bring arbitrage capital into the market.

The broader point is that investment strategies, such as merger arbitrage, convertible arbitrage, and leveraged buyouts, are not only exposed to idiosyncratic risks, but also to systematic risks (i.e., systematic funding risks in this case). The risks are soft risks because they are difficult to relate to a particular series of asset returns. Instead, analysts must examine data on credit and liquidity spreads as well as quantitative and anecdotal data on the availability of credit in the market to understand the probability of a liquidity freeze.

Money market mutual fund (MMMF) investors can write checks and make electronic bank transfers. Like banks, MMMFs are obligated to repay investors/depositors on demand. In general, underlying MMMF assets are high credit quality instruments with short maturities (e.g., a few weeks to a few months). However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall. The liabilities of MMMFs are, therefore, more liquid than their investments, similar to banks.

MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. The reason behind the difference is that extremely short-term securities are not likely to revalue based on changes in interest rates and credit spreads. MMMFs set a notional value of each share equal to \$1.00. However, credit write-downs cannot be disregarded and it is possible for net asset values (NAVs) to fall below \$1.00. This is known as **breaking the buck**.

Liquidity risk can also cause NAVs to fall below \$1.00. MMMFs, like depository institutions, are subject to runs. If a large proportion of investors try to redeem shares in adverse market conditions, the fund may be forced to sell money market paper at a loss. This can potentially result in write-downs and breaking the buck.

ECONOMICS OF THE COLLATERAL MARKET

LO 55.4: Compare transactions used in the collateral market and explain risks that can arise through collateral market transactions.

Collateral markets have two important purposes. First, they enhance the ability of firms to borrow money. Cash is only one type of asset that is borrowed. Securities are also borrowed in collateral markets. Second, collateral markets make it possible to establish short positions in securities.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. Securities are used as collateral for secured loans. Collateralized loans can be short term or longer term. Overnight loans are often extended automatically. The full value of the securities is not lent in a collateralized loan. The difference is called a **haircut**. For example, a lender may be willing to lend \$95 against \$100 of collateral.

Collateral values fluctuate and most collateralized borrowing arrangements require that variation margin be paid to make up the difference (called **remargining**). Variation margin is the additional funds a broker requests so that the initial margin requirement keeps up with losses. The haircut ensures that the value of the collateral can fall by a certain percentage (i.e., 5% in the previous example) and still leave the loan fully collateralized. The variation margin protects the lender.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as **rehypothecation** or **repledging**.

The role of collateral has expanded in contemporary finance, hand-in-hand with the development of securitization. Securitization creates securities that can be pledged as collateral for credit. Securitized assets generate cash flows, may appreciate in value, and can be used as collateral for other transactions.

Life insurance companies own large portfolios of high-quality assets. They may use these assets for collateralized loans to borrow at low rates and reinvest at higher rates. Hedge funds pledge securities to finance portfolios at rates cheaper than unsecured loans.

Markets for collateral take the following forms:

- **Margin loans.** Margin loans are used to finance security transactions. The margin loan is collateralized by the security and is often provided by the broker intermediating the trade. The broker maintains custody of the securities in a street name account (i.e., securities are registered in the name of the broker rather than the owner). This structure makes it easier to seize and sell securities to meet margin calls. An added advantage to the broker is that securities in street name accounts can be used for other purposes, such as lending to other customers for short sales. In practice, the broker uses the customer's collateral to borrow money in the money market to provide margin loans to customers. The margin loan to the broker is collateralized by the repledged customer collateral. The Federal Reserve's Regulation T sets the initial margin requirement for securities purchases at 50%. **Cross-margin agreements** are used to establish the net margin position of investors with portfolios of long and short positions. In general, cross margin involves transferring excess margin in one account to another account with insufficient margin, resulting in lower overall margin for the investor.
- **Repurchase agreements or repos.** Repurchase agreements, also known as repos and RPs, are another form of collateralized short-term loans. They involve the sale of a security at a forward price agreed upon today. The interest on the loan is implied from the difference between spot and forward prices of the securities. While traditionally collateral had little or no credit risk (collateral was usually Treasury bills), today acceptable collateral encompasses whole loans, high-yield bonds, and structured credit products. Repos allow banks and other firms to finance inventories of structured credit products and allow for high investment grade ratings for senior tranches of asset-backed securities (ABSs) and collateralized debt obligations (CDOs).
- **Securities lending.** Securities lending involves the loan of securities to another party in exchange for a fee, called a **rebate**. The lender of the securities continues to receive the dividends and interest cash flows from the securities. Lenders of securities are often hedge funds or other large institutional investors of equities. Securities are held in street name accounts to make them available for lending to traders who want to short stocks. Fixed income securities lending typically involves the loan of Treasury securities for cash. The cash is invested in a higher risk bonds and the investor's objective is to earn the spread between the two.
- **Total return swaps.** In a total return swap (TRS), one party pays a fixed fee in exchange for the total return (both income and capital gains) on a reference asset, typically a stock. The advantage is that the party paying the fee can earn the return from the underlying asset without owning the asset. The party providing the return (such as a hedge fund) is, in essence, short the asset.

Professor's Note: Securities lending, like repurchase agreements, are often structured as sales of securities, not loans of securities, so the holder of the collateral can rehypothecate the securities, or even sell them in a timely fashion if the loan is not repaid.



LEVERAGE RATIO AND LEVERAGE EFFECT

LO 55.5: Describe the relationship between leverage and a firm's return profile, calculate the leverage ratio, and explain the leverage effect.

A firm's **leverage ratio** is equal to its assets divided by equity (total assets / equity). That is:

$$L = \frac{A}{E} = \frac{(E + D)}{E} = 1 + \frac{D}{E}$$

For an all-equity financed firm, the ratio is equal to 1.0, its lowest possible value. As debt increases, the leverage ratio (i.e., multiplier) increases. For example, a firm with \$100 of assets financed with \$50 debt and \$50 equity has a leverage ratio equal to 2.0 ($\$100 / \$50 = 2$).

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the **leverage effect**. The leverage effect can be expressed as:

$$r_E = Lr_A - (L - 1)r_D$$

where:

r_A = return on assets

r_E = return on equity

r_D = cost of debt

L = leverage ratio

It may help to think of this formula in words as follows:

$$\text{ROE} = (\text{leverage ratio} \times \text{ROA}) - [(\text{leverage ratio} - 1) \times \text{cost of debt}]$$

For a firm with a zero cost of debt, return on equity is magnified by the leverage factor; however, debt is not free. Thus, return on equity (ROE) increases with leverage, but the cost of borrowing, because there is more debt, also increases. The $L - 1$ factor multiplies the cost of debt by the proportion of the balance sheet financed with debt. For example, with a leverage ratio of 2, 50% of the balance sheet is financed with debt and 50% with equity. So for every \$2 of assets, \$1 comes from shareholders and \$1 comes from borrowed funds. We multiply the cost of debt by 1 in this case. If the leverage ratio is 4, 25% is financed with equity and 75% is financed with debt. Thus, for every \$4 of assets, \$1 is equity and \$3 is borrowed funds. In the formula, we multiply the cost of debt by 3. The higher the leverage factor, the bigger the multiplier but also the higher the debt costs. Leverage amplifies gains but also magnifies losses. That is why leverage is often referred to as a double-edged sword.

The effect of increasing leverage is expressed as:

$$\frac{\partial r_E}{\partial L} = r_A - r_D$$

where:

∂r_E = change in retained earnings

∂L = change in the leverage ratio

This formula implies that, given a change in the leverage ratio, ROE changes by the difference between ROA and the cost of debt.

The equity in the denominator of the leverage ratio depends on the entity. If it is a bank, it may be the book value of the firm. It might also be calculated using the market value of the firm. The net asset value (NAV) of a fund is the appropriate denominator for a hedge fund. The NAV reflects the current value of the investors' capital in the fund.

Example: Computing firm ROE (total assets = \$2)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to \$2, and equity financing equal to \$1. The firm's cost of debt is 2%. Calculate the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(2 / 1) \times 5\%] - [(2 - 1) \times 2\%] = 8\%$$

Example: Computing firm ROE (total asset = \$4)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to \$4, and equity financing equal to \$1. The firm's cost of debt is 2%. Calculate the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(4 / 1) \times 5\%] - [(4 - 1) \times 2\%] = 14\%$$

Given a cost of debt of 2%, increasing the leverage factor from 2 to 4 increased the firm's ROE from 8% to 14%.

Leverage is also influenced by the firm's hurdle rate (i.e., required ROE). For example, assume a firm's hurdle rate (i.e., ROE) is 10%, ROA equals 6%, and its cost of debt equals 2%. The firm will choose a leverage ratio of 2.0. That is:

$$\text{ROE} = (2 \times 6\%) - (1 \times 2\%) = 10\%$$

EXPLICIT AND IMPLICIT LEVERAGE

LO 55.6: Explain the impact on a firm's leverage and its balance sheet of the following transactions: purchasing long equity positions on margin, entering into short sales, and trading in derivatives.

Purchasing stock on margin or issuing bonds are examples of using leverage explicitly to increase returns. However, there are other transactions that have implicit leverage. It is important to understand the **embedded leverage** in short positions and derivatives, such as options and swaps. By constructing economic balance sheets for investors and/or firms, it is possible to measure the implicit leverage of these transactions.

Margin Loans and Leverage

First, consider margin loans. The stock purchased with the margin loan is collateral for the loan. The haircut (h) is the borrower's equity and $1 - h$ is loaned against the market value of the collateral. The leverage is calculated as $1 / h$. The Federal Reserve requires that an investor put up a minimum of 50% equity (i.e., $h = 50\%$) in a stock purchase using borrowed funds.

First, assume that a firm has \$100 cash invested by the owners (i.e., no borrowed funds). The balance sheet in this case is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|---------------|-------------------------------|--------------|
| | Debt | \$0 |
| <u>Cash</u> | <u>Equity</u> | <u>\$100</u> |
| Total assets | \$100 | TL and OE |

If the firm uses the cash to purchase stock, the balance sheet is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|---------------|-------------------------------|--------------|
| | Debt | \$0 |
| <u>Stock</u> | <u>Equity</u> | <u>\$100</u> |
| Total assets | \$100 | TL and OE |

Thus, the leverage ratio is equal to 1 (i.e., \$100 / \$100 or 1.0 / 1.0).

Topic 55**Cross Reference to GARP Assigned Reading – Malz, Chapter 12**

Next, assume that the firm uses 50% borrowed funds and invests 50% (i.e., $b = 50\%$) equity to buy shares of stock. Immediately following the trade, the margin account balance sheet has 50% equity and a \$50 margin loan from the broker. That is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|---------------|-------------------------------|---------------------------|
| | Margin loan | \$50 |
| <u>Stock</u> | <u>\$100</u> | <u>Equity</u> <u>\$50</u> |
| Total assets | \$100 | TL and OE \$100 |

The full economic balance sheet as a result of the borrowed funds (remember, owners put in \$100 of equity initially so the firm now has \$100 of stock and \$50 of cash) is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|---------------|-------------------------------|----------------------------|
| Cash | \$50 | Margin loan \$50 |
| <u>Stock</u> | <u>\$100</u> | <u>Equity</u> <u>\$100</u> |
| Total assets | \$150 | TL and OE \$150 |

Thus, the leverage ratio has increased to 1.5 (i.e., \$150 / \$100 or 1 / 0.667). Note that the broker retains custody of the stock to use as collateral for the loan.

Short Positions and Leverage

In a short trade, the investor borrows the shares of stock and sells them. The transaction lengthens the balance sheet because the cash generated from the short sale along with the value of the borrowed securities appear on the balance sheet.

Assume the firm borrows \$100 of stock and sells it short. The firm has an asset equal to the proceeds from selling the stock and a liability equal to the value of the borrowed shares. However, the firm cannot use the cash for other investments as it is collateral. It ensures that the stock can be repurchased and returned to the lender. It is in a segregated short account. In the event that the stock price increases rather than decreases, the firm must also put \$50 in a margin account.

Immediately following the trade, the margin account and short account has \$50 equity and a \$50 margin loan from the broker.

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|----------------------------|-------------------------------|---------------------------|
| \$150 due from broker: | | |
| Margin | \$50 | Borrowed stock \$100 |
| <u>Short sale proceeds</u> | <u>\$100</u> | <u>Equity</u> <u>\$50</u> |
| Total assets | \$150 | TL and OE \$150 |

The firm's full economic balance sheet given the short sale is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | | |
|-----------------|-------------------------------|----------------|-------|
| Cash | \$50 | Borrowed stock | \$100 |
| Due from broker | \$150 | Equity | \$100 |
| Total assets | \$200 | TL and OE | \$200 |

Thus, the leverage ratio has increased to 2.0 (i.e., \$200 / \$100 or 1 / 0.50). The leverage is higher in this case than in the previous margin example because the full value of the stock is borrowed in a short transaction. Leverage is inherent in the short position but is a choice in the long position. The firm only borrows 50% of the balance of the stock in the long position.

If the short position plays a hedging role in the portfolio, the position will reduce market risk. This means that leverage will overstate the overall risk because it ignores the potential risk reducing benefits of the short positions. As such, a distinction must be made between gross and net leverage. **Gross leverage** is the value of all the assets, including cash generated by short sales, divided by capital. **Net leverage** is the ratio of the difference between the long and short positions divided by capital.

Derivatives and Leverage

Derivatives allow an investor to gain exposure to an asset or risk factor without actually buying or selling the asset. Derivatives also allow investors to increase leverage. Although derivatives are generally off-balance sheet, they should be included on the economic balance sheet as they affect an investor's returns. Derivatives are synthetic long and short positions. To estimate the economic balance sheet, find the **cash-equivalent market value** for each type of derivative. Derivatives include:

- **Futures, forward contracts, and swap contracts.** These contracts are linear and symmetric to the underlying asset price. The amount of the underlying instrument represented by the derivative is set at the initiation of the contract so values can be represented on the economic balance sheet by the market value of the underlying asset. These contracts have zero net present values (NPVs) at initiation.
- **Option contracts.** These contracts have a non-linear relationship to the underlying asset price. The amount of the underlying represented by the option changes over time. The value can be fixed at any single point in time by the option delta. Thus, on the economic balance sheet, the cash equivalent market values can be represented by the delta equivalents rather than the market values of the underlying assets. These contracts do not have zero NPVs at initiation because the value is decomposed into an **intrinsic value** (which may be zero) and a **time value** (which is likely not zero).

In this next example, the counterparty is assumed to be the prime broker or broker-dealer executing the positions. This means that margin will be assessed by a single broker on a portfolio basis.

Topic 55

Cross Reference to GARP Assigned Reading – Malz, Chapter 12

First, assume the firm enters a 1-month currency forward contract and is short \$100 against the euro and the 1-month forward exchange rate is \$1.25 per euro. The balance sheet is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|--------------------------------------|-------------------------------|-------|
| \$100 equivalent of €80 bank deposit | Broker loan | \$100 |

Now, assume the firm buys a 3-month at-the-money call option on a stock index with an underlying index value of \$100. The call's delta is currently 50%. The transaction is equivalent to using a \$50 broker loan to buy \$50 of the stock index. That is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | |
|--------------------------|-------------------------------|-------------|
| \$50 long index position | \$50 | Broker loan |

Next, assume the firm enters a short equity position via a total return swap (TRS). The firm pays the total return on \$100 of ABC stock and the cost of borrowing the ABC stock (i.e., the short rebate). This is equivalent to taking a short position in ABC. Assuming the market price of ABC is \$100, we have:

| <i>Assets</i> | <i>Liabilities and Equity</i> | | |
|---|-------------------------------|--------------------|-------|
| \$100 due from broker (proceeds from short sale) | \$100 | Borrowed ABC stock | \$100 |

Finally, assume the firm adds short protection on company XYZ via a 5-year credit default swap (CDS) with a notional value of \$100. This position is equivalent to a long position in a par-value 5-year floating rate note (FRN) financed with a term loan.

The firm's combined economic balance sheet that includes all of the derivatives positions is:

| <i>Assets</i> | <i>Liabilities and Equity</i> | | |
|--------------------------------|-------------------------------|------------------------|--------------|
| Cash | \$50 | Short-term broker loan | \$150 |
| Due from broker | \$150 | | |
| \$50 margin | | | |
| \$100 short sale proceeds | | Term loan | \$100 |
| Equivalent of €80 bank deposit | \$100 | Borrowed ABC stock | \$100 |
| Long equity index | \$50 | | |
| <u>XYZ FRN</u> | <u>\$100</u> | <u>Equity</u> | <u>\$100</u> |
| Total assets | \$450 | TL and OE | \$450 |

The firm has increased its leverage to 3.5 in its long positions. The long positions combined with the short position (the ABC TRS) means the firm has gained economic exposure to securities valued at \$450 using \$50 of cash.

Notice that computing leverage is complex when derivatives are used. Also, correctly interpreting leverage is important since risk may be mitigated if short positions are used to hedge. For example, currency and interest rate risks can be hedged accurately. However, the positions are of the same magnitude as the underlying assets. If the positions are carried on the economic balance sheet, leverage will be overstated and other material risks in the portfolio may be ignored.

SOURCES OF TRANSACTIONS LIQUIDITY RISK

LO 55.7: Explain methods to measure and manage funding liquidity risk and transactions liquidity risk.

An asset is liquid if it resembles money. That is, it can be exchanged for goods or services quickly and at a certain value. However, assets have to be liquidated in order to buy goods and services because we do not have a barter economy.

Transactions liquidity implies that an asset can be bought or sold without moving its price. However, large transactions may move an asset's price because they create a short-term imbalance between supply and demand. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

In order to understand transactions liquidity risk, it is important to understand market microstructure fundamentals. These fundamentals are:

- **Trade processing costs.** The first cost is associated with finding a counterparty in a timely fashion. In addition, processing costs, clearing costs, and the costs of settling trades must also be considered. These costs do not typically increase liquidity risk except in circumstances, either natural or man-made, where the trading infrastructure is affected.
- **Inventory management.** Dealers provide trade immediacy to market participants. The dealer must hold long or short inventories of assets and must be compensated by price concessions. This risk is a volatility exposure.
- **Adverse selection.** There are informed and uninformed traders. Dealers must differentiate between liquidity or noise traders and information traders. Information traders know if the price is wrong. Dealers do not know which of the two are attempting to trade and thus must be compensated for this lemons risk through the bid-ask spread. The spread is wider if the dealer believes he is trading with someone who knows more than he does. However, the dealer does have more information about the flow of trading activity (i.e., is there a surge in either buy or sell orders).
- **Differences of opinion.** It is more difficult to find a counterparty when market participants agree (e.g., the recent financial crisis where counterparties were afraid to trade with banks because everyone agreed there were serious problems) than when they disagree. Investors generally disagree about the correct or true price on an asset and about how to interpret new information about specific assets.

These fundamentals differ across different types of market organizations. For example, in a quote-driven system, common in over-the-counter (OTC) markets, market makers are expected to publicly post 2-way prices or quotes and to buy or sell at those prices within identified transaction size limits. In contrast, order-driven systems, typically found on organized exchanges, are more similar to competitive auction models. Typically the best bids and offers are matched throughout the trading session.

Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called **adverse price impact**) and when the price of an asset deteriorates in the time it takes a trade to get done (called **slippage**).

In general, regulators have focused more on credit and market risks and less on liquidity risk. Liquidity risk is difficult to measure. However, since the financial crisis, more attention is being paid to measuring liquidity risks in a firm.

TRANSACTIONS COST

LO 55.8: Calculate the expected transactions cost and the spread risk factor for a transaction, and calculate the liquidity adjustment to VaR for a position to be liquidated over a number of trading days.

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars 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

This confidence interval estimates the expected transactions costs in dollar terms. The $\frac{1}{2}(s + 2.33\sigma_s)$ component is referred to as the 99% spread risk factor.

Example: Computing transactions cost

Brieton, Inc., recently traded at an ask price of \$100 and a bid price of \$99. The sample standard deviation of the spread is 0.0002. Calculate the expected transactions cost and the 99% spread risk factor for a transaction.

Answer:

$$\text{midprice} = (100 + 99) / 2 = 99.50$$

$$s = (100 - 99) / 99.5 = 0.01005$$

$$\text{transactions cost} = 99.50 \times \frac{1}{2}[0.01005 + 2.33(0.0002)] = \$0.523$$

$$\text{spread risk factor} = \frac{1}{2}[0.01005 + 2.33(0.0002)] = 0.005258$$

Note that in this example, we use the current midprice as the estimate for the next day asset midprice.

ADJUSTING VAR FOR POSITION LIQUIDITY

Liquidity-adjusted value at risk (LVaR) is a tool used to measure the risk of adverse price impact. The trader will often liquidate the position over a period of days in order to ensure an orderly liquidation of the position.



Professor's Note: The actual calculation of liquidity-adjusted VaR (using constant and exogenous spread approaches) was shown in Topic 53. Here we discuss how VaR may be overstated when adjusting for different time horizons (via the square root of time rule) since this adjustment does not account for the liquidation of positions over the time period of analysis.

Adjusting VaR for liquidity requires an estimate of the number of days it will take to liquidate a position. The number of trading days is typically denoted T . Assuming the position can be divided into equal parts across the number of trading days and liquidated at the end of each trading day, a trader would face a 1-day holding period on the entire position, a 2-day holding period on a fraction $(T - 1) / T$ of the position, a 3-day holding period on a fraction $(T - 2) / T$ of the position, and so on. The 1-day position VaR adjusted by the square root of time is estimated for a given position as:

$$\text{VaR}_t \times \sqrt{T}$$

However, this formula overstates VaR for positions that are liquidated over time because it assumes that the whole position is held for T days. To adjust for the fact that the position could be liquidated over a period of days, the following formula can be used:

$$\text{VaR}_t \times \sqrt{\frac{(1 + T)(1 + 2T)}{6T}}$$

For example, if the position can be liquidated in four trading days ($T = 4$), the adjustment to the overnight VaR of the position is 1.3693, which means we should increase VaR by 37%. This is greater than the initial 1-day VaR, but less than the 1-day VaR adjusted by the square root of T .

MEASURING MARKET LIQUIDITY

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity.

- **Tightness (or width)** refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. The narrower the spread, the tighter it is. The tighter it is, the greater the liquidity.
- **Depth** describes how large an order must be to move the price adversely. In other words, can the market absorb the sale? The market can likely absorb a sale by an individual investor without an adverse price impact. However, if a large institution sells, it will likely adversely impact the price.
- **Resiliency** refers to the length of time it takes lumpy orders to move the market away from the equilibrium price. In other words, what is the ability of the market to bounce back from temporary incorrect prices?

Both depth and resiliency affect how quickly a market participant can execute a transaction.

FUNDING LIQUIDITY RISK MANAGEMENT

Redemption requests, especially in times of market stress, may require hedge fund managers to unwind positions rapidly, exposing the fund to transaction liquidity risk. If this happens to many funds at once, fire sales may result. Hedge funds manage liquidity via:

- **Cash.** Cash can be held in money market accounts or Treasury bills and unencumbered liquidity. Cash is not wholly without risk, however, because money market funds may suspend redemptions in times of stress or crisis, and broker balances are at risk if the broker fails.
- **Unpledged assets.** Unpledged assets, also called assets in the box, are assets not currently being used as collateral. They are often held with a broker. Price volatility of the assets affects their liquidity. Only Treasury securities, and more specifically Treasury bills, may be used as collateral during a financial crisis. Even government agency securities were not sufficient collateral during the 2007–2009 financial crisis. Unpledged assets can be sold, rather than pledged, to generate liquidity. However, in times of market stress, asset prices are often significantly depressed.
- **Unused borrowing capacity.** This is not an unfettered source of liquidity as unused borrowing capacity can be revoked by counterparties by raising haircuts or declining to accept pledged assets as collateral when it is time to rollover the loan. These loans are typically very short term and credit can, as it did during the 2007–2009 financial crisis, disappear quickly.

During the crisis, a systemic risk event, hedge funds that had not experienced large losses still faced a liquidity crisis as investors, seeking liquidity themselves, issued redemption requests.

KEY CONCEPTS

LO 55.1

Liquidity has two essential properties, which relate to two essential forms of risk. Transactions liquidity deals with financial assets and financial markets and is related to the ability to sell an asset quickly, cheaply, and without moving the price too much. Funding liquidity is related to individual's or firm's creditworthiness.

LO 55.2

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all deposits in liquid assets, but make loans with deposits instead. This is known as a fractional-reserve bank and the process of using deposits to finance loans is known as asset-liability management (ALM).

LO 55.3

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Liquidity issues arose during the recent financial crisis for a variety of investment strategies.

Money market mutual funds (MMMFs) have net assets (NAVs) equal to \$1.00. However, credit write-downs can result in net asset values falling below \$1.00. This is known as breaking the buck. Liquidity risk can also cause NAVs to fall below \$1.00.

LO 55.4

Collateral markets enhance the ability of firms to borrow money. They also make it possible to establish short positions in securities. Cash and securities may be borrowed in the market for collateral.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. The full value of the securities is not lent. The difference is called a haircut.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as rehypothecation or repledging.

LO 55.5

A firm's leverage ratio is equal to its assets divided by equity. That is:

$$L = \frac{A}{E} = \frac{(E + D)}{E} = 1 + \frac{D}{E}$$

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the leverage effect. The leverage effect can be expressed as:

$$r_E = Lr_A - (L - 1)r_D$$

LO 55.6

There is embedded leverage in short positions and derivatives such as options and swaps. Economic balance sheets can be constructed to help investors and/or firms measure the implicit leverage of these transactions.

LO 55.7

Transactions liquidity implies that an asset can be bought or sold without moving its price. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

To understand transactions liquidity risk, one must understand market microstructure fundamentals. Trade processing costs, inventory management, adverse selection (i.e., dealing with informed versus uninformed traders), and differences of opinions regarding asset prices affect transactions liquidity.

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity. Tightness (or width) refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. Depth describes how large an order must be to move the price adversely. Resiliency refers to the length of time it takes lumpy orders to move the market away from the equilibrium price.

Hedge funds manage liquidity via cash, unpledged assets, and unused borrowing capacity. In times of market stress, redemption requests may require hedge fund managers to unwind positions rapidly, exposing the fund to transactions liquidity risk. If this happens to many funds at once, fire sales may result.

LO 55.8

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars is:

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

The spread risk factor is equal to $\frac{1}{2}(s + 2.33\sigma_s)$.

Liquidity-adjusted VaR is a tool used to measure the risk of adverse price impact. Traders will often liquidate positions over a period of days in order to ensure an orderly liquidation of the position.

LO 55.9

Risks associated with liquidity are interrelated and can exacerbate problems. For example, an increase in funding liquidity risk can lead to an increase in transactions liquidity risk. Also, severe stress to the financial system from a liquidity risk event would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may impact other market participants.

CONCEPT CHECKERS

1. Jackson Grimes, a trader for Glenn Funds, works on the repurchase agreement (repo) desk at his firm. Markets have been highly volatile but Glenn Funds has a large capital base and is sound. Grimes reports to the CEO that in the last month, the firm Glenn Funds borrows from has been consistently increasing collateral requirements to roll over repos. From the perspective of Glenn Funds, this represents:
 - A. systematic risk.
 - B. transactions liquidity risk.
 - C. balance sheet risk.
 - D. maturity transformation risk.
2. Chris Clayton, an analyst for a private equity fund, noticed that merger arbitrage strategies at several hedge funds experienced large losses in late 2007 to early 2008. These losses were likely due to:
 - A. abandoned merger plans due to a lack of available financing.
 - B. target prices falling precipitously due to stock market corrections.
 - C. acquirers filing for bankruptcy as the subprime mortgage crisis unfolded.
 - D. idiosyncratic risks surrounding the merger arbitrage strategy.
3. With respect to the valuation of money market mutual fund (MMMF) assets, funds:
 - A. are not required to mark-to-market the underlying assets daily.
 - B. must reflect changes in the values of underlying assets that are the result of changes in credit risks but may ignore value changes that are the result of changes in interest rates.
 - C. will set the notional values of each of the underlying assets equal to \$1.00.
 - D. are not allowed to invest in any asset with a rating below AAA because asset values must not fluctuate outside of a 10% range around the historical value in order to keep the notional value equal to \$1.00.
4. Charleston Funds intends to use leverage to increase the returns on a convertible arbitrage strategy. The return on assets (ROA) of the strategy is 8%. The fund has \$1,000 invested in the strategy and will finance the investment with 75% borrowed funds. The cost of borrowing is 4%. The return on equity (ROE) is closest to:
 - A. 4%.
 - B. 32%.
 - C. 20%.
 - D. 12%.
5. Brett Doninger recently placed an order to sell a stock when the market price was \$42.12. The market was volatile and, by the time Doninger's broker sold the stock, the price had fallen to \$41.88. In the market, this phenomenon is known as:
 - A. adverse selection.
 - B. transactional imbalance.
 - C. slippage.
 - D. the spread risk factor.

CONCEPT CHECKER ANSWERS

1. C Funding liquidity risk or balance sheet risk results when a borrower's credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit. In this case, the lender is increasing the haircut and is thus changing the terms of credit. Glenn Fund's creditworthiness does not actually have to decline for a lender to withdraw credit or change the terms of credit.
2. A Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target's stock price typically increases and the acquirer's price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.
3. A MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall.
4. C $\text{debt} = \$1,000 \times 0.75 = \750
 $\text{leverage ratio} = \text{total assets} / \text{equity}$
 $\text{leverage ratio} = \$1,000 / \$250 = 4$

$$r_E = Lr_A - (L - 1)r_D$$

where:

r_A = return on assets

r_E = return on equity

r_D = cost of debt

L = leverage ratio

$$\text{return on equity} = 4(8\%) - [(4 - 1)(4\%)] = 32\% - 12\% = 20\%$$

5. C Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called adverse price impact), and when the price of an asset deteriorates in the time it takes a trade to get done. When the price deteriorates in the time it takes to get a trade done, it is called slippage.

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:

THE FAILURE MECHANICS OF DEALER BANKS

Topic 56

EXAM FOCUS

Understanding the key failure mechanics for dealer banks is crucial for mitigating liquidity and solvency risks. Liquidity risks are accelerated when counterparties or prime broker clients question the solvency of a large dealer bank and, in turn, limit their exposure. This results in increased liquidity risk and insolvency risk for the bank and increased systemic liquidity risk for the financial markets in which dealer banks play commingled roles. Dealer banks play key roles as prime brokers, securities underwriters, special purpose entities (SPE), and as counterparties in the over-the-counter (OTC) derivatives and repo markets. Diseconomies of scope in risk management and corporate governance were revealed by the recent market crisis. Thus, new policies to alleviate dealer bank risks were implemented to address off-balance sheet risks, capital requirements, leverage, liquidity risks, clearing banks, and adverse selection effects in “toxic” asset markets.

FUNCTIONS OF DEALER BANKS

LO 56.1: Describe the major lines of business in which dealer banks operate and the risk factors they face in each line of business.

Large dealer banks provide a variety of intermediary functions in the markets for over-the-counter (OTC) derivatives, repurchase agreements, and securities. In addition, large dealer banks act as a prime broker for hedge funds and provide asset management for wealthy individuals and institutions.

Large dealer banks play an important function in the OTC derivatives market. Dealer banks transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties. Examples of types of OTC derivatives are interest rate swaps, collateralized debt obligations (CDOs), collateralized mortgage obligations (CMOs), and credit default swaps (CDSs).

Counterparty risk in the OTC market refers to the risk that one or more of the counterparties will default on their contractual obligations. The total amount of wealth does not change as derivatives transfer wealth from one counterparty to another as contingencies are realized over time. However, if a counterparty incurs large losses, their derivatives contracts incur frictional bankruptcy costs that result in distress costs for their counterparties. Dealer banks are often counterparties to other dealer banks and large market players. Therefore, the solvency and liquidity problems of one large dealer bank can quickly result in increased systemic risk and a potential liquidity crisis.

If the dealer bank does not have the liquidity to function, they will become insolvent. The failure of a large dealer bank would result in increased systemic risk for the OTC market. When counterparties question the solvency of a dealer bank, they will take actions to reduce their exposure and exit their positions. For example, the default of Lehman Brothers in September of 2008 not only disrupted the OTC derivatives markets, but the repercussions were also felt by other financial markets and institutions.

Another important function of large dealer banks is in the short-term repurchase or **repo market**. Large dealer banks finance significant fractions of another dealer bank's assets through repos. Prior to the recent crisis, dealer banks used overnight repos to finance holdings of agency securities, corporate bonds, Treasuries, mortgages, and collateralized debt obligations (CDOs) with little incremental capital. Some large dealer banks had very high leverage due to the lack of capital requirements for these repos. The high leverage caused significant solvency risk when the use of subprime mortgages as collateral was questioned.

The systemic and firm specific risk is significantly increased if a repo counterparty questions the solvency of a dealer bank. Counterparties are unlikely to renew repos, and the repo creditors may be legally required to sell collateral immediately. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. As many dealer banks act as counterparties for other positions, the solvency of one dealer bank is likely to have a ripple effect and greatly increase the systemic risk of these markets.

Dealer banks provide investment banking functions through the management and underwriting of securities issuances. These investment banking functions also include advising corporations regarding mergers and acquisitions and merchant banking functions, such as the buying and selling of oil, metals, and other commodities. These functions provide an important source of revenue for dealer banks. An additional strain on liquidity is caused by the lack of cash inflows when issuers question the solvency of the dealer bank and take their business elsewhere. This can lead to systemic risk as new issues and the liquidity of existing issues are halted, as few institutions are able or willing to fill the void when a large dealer bank's solvency or liquidity are questioned.

Large dealer banks act as a **prime broker** to large investors such as hedge funds. In this context, the services provided by the dealer banks include custody of securities, clearing, securities lending, cash management, and reporting. When the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by securities. The prime broker may not be able to use those same securities as collateral with other lenders who may also question their solvency. Thus, the dealer bank's liquidity position is weakened if large clients reduce their exposure by exiting their positions or entering new positions to offset their risk.

In addition, if prime broker clients leave, then their cash and securities are no longer in the pool of funds to meet the dealer bank's liquidity needs for other clients. A systemic shortage of collateral and a liquidity crisis can result from the reduction of collateral securities caused by the flight of prime brokerage clients. Systemic risk is even greater when hedge funds do not mitigate their exposure through diversification. Prior to the recent financial crisis, hedge funds had significant positions with only a few dealer banks.

Dealer banks also provide an important function as a counterparty for derivatives for brokerage clients. Dealer banks sometimes operate “internal hedge funds” and private equity partnerships. Off-balance sheet entity functions such as internal hedge funds, structured investment vehicles, and money market funds can have substantial losses. The dealer banks have an incentive to voluntarily support these entities to protect their reputation and franchise value. When a dealer bank shows signs of distress, counterparties and others may begin to exit their relationships, which severely increases the dealer bank’s liquidity risk.

In addition, large dealer banks provide traditional commercial banking functions, such as gathering deposits for corporate and consumer lending. The risks for a dealer bank are similar to a traditional bank with respect to these functions. However, prior to the recent financial crisis, dealer banks did not have access to the discount window (borrowing money from the central bank), and their accounts were not federally insured. For these reasons, a run on the bank’s deposits was more likely to lead to a liquidity crisis. With increased concerns of the solvency of large dealer banks, the availability of credit across the industry was threatened. This had the potential to lead to severe market slowdowns if borrowers were unable to obtain credit.

DEALER BANK MARKETS

Large dealer banks operate in markets that are outside the scope of traditional bank-failure resolution mechanisms, such as conservatorship or receivership. The dealer banks are organized under the umbrella of holding companies in order to provide the wide variety of commercial banking, merchant banking, investment banking, brokerage, and off-balance sheet partnership activities. In addition, dealer banks often have large asset-management divisions that provide custody of securities, cash management, brokerage, and alternative investments vehicles. Dealer banks are also typically the general partner with limited partner clients.

In the primary securities market, dealer banks are the security underwriter. They buy equity and bond securities from issuers and sell them to institutions and investors over a period of time. Dealer banks also play a major role in the secondary securities market in providing liquidity to the market. They are the primary intermediary in the OTC securities markets by assisting in the private negotiation between investors and corporations, municipalities, certain national governments, and securitized credit products. Dealer banks are also actively involved in publicly traded equity markets by acting as brokers, custodians, securities lenders, and facilitating large block trades.

A major market in which dealer banks operate is the repurchase agreements, or repos, market. Repos are short-term cash loans collateralized by securities. In the repo market, one counterparty borrows cash from another counterparty. The majority of repos are for a very short period of time, such as overnight. The loans are collateralized by government bonds, corporate bonds, mortgages, agency securities, or other securities such as CDOs. In order to reduce counterparty risk, a clearing bank often acts as a third party and holds the collateral. The clearing bank facilitates the trade and somewhat reduces the risk of default for the lender. It is common for counterparties to renew these positions on a continuous basis as long as the solvency of the dealer bank is not questioned. It is not uncommon for these counterparties to be another dealer bank.

Dealer banks are usually counterparties in the OTC derivatives market. The most prominent OTC derivatives are interest rate swaps where variable rate commitments often linked to the London Interbank Offering Rate (LIBOR) are exchanged for a fixed rate for a specific time period. Dealer banks typically perform what is known as a “matched book” dealer operation. They transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties, who are oftentimes other dealer banks. Thus, dealer banks have large OTC derivatives exposures with other dealer banks. In addition to dealing with interest rate swaps, dealers are often counterparties in CDSs. In these contracts, the dealer bank transfers the default risk rather than the interest rate risk for the counterparties involved in the contracts.

Some large dealer banks are very active in off-balance sheet financing. In these markets, a bank can sell residential mortgages or other loans to a special purpose entity (SPE). The SPE compensates the sponsoring bank for the assets with the proceeds of debt that it issues to third-party investors or hedge funds. The SPE pays for the principal and interest of the debt issued with the cash flows from the mortgages or other assets that were purchased from the sponsoring bank. Thus, the SPE holds the collateralized pool of assets and provides an innovative product for hedge funds and other investors to purchase. These SPEs also provide a means for financial institutions to diversify their exposure by transferring risk to other investors who are either in or outside the financial industry.

For example, prior to the recent financial crisis, dealer banks were actively participating as sponsor banks for structured investment vehicles (SIVs), which are a form of a special purpose entity. The SIV finances residential mortgages or other debt obligations with short-term debt sold to other investors in the form of CDOs and CMOs.

Before the recent crisis, banks were not required to include the off-balance sheet assets and debt obligations in minimum capital requirement and accounting reports. Thus, some dealer banks became highly leveraged as they were allowed to operate much larger loan purchases and origination businesses with a limited amount of capital. The fall in residential housing values in the summer of 2007 led to the rise of mortgage defaults, which threatened the ability of the SIV to make payments. As short-term creditors became concerned with the solvency of the SIVs, they refused to renew loans, and this created a liquidity and solvency issue for SIVs. Dealer banks had to provide support to SIVs to protect its reputation and franchise value.

DISECONOMIES OF SCOPE

As mentioned, dealer banks act as holding companies in order to provide a wide variety of commercial banking, prime brokerage, investment banking, asset management, and off-balance sheet activities. The recent financial crisis caused many to question the ability of dealer banks to manage risks properly. It is sometimes argued that forming large bank holding companies results in economies of scope with respect to information technology, marketing, and financial innovation. However, the recent financial crisis clearly identified diseconomies of scope in risk management and corporate governance. The executive management and board of directors did not fully understand or control the risk taking activities within their organizations.

For example, prior to their insolvency, Bear Stearns and Lehman relied heavily on overnight repos with leverage ratios above 30. These dealer banks held these assets on their balance

sheets with little incremental capital. Management did not properly manage the amount of off-balance sheet risk the bank was exposed to. Thus, the over-leveraged positions made it impossible to overcome the liquidity and solvency issues that quickly arose when the values of the bank's assets were questioned. Increased awareness or more appropriate risk models may have prevented the insolvency of these dealer banks.

LIQUIDITY CONCERN FOR DEALER BANKS

LO 56.2: Identify situations that can cause a liquidity crisis at a dealer bank and explain responses that can mitigate these risks.

A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation (as discussed in the following). The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.

As mentioned previously, when OTC derivatives counterparties question the solvency of a dealer bank, they will begin to reduce their exposures to the dealer. A counterparty could reduce their exposure by borrowing from the dealer or by entering into new offsetting derivatives contracts with the dealer. A counterparty may also request to have in-the-money options revised to at-the-money strike prices and, thus, reduce their exposure to the dealer by receiving cash from the option position.

Another means that a counterparty has of reducing their exposure to a dealer is through a **novation** to another dealer. For example, a hedge fund may use a credit default swap from a dealer to protect themselves from a loss on a borrower. If the hedge fund was concerned about the solvency of the dealer bank, they could request a novation from another dealer bank to protect themselves from default arising from the original dealer bank. Although these novations are often granted by dealer banks, in the case of Bear Stearns, the request was denied, which raised additional concerns regarding the solvency of Bear Stearns. In addition to decreasing the reputation capital and franchise value of this dealer bank, the liquidity position was also under increased stress. A novation could result in the removal of the cash collateral of the original dealer bank and transfer of this collateral to the second dealer bank.

Central clearing mitigates the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures. OTC derivatives are novated or “cleared” to a central clearing counterparty that stands between the original counterparties. The use of a central clearing counterparty also mitigates the systemic risk of financial markets and institutions when the solvency of a large dealer bank is questioned. However, the use of central clearing counterparties is only effective with derivatives that contain relatively standard terms. Thus, this was not an effective means of dealing with the infamous customized AIG credit derivatives.

Further liquidity pressure can arise if derivative counterparties desire to reduce their exposure by entering new contracts that require the dealer bank to pay out cash. For example, a dealer bank may try to signal their strength to the market by quoting competitive bid-ask spreads on an OTC option. If the bid price is then accepted, the dealer

must settle with a cash payment to the counterparty which reduces their liquidity. If the dealer refuses to quote competitive bid prices, it may further signal their liquidity concerns to the market.

Money market funds, securities lenders, and other dealer banks finance significant fractions of a dealer bank's assets through short-term repurchase agreements. As mentioned previously, if the repo counterparty questions the solvency of a dealer bank, they are unlikely to renew repos. In this event, the repo creditors may have an incentive, or be legally required, to sell the collateral immediately. If the sale of the collateral is less than the cash position, then the dealer counterparty may face litigation for the improper disposal of assets. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. They could reinvest their cash in new repos, but other counterparties are unlikely to take these positions if the dealer bank's solvency is questioned.

The dealer bank can mitigate the liquidity risk caused by a run of short-term creditors by establishing lines of bank credit, holding cash and liquid securities, and by laddering the maturities of its liabilities. When a dealer bank ladders its liabilities, the maturities are spread out over time so that only a small fraction of its debt needs to be refinanced overnight. In 2008, the New York Federal Reserve Bank created the Primary Dealer Credit Facility to finance securities of investment banks. Immediately following the failure of Lehman, the remaining two dealer banks, Morgan Stanley and Goldman Sachs, became regulated bank holding companies. As a bank holding company, the firms gained access to the discount window and could turn to the government for financial support, including FDIC deposit insurance and loan guarantees.

Prime brokerage accounts are a source of cash inflows for large dealer banks. In normal circumstances, the cash and securities of prime brokerage clients are a source of liquidity for the bank. In the United Kingdom, assets from client prime brokerage accounts are commingled with the bank's own assets. However, in the United States, dealer banks are allowed to pool the money together into a separate account from the bank's own funds. Thus, the prime broker is able to use the cash from one client to help meet the liquidity needs of another client.

As mentioned previously, when the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by the securities held in their account with the prime broker. The prime broker may not be able to use those same securities as collateral with other lenders who may question their solvency. Lenders may not find any incentive to lend to the questionable dealer bank. Thus, even without a run by prime brokerage accounts, considerable strain could be placed on the dealer bank's liquidity position.

In addition, if prime broker clients do leave on short notice, then their cash and securities are no longer in the pool of funds to meet the needs of other clients. In this case, the dealer bank must use its own cash to meet liquidity needs. The reduction of collateral securities caused by the flight of prime brokerage clients can lead to a systemic shortage of collateral and a liquidity crisis. In the future, hedge funds are likely to mitigate their exposure to a few dealer banks by diversifying their sources of prime brokerage with custodian banks.

Under normal conditions, a clearing bank may extend daylight overdraft privileges to clearing customers who are creditworthy. However, when the solvency of a dealer bank is questioned, the clearing bank may refuse to process transactions that are insufficiently funded by the dealer bank's cash fund account. For example, in the case of Lehman's default, J.P. Morgan Chase was the clearing bank that invoked its "full right of offset." Under this legal right, J.P. Morgan Chase was able to offset their exposures using Lehman's cash, and at the same time, discontinued to make cash payments during the day on Lehman transactions that would bring Lehman's account below zero. The failure to meet its transaction obligations on that day forced Lehman into bankruptcy. To mitigate this risk in the future, "emergency banks" are proposed to act as either a clearing bank or a tri-party repo "utility."

The basic economic principles causing a liquidity crisis, and potentially the insolvency of a large dealer bank, are not that different from the traditional retail bank run. Banks may finance illiquid assets with short-term deposits. However, an unexpected liquidity demand from depositors or the inability of borrowers to repay their loans may lead to concerns about the solvency of the bank. If the concern persists, a bank run could lead to liquidity problems, and the concern about the bank's failure could end up as a self-fulfilling prophecy.

While the basic economic principles of a bank run are similar for large dealer banks and retail banks, the institutional mechanisms and the systemic destructiveness are very different. For example, dealer banks play an essential role in providing liquidity in the OTC derivatives and securities markets. When the solvency of a dealer bank is questioned, counterparties of these markets and prime brokerage clients begin to reduce their exposure to the dealer. The OTC derivatives counterparty may reduce their exposure by borrowing from the dealer, entering new offsetting derivatives contracts with the dealer, or requesting a novation. A counterparty may also request to receive cash from options positions that are in-the-money by having them revised to at-the-money. Prime broker clients may remove collateral and cash, which results in further accelerating the liquidity crisis. The fact that dealer banks are often counterparties to other dealer banks increases the systemic risk in the financial markets where dealer banks play essential roles.

Another area that dealer banks are very active involving liquidity is the repo markets. Especially in cases where the dealer banks are highly leveraged, the liquidity position is severely threatened when the dealer bank's solvency is questioned and counterparties are unwilling to renew repo positions overnight. Thus, a dealer bank is involved in many functions that result in increased liquidity pressures that traditional banks are not exposed to.

POLICIES TO ALLEViate DEALER BANK RISKS

LO 56.3: Describe policy measures that can alleviate firm-specific and systemic risks related to large dealer banks.

The 2009 Public Private Investment Partnership (PPIP) was instituted by the U.S. Treasury Department's 2008 Troubled Asset Relief Program (TARP) to help dealer banks and the financial industry recover from the crisis at hand. One of the policy objectives was to mitigate the effect of adverse selection in the market for "toxic" assets, such as the CDOs backed by subprime mortgages. Adverse selection is the principle that buyers are only willing to buy the assets at a deep discount due to the information asymmetries that exist regarding the asset's true value. A dealer bank may be forced to sell illiquid assets in order to meet liquidity needs. This results in additional losses due to the lack of demand for those assets. The PPIP subsidizes bidders of "toxic assets" by offering below-market financing rates and absorbing losses beyond a predetermined level.

The United States Federal Reserve System and the Bank of England provided new secured lending facilities to large dealer banks when they were no longer able to obtain credit from traditional counterparties or the repo market. When the dealer bank's solvency is questioned, tri-party clearing banks are likely to limit their exposure to the dealer bank. A tri-party repo utility is proposed as an alternative and would be designed to have fewer conflicting incentives and less discretion in rolling over a dealer's repo positions. New standards could be adapted for transaction documentation, margin requirements, and daily substitution of collateral with respect to repos. These standards could be incorporated through either the new repo utility or traditional tri-party clearing approaches.

Another potential approach is the creation of an "emergency bank" that could manage the orderly unwinds of repo positions of dealer banks with liquidity difficulties. The central bank would grant access to the discount window for the emergency bank to insulate critical clearing banks from losses during this unwinding process.

Capital requirements will most likely be increased and include off-balance sheet positions in an effort to reduce the leverage positions of dealer banks. The separation of tri-party repo clearing from other clearing account functions would also reduce a dealer bank's leverage by tightening the dealer's cash-management flexibility.

Central clearing will reduce the threat of OTC derivatives counterparties fleeing a questionable dealer bank. Although this would not eliminate the liquidity effect resulting from a derivative counterparty reducing their exposure to a particular dealer bank, it would reduce the total exposure to the dealer that would need to be managed through clearing.

Some large dealer banks and financial institutions are viewed as being "too-big-to-fail" based on the systemic risk their insolvency would place on the financial markets. Therefore, another proposed resolution for large dealer banks with questionable solvency that are deemed too-big-to-fail is to provide bridge banks similar to the approach used for traditional banks.

KEY CONCEPTS

LO 56.1

Large dealer banks are active participants in over-the-counter (OTC) derivatives, repo, and securities markets. Their functions in these markets, as well as asset managers and prime brokers, result in a variety of liquidity risks when their solvency is questioned and counterparties reduce their exposure with them.

LO 56.2

A liquidity crisis is accelerated when prime broker clients or counterparties in the OTC derivatives or repo markets question the solvency of a dealer bank and desire to exit their positions or reduce their exposures with the dealer bank.

LO 56.3

The creation of emergency banks in the form of tri-party repo utilities and clearing banks are policy proposals to mitigate firm specific and systemic liquidity risk in the OTC derivatives and repo markets. The U.S. Treasury Department's 2008 Troubled Asset Relief Program (TARP) was designed to mitigate adverse selection in "toxic" asset markets by providing below market financing and absorbing losses above a pre-specified amount.

CONCEPT CHECKERS

1. A dealer bank's liquidity crisis is least likely to be accelerated by:
 - A. the refusal of repurchase agreement creditors to renew their positions.
 - B. the flight of prime brokerage clients.
 - C. a counterparty's request for a novation through another dealer bank.
 - D. depositors removing their savings from the dealer bank.
2. Banks are most likely to diversify their exposure to a specific asset class such as mortgages by grouping these assets together and selling them to:
 - A. hedge funds.
 - B. government agencies.
 - C. the U.S. Federal Reserve.
 - D. special purpose entities.
3. The formation of large bank holding companies results in diseconomies of scope with respect to:
 - A. risk management.
 - B. technology.
 - C. marketing.
 - D. financial innovation.
4. One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is most likely the:
 - A. use of central clearing.
 - B. use of a novation through another dealer bank.
 - C. requirement of dealer banks to pay out cash to reduce counterparty exposure.
 - D. creation of new contracts by counterparties.
5. Which of the following items is not a policy objective of the U.S. Treasury Department's 2008 Troubled Asset Relief Program to help dealer banks recover from the subprime market crisis?
 - A. Provide below-market financing rates for bidders of "toxic" assets.
 - B. Absorb losses beyond a pre-specified level.
 - C. Force the sale of illiquid assets in order to better determine the "true" value.
 - D. Mitigate the effect of adverse selection.

CONCEPT CHECKER ANSWERS

1. D A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation. The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.
2. D Banks can diversify their exposure to a specific asset class, such as mortgages, by grouping these assets together and selling them to special purpose entities.
3. A Some argue that information technology, marketing, and financial innovation result in economies of scope for large bank holding companies. Conversely, the recent financial crisis raised the concern that the size of bank holding companies creates diseconomies of scope with respect to risk management.
4. A One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is the use of central clearing through a counterparty. However, central clearing is only effective when the underlying securities have standardized terms. The reduction of a counterparty's exposure through novation, entering new offsetting contracts, or requiring a dealer bank to cash out of a position will all reduce the liquidity of the dealer bank.
5. C The U.S. Treasury Department's 2008 Troubled Asset Relief Program was designed to create policies to help dealer banks recover from the subprime market crisis by mitigating the effect of adverse selection, by providing below-market financing rates for bidders of "toxic" assets, and by absorbing losses beyond a pre-specified level. Forcing the sale of illiquid assets would worsen the liquidity position of the troubled dealer bank.

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:

STRESS TESTING BANKS

Topic 57

EXAM FOCUS

This topic focuses on the use of bank stress testing to determine if liquidity and capital are adequate. The discussion focuses primarily on capital adequacy but notes that the issues are similar with respect to liquidity. For the exam, understand the details of the 2009 Supervisory Capital Assessment Program (SCAP), the first stress testing required after the 2007–2009 financial crisis. Also, be able to explain the issue of coherence in stress testing and describe the challenges with modeling the balance sheet using stress tests in the context of the stress test horizon. Finally, understand the differences in disclosure between U.S. and European stress tests and the way that stress test methodologies and disclosure have changed since the 2009 SCAP.

STRESS TESTING

In the wake of the 2007–2009 financial crisis, regulators and other policymakers realized that standard approaches to risk assessment, such as regulatory capital ratio requirements, were not sufficient. At that point, supervisory stress testing became a popular tool for measuring bank risk. There was a “pop-quiz” quality to the post-financial crisis stress tests. They were difficult to manipulate because they were sprung on banks at short notice. As a result, the information provided by the stress tests to regulators and the market was truly new. This allowed financial markets to better understand bank risks and, as a result, regain a level of trust in the banking sector.

The goal of stress testing, as well as capital/liquidity and “economic capital/liquidity” (i.e., internal, bank-specific) models, is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities. It is relatively easy for banks to swap out of lower risk assets and into higher risk assets. Stress testing provides clarity about the true risk and soundness of banks.

Stress testing is an old tool that banks and other firms have used to examine risk. It asks the question “what is the institution’s resilience to deteriorating conditions?” and simulates financial results given various adverse scenarios. Stresses are generally of two basic types: scenarios or sensitivities. An example of a scenario is a severe recession. An example of sensitivity is a significant increase in interest rates. Risk managers can stress test the sensitivity of a single position or loan or an entire portfolio.

SUPERVISORY CAPITAL ASSESSMENT PROGRAM (SCAP)

LO 57.1: Compare and contrast the features and scope of supervisory stress tests before and after the Supervisory Capital Assessment Program (SCAP).

In the wake of the financial crisis, there was much uncertainty about the soundness of the U.S. banking system. Regulators needed to assess the capital strength of financial institutions. If there was a gap between what a bank needed in terms of capital and what it had, regulators had to find a credible way to “fill the hole.” The 2009 U.S. bank stress test, known as the **Supervisory Capital Assessment Program (SCAP)**, was meant to serve that purpose. It was the first macro-prudential stress test after the 2007–2009 financial crisis. Macro-prudential regulation focuses on the soundness of the banking system as a whole (i.e., focuses on systematic risks) while micro-prudential regulation focuses on the safety and soundness of the individual institution.

At this point the Federal government planned to infuse equity capital into banks that were undercapitalized based on stress testing. The Treasury intended to borrow money and “downstream” it as equity in banks via the Treasury’s Capital Assistance Program (CAP). If banks could not convince investors to fill the hole (i.e., infuse banks with needed equity capital), current investors would be diluted by the government’s equity investment. In the end, 19 SCAP banks were required to raise \$75 billion within six months. The undercapitalized banks raised \$77 billion of Tier 1 common equity and did not need to draw on the CAP funds.

Prior to 2009, stress testing was relatively simple. Figure 1 summarizes the differences in stress testing pre-SCAP and post-SCAP.

Figure 1: Comparison of Stress Testing Pre-SCAP and Post-SCAP

| Pre-SCAP | Post-SCAP |
|--|--|
| Primarily assessed exposure to single-shocks (e.g., volatility increases OR interest rate increases OR increasing unemployment). | Considers broad macro-scenarios and market-wide stresses with multiple factors occurring/changing at once, as evidenced in the 2007–2009 financial crisis. |
| Focused on specific bank products or business units (e.g., lending or trust). | Focuses on the whole firm, a more comprehensive look at the effect of the stress scenarios on the institution. |
| Typically focused on earnings shocks (i.e., losses) but not on capital adequacy. | Explicitly focuses on capital adequacy. Considers the post-stress common equity threshold to ensure that a bank remains viable. |
| Focused exclusively on losses. | Focuses on revenues, costs, and projected losses. |
| Stress testing was static in nature. | Stress testing is now dynamic and path dependent. |

CHALLENGES IN DESIGNING STRESS TESTS

LO 57.2: Explain challenges in designing stress test scenarios, including the problem of coherence in modeling risk factors.

One of the challenges of designing useful stress tests is **coherence**. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. For example, an increase in volatility can lead to credit markets freezing. High unemployment and falling equity prices often go hand-in-hand. It is not sufficient to specify one potential problem (i.e., risk factor) because the others do not remain fixed. The supervisor's key challenge is to specify the joint outcomes of all relevant risk factors.

Additionally, not everything goes bad at once. For example, if some currencies are depreciating, others must be appreciating. If there is a "flight to quality," there must also be safe haven assets in the stress model. So while it is important to look at, for example, what happens if U.S. Treasury debt becomes riskier and is no longer a safe haven, the model would at the same time have to identify the "risk-free" asset(s) in which capital would flee under those circumstances.

The problem is even greater when designing stress scenarios for marked-to-market portfolios of traded securities and derivatives. Risk is generally managed with a value at risk (VaR) system. Hundreds of thousands of positions in the trading book must be mapped to thousands of risk factors, tracked on a daily basis. The data that results is used to estimate volatility and correlation parameters. It is very difficult to find coherent outcomes in such a complex, multi-dimensional universe.

The 2009 SCAP tested rather simple scenarios with three variables: growth in GDP, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of "flight to safety," the failure of Lehman, and higher risk premia). While the market risk scenario did not test for something new, the overall framework achieved coherence of financial and other stresses of the time period.

One thing to note is that prior to 2011 all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 Comprehensive Capital Analysis and Review (CCAR) asked banks to submit results from their own stress scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities. This was an important step forward from the 2009 SCAP as it gave supervisors a sense of what banks think are the high risk scenarios. This provides regulators with not only bank-specific (i.e., micro-prudential) insight but also improves macro-prudential supervision as it highlights common risks across banks that may have been underemphasized or unnoticed before.

CHALLENGES IN MODELING LOSSES AND REVENUES

LO 57.3: Identify and explain challenges in modeling a bank's losses and revenues over a stress test horizon period.

Current stress tests are based on macro-scenarios (e.g., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress testing into micro (i.e., bank-specific) outcomes related to revenues and losses. Supervisors need to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas. Although not limited to these products, geographic differences are especially important in modeling losses in both commercial and residential real estate lending.

Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. The geographic diversity with respect to macro-factors makes a “one-size-fits-all” stress testing regime less meaningful.

Geography is not the only difference supervisors must contend with. Risks affect different asset classes in different ways. For example, during recessions people buy fewer automobiles overall. However, if a person needs a car during a recession, he is more likely to buy a used car. Thus, if default rates increase, loss given default (LGD) (i.e., loss severity) may not increase as much.

The business cycle also affects different industries at different times. Consider the airline industry versus the healthcare industry during a recession. Airplanes are collateral for loans to airlines. If the airline industry is depressed, the bank gets stuck with collateral that is very difficult to sell except at extremely depressed prices. Healthcare is somewhat recession-proof but that doesn't mean the bank can transform an airplane it is stuck with into a hospital. These factors increase the difficulty of mapping broader macro-factors to bank-specific stress results.

Modeling revenues over a stress test horizon period is much less developed than modeling losses. The 2009 SCAP did not offer much clarity on how to calculate revenue during times of market stress. The main approach to modeling revenue is to divide a bank's total income into interest and non-interest income. The yield curve can be used to estimate interest income, and it can reflect credit spreads during stress testing scenarios; however, it remains unclear how bank profitability is directly influenced by the net impact of changing interest rates. Estimating noninterest income, which includes fees and service charges, is even more difficult to model. This is alarming given the steady increase in noninterest income among U.S. banks.

CHALLENGES IN MODELING THE BALANCE SHEET

LO 57.4: Explain the challenges in modeling a bank's balance sheet over a stress test horizon period.

The typical stress test horizon is two years. Over this period, both the income statement and balance sheet must be modeled to determine if capital is adequate post-stress. Generally speaking, capital is measured as a ratio of capital to assets. There are different types of capital (e.g., Tier 1 and Tier 2) but in general (and for the sake of simplicity), capital can be defined as common equity. **Risk-weighted assets (RWA)** are computed based on the Basel II risk weight definitions. For example, agency securities have a lower risk weight than credit card loans.

In a stress model, the beginning balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point, the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. These decisions make modeling the balance sheet over the stress horizon quite difficult. The stress model doesn't determine if it would be a good time to sell a subsidiary or lower dividend payments.

The challenges of balance sheet modeling exist under both static and dynamic modeling assumptions. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon. At the end of the stress horizon the bank must estimate the reserves needed to cover losses on loans and leases for the next year. This means that a two-year horizon stress test is actually a three year stress test (i.e., a T-year stress test requires the bank to estimate required reserves to cover losses for T+1 years).

STRESS TEST COMPARISONS

LO 57.5: Compare and contrast the 2009 SCAP stress test, the 2011 and 2012 CCAR, and the 2011 EBA Irish and EBA European stress tests in their methodologies and key findings.

Disclosure was a significant feature of the 2009 SCAP. It disclosed projected losses for each of the 19 participating banks for eight asset classes. It also disclosed resources the bank had to absorb losses other than capital (e.g., pre-provision net revenue and reserve releases if available). This high level of disclosure created transparency. It allowed investors and the market to check the severity of stress tests and to comprehend stress test outcomes at the individual bank level. Before the 2009 SCAP, banks only reported realized losses, not forecasted losses (i.e., possible losses given the stress scenario).

The 2011 CCAR required only that macro-scenario results be published, not bank level results. This differed dramatically from the 2009 SCAP requirements. The market had to figure out whether a bank had passed the test or not (i.e., market participants had to “do the math” themselves). For example, if a bank increased its dividend, it was assumed by the market to have “passed” the stress test. However, the 2012 CCAR disclosed virtually the same amount and detail of bank level stress data as the 2009 SCAP (i.e., bank level loss rates and losses by major asset classes). The regulatory asset classes are:

1. First and second lien mortgages.
2. Commercial and industrial (C&I) loans.
3. Commercial real estate loans.
4. Credit card lending.
5. Other consumer loans.
6. Other loans.

One of the key contributions of the CCAR was that in both 2011 and 2012 the CCAR required banks to submit the results of their own scenarios, both baseline and stress, not just supervisory stress test results. The Fed also reported dollar pre-provision net revenue (PPNR), gains and losses on available-for-sale and held-to-maturity securities, and trading and counterparty losses for the six institutions with the largest trading portfolios. These firms were required to conduct the trading book stress test. The numbers that were reported were supervisory estimates, not bank estimates, of losses under the stress scenario.

In contrast, the 2011 European Banking Authority (EBA) Irish and 2011 EBA European-wide stress tests, both disclosed after the CCAR, contained considerable detail. In the Irish case, the report contained a comparison of bank and third party estimates of losses. The EBA data was available in electronic, downloadable form. Ireland needed credibility, having passed the Committee of European Bank Supervisors (CEBS) stress test in July 2010 only to need considerable aid four months later. In general, the faith in European supervisors was harmed and only by disclosing detailed information on bank-by-bank, asset-class, country, and maturity bucket basis could the market interpret the data and draw its own conclusions about individual bank risks. Figure 2 summarizes the differences among the various stress test regimes.

Figure 2: Comparison of Macro-prudential Stress Tests

| <i>Stress Test</i> | <i>Methodologies</i> | <i>Disclosure</i> | <i>Findings</i> |
|---|--|---|--|
| SCAP (2009). All banks with \$100 billion or more in assets as of 2008 year end were included. | Tested simple scenarios with three dimensions, GDP growth, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of “flight to safety,” the failure of Lehman, and higher risk premia). A “one-size-fits-all” approach. | First to provide bank level projected losses and asset/product level loss rates. | 19 SCAP banks were required to raise \$75 billion within six months. The undercapitalized banks actually raised \$77 billion of Tier 1 common equity and none of the banks were forced to use the Treasury’s Capital Assistance Program funds. |
| CCAR (2011) | In recognition of “one-size-fits-all” stress testing, CCAR asked banks to submit results from their own baseline and stress scenarios. | Only macro-scenario results were published. | |
| CCAR (2012) | Banks were again asked to submit their own baseline and stress test results. | Similar in detail to SCAP 2009—bank level and asset/product level loss rates disclosed. | |
| EBA Irish (2011) | Similar in design to EBA Europe 2011. | Comparison of bank and third party projected losses; comparison of exposures by asset class and geography. Data is electronic and downloadable. | After passing the 2010 stress tests, 2011 stress tests revealed Irish banks needed €24 billion. Greater disclosure in 2011 resulted in tightening credit spreads on Irish sovereign and individual bank debt. |
| EBA Europe (2011). [formerly the Committee of European Bank Supervisors (CEBS)] 90 European banks were stress tested. | Specified eight macro-factors (GDP growth, inflation, unemployment, commercial and residential real estate price indices, short and long-term government rates, and stock prices) for each of 21 countries. Specified over 70 risk factors for the trading book. It also imposed sovereign haircuts across seven maturity buckets. | Bank level projected losses. Comparisons of exposures by asset class and geography. Data is electronic and downloadable. | Eight banks were required to raise €2.5 billion. |

The key benefit of greater disclosure is transparency. Transparency is especially important in times of financial distress. However, during “normal” times, the costs of disclosure may outweigh the benefits. For example, banks may “window dress” portfolios, making poor long-term investment decisions to increase the likelihood of passing the test. Traders may place too much weight on the public information included in stress test disclosure and be disincentivized to produce private information about financial institutions. This harms the information content of market prices and makes prices less useful to regulators making policy decisions.

One thing to note is that prior to the CCAR 2011 requirements, all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 CCAR asked banks to submit results from their own scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities.

KEY CONCEPTS

LO 57.1

After the 2007–2009 financial crisis, it was clear that traditional risk measures such as regulatory capital ratios were insufficient. Supervisory stress-testing became an important risk-assessment tool at that point.

The goal of stress testing is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities.

The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

LO 57.2

One of the challenges regulators face is designing coherent stress tests. The sensitivities and scenarios must be extreme but must also be reasonable and possible (i.e., coherent). Problems are inherently multi-factor, making it more difficult to design a coherent stress test.

LO 57.3

Current stress tests are based on macro-scenarios (i.e., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress tests into micro (i.e., bank specific) outcomes related to revenues and losses. Supervisors must be able to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas.

LO 57.4

In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon, typically two years.

LO 57.5

Disclosure was a significant feature of the 2009 SCAP. This high level of disclosure lead to transparency and allowed investors and the market the ability to check the severity of the stress tests and the outcomes of the stress at the individual bank level.

In 2011, CCAR required only macro-scenario results be published, not bank level results, differing significantly from the 2009 SCAP requirements. The 2012 CCAR disclosed virtually the same amount and detail of bank level stress data as the 2009 SCAP. The EBA Irish and the EBA Europe required significant disclosures as well. The disclosures were needed to increase trust in the European banking system.

CONCEPT CHECKERS

1. Which of the following changes in stress testing was not the result of the 2009 Supervisory Capital Assessment Program (SCAP)?
 - A. Banks are now required to provide the results of their own scenario stress tests.
 - B. Stress scenarios are now broader in nature.
 - C. Stress testing now focuses on the whole firm.
 - D. Stress testing now focuses on revenues, costs, and losses.
2. Piper Hook, a bank examiner, is trying to make sense of stress tests done by one of the banks she examines. The stress tests are multi-factored and complex. The bank is using multiple extreme scenarios to test capital adequacy, making it difficult for Hook to interpret the results. One of the key stress test design challenges that Hook must deal with in her examination of stress tests is:
 - A. multiplicity.
 - B. efficiency.
 - C. coherence.
 - D. efficacy.
3. Greg Nugent, a regulator with the Office of the Comptroller of the Currency, is presenting research on stress tests to a group of regulators. He is explaining that macro-variable stress testing can be misleading for some banks because of geographical differences in macro risk factors. He gives the example of the wide range of unemployment rates across the U.S. following the 2007–2009 financial crisis. Which type of loan did Nugent most likely identify as having losses tied to unemployment rates?
 - A. Residential real estate loans.
 - B. Credit card loans.
 - C. Commercial real estate loans.
 - D. Industrial term loans.
4. A risk modeler has to make assumptions about acquisitions and spinoffs, if dividend payments will change, and if the bank will buy back stock or issue stock options to employees. These factors make it especially challenging to:
 - A. get a CAMELS rating of 2 or better.
 - B. determine if the bank has enough liquidity to meet its obligations.
 - C. meet the Tier 1 equity capital to risk-weighted assets ratio.
 - D. model a bank's balance sheet over a stress test horizon.
5. One of the key differences between the 2011 CCAR stress test and the 2011 EBA Irish stress test is that:
 - A. the CCAR did not require banks to provide results from their own stress scenarios.
 - B. the EBA Irish did not find any banks in violation of capital adequacy requirements.
 - C. the CCAR required disclosure of macro-level, not bank level, scenario results.
 - D. the EBA Irish allowed for 1-year stress horizons.

CONCEPT CHECKER ANSWERS

1. A The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

The 2011 CCAR, not the 2009 SCAP, required that banks provide results of their own stress scenarios along with supervisory stress scenarios.
2. C One of the challenges of designing useful stress tests is coherence. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. Hook is dealing with the possibly incoherent results of the bank's stress tests.
3. B Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. Residential mortgages are affected by unemployment as well but people are generally more likely to quit paying credit card bills before mortgages.
4. D In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. This makes it challenging to model the balance sheet over the stress horizon.
5. C The 2011 CCAR required banks to provide results from their own stress scenarios but the EBA Irish did not. After the 2011 EBA Irish tests, €24 billion was required to increase the capital of several banks. The 2011 CCAR, unlike the SCAP and the 2012 CCAR, only required the disclosure of macro-level scenario results. The EBA Irish did not change the stress horizon from two years to one year.

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:

GUIDANCE ON MANAGING OUTSOURCING RISK

Topic 58

EXAM FOCUS

This short and nontechnical topic begins by examining the general risks arising from a financial institution's use of service providers. It then provides details on the key elements of an effective service provider risk management program. For the exam, focus on the three broad areas of due diligence. Also, be familiar with the details from the numerous contract provisions that should be addressed with third-party service providers.

LO 58.1: Explain how risks can arise through outsourcing activities to third-party service providers, and describe elements of an effective program to manage outsourcing risk.

RISKS OF OUTSOURCING ACTIVITIES TO THIRD-PARTY SERVICE PROVIDERS

The following risks could arise when a financial institution outsources its operational functions to third-party service providers:

- **Compliance risk** refers to a service provider not operating in compliance with the relevant local laws and regulations.
- **Concentration risk** refers to having very few service providers to choose from or that the service providers are clustered in only a few geographic areas.
- **Reputational risk** refers to a service provider executing its tasks in a substandard manner, resulting in a negative public perception of the financial institution.
- **Country risk** refers to using a service provider based in a foreign country and subjecting the financial institution to potential economic and political risks in that country.
- **Operational risk** refers to potential losses sustained by a financial institution as a result of internal control breaches and human error caused by a service provider.
- **Legal risk** refers to subjecting the financial institution to lawsuits and other costs due to potentially negligent activities of a service provider.

EFFECTIVE PROGRAM TO MANAGE OUTSOURCING RISK

The risk management program with service providers needs to contain adequate oversight and controls over activities that have a material impact on the institution's finances and operations. In addition, importance must be placed on activities relating to sensitive customer information and new products and services. The depth and complexity of the program may be relatively low if there are few outsourced activities, and the service providers are established and reliable. Conversely, the depth and complexity may be relatively high if there are many service providers involved in outsourced activities.

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Risk management programs should include (1) risk assessments, (2) due diligence in selecting service providers, (3) contract provisions, (4) incentive compensation review, (5) oversight and monitoring of service providers, and (6) business continuity and contingency plans.

The last five elements will be discussed in subsequent sections. The crucial first step is to perform **risk assessments** of the applicable business activities to determine whether these activities are best executed in-house or by a third party. Assuming the outsourcing option is consistent with the financial institution's business objectives, then a cost-benefit analysis and a risk analysis of the service provider should be performed. Two key questions to be answered include the following: (1) Do qualified and experienced service providers exist? (2) Is the financial institution sufficiently qualified to perform oversight duties and manage the relationship with the service provider? Risk mitigation techniques should be updated on a sufficiently regular basis as a result of updated risk assessments.

DUE DILIGENCE ON SERVICE PROVIDERS

LO 58.2: Explain how financial institutions should perform due diligence on third-party service providers.

In performing due diligence on a third-party service provider, a financial institution should involve any relevant technical specialists and/or important stakeholders. The three key areas of review include (1) business background, reputation, and strategy; (2) financial performance and condition; and (3) operations and internal controls. Ultimately, the financial institution must ensure that the service provider follows all relevant laws and regulations in performing services on the institution's behalf.

Business Background, Reputation, and Strategy

There should be a review of the potential service provider's past business history and of its key management personnel. The service provider should provide evidence of an adequate background check system for its new employees.

A review of the service provider's experience, strategy and mission statement, service philosophy, methods of maintaining and improving quality, and company policies is needed. The flexibility and feasibility of the service provider's business model should be evaluated to determine the likelihood of providing services to the financial institution for the long term.

References should be contacted and confirmed, and any licenses and certifications necessary to perform the services should be confirmed. A search for any past or present legal and compliance problems should also be undertaken.

Financial Performance and Condition

The service provider's most recent financial statements (and annual report, if applicable) should be obtained to analyze its assets, liabilities, liquidity, and operating performance for sufficiency. Financial information of any subcontractors should be obtained and analyzed for the same reason. The expected financial impact of the potential contract on the service provider should be determined.

The service provider's long-term survival prospects should be analyzed by considering how long it has been operating as well as its market share growth. Furthermore, its ability to provide the service for the length of the contract in terms of capital and personnel needs to be ascertained. Finally, the amount of insurance coverage and any other issues that may impact the service provider's finances should be considered.

Operations and Internal Controls

The service provider's internal controls, IT systems development and support, IT security systems, and methods of securing confidential information should be evaluated. Additionally, there should be a review of the service provider's staff training, analysis of the service support provided, and confirmation that employee background checks are being performed. Finally, queries should be made about the process involved in maintaining records and any disaster recovery processes in place.

CONTRACT PROVISIONS

LO 58.3: Describe topics and provisions that should be addressed in a contract with a third-party service provider.

Considerations and contract provisions for third-party service providers should include the following elements:

Scope. A contract will state the rights and responsibilities of each party. Examples include (1) contract duration, (2) support, maintenance, and customer service, (3) training of financial institution employees, (4) policies regarding subcontracting, (5) insurance coverage, and (6) policies regarding the use of the financial institution's assets and employees.

Cost and compensation. A contract should indicate the party (or parties) responsible for the payment of any equipment purchases, legal fees, and audit fees pertaining to the service provider's activities. In addition, there should be a listing of all forms of compensation (i.e., fixed, variable, special charges).

Incentive compensation. A contract should include a provision to allow the financial institution to review the appropriateness of incentive compensation (if applicable). Specifically, the service provider may be involved in sales on behalf of the financial institution. Therefore, the incentives should be structured to ensure that the service provider places the interests of the customers (i.e., suitable financial products) over their own interests (i.e., earning higher fees) and to ensure that the service provider does not expose the financial institution to excessive risks.

Right to audit. A contract could optionally contain a provision to allow the financial institution to audit the service provider. It may also require the receipt of various audit reports [e.g., American Institute of Certified Public Accountants (AICPA) Service Organization Control 2 report, Federal Financial Institutions Examination Council (FFIEC) Technology Service Provider examination report] relating to the service provider at stipulated intervals.

Establishment and monitoring of performance standards. A contract should state specific and measurable performance standards (i.e., metrics) with regard to the service provider's work.

Oversight and monitoring. A contract should include a provision requiring the service provider to provide annual financial statements (and the annual report, if applicable) to the financial institution to allow the financial institution to monitor the service provider's ability to continue as a going concern. In addition, a provision should be included to allow the financial institution to increase monitoring and oversight activities when performance deficiencies, control weaknesses, and viability concerns are noted. With regard to higher-risk service providers, a contract could stipulate extra reporting by the service provider or additional monitoring by the financial institution.

Confidentiality and security of information. A contract must contain extensive provisions concerning the confidentiality and security of information pertaining to both the financial institution and its customers. The service provider should only be given such information that is necessary to perform its tasks. Specifically, in the United States, the FFIEC guidance and section 501(b) of the Gramm-Leach-Bliley Act must be followed and should be noted in the contract.

With regard to nonpublic personal information (NPPI) pertaining to the financial institution's customers, a contract should address access, security, and retention of NPPI data by the service provider (if applicable) to comply with privacy laws and regulations. A contract should also require the service provider to give notice to the financial institution of any breaches of data. In that regard, a contract needs to clarify the parties' roles and responsibilities pertaining to NPPI data.

Ownership and license. A contract should state when service providers are permitted to use the financial institution's property (i.e., data and equipment). In addition, clarification is needed regarding the ownership and control of data produced by a service provider. In the event of software purchased from a service provider, it could be necessary to have escrow agreements in place so that the financial institution could access the source code and programs under certain conditions, such as discontinued product support or insolvency of a service provider.

Indemnification. A contract should require the service provider to indemnify (i.e., hold harmless) the financial institution in the event of any legal proceedings arising from the service provider's negligence.

Default and termination. A contract should clarify the types of actions that would constitute a default together with any reasonable remedies that could be undertaken by the financial institution and methods to overcome default by the service provider. In terms of termination, common reasons, such as change in control, poor performance, and nonperformance of duties, should be explained and measured. There should be a provision that requires the service provider to give sufficient notice of termination to the financial institution in the event of a termination by the service provider. Finally, it is important to include provisions detailing the service provider's requirement to return the financial institution's data, records, and any other property.

Topic 58**Cross Reference to GARP Assigned Reading – Board of Governors of the Federal Reserve System**

Dispute resolution. A contract should lay out an agreed-upon dispute resolution plan to resolve disputes quickly and minimize disruption during a dispute.

Limits on liability. A contract may allow for service providers to limit their liability subject to approval by the financial institution's board of directors and management team.

Insurance. A contract should stipulate the requirement of service providers to carry sufficient insurance and provide evidence of coverage. In addition, any significant changes in coverage should be communicated to the financial institution.

Customer complaints. A contract should state which party will deal with customer complaints. If it is the service provider, then they should be required to prepare reports to the financial institution listing the complaints and their status.

Business resumption and contingency plan of the service provider. A contract should detail how the service provider will continue to provide services should a major disaster occur. The focus should be on critical services and any necessary alternative arrangements. Other items, such as backups, disaster recovery and business continuity plans, responsibility for maintaining and testing of such plans, and frequency of testing of such plans, should be included.

Foreign-based service providers. A contract could attempt to provide for the law and regulations of only one jurisdiction (i.e., the financial institution's) to apply for the purposes of contract enforcement and resolution of disputes. This would avoid potentially confusing situations where the foreign laws differ substantially from local laws.

Subcontracting. The subcontractor should be held to the same contract terms in the event that subcontracting is permitted. The contract should explicitly state that the primary service provider is ultimately responsible for all the work performed by the service provider and its subcontractors. The contract should provide a list of acceptable tasks that may be subcontracted and how the primary service provider will supervise and review the subcontractor's work. Finally, the primary service provider's method of performing financial due diligence on the subcontractor should be documented in the contract.

KEY CONCEPTS

LO 58.1

The following risks could arise when a financial institution outsources its operational functions to third-party service providers: (1) compliance risk, (2) concentration risk, (3) reputation risk, (4) country risk, (5) operational risk, and (6) legal risk.

An effective program to manage outsourcing risk should include (1) risk assessments, (2) due diligence in selecting service providers, (3) contract provisions, (4) incentive compensation review, (5) oversight and monitoring of service providers, and (6) business continuity and contingency plans.

LO 58.2

In performing due diligence on a third-party service provider, a financial institution should involve any relevant technical specialists and/or important stakeholders. The three key areas of review include (1) business background, reputation, and strategy; (2) financial performance and condition; and (3) operations and internal controls.

LO 58.3

Considerations and provisions that should be addressed in a contract with a third-party service provider include the following: (1) scope, (2) cost and compensation, (3) incentive compensation, (4) right to audit, (5) establishment and monitoring of performance standards, (6) oversight and monitoring, (7) confidentiality and security of information, (8) ownership and license, (9) indemnification, (10) default and termination, (11) dispute resolution, (12) limits on liability, (13) insurance, (14) customer complaints, (15) business resumption and contingency plan of the service provider, (16) foreign-based service providers, and (17) subcontracting.

CONCEPT CHECKERS

1. Bank Inc., (Bank) operates in the United States and has a service contract in place with Service Co. (Service), which operates in France. Service manages a significant amount of confidential customer data for Bank, and recently a computer glitch at Service resulted in the accidental public disclosure of confidential customer data. As a result of the data breach, which of the following risks is Bank least likely to face?
 - A. Compliance risk.
 - B. Country risk.
 - C. Legal risk.
 - D. Operational risk.
2. Which of the following statements regarding risk management programs with service providers to manage outsourcing risk is correct?
 - A. The program should focus on business continuity and contingency plans.
 - B. The program should contain more detail if there are only a few outsourced activities to established service providers.
 - C. The program should contain adequate oversight and controls over all activities that impact the financial institution.
 - D. The program should require risk assessments to be updated as a result of updated risk mitigation techniques on a sufficiently regular basis.
3. When performing due diligence on a service provider, ascertaining the sufficiency of its insurance coverage would most appropriately be covered under which of the following categories?
 - A. Business background, reputation, and strategy.
 - B. Financial performance and condition.
 - C. Operations and internal controls.
 - D. Oversight and monitoring.
4. The use of performance metrics to assist in determining an acceptable level of performance by a service provider would most appropriately be included in which of the following provisions of a contract with a financial institution?
 - A. Customer complaints.
 - B. Default and termination.
 - C. Indemnification.
 - D. Right to audit.
5. Which of the following provisions would a financial institution least likely include in a contract with a third-party service provider?
 - A. Establishment and monitoring of performance standards.
 - B. Indemnification.
 - C. Ownership and license.
 - D. Right to audit.

CONCEPT CHECKER ANSWERS

1. B Country risk refers to using a service provider based in a foreign country and subjecting the financial institution to potential economic and political risks in that country. Clearly, it is not a relevant risk arising from the breach of confidential customer data.

Compliance risk is a possibility given the apparent lack of security controls of the service provider that resulted in the data breach. Operational risk is clearly a relevant risk to the financial institution here given the data breach caused by the service provider. Legal risk is clearly a relevant risk given that the customers affected by the data breach may sue the financial institution as a result of the breach.

2. A Unexpected events could result in the inability of the service provider to provide its services to the financial institution. Depending on the nature and importance of the services provided, the financial institution may be exposed to substantial losses as a result of the inability of the service provider to provide its services. Therefore, business continuity and contingency plans should be a key focus in any risk management program with service providers.

The program should contain *less* detail if there are only a few outsourced activities to established service providers given that the risk to the financial institution would be reduced substantially as a result of the service provider being established. The program should *not* deal with all activities that impact the financial institution but instead focus only on those that have a material impact. The program should require risk mitigation techniques to be updated on a sufficiently regular basis as a result of updated risk assessments.

3. B A review of a potential service provider's financial performance and condition would include queries regarding its level of insurance coverage.

The area of business background, reputation, and strategy takes a more global view of the service provider and would be far less concerned with financial matters such as insurance. Operations and internal controls deal with compliance with relevant laws and regulations, for example, and would be less concerned with financial matters such as insurance. Oversight and monitoring is not an element within the due diligence process, but it is one of the elements (together with due diligence) of an effective risk management program with service providers.

4. B With regard to the default and termination provision, common reasons include poor performance and nonperformance of duties, which would be detected through the use of performance metrics. The customer complaints provision deals with which party will deal with customer complaints. The indemnification provision deals with the service provider to indemnify the financial institution in the event of any legal proceedings arising from the service provider's negligence. The right to audit provision deals with allowing the financial institution to audit the service provider.

5. D The right to audit provision is optional and is the least important provision of the four listed. The use of performance standards is essential for monitoring and oversight purposes that may result in the determination of default by the service provider and possible termination of the contract. The indemnification provision is important because it deals with the service provider indemnifying (i.e., holding harmless) the financial institution in the event of any legal proceedings arising from the service provider's negligence. The ownership and license provision is crucial because it would state when service providers are permitted to use the financial institution's property (i.e., data and equipment) as well as clarify the ownership and control of data produced by a service provider.