
The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

HANGING UP THE PHONE—ELECTRONIC TRADING IN FIXED INCOME MARKETS AND ITS IMPLICATIONS

Topic 77

EXAM FOCUS

This short and nontechnical topic develops the algorithmic trading concepts covered in the previous topic (Topic 76). The focus here is on the fixed-income market in that it has lagged behind other asset classes in adopting the electronic format as the primary means of trading. For the exam, be familiar with the basic terminology in this topic, which will help you understand the broader issues. Also, focus on the details of the evolution of fixed-income markets as well as the impacts of electronification on market quality.

EVOLUTION OF FIXED-INCOME MARKETS

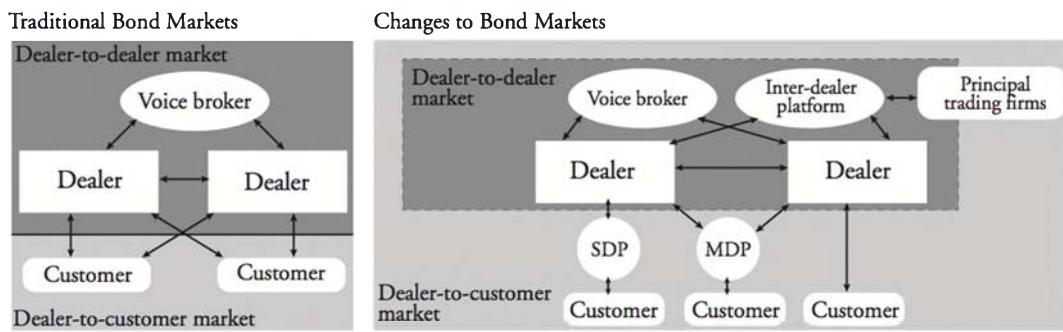
LO 77.1: Describe how the fixed income markets have been evolving.

In the past, fixed-income trading focused on dealers and trades occurred in the **over-the-counter** (OTC) market. Within the OTC market, dealers could trade with each other or they could trade with institutional customers; trading was done by telephone or electronic chat on a bilateral basis with no central clearing party. Customers were required to contact dealers to buy or sell securities, so the matching process entailed search costs and lacked anonymity. Dealers could transact anonymously with each other through voice brokers.

In the late 1990s, **electronic trading platforms** (ETPs) began to be used in both the dealer-to-dealer and dealer-to-customer markets. With dealer-to customer markets, there are *single-dealer platforms* (SDPs) that are electronic versions of the traditional OTC market. In addition, there are *multi-dealer platforms* (MDPs) that allow customers to obtain quotes from multiple dealers at the same time, which reduces search costs. One feature of MDPs is automated record-keeping, which assists in subsequent reviews of best execution.

Overall, there has been a clear movement toward greater anonymity in the fixed-income markets with the shift from bilateral phone transactions to multilateral computer transactions. The multilateral computer transactions focus on liquid government securities with trading being done similar to a *central limit order book* (CLOB) system where limit orders are matched to market orders.

Figure 1: Changes to the Fixed-Income Markets



Source: Figure 1, "The Blurring of Traditional Market Boundaries," in Morten Bech, Anamaria Illes, Ulf Lewrick, and Andreas Schrimpf, "Hanging Up the Phone—Electronic Trading in Fixed Income Markets and Its Implications," *BIS Quarterly Review* (March 2016): 81.

With the rise in **electrification**, **automated trading** (AT) in the form of computer algorithms has become more common in certain bond segments (after lagging behind other asset classes for many years). A key subset of AT is **high-frequency trading** (HFT); HFT can only work if trading occurs rapidly and there is sufficient intraday inventory. Investors who use AT and HFT strategies are known as **principal trading firms** (PTFs). As the number of PTFs increases, there has been a blurring of the traditional market boundaries in the dealer-to-dealer market as illustrated in Figure 1. AT and HFT are most prevalent for liquid bonds and for futures. Trading characteristics of HFT include (1) many orders generated, (2) open positions held for a very short time (e.g., seconds), and (3) canceling a large number of orders generated (often over 80%).

In the dealer-to-customer market, trading speed is much less of an issue. Trading is done through a **request for quote** (RFQ) process that is usually manual in nature and analogous to OTC trading in a multilateral electronic format. Participants may request a quote from market makers for a security for a given trade size. Alternatively, a **click to trade** (CTT) process is available whereby participants are given guaranteed prices, usually for smaller transactions. RFQ is only suitable for AT strategies or less frequently traded corporate bonds that are not as driven by speed since RFQ does not use algorithms with a continuous market. As a result, there is not much HFT under RFQ. However, AT does exist within RFQ because dealers do respond automatically to trading requests and generate algorithmic orders for risk management purposes.

Corporate bond trading has recently developed to permit market participants to trade with nondealers with the dual goals of creating liquidity away from the dealers and permitting multilateral trading opportunities. The resulting trading processes are similar to RFQ, given the lack of liquidity of some corporate bond issues. A system of "dark platforms" is being developed whereby buyers and sellers would deal with each other directly but be matched on an anonymous basis. In addition, there is the idea of developing standardized secondary market auctions in certain bond issues to increase liquidity.

Collectively, the various changes that occurred as a result of the evolution of fixed-income markets has seen increased market diversity. There is now more interaction between market participants, greater transparency, and more ways to trade. Although the fixed-income markets lag behind other assets when it comes to electronic trading, a key reason for the lag is the greater variety of bonds in terms of maturities, coupons, and covenants, for example. As a result, there are greater challenges posed to match buyers and sellers.

ELECTRONIFICATION DRIVERS

LO 77.2: Explain the drivers behind the electronification of fixed income markets.

The main drivers behind electronification are the possibility of lower trading costs and improved market liquidity.

Technological Advances

Massive increases in computing speed and capacity have allowed ETPs to process substantially more trades in fixed-income securities. The automated trade processing and settlement process has decreased the cost and risk of human error. The resulting decrease in per-trade costs and search costs reinforces the continued use of ETPs. Furthermore, the upfront cost of developing trading platforms has decreased, which has increased the number of ETPs. With greater competition, the per-trade cost has fallen even further and provided ETPs a permanent place in fixed-income trading.

Given the current prolonged environment of low interest rates and bond yields, many bond investors are attempting to minimize their trading costs, which promotes an increased use of ETPs.

Improving Market Liquidity

The primary and secondary bond markets have seen increased issuances in recent years together with a greater demand by investors to have the flexibility to buy or sell bonds relatively quickly. All of that points to the potential for ETPs to benefit from economies of scale, especially for commonly-traded securities.

There is a trend in the market toward greater price transparency. ETPs can fulfill that need given their ease in being able to monitor markets, compare prices between dealers, and document trades executed at the best available price.

One point about liquidity should be noted, however. The proliferation of ETPs has the potential to fragment trading activity, thereby decreasing liquidity.

Increased Regulation

Since the financial crisis of 2007–2009, new regulations such as the required clearing of standardized OTC derivatives, additional trade reporting details, and greater pre- and post-trade transparency have encouraged trading on ETPs. Other new regulations have increased banks' costs of assuming risk. By trading on ETPs, banks are able to provide liquidity at lower cost or they allow other investors to provide liquidity.

IMPACT OF ELECTRONIFICATION ON MARKET QUALITY

LO 77.3: Identify and describe the implications that electronification has on market quality.

The impact of electronification on **market quality** lies in the improvements of price efficiency and market liquidity. In a quicker electronic environment, arbitrage opportunities can be spotted and profited from with greater speed. The information is then rapidly incorporated into securities prices, thereby increasing price efficiency. With a greater sense of transparency and more competition in market places, trading costs should fall. In addition, algorithms continue to be developed that can better time the execution of trades so that large transactions are divided into smaller ones to minimize market impact or diverted to more liquid sources.

It is important to consider the impact of electronification during periods of financial distress where the ability and willingness of market makers to provide immediate liquidity and the ability of traders to engage in arbitrage will determine the severity of impact to the market. There is some evidence to suggest that as a result of automated trading algorithms, there has been an increasing occurrence of sudden and intermittent price swings (or “flash crashes”). Specifically, PTFs and bank dealers lowered their risk by providing less liquidity to the market with market depth falling drastically immediately before a period of very high volatility. PTFs reduced market depth the most, yet kept narrow bid-ask spreads, while bank dealers simply widened their bid-ask spreads. The conclusion here is that the risk involved with trading algorithms may be magnified during periods of market stress. For example, significant price changes during such periods are often challenging to account for in trading algorithms. As a result, liquidity providers manage their risk by suspending quoting or the provision of liquidity, but this only shifts the risk to the other liquidity providers.

Market robustness refers to a market's ability to deal with shocks. In that regard, it is not clear whether electronic trading has impacted market robustness for at least two reasons. First, there is insufficient trading activity data that exists before electronic trading. And numerous factors impact liquidity, so it is not possible to isolate any given factor. One study looked at bid-ask spreads and quoted depth between 2008 and 2015 for 10-year U.S. government bonds and 10-year Italian government bonds. The U.S. government bonds involved trading on a fully automated CLOB, with PTFs providing most of the liquidity. The 10-year Italian government bonds had dealers providing all of the liquidity who quoted executable prices (i.e., CTT). There were two main conclusions, the first being that there are temporary jumps in liquidity in both markets, which explains that ETPs assist in pooling liquidity but are unable to create liquidity during periods of supply and demand imbalances. The second is that the U.S. market has less volatility in bid-ask spreads and greater volatility in market depth; in contrast, the Italian market has wider volatility in spreads but more stability in market depth.

Although there has been a shift from voice to electronic trading, dealers continue to be the main source of liquidity in many fixed-income markets. PTFs that are market makers have taken on the role as a secondary source of liquidity but can only do so for a brief time. PTFs mainly work with small amounts of risk capital, so they are unable to maintain a sufficiently wide amount of inventory (including less frequently traded securities) in the long term.

In more recent years, dealers have greater capital buffers and smaller trading book exposures. The results for the dealers have been greater resilience but greater cost in providing immediate liquidity. Dealers have been using more electronic methods, including mass updating of quotes to reflect changing market conditions (i.e., automated market making and hedging). By doing so, they can better control inventory risk and minimize costs. Alternatively, dealers are not fulfilling investors' orders by taking offsetting positions themselves, but they are finding them in the market instead. Overall, there has been a decline in dealer bond inventories despite steady or increasing trading volumes. As a result, there is greater execution risk (unfavorable price change between order placement and order execution) assumed by the investor.

In general, electronic trading has noticeably increased the speed and transparency of trading. At the same time, however, traders and PTFs remain less willing to jump in and prevent any abrupt periods of illiquidity.

TRADITIONAL LIQUIDITY METRICS VS. THE NEW MARKET ENVIRONMENT

LO 77.4: Compare the qualifications of traditional instruments of liquidity conditions and the new market environment.

Traditional liquidity metrics may no longer be as relevant in the new market environment. For example, HFT strategies allow for very competitive pricing with tighter bid-ask spreads in both normal and very volatile states. To fend off strong market orders, HFT strategies engage in smaller trade and quote sizes, and they cancel and submit new orders very often. In such a case, there is some confusion as to actual market liquidity in that narrow bid-ask spreads would be an indicator of strong liquidity, but the smaller trade and quote sizes would suggest the opposite. In addition, the shortening lifespan of quotes and orders creates challenges in determining market liquidity because the orders are considered fleeting in that they could be canceled on a moment's notice.

The new market environment requires new metrics, such as **implementation shortfall**, to evaluate market liquidity with greater precision. Implementation shortfall tries to measure the full cost of taking a position of a given size for a particular bond.

KEY CONCEPTS

LO 77.1

Overall, there has been a clear movement toward greater anonymity with the shift from bilateral phone transactions to multilateral computer transactions.

As the number of principal trading firms (PTFs) increases, there has been a blurring of the traditional market boundaries in the dealer-to-dealer market. In the dealer-to-customer market, trading speed is much less of an issue. Trading is done through a request for quote (RFQ) process that is usually manual in nature and analogous to over-the-counter (OTC) trading in a multilateral electronic format. Trading can also be done through a click to trade (CTT) process whereby participants are given guaranteed prices, usually for smaller transactions.

Collectively, the various changes that occurred as a result of the evolution of fixed-income markets has seen increased market diversity. There is now more interaction between market participants, greater transparency, and more ways to trade.

LO 77.2

Technological advances in the form of massive increases in computing speed and capacity have allowed electronic trading platforms (ETPs) to process substantially more trades in fixed-income securities. The automated trade processing and settlement process has decreased the cost and risk of human error.

The desire to improve market liquidity has been shown with a greater demand by investors to have the flexibility to buy or sell bonds relatively quickly and a greater demand for price transparency. Both points encourage the continued use of ETPs.

Since the financial crisis of 2007–2009, new regulations such as the required clearing of standardized OTC derivatives, additional trade reporting details, and greater pre- and post-trade transparency have encouraged trading on ETPs.

LO 77.3

The impact of electronification on market quality lies in the improvements of price efficiency and market liquidity. In a quicker electronic environment, arbitrage opportunities can be spotted and profited from with greater speed. The information is then rapidly incorporated into securities prices, thereby increasing price efficiency.

There is some evidence to suggest that as a result of automated trading algorithms, there has been an increasing occurrence of sudden and intermittent price swings (or “flash crashes”). Specifically, PTFs and bank dealers lowered their risk by providing less liquidity to the market with market depth falling drastically immediately before a period of very high volatility.

Although there has been a shift from voice to electronic trading, dealers continue to be the main source of liquidity in many fixed-income markets. In more recent years, dealers have greater capital buffers and smaller trading book exposures. The results for the dealers have been greater resilience but greater cost in providing immediate liquidity.

In general, electronic trading has noticeably increased the speed and transparency of trading. At the same time, however, traders and PTFs remain less willing to jump in and prevent any abrupt periods of illiquidity.

LO 77.4

The traditional liquidity metrics may no longer be as relevant in the new market environment. For example, high-frequency trading (HFT) strategies engage in smaller trade and quote sizes, and they cancel and submit new orders very often. In such a case, there is some confusion as to actual market liquidity in that narrow bid-ask spreads would be an indicator of strong liquidity, but the smaller trade and quote sizes would suggest the opposite.

The new market environment requires new metrics, such as implementation shortfall, to evaluate market liquidity with greater precision.

CONCEPT CHECKERS

1. A trading process that provides platform participants with guaranteed prices, usually for smaller transactions is best described as:
 - A. click to trade (CTT).
 - B. high-frequency trading (HFT).
 - C. over-the-counter (OTC).
 - D. request for quote (RFQ).
2. High-frequency trading (HFT) is least likely to be described as:
 - A. large transaction sizes.
 - B. generating many orders.
 - C. large numbers of orders canceled.
 - D. open positions being held for very brief periods.
3. Which of the following factors is least likely a key driving force behind the electronification of trading in fixed-income markets?
 - A. Lower costs.
 - B. Increased regulation.
 - C. Improving market liquidity.
 - D. Greater selection of securities.
4. Which of the following statements regarding the impact of electronification on market quality is correct?
 - A. Principal trading firms are now the main source of liquidity in many fixed-income markets.
 - B. Electronification can assist in exploiting arbitrage opportunities in the market.
 - C. During periods of market stress, bank dealers maintain narrow bid-ask spreads.
 - D. Trading algorithms have developed in complexity so as to easily account for significant price changes during periods of market stress.
5. Which of the following statements regarding measuring liquidity conditions and high-frequency trading (HFT) is most accurate?
 - A. The shortening lifespan of orders makes it more difficult to determine market liquidity.
 - B. HFT strategies allow for very competitive pricing with tighter bid-ask spreads only in normal states.
 - C. To avoid the risk of getting picked off by market orders, HFT strategies often engage in larger trade and quote sizes.
 - D. Traditional liquidity metrics such as implementation shortfall may no longer be as relevant in the new market environment.

CONCEPT CHECKER ANSWERS

1. A A CTT process provides participants with guaranteed prices, usually for smaller transactions.
2. A Trading characteristics of HFT include (1) many orders generated, (2) open positions held for a very short time (e.g., seconds), and (3) canceling a large number of orders generated (e.g., often over 80%).
3. D The main drivers behind electronification are the possibility of lower trading costs and improved market liquidity. Since the financial crisis of 2007–2009, new regulations such as the required clearing of standardized OTC derivatives, additional trade reporting details, and greater pre- and post-trade transparency have encouraged trading on electronic trading platforms (ETPs).
4. B In a quicker electronic environment, arbitrage opportunities can be spotted and profited upon with greater speed. The information is then rapidly incorporated into securities prices, thereby increasing price efficiency.

Although there has been a shift from voice to electronic trading, dealers continue to be the main source of liquidity in many fixed-income markets. PTFs that are market makers have taken on the role as a secondary source of liquidity but can only do so for a brief time. During periods of market stress, PTFs reduced market depth the most, yet kept narrow bid-ask spreads, while bank dealers simply widened their bid-ask spreads. The risk involved with trading algorithms may be magnified during periods of market stress. For example, significant price changes during such periods are often challenging to account for in trading algorithms.

5. A With HFT, it is more difficult to determine market liquidity because orders could be canceled at a moment's notice.

HFT strategies allow for very competitive pricing with tighter bid-ask spreads in *normal and very volatile* states. To avoid the risk of getting picked off by market orders, HFT strategies often engage in *smaller* trade and quote sizes. The new market environment requires new metrics, such as implementation shortfall, to evaluate market quality with greater precision.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

HOW HAVE CENTRAL BANKS IMPLEMENTED NEGATIVE POLICY RATES?

Topic 78

EXAM FOCUS

The traditional lower bound for policy interest rates has always been zero. This theoretical lower bound has been crossed by five central banks since mid-2014. Danmarks Nationalbank (Denmark), the European Central Bank, Sveriges Riksbank (Sweden), the Swiss National Bank, and, most recently, the Bank of Japan have all descended into unconventional monetary policy by adopting negative interest rate regimes. Policy implementation differs between these five central banks, and the true effect is still unknown, although some anticipated risks are present. For the exam, understand the implications and risks associated with negative policy rates.

MOTIVATIONS UNDERLYING NEGATIVE RATE POLICIES

LO 78.1: Describe the framework that led to the introduction of negative policy rates.

Every central bank that has resorted to negative policy rates had some measure of macroeconomic challenge that drove them in that direction. For some, the primary motivation was countering inflation expectations, while others were dealing with currency appreciation. Each faced their own somewhat unique scenario that brought them to the point of installing a negative policy rate regime.

The European Central Bank (ECB) adopted negative policy rates in mid-2014 citing medium- to long-term inflation expectations. Sweden's central bank also cited inflation concerns as its reason for adopting negative rates. In both cases, the ECB and the Swedish central bank have used negative rates to complement other unconventional expansionary measures. The ECB paired negative rates with open market purchasing of government bonds and asset-backed securities. At its policy meeting in June 2016, it added the purchase of corporate bonds as well. The Riksbank of Sweden, which is the oldest central bank in the world, combined negative rates with a government bond purchasing program that would result in the central bank owning just over 30% of the outstanding Swedish sovereign debt. Its goal is to increase inflation up to a target rate of 2%, which is a level not seen in four years.

Some notable externalities have been observed as a result of the ECB's negative rate policies. When negative rates were employed in mid-2014, investors began to shift assets to Switzerland for higher returns. This created excess demand for the Swiss franc, which yielded currency appreciation. Currency appreciation is bad for a country's export

businesses. To prevent harmful and undesired currency appreciation, the Swiss National Bank (SNB) was forced to introduce its own negative rate policy, and it also placed a floor on its currency. It began with a -0.25% rate in December 2014. The Swiss franc remained under pressure, and the SNB decided to abandon the currency floor and lower interest rates to -0.75% . This has been a partially effective solution for the Swiss franc. Denmark had the exact same issue experienced by Switzerland. Learning from the SNB's experience, the Danish central bank cut rates in early 2015 to -0.75% right from the start. This did eventually normalize its currency, and in January 2016, Denmark slightly raised rates to -0.65% .

IMPLICATIONS OF NEGATIVE RATE POLICY IMPLEMENTATION

LO 78.2: Explain the implications of the technical implementation of negative policy rates.

Negative interest rate policy (NIRP) has largely taken place within existing central bank operational frameworks, but a few alterations were necessary. The SNB had to change its terms of business, which are internal guidelines for monetary policy, to permit NIRP. Most central banks also needed to allow for individual exemption thresholds so that only deposits with the central bank above a certain threshold would earn a negative interest rate. For example, the SNB's threshold for application of negative rates is based on its reserve requirements, and the actual threshold is set individually for each bank. This customization required technological upgrades to accommodate the new idea for expansionary economic policy. One major implementation piece that applied to all NIRP-applying central banks was an abundance of communication with the general public. They each carefully signaled to the markets that they were considering this option well before they actually implemented it. The ECB adopted NIRP in mid-2014, but they had been signaling this direction for a little over a year before implementation.

In all jurisdictions, central banks currently hold reserve accounts from commercial banks. In Switzerland and at the ECB, these deposits are held as overnight deposits, but in Denmark and Sweden, a portion of the deposits are held overnight and a portion are one-week liabilities. Overnight deposits have a different rate than one-week deposits. The ECB, the SNB, and the Danish central bank all have chosen to apply thresholds that exempt a portion of reserve holdings from negative rates. Deposit amounts below the customized threshold do not have a negative rate, but deposits that exceed the threshold do have negative rates applied. As of February 2016, the Danish and Swedish central banks had average rates just above -0.50% while the ECB and SNB were a little higher at an average of -0.25% .

From an implementation perspective, the negative rate experiment appears to transmit NIRP into money market rates in the same way that positive rates are relayed. One of the primary money market assets is sovereign debt instruments. When observing yield curves for several different governments' sovereign debt obligations, it is evident that Japan, along with other major European economies with NIRP programs, has deeply negative sovereign yield curves.

Negative policy rates have translated into negative yields on sovereign debt obligations and have also passed-through to nonsovereign money market instruments as well. In an attempt

to avoid negative yields, banks and investors have been opting for longer-term maturities with positive yields or riskier counterparties altogether. This trend creates additional risk when policy rates eventually rise because bond prices decline as market rates rise and longer-term maturities are more sensitive to interest rate risk than shorter-term maturities.

One interesting implementation challenge has been the historically constant net asset value (NAV) applied to money market mutual funds. These instruments have traditionally had a constant NAV of \$1 per share. How does this get adjusted if rates are negative? Some money market funds have been lengthening their maturities to incorporate only positive yields. If negative rates persist, there may need to be a shift from a constant NAV to a variable NAV to accommodate NIRP programs.

Initially, the introduction of negative policy rates produced lower yields (higher prices) for longer-maturity debt instruments. This may have been a direct result of investors shifting down the yield curve in search of positive yields. It may have also been from central bank asset purchase programs in effect at the same time.

Another implementation issue was how to address floating rate loans that were linked to LIBOR, which would be impacted by a negative rate regime. In Switzerland, banks had to adjust their contracts to place a zero bound mandate on floating rate mortgages so that banks would not end up owing consumers money. There is a possible risk of market segmentation as each jurisdiction has addressed floating rate debt instruments in its own way. Another issue with negative rates and floating rate bonds is that banks have traditionally hedged floating rate debts with interest rate swaps, which were not set up for the potential of negative rates. A new hedging instrument may be needed since some debt instruments have already slipped into negative yields.

The larger question is whether NIRP is transmitted to the broader economy through lower lending rates for businesses and households. Commercial banks are passing on the negative rates to wholesale depositors, which are large institutional clients like pensions and mutual funds. However, retail investors are not currently being affected by negative rates on their deposits. The concern is that if negative rates are charged to retail customers, then they will simply withdraw their funds and store their money in a nonbank format. This would deny commercial banks a major source of loanable funds. Swiss banks have actually offset the negative rates that should have been passed-through to retail customers by raising lending rates for the general public. Higher lending rates is the opposite reaction that was hoped for with negative rates in the first place.

THE LOWER BOUND FOR NOMINAL RATES

LO 78.3: Identify factors that determine the lower bound for nominal interest rates.

The theoretical lower bound for nominal interest rates has always been considered in the context of opportunity cost. Why would a depositor leave money with a bank if negative rates apply? They could withdraw their money and hold cash, which does not have a negative yield, or does it? Holding cash in size does carry the cost of storage, transportation, insurance, and security. Current thinking is that the theoretical lower bound for nominal rates is slightly below zero to account for holding costs.

The overall trend for total currency in circulation has been rising over the last 14 years, but note that this trend indicates no material alteration after NIRP programs began in late 2014. If there would have been a significant increase in cash storage, the most likely way to see it would be in the circulation of large denominations of bills because this is the easiest way to store cash in large quantities. There was not a noticeable increase in cash circulation for the €100, €200, or €500 notes. This confirms that cash storage has not increased in the Eurozone since the beginning of NIRP programs.

The way in which negative rates have been transmitted to customers has probably enabled the lower bound on interest rates to fall below zero. Negative rates have not been passed-through to retail customers. If negative rates ever do get passed on to retail customers, the lower bound on nominal rates will likely rise, perhaps all the way to zero, as currency in circulation increases due to commercial bank withdrawals and customers storing wealth in nontraditional venues (e.g., under the mattress). There may be new innovations in the future, such as digital currencies, that could provide a cost-effective store of value that is insulated from negative domestic deposit rates.

RISKS OF NEGATIVE POLICY RATES

LO 78.4: Identify and compare the risks associated with negative policy rates.

The whole idea behind negative policy rates is to encourage banks to lend more money, which would theoretically stimulate the economy. It has been observed that commercial banks are passing the negative rates along to their wholesale customers, but not to their retail customers. In fact, many commercial banks have increased lending rates to offset the profit margin impact of negative rates that are not passed-through to customers. If commercial banks are truly offsetting negative rates with higher borrowing costs, this will have a contractionary and not an expansionary outcome, and it could squeeze profitability at banks. Note that European GDP has actually declined since the start of NIRP programs in 2014.

Some commercial banks could take other unintended actions beyond increasing lending rates. There is the risk that they might decrease certificate of deposit (CD) rates and interest rates on retail customer savings accounts. They may also institute fees, like monthly maintenance charges on checking accounts, ATM convenience fees, and possibly even fees to see a bank teller, to offset the cost of NIRP. These fees are all speculation at this point, but they are very real possibilities and would all continue to work against the stated objective of negative rates, which is to encourage lending and rekindle economic activity.

There is also a risk that more countries will adopt NIRP programs to compete. Japan, the third largest economy in the world, was the most recent central bank to move into negative interest rates. They implemented this policy in early 2016. Interestingly, there has been a noticeable increase in the sale of safes in Japan, which indicates that Japanese citizens may be preparing to hoard cash.¹ This is also not the intended effect. There is some speculation that Canada could be the next country considering negative rates.

1. Liam Halligan, "Why Negative Interest Rates Are Mad, Bad—and Dangerous," *The Spectator*, August 27, 2016.

Another potential risk is the return needs of institutional investors. Pension funds and insurance companies have specific return requirements to meet their obligations. In a negative yield environment, these two institutional investors need to move away from sovereign debt instruments and search for their required yield in riskier venues. This will likely drive up valuations on riskier assets and potentially set the stage for another financial crisis. Clear evidence of this can be seen by monitoring Robert Shiller's cyclically adjusted price earnings (CAPE) ratio, which, as of late 2016, was between 26 and 29 with a long-term median of only 16.05.² Jeremy Siegel's argument that CAPE ratios are higher than normal due to accounting rule changes may have some merit, but by any standard, valuations are currently high.³

Another potential risk relates to the currency impact of negative rates. There is a real potential of currency wars because negative rates devalue a domestic currency with regard to other trading partners. This is precisely why Switzerland had to dip into negative rates and others may need to follow simply to defend the value of their currencies.

Central bank credibility is also at risk. The Bank of Japan has recently admitted that even it is questioning its own credibility with negative rate policies.⁴ It further acknowledged that its move has had little effect on inflation. This leaves us with a big question: If negative rates and asset purchase programs do not spark the hoped for economic activity, then what tools do central banks have left?

2. "Shiller PE Ratio," Multpl, <http://www.multpl.com/shiller-pe>.

3. Jeremy J. Siegel, "The Shiller CAPE Ratio: A New Look," *Financial Analysts Journal* 72, no. 3 (May/June 2016): 41–50.

4. James Mackintosh, "Bank of Japan Confesses: Even We Don't Trust the Bank of Japan," *The Wall Street Journal*, September 26, 2016.

KEY CONCEPTS

LO 78.1

The two primary motivations underlying the adoption of a negative policy rate are encouraging inflation and combating currency appreciation. The European Central Bank (ECB) and the Swedish central bank both lowered rates into negative territory to encourage inflation back up to a 2% target. The Swiss central bank and the Danish central bank both had to deal with currency appreciation as a result of the ECB's negative rate policy. This led them both to also adopt negative rates to lower the relative value of their respective currencies.

LO 78.2

Negative interest rate policy (NIRP) has been implemented within existing central bank frameworks with some modifications. Some central banks needed to adjust their guidelines for operations and also allow for a portion of their deposits to have one interest rate, and then a negative rate for any assets on deposit above a given threshold level. Central banks will eventually need to address the issue of constant net asset value (NAV) in money market funds, which invest with short-term money market instruments. They also need to make special accommodations for variable rate loans. There is evidence that negative rates have affected sovereign lending rates, but commercial banks have not passed these costs on to retail customers. They have actually raised certain retail borrowing costs to offset negative rates in other product lines. This is opposite from the intended effect.

LO 78.3

The theoretical lower bound for interest rates has always been considered in terms of opportunity cost. The cost of holding, storing, and securing large quantities of cash causes the theoretical lower bound for interest rates to be somewhat lower than zero. The fact that negative rates have not yet been transferred to retail customers has made the lower bound lower than it otherwise might be.

LO 78.4

There are many risks involved with negative interest rate policies. They include not enjoying the hoped for economic growth, the potential of increased lending rates and bank service fees, the risk of more countries needing to adopt negative interest rate policy programs to not fall behind, the risk of unmet return needs for pension funds and insurance companies, the risk of currency wars, and the risk of lost central bank credibility.

CONCEPT CHECKERS

1. Which of the following central banks that have adopted negative policy rates did not do so to encourage inflation to rise up to a healthy target rate?
 - A. The European Central Bank.
 - B. The Swedish central bank.
 - C. The Swiss central bank.
 - D. The Australian central bank.
2. Which of the following statements about negative interest rate policy (NIRP) implementation is not accurate?
 - A. The existing structure of most central banks allowed for only deposits above a specified threshold to be charged a negative rate.
 - B. Negative interest rate policies have been implemented within existing central bank frameworks with some modifications.
 - C. One consideration that still needs to be addressed is constant net asset value (NAV) on money market mutual funds.
 - D. Hedging of interest rate risk using swap contracts may need adjustments in a negative rate world.
3. Which of the following statements best captures the translation of negative policy rates into market rates?
 - A. Negative policy rates have driven up sovereign debt yields into positive values.
 - B. Negative policy rates have increased commercial bank lending rates in certain loan classes.
 - C. Negative policy rates have not yet reached nonsovereign money market instruments.
 - D. Negative policy rates have been passed along to retail banking customers.
4. Which of the following statements is correct relative to the theoretical lower bound for nominal interest rates?
 - A. The theoretical lower bound for interest rates is zero.
 - B. The theoretical lower bound is not impacted by the measure of pass-through to bank customers.
 - C. There is no theoretical lower bound.
 - D. The theoretical lower bound for interest rates is close to but slightly less than zero.
5. Which of the following options is a known potential risk of NIRP programs?
 - A. Decreased lending rates for borrowers.
 - B. Domestic currency appreciation.
 - C. Reduced credibility for central banks.
 - D. Decreased bank service fees.

CONCEPT CHECKER ANSWERS

1. C The European central bank and the Swedish central bank both lowered policy rates into negative territory to encourage inflation. The Australian central bank has not adopted a negative rate regime. The Swiss central bank adopted negative policy rates to combat an appreciating currency started by the ECB's negative rate program.
2. A Central banks did largely implement NIRP within their existing frameworks, but they needed to alter their terms of business to allow for negative rates on only assets on deposits above a certain threshold level. This only applies to a few of the central banks that impose the threshold model. Central banks will still need to address the constant NAV issue on money market mutual funds. New hedging instruments may be necessary since existing interest rate swaps were not set up for a negative rate regime.
3. B Negative policy rates have translated into *negative* yields on sovereign debt obligations and have also passed-through to nonsovereign money market instruments. They have been passed along to most wholesale depositors (by commercial banks) but *not* to retail customers. Lending rates for retail customers have actually risen somewhat to offset the negative rates carried by the bank in other depository accounts.
4. D The theoretical lower bound for interest rates is close to but slightly less than zero to account for storage costs of owning large quantities of cash. The lower bound is greatly impacted by pass-through to customers. If negative rates are passed-through to retail customers, then the true theoretical lower bound might be more apparent as all bank customers would then feel the effect of negative rates. The trouble is that this could create substantial withdrawal requests and move in the opposite direction of the desired stimulus.
5. C The credibility of central banks has been called into question as a result of NIRP programs. One risk of negative interest rate programs is *increased* lending rates. This occurs when commercial banks decide to not pass along negative rates to retail customers. Increased lending rates will slow the economy and not boost GDP. Another risk is domestic currency *depreciation*. Negative rates will lower a country's currency with regard to trading partners and potentially lead to currency wars. Also, banks may *increase* fees to offset the cost of NIRP.

The following is a review of the Current Issues in Financial Markets principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

CORPORATE DEBT IN EMERGING ECONOMIES: A THREAT TO FINANCIAL STABILITY?

Topic 79

EXAM FOCUS

This topic details the increased international borrowings of large corporates in emerging economies. Over the past decade, the share of international debt as a proportion of total debt has ballooned, driven in large part by large nonfinancial borrowers. Additionally, these emerging economy corporate borrowers often play the role of financial intermediaries but evade regulatory oversight. As a result, there are greater risks to both domestic banking systems and the broader economy. Changes in monetary policy influence the global market for capital. As the Federal Reserve scales back quantitative easing and global funding tightens, financial instability may result. There are four basic risks facing global corporate borrowers. They are maturity, currency, rollover, and speculative risks. Balance sheet measures of risk are traditional, but market measures such as foreign exchange (FX) beta are likely better able to capture risks to the financial system that result from cross-border borrowing. For the exam, be able to explain the ways in which these corporate risks are transmitted to the financial system, both directly and indirectly. Three case studies are examined, India, Turkey, and Latin America. Understand the basic facts and concerns laid out in each case study. Also, be able to explain the policy implications and recommendations that arise from the risks associated with corporate debt in emerging economies.

EMERGING ECONOMY TRENDS

LO 79.1: Describe the general trends of emerging economies over the past decade.

Leading up to the recent global financial crisis, from 1999 to 2007, international balance sheets of emerging economies improved. The improvement stemmed from a number of sources including current account surpluses, a shift to equity financing from debt financing, and an increase in the stockpiles of liquid foreign reserves. Since 2010, several factors have led to a partial reversal of this positive trend.

In May 2013, the Federal Reserve announced that it would gradually reduce the amount of money it was injecting into the economy. Beginning in 2008, the Fed has kept interest rates extremely low by injecting money into the financial system. This stimulus is called **quantitative easing (QE)**. Following the Fed's announcement of a plan to reverse quantitative easing, market participants panicked, withdrawing money from bond markets, pushing bond yields up significantly. This reaction has been termed the May 2013 "taper tantrum." U.S. monetary policy significantly influences global financial conditions. The result of this announcement by the Fed has been wide speculation that dollar funding will

tighten. At the same time, a macroeconomic slowdown in emerging economies is expected. The combination could lead to increasing financial instability in emerging economies.

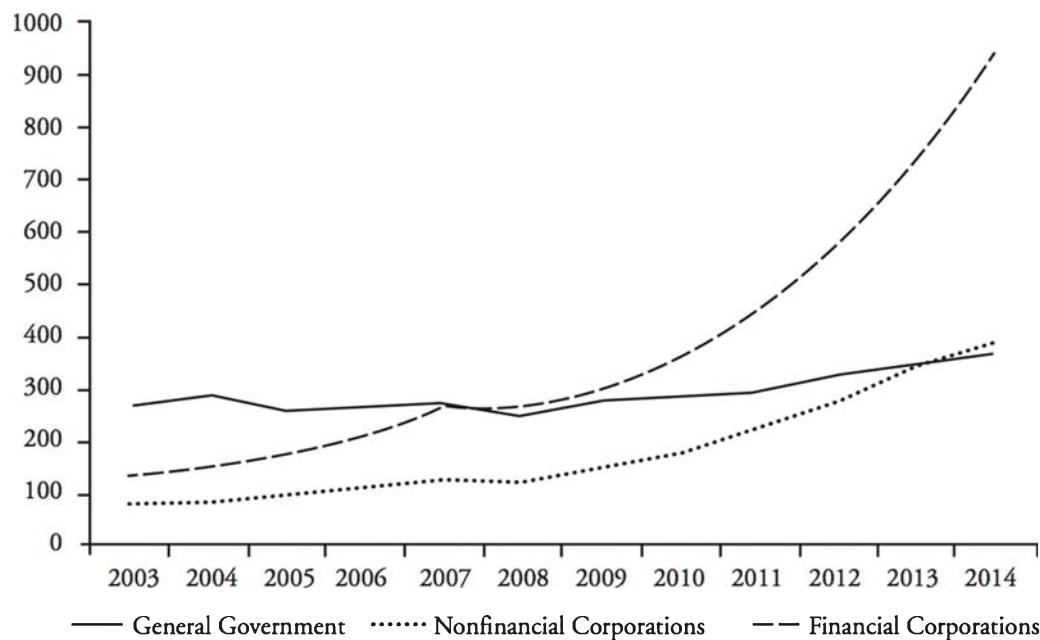
When the Federal Reserve withdraws quantitative easing, global borrowers will find it more difficult to borrow. The Federal funds rate plays a vital role in the availability of dollar funding. Emerging economies with poor economic fundamentals and deep financial markets will likely feel the greatest impact from Federal Reserve tightening. The impact of changing monetary policy may be experienced on both the price (higher interest rates) and quantity (less funding available in global markets) sides.

Several factors are contributing to the potential crisis:

- Fed tightening will create a tighter supply of dollars available throughout the world (i.e., the quantity side).
- Borrowing costs will likely increase in local and foreign currency terms (i.e., the price side).
- An appreciating dollar will increase the value of dollar-denominated debt, increasing the burden to borrowers. This has already occurred in emerging markets.
- Macro-fundamentals have deteriorated in many emerging economies since 2007:
 - ◆ Current account balances have declined with some countries running large deficits.
 - ◆ Foreign debt has increased; many countries have large amounts of foreign currency debt.
 - ◆ Leverage has increased in the corporate sector.
 - ◆ Growth forecasts have been revised downward.
 - ◆ Commodity prices have dropped, damaging the income prospects of commodity exporters.

Strains on the balance sheets of nonfinancial and household sectors (not just banks and sovereigns) can trigger systemic financial shocks. Large companies can borrow from international banks, the international bond market, and nonbank intermediaries. Smaller borrowers may obtain funding from banks in their home currencies. Corporations may borrow from domestic banks that, in turn, borrow in foreign markets. Foreign currency debt obligations, whether directly owed to foreign creditors or to domestic lenders, is a concern.

Figure 1 illustrates the increases in both financial and nonfinancial corporate debt issued by emerging market economies. In Figure 1, emerging economies include Argentina, Brazil, Chile, China, Colombia, India, Indonesia, Israel, Korea, Malaysia, Mexico, Philippines, South Africa, Thailand, and Turkey. Corporate debt issued by financial firms has increased from approximately \$150 billion in 2003, to \$400 billion in 2010, to nearly \$1 trillion in 2014. Nonfinancial corporate debt has doubled to around \$400 billion since 2010.

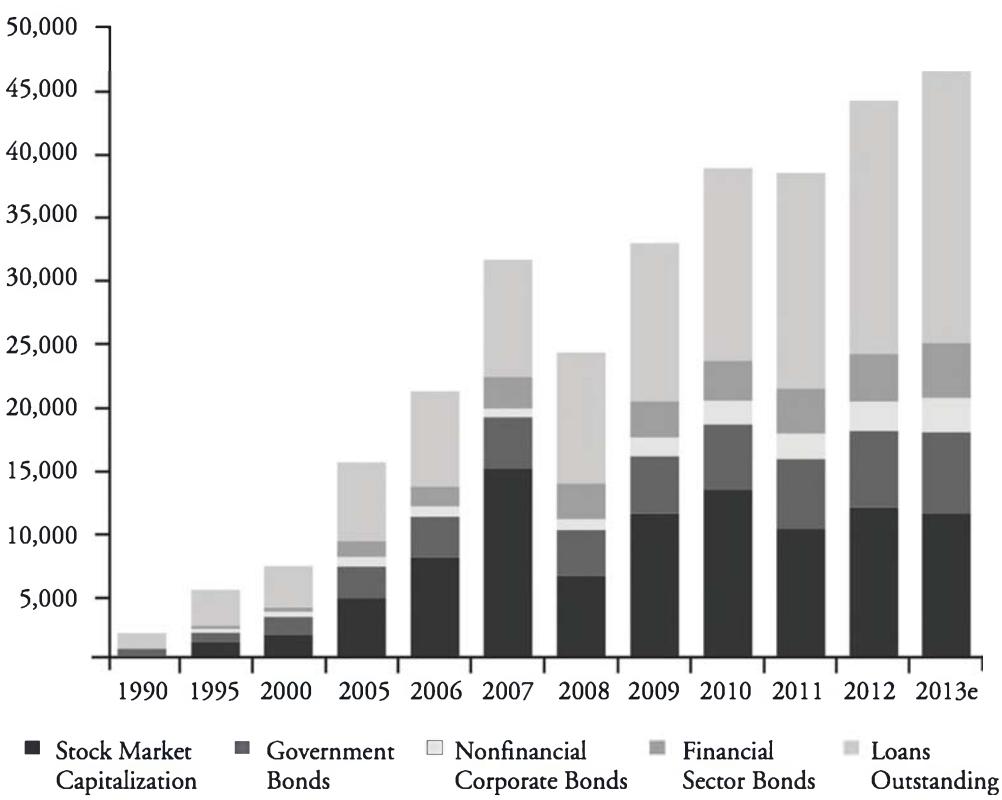
Figure 1: Corporate Debt Issued by Emerging Market Economies

Source: Figure 1, “International Bond Issuance by Emerging Market Economies,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 3.

Corporate bond issuances have been numerous in both local and international markets between 2000 and 2013, \$971 billion in international markets (approximately 53% from Latin America) and \$1.3 trillion in local markets (approximately 62% from emerging Asia). Additionally, the foreign currency debt of emerging market borrowers has ballooned to more than \$3 trillion in 2013, compared to domestic currency debt of around \$750 billion. Of the nearly \$4 trillion debt, domestic currency-denominated debt accounts for only about 20%.

Figure 2 illustrates the breakdown of all emerging market financing into five categories: loans, financial sector corporate bonds, nonfinancial sector corporate bonds, government bonds, and stock market capitalization. Emerging economies represented in Figure 2 include Argentina, Brazil, Bulgaria, China, Colombia, Czech Republic, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Philippines, Poland, Russia, South Africa, Thailand, Turkey, and Ukraine. Although the slice is growing, it is clear from the breakdown that nonfinancial corporate bonds still comprise a relatively small part of total financing (5.3% in 2013). Including financial sector bonds, the total is around 14.8% in 2013. Though relatively small in terms of total financing, this debt can be a source of financial instability. It must be noted though that because these are globally active firms (i.e., costs and revenues are often denominated in foreign currencies), one should expect that treasury activities would also have large foreign components.

Figure 2: Emerging Market Financing (in \$ Billions)



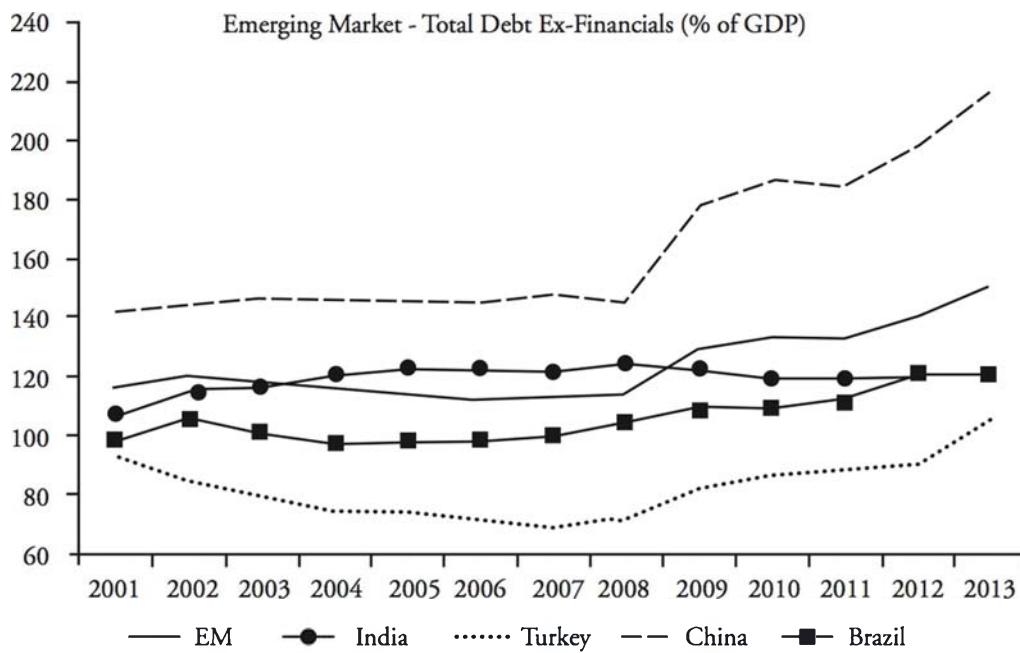
Source: Figure 3, “The Financial Structure of Emerging Market Economies,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 5.

RISK FACTORS ASSOCIATED WITH CORPORATE DEBT

LO 79.2: Examine the risk factors that firms face due to external debt and explain how these risks are transmitted to the financial system.

Traditionally, the focus of excess and potentially dangerous leverage has been on banks and sovereigns. However, it is also important to monitor the level of corporate debt. As an example, in emerging Asia, all sectors (government, financial, and corporate), have seen foreign currency bonds increase (from 2000 to 2012), but corporate debt has increased the most and has the largest dollar amount of the three (approximately half of the more than \$700 billion total in 2012). Figure 3 documents the growth in private sector indebtedness from 2001 to 2013 (as a percent of GDP) of Brazil, China, India, and Turkey. Foreign investors hold most emerging market corporate debt. When corporations issue foreign currency bonds, it contributes to the decline in the net foreign currency position of many emerging countries. Increasing foreign debt loads makes emerging economies more susceptible to macroeconomic slowdowns and shifting funding conditions that may result from monetary policy changes (e.g., withdrawal of quantitative easing) in the United States and other countries.

Figure 3: Growth in Private Sector Indebtedness



Source: Figure 11, “Debt Liabilities of Nonfinancial Sector in Emerging Market Economies,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 14.

There are four basic risks borrowing firms face. They are:

- **Maturity risk:** relying on short-term funding for longer-term investments.
- **Currency risk:** firms issue liabilities in a different currency than asset and revenue streams. In other words, firms may use foreign currency debt to fund domestic currency investments. Sometimes the relationship between the exchange rate and variables that affect a firm's profitability, such as commodity prices or demand for the product or service, may be underestimated.
- **Rollover risk:** borrowers may not be able to renew debt as lenders may be sensitive to shifts in financial opportunities in other market segments. Also, lenders may be sensitive to macroeconomic, sectoral, or firm-level (projection) shocks. Finally, lenders may be forced to liquidate positions to meet redemption requests.
- **Speculative risk:** in some cases, the treasury operations of corporations act as profit centers as firms speculate in currency derivatives or exploit carry trade opportunities in financial markets.

As risk-spreads compress, corporate risk taking increases, especially for global firms that are more reliant on external financing. This happens during periods of *high global liquidity* [proxied by a drop in risk indices such as the volatility index (VIX)]. When the reverse occurs and liquidity tightens (e.g., in 2001 and from 2007–2009), these firms suffer the most. Interconnectedness between firms means a shock to one can reverberate across firms (i.e., systemic risk). Also, more leverage means magnified outcomes. For example, if commodity prices fall, leveraged companies must increase output to service debt, pushing commodity prices down even more.

The strains on corporate balance sheets can lead to systemic financial risk. These risks are transmitted to the financial system both directly and indirectly. There are four **direct transmission channels**:

1. If a firm incurs losses on its foreign financial activities, its creditworthiness, both foreign and domestic, will deteriorate. Also, incurred losses increase the riskiness of the balance sheet assets of the financial institutions with which the borrower does business.
2. If foreign debt cannot be rolled over, the company may be forced to withdraw liquid assets from domestic institutions or liquidate domestic assets to meet its immediate financial obligations.
3. If foreign currency exposure is hedged in the derivatives market with a domestic bank as a counterparty, settlement of the positions may impair the bank.
4. When large corporations seek bank funding (because they lose access to bond markets), they squeeze out small and medium-sized enterprises (SMEs). Smaller companies will have reduced access to bank funding (i.e., there is a negative relationship between SME access to loans and the external funding conditions of large corporations).

There are three **indirect transmission channels**, the first two through banks and the third affecting the economy as a whole:

1. Corporations may provide intermediation services. If a firm makes short-term loans to nonfinancial intermediaries and the intermediaries are counterparties to banks, stress to the corporate lender (via a withdrawal of funding) will transmit to the banks. This is more likely in emerging economies. Financial firms are highly regulated in emerging economies, providing incentives for nonfinancial firms to act as intermediaries (compared to nonfinancial firms in advanced economies). Regulatory burdens on financial firms in emerging economies tend to have:
 - ◆ Higher capital requirements.
 - ◆ More binding capital requirements.
 - ◆ Stricter definitions of what constitutes capital.
 - ◆ More conservative risk weights.

Corporations in emerging markets have an incentive to borrow then conduct *on-lending* (i.e., lend money that has been borrowed previously from an organization or person) because they can avoid the high regulatory costs borne by financial institutions.

2. When emerging market governments issue a significant amount of domestic currency debt and corporations in the same countries have large amounts of foreign currency debt, financially stressed sovereigns may default on domestic currency debt rather than depreciate the local currency. Knowing this, investors will drive up the sovereign risk premium. If banks hold a portion of the sovereign debt, they will lose in the mark-to-market value of some of these assets, which reduces bank capital and increases systemic risk.
3. If financial losses due to high corporate leverage jeopardize the level of production or the viability of borrowing firms, specific sectors and the overall economy are threatened. At the firm level, this risk may not be important, but in the aggregate, risks may be considerable.

CASE STUDIES

LO 79.3: Analyze the role of corporate debt in emerging economies using the following case studies:

- External commercial borrowings in India.
 - Foreign currency lending to Turkish corporates.
 - Corporate bond issuance in Latin America.
-

Case Study 1: External Commercial Borrowings in India

India's external debt totaled \$461.9 billion at the end of 2014. **External commercial borrowings** (ECBs) make up the greatest share of the total at 37%, followed by nonresident Indian deposits (23.8%), loans from multilateral and bilateral agencies (17.4%), and short-term trade credit (17.1%). Commercial bank loans comprise the greatest slice of the \$170.8 billion of corporate borrowings. The rest is securitized borrowings, including foreign currency convertible bonds (FCCBs). The ECB share of total debt has grown precipitously. Since 1995, the fraction of ECB debt to total external debt was 13.1% in 1995, 19.7% in 2005, and 37% in 2014.

Several factors have contributed to the growth, including:

- An increase in investor demand and risk appetite for emerging market debt.
- Increasing interest rates in India relative to foreign rates.
- Strong investment demand in India.
- Improved sovereign credit ratings.
- An underdeveloped local corporate bond market in India.

ECBs are used to finance:

- Modernization.
- Capital goods importation.
- Acquisitions abroad.
- Rupee spending on local capital goods.
- Refinancing of existing ECBs. To refinance rupee loans, the borrower must get approval from the Indian central bank, the Reserve Bank of India (RBI).

Corporate on-lending is generally not permitted by law. Investing borrowed funds in capital markets is also prohibited. The most a firm can borrow in a single year is \$750 million. For longer-term loans (loans with maturities greater than five years), costs are capped at 500 basis points above six-month LIBOR.

Borrowers face the risk of a depreciating rupee. This leads to three questions.

1. Are firms with higher external borrowings more negatively affected by adverse currency movements? Some firms may hedge exchange rate risk in derivatives markets or naturally via the exporting of goods.
2. Because some firms hedge foreign exchange exposure, is exposure to exchange rate movements best captured by examining the sensitivity of stock returns to currency movements? In other words, which is the better measure, market-based measures such as FX β (the sensitivity of the firm's excess returns to the rate of exchange) or balance sheet measures of foreign borrowing?

3. For a given high FX β group of firms (i.e., those with high foreign debt and unhedged exposure), are those with proportionally high foreign borrowings relative to total debt or to total assets more vulnerable to exchange rate shocks?

To examine these questions, data from the RBI on foreign borrowings of Indian corporations, financial information on publicly traded companies from the Prowess database of the Centre for Monitoring Indian Economy (CMIE), and National Stock Exchange (NSE) NIFTY index of 50 firms and the USDINR exchange rate data from Datastream are used. For purposes of analysis, 468 firms are matched between the RBI and Prowess databases.

Figure 4 shows matched sample summary statistics. The average maturity is 6 years, the median borrowing amount is \$20 million, and the average borrowing amount is approximately 68 million.

Figure 4: Sample Summary Statistics

2013	Mean	Median	St. Dev.	P5	P95
Amount (US\$ millions)	67.942	20.00	148.259	3	300.00
Maturity (years)	6.239	5.25	2.518	3	11.25
Number of Facilities (per firm)	3.803	2.00	4.907	1	13.00

From January 2004 to December 2014, the average maturity has remained around 6 years. However, the inflation-adjusted average amount of ECB spiked to more than \$60 million before the financial crisis of 2007–2009, fell below \$40 million, and rebounded to the current average of approximately \$67 million since 2009.

Balance sheet summary statistics are presented in Figure 5. Foreign currency debt comprises 33.8% of total debt. Total debt makes up 35.6% of assets for the sample firms. Across the sample period 2004 to 2014, debt as a percent of assets has trended slightly upward but has remained fairly steady around 35%. However, foreign debt as a percent of assets has been more cyclical, rising sharply in the few years leading up the 2007–2009 global financial crisis, peaking in 2007 and then falling back a bit to the 2014 level of 33.8%.

Figure 5: Balance Sheet Summary Statistics

	N	Mean	Median	St. Dev.	P5	P95
Total Debt (bn INR)	4,868	19.650	2.910	85.330	0.110	65.56
Long-Term Debt (bn INR)	4,868	16.410	1.720	76.190	0.020	55.02
Foreign Currency Debt (bn INR)	2,819	6.608	1.103	21.421	0.032	23.548
Long-Term Debt/Total Debt	4,858	0.662	0.705	0.269	0.110	1.000
Foreign Currency Debt/Total Debt	2,814	0.338	0.280	0.262	0.015	0.879
Foreign Currency Debt/Total Assets	2,819	0.116	0.089	0.105	0.004	0.318
Debt/Assets	4,868	0.356	0.352	0.196	0.050	0.661

For each firm, the following equation estimates a market-based measure of foreign exchange risk:

$$R_{i,t} = \alpha + \beta_M R_{M,t} + \beta_{FX} R_{FX,t} + \varepsilon_t$$

where:

$R_{i,t}$ = return for firm i on day t

$R_{M,t}$ = market return (Indian stock market proxied by the NIFTY index return)

$R_{FX,t}$ = USDINR daily return defined as $(P_t - P_{t-1}) / P_{t-1}$; where P_t = number of INR required to buy \$1 at the end of period t

The model is estimated over a 75-day trading window, using ordinary least squares (OLS) regression to obtain rolling estimates of β_{FX} for each sample firm. Figure 6 presents the results. Note that for the highest average β_{FX} firms, β_{FX} ranges from 0.552 to 0.318. The firms' industries, leverage ratios, foreign debt to total debt ratios, and the frequency with which the firms borrow vary widely across the list. This means there is no "typical" firm that has high currency risk exposure.

Figure 6: Foreign Exchange Betas

Company Name	FX β	NIFTY β	Foreign/ Total Debt	Debt/ Assets	No. of ECB Issuance	Avg. Amt. (US\$ mn)	Avg. Maturity
Ajanta Pharma Ltd.	0.552	0.806	0.332	0.344	1	5.920	5.000
Prakash Industries Ltd.	0.520	1.050	0.461	0.435	2	39.711	5.000
Rolta India Ltd.	0.502	1.111	0.756	0.327	7	46.328	6.905
Shree Ashtavinayak Cine Vision Ltd.	0.484	0.724	0.359	0.303	1	29.104	5.583
Supreme Petrochem Ltd.	0.482	0.746	0.200	0.209	1	8.054	6.083
Suryajyoti Spinning Mills Ltd.	0.482	0.690	0.159	0.617	2	6.300	5.625
Aksh Optifibre Ltd.	0.447	0.733	0.625	0.266	5	7.809	4.267
Wipro Ltd.	0.407	0.982	0.289	0.104	2	188.536	5.083
S Kumars Nationwide Ltd.	0.405	1.177	0.049	0.634	2	38.661	5.958
Jagran Prakashan Ltd.	0.400	0.496	0.243	0.208	3	7.138	4.833
Paramount Communications Ltd.	0.399	0.736	0.271	0.529	2	15.473	5.000
Micro Inks Pvt. Ltd.	0.389	0.643	0.802	0.205	10	5.799	3.750
Eveready Industries (India) Ltd.	0.372	0.880	0.324	0.294	1	22.179	7.000
Hi-Tech Gears Ltd.	0.361	0.749	0.436	0.302	4	3.208	5.375
Kanoria Chemicals Inds. Ltd.	0.357	0.584	0.257	0.382	2	14.227	6.042

Figure 6: Foreign Exchange Betas (Continued)

<i>Company Name</i>	<i>FX β</i>	<i>NIFTY β</i>	<i>Foreign/ Total Debt</i>	<i>Debt/ Assets</i>	<i>No. of ECB Issuance</i>	<i>Avg. Amt. (US\$ mn)</i>	<i>Avg. Maturity</i>
Hitachi Home Life Solutions (India) Ltd.	0.352	0.819	0.734	0.188	3	6.393	4.333
Karur K C P Packkagings Ltd.	0.329	0.496	0.195	0.549	1	8.970	5.000
Glenmark Pharmaceuticals Ltd.	0.323	0.636	0.403	0.323	4	25.976	5.021
Micro Technologies (India) Ltd.	0.318	0.677	0.447	0.202	1	12.640	5.417

An event study is used to examine the stock market response to various announcements regarding the probability of reducing quantitative easing by the Federal Reserve. On May 22, 2013, Federal Reserve Chairman Ben Bernanke reported to Congress that tapering would begin following the next couple of Federal Open Market Committee (FOMC) meetings. He followed the statement on June 19, 2013, suggesting bond purchases would be reduced later in 2013. He unexpectedly reversed the statements on September 18, 2013, saying the Fed would delay tapering asset purchases until the economy strengthened. To examine the effect of the announcements on high versus low exposure (to FX shocks) firms, the sample is divided into terciles (i.e., into thirds—high, medium, and low β_{FX} firms). The cumulative abnormal returns (CARs) are estimated over the five days following the announcements.

When examining event study results, the signs are as expected, a negative response to the first two announcements and a positive response to the last announcement [except low β_{FX} , which barely (i.e., statistically insignificantly different from zero) responds to the postponement announcement]. High β_{FX} firms are most sensitive to the announcement (statistically significant at the 1% level). However, there are no statistically significant differences between the low, mid, and high foreign debt to total debt ratio firms and low, mid, and high foreign debt to total asset firms, though the firms do react as predicted, negative to the first two announcements and positively to the last. These results support the supposition in the second question previously posed; market-based measures of foreign exchange risk better capture vulnerabilities than balance sheet measures.

The third hypothesis (i.e., question 3 stated previously) is inconclusive. When double sorting the firms, putting high β_{FX} firms with high foreign debt to total debt or high foreign debt to asset firms and low β_{FX} firms with low firms, there are differences (“double high” firms respond the most, “double low” firms respond the least), but the differences are statistically insignificant.

There are several conclusions that can be drawn from the analysis of Indian ECBs. They include:

- Firms with high external borrowings are adversely affected by adverse exchange rate movements.
- Market measures, such as β_{FX} , capture sensitivity to exchange rate shocks better than balance sheet measures.

- External corporate borrowings are likely to continue to grow as a proportion of Indian external debt. The interest rate differential between advanced economies such as the U.S. and the Indian economy encourage foreign borrowing.
- As foreign debt increases, policymakers must be aware of increased risks due to foreign exchange volatility. Volatility may arise from changes in U.S. monetary policy or shocks to changes in the current account balance.
- Adverse currency movements may prevent firms from rolling over debt.
- If foreign debt is guaranteed by local banks via standby letters of credit, currency shocks may be transmitted to the domestic banking system.

To recognize and mitigate these risks, policymakers should:

- Use market-based measures (such as FX β) to identify at-risk firms. This solution is, however, not available for private firms.
- The currency hedging activities of firms, either natural via exporting goods and services, or through derivatives markets, must be taken into account when assessing the risk of firms to foreign exchange movements.

Risks to the banking system must be taken into account. To protect banks, policymakers should consider:

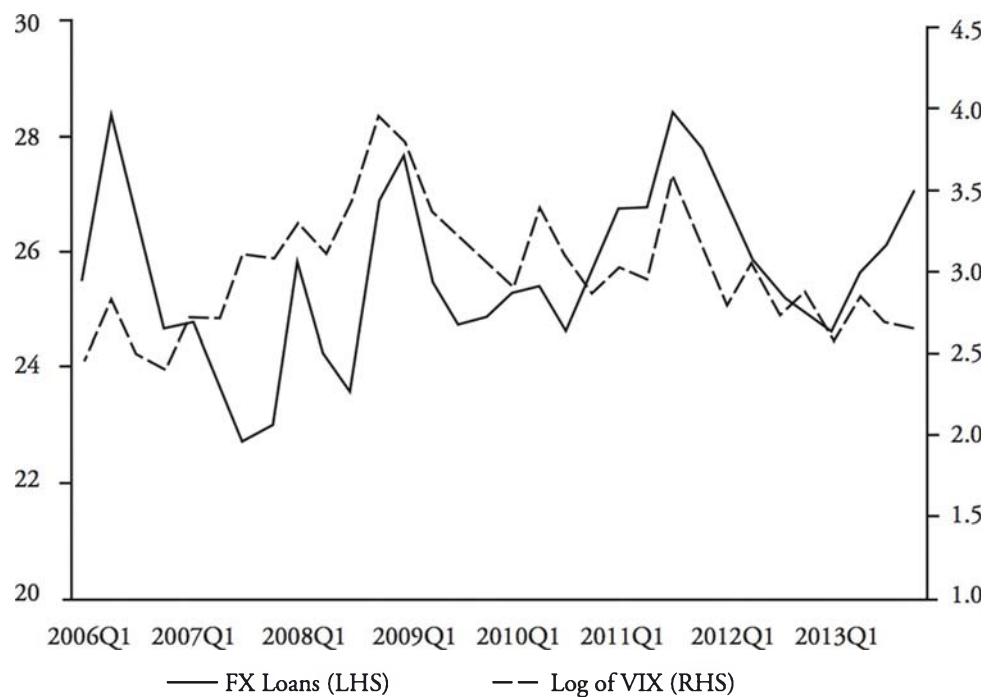
- Raising risk weights or lowering concentration limits (limiting exposure to individual borrowers) for banks linked to firms with high foreign exchange risk.
- Placing limits on off-balance sheet guarantees such as standby letters of credit to firms with high foreign exchange risk.
- Tightening the approval process for bank guarantees. Currently, ECBs must get approval for bank guarantees.

Case Study 2: Commercial Borrowings in Turkey

Despite the rise in foreign currency debt, the bulk of corporate borrowings still reside in domestic banks. In Turkey, 80% of corporate borrowings are from domestic banks. The amount was more than 90% in the mid 1980s, dipped to a low of approximately 50% in the early 2000s, and has generally been increasing since then, to the current level of more than 80%. Private, nonbank debt has also increased in Turkey over the last 15 years.

The domestic credit boom in Turkey can be traced back to global liquidity. When funds are readily available, companies can borrow directly in global financial markets, bypassing local banks. When global capital flows decrease (e.g., Federal Reserve monetary policy shifts away from easing), foreign banks become a more important source of funding for companies. In fact, for a large group of emerging economies, including several South American countries, Croatia, the Czech Republic, Indonesia, South Africa, and others, there is a positive correlation between the VIX and the share of foreign currency loans provided by banks. The same pattern is evident when plotting the relationship for Turkey alone (see Figure 7).

Figure 7: Foreign Exchange Lending (Turkey)



Source: Figure 19, “Global Liquidity and FX Lending in Turkey,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 29.

Figure 7 plots the share of foreign currency loans to total loans (left y-axis) and compares it to the log of VIX (right y-axis). The FX loan line measures the relative size of foreign currency loans to total gross loans. It provides an indicator of both currency and credit risk.

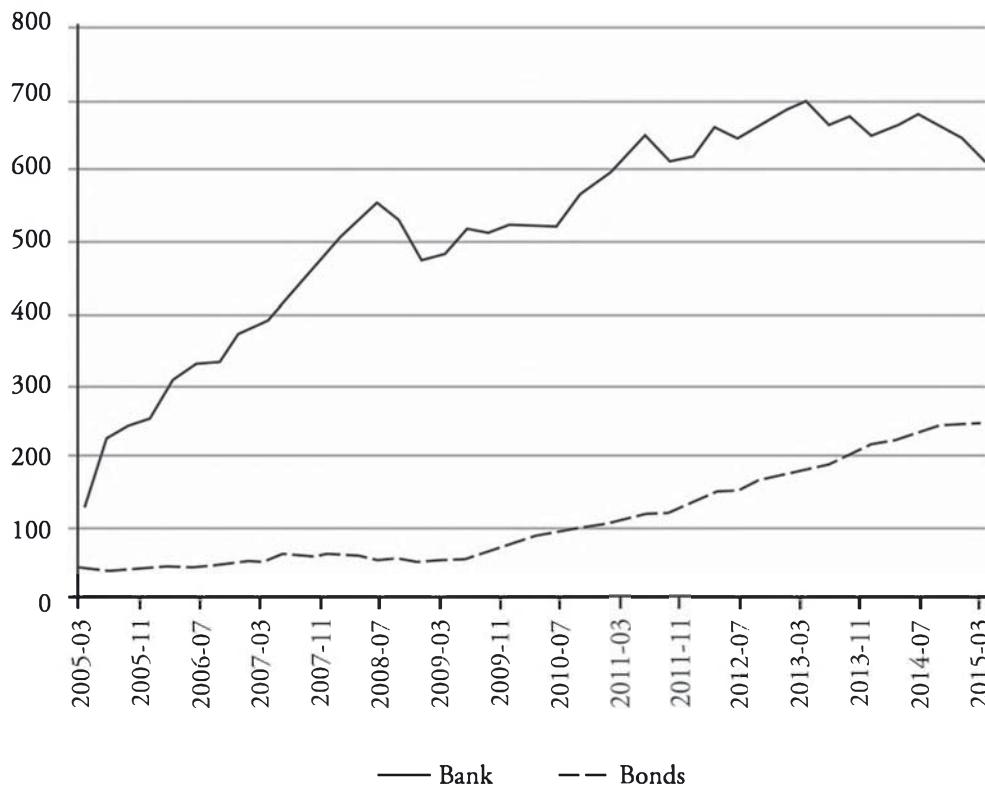
There has been a major credit boom in Turkey. Foreign currency loans increased eightfold between 2006 and 2015, driven by corporate borrowers (not households). However, the share of FX loans to total loans has increased only 50%. This means Turkey is borrowing significantly more overall, not just in foreign currencies. On average, the share of foreign currency loans to total loans is 52% [based on Central Bank of Turkey (CBRT) data and confirmed using loan level transactions data]. The percent has remained relatively constant, implying that total loans and FX loans are growing at roughly the same rates in Turkey. The manufacturing sector has the greatest proportion of FX loans and the construction sector has the lowest proportion. The construction sector did see the greatest increase leading up the global financial crisis starting in 2007 (a threefold increase). The CBRT imposed a rule in June 2009 that nonforeign currency earning firms may only borrow in foreign currency from domestic banks for loan amounts greater than \$5 million.

Studies of Turkey’s debt market indicate less sensitivity to volatility following stricter rules implemented in 2009–2010 following the global financial crisis. This implies that policymakers can dampen risk taking by corporations with macro-prudential policies and changes in regulation.

Case Study 3: Corporate Bond Issuance in Latin America

Figures 8 and 9 examine a subset of Latin American countries: Argentina, Brazil, Chile, Columbia, Mexico, and Peru. Figure 8 shows that nonfinancial corporate bond issuances in Latin America increased threefold between 2010 and 2015. Before the financial crisis, international borrowings were financed by foreign banks. Since the crisis, bond issuances have increased and now account for about one-third of total international corporate borrowing in Latin America.

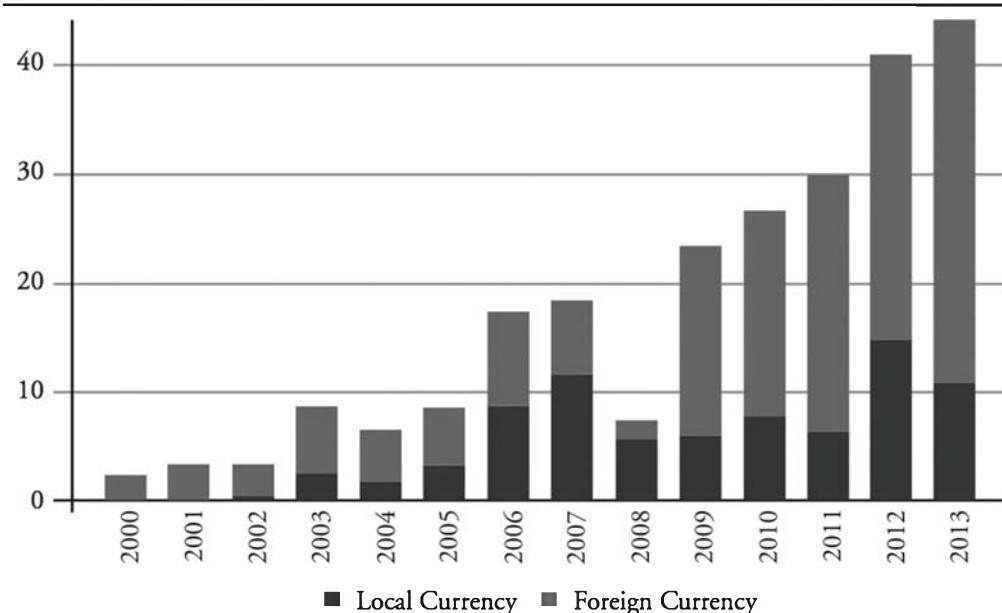
Figure 8: Outstanding Bonds and Liabilities (Latin America in \$ Billions)



Source: Figure 24, “Outstanding International Bonds and Liabilities,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 34.

Figure 9 indicates that foreign currency bonds as a percent of total bond issuances across Latin America increased from 36% in 2007 to 76% in 2013.

Figure 9: Currency Bond Issuances (Latin America in \$ Billions)



Source: Figure 25, “Domestic- and Foreign-Currency Bond Issuances in LAC,” in the Committee on International Economic Policy and Reform, “Corporate Debt in Emerging Economies: A Threat to Financial Stability?” (Brookings Institution, September 2015), 35.

Reviewing the subset of Latin American countries shows that foreign currency bond issues increased in all six countries.

There is some evidence that corporations may be playing an intermediary role in Latin America. There is a statistically significant correlation between external borrowing by nonfinancial corporations and domestic credit growth.¹ Caballero, Panizza, and Powell find that nonfinancial firms use bond proceeds to maintain liquid assets when carry trade conditions are attractive.² As described in LO 79.2, nonfinancial firms can avoid capital controls imposed on financial institutions. Banks, due to regulation, are often constrained to arbitrage away interest rate differentials. Corporations, playing the role of intermediaries, can effectively participate in currency carry trade.



Professor's Note: A currency carry trade involves selling a currency with a low interest rate and buying one with a higher rate, capturing the difference between rates.

Caballero et. al estimate a regression to try and capture the role of nonfinancial firms as intermediaries.³ They find that nonfinancial corporates in countries (and in years) with average capital account openness engage in carry trade activity. The activity increases when interest rate differentials between countries increase. They also find that in countries with large interest rate differentials, nonfinancial firms have a greater incentive to participate in carry trade activities when the capital account is closed. This means relative capital account

1. Andrew Powell, “Global Recovery and Monetary Normalization: Escaping a Chronicle Foretold?” 2014 Latin American and Caribbean Macroeconomic Report (Washington, D.C.: Inter-American Development Bank, 2014).
2. Julian Caballero, Ugo Panizza, and Andrew Powell, “The Second Wave of Global Liquidity: Why Are Firms Acting Like Financial Intermediaries?” (unpublished paper, Inter-American Development Bank and the Graduate Institute, Geneva, 2015).
3. Ibid.

openness is important to the likelihood of nonfinancial firm carry trade activity, but the study indicates that the result is actually driven by controls on capital account inflows.

Conclusions from this analysis include:

- Capital controls can be avoided by nonfinancial firms. Corporations issuing foreign currency bonds use internal capital markets and intercompany loans, normally considered foreign direct investment.
- Given increasing interest rate differentials, the incentive for nonfinancial firms to engage in carry trade is greater in countries with restrictions on the capital account (specifically controls on capital account inflows).
- Independence from global financial conditions is limited by the access nonfinancial firms have to issue bonds in international markets.

POLICY IMPLICATIONS

LO 79.4: Explain the policy implications related to the risks associated with issuance of corporate debt in emerging economies.

As noted in LO 79.2, there are four basic risks firms face: (1) maturity risk, (2) currency risk, (3) rollover risk, and (4) speculative risk. Policymakers may attempt to monitor and prevent firms from engaging in activities that lead to these risks, but it is virtually impossible. Instead, firms themselves (i.e., those borrowing in foreign markets) have both the ability and the incentive to control risk taking. It does not appear that balance sheets can be regulated directly in terms of the types of borrowed funds (e.g., bank loans, the issuance of bonds in international markets, etc.). So what should policymakers and regulators do?

1. Be aware of the potential for nonfinancial firms to transmit balance sheet stress to the financial system and to the macro economy.
2. Use market-based metrics like FX β to identify firms vulnerable to FX shocks. Market metrics incorporate the market's views of firms' hedging activities (natural or in derivatives markets). A firm's susceptibility to exchange rate movements is affected by its hedging activities.

The key question is whether the stress or failure of nonfinancial emerging market borrowers can be transmitted to the banking system and the broader economy. The means by which these risks transmit from nonfinancial firms to the banking system and the broader economy were detailed in LO 79.2. Firms with little relationship to leveraged financial intermediaries (e.g., banks) or firms that do not account for a significant amount of overall economic activities are of little concern in terms of managing these risks at the policymaker or macro level. For example, firms like Walmart and Ford Motor Co. in the United States are examples of firms that would be of significant concern to policymakers because of the interconnectedness to other companies, financial institutions, and so on.

To manage direct channel risks, traditional regulatory (prudential) tools can be employed. They are:

- Sufficient, stringent capital regulations.
- Sufficient, stringent liquidity regulations.
- Sufficient, stringent concentration limits.

These built-in regulatory buffers support stability at the individual financial institution level and in financial markets as a whole. The buffers must be sufficient to manage risks. Potential measures that may be undertaken to ensure sufficient, stringent capital, liquidity, and concentration limits include (1) adjusting asset risk weights used to measure capital, (2) increasing run-off rates used to calculate liquidity requirements, (3) imposing necessarily severe stress tests for assets and liabilities, and (4) central clearing of derivatives contracts.

Adjusting asset risk weights used to measure capital. These weights are generally determined based on historical experience. Because the increased foreign borrowing by corporations in emerging economies is recent, there is little experience to guide policymakers in terms of the risks posed to the financial system by volatile foreign exchange rates. As such, supervisors should err on the side of conservatism, setting asset risk weights higher than it would appear necessary. Regulators might tie risk weights to the company's FX β , increasing the weights for firms with greater exposure.

Increasing run-off rates used to calculate liquidity requirements. The previous argument regarding capital also applies to liquidity requirements and the liquidity coverage ratio (LCR). Banks must have liquid assets sufficient to cover liquidity needs over a 30-day stress period. Run-off rates, the rate at which various deposits will be withdrawn, must be assumed. There are minimum international standards, but supervisors should set run-off rates higher for corporates with greater foreign exchange exposures, again tying it to the company's FX β .

Imposing necessarily severe stress tests for assets and liabilities. In periods of financial stress, banks may prefer to lend to large corporates than to SME (i.e., small and medium-sized enterprises) borrowers. This means exchange rate shocks will be transmitted to SMEs through the banking system. Concentration limits restrict exposure to individual borrowers but in periods of stress can increase shocks felt in the economy. As an alternative, in some developing and developed economies, SME lending is subsidized. Central banks push commercial banks to lend certain classes of borrowers (like SMEs) by providing low-cost liabilities. However, subsidies create inefficiencies. The subsidized borrowers are likely not the most productive in the broader economy. Many economists would argue doing nothing is better than this type of direct lending solution.

Central clearing of derivatives contracts. Another solution that reduces risk is central clearing of all derivatives contracts. Benefits include:

- Margin requirements reduce counterparty risks.
- The size and concentration of positions can be monitored with central clearing parties.
- Central clearing facilitates trade compression and multilateral netting, reducing systemic (interconnectedness) risks.

Because the risks posed by nonfinancial corporate borrowers are the focus, the final user exemption must be eliminated. Nonfinancial entities are currently exempt from the Dodd-Frank Act mandatory clearing requirement. If exempt, nonfinancial firms have an incentive to take part in regulatory arbitrage, providing risk-transfer services like those provided by intermediaries while circumventing the clearing mandate. Corporates with large amounts of foreign currency debt that are also counterparties to derivatives contracts should be required to centrally clear contracts, like financial firms.

Professor's Note: The bottom line of this topic is that nonfinancial corporations (in this case in emerging markets) are generally unregulated but can, via international borrowing, transmit risks to domestic banking systems and the broader economy, generating new sources of risk to global financial stability. The warning is that policymakers and supervisors must take this into consideration when setting limits on bank capital, liquidity, and concentration limits to individual borrowers. Regulators must make sure that these risks are controlled. While easier said than done, the real solution is to regulate activities and functions, not entities. For example, a corporate making loans to other companies using money market funding (i.e., maturity transformation) should be subject to capital requirements. Corporates acting like banks (performing liquidity, maturity, or credit transformation) should be regulated because of the bank-like functions they perform. This, however, is a tall order and one that would require significant changes in the way supervision currently works.



KEY CONCEPTS

LO 79.1

Traditionally, the focus of excess leverage has been on banks and sovereigns. Policymakers must also monitor corporate debt. In the last decade, there has been a significant increase in debt issued by corporate borrowers in emerging markets. Leading up to the financial crisis, international balance sheets of emerging economies improved. Since 2010, the trend has reversed. In 2013, the Federal Reserve announced it would taper off quantitative easing. A tightening of dollar funding will result. An appreciating dollar will increase the cost of dollar-denominated debt to foreign borrowers. There has also been a macroeconomic slowdown in emerging economies. Strains on the balance sheets of nonfinancial and household sectors (not just banks and sovereigns) can trigger systemic financial shocks.

LO 79.2

The key risks facing emerging economy corporate borrowers are risks arising from funding longer-term assets with shorter-term liabilities (maturity risk), risks arising from borrowing in a currency different from that in which revenues are earned (currency risk), investors being unwilling to renew debt (rollover risk), and risks that come from speculative activities (speculative risk).

Excessive leverage on corporate balance sheets can lead to systemic financial risk that can be transmitted to the financial system directly and indirectly. Direct transmission channels include:

1. Losses associated with loans to the firm and bonds issued by the firm can impair the assets of banks.
2. Withdrawals by corporate borrowers to meet the obligations of foreign creditors can result in runs on the liabilities of the banking system.
3. Counterparties providing currency hedges in derivatives markets may feel stress.
4. Banks may increase funding to large corporate borrowers at the expense of small and medium-sized enterprises.

Indirect transmission channels include:

1. Corporate lenders may provide intermediation services, avoiding the regulatory costs that financial firms must bear.
2. Governments may be at risk (choosing to default on domestic currency debt rather than depreciate the local currency) if there is excessive foreign currency debt by corporates in emerging markets.
3. High corporate leverage can trigger recessions when the level of production is jeopardized and there is a reduction in aggregate demand.

LO 79.3

Three case studies exemplify the risks associated with emerging economy corporate debt.

Case Study 1: India

India has seen a significant increase in external corporate borrowings (ECBs). Conclusions regarding this shift include:

- Firms with high external borrowings are adversely affected by adverse exchange rate movements.
- Market measures, such as β_{FX} , capture sensitivity to exchange rate shocks better than balance sheet measures.
- External corporate borrowings are likely to continue to grow as a proportion of Indian external debt due to interest rate differentials.
- As foreign debt increases, policymakers must be aware of increased risks due to foreign exchange volatility.
- Adverse currency movements may prevent firms from rolling over debt.
- If foreign debt is guaranteed by local banks via standby letters of credit, currency shocks may be transmitted to the domestic banking system.

Case Study 2: Turkey

Despite the rise in foreign currency debt, the bulk of corporate borrowings still resides in domestic banks. The domestic credit boom in Turkey can be traced back to excess global liquidity. When funds are readily available, companies can borrow directly in global financial markets, bypassing local banks. Studies of Turkey's debt market indicate less sensitivity to volatility following stricter rules implemented in 2009–2010 following the global financial crisis. This implies that policymakers can dampen risk taking by corporations with macro-prudential policies and changes in regulation.

Case Study 3: Latin America

Latin American corporate (nonfinancial firms) bond issuances increased threefold between 2010 and 2015. There is some evidence that corporations may be playing an intermediary role in Latin America. Conclusions from the case study on Latin America include:

- Capital controls can be avoided by nonfinancial firms.
- Given increasing interest rate differentials, the incentive for nonfinancial firms to engage in carry trade is greater in countries with restrictions on the capital account.
- Independence from global financial conditions is limited by the access nonfinancial firms have to issue bonds in international markets.

LO 79.4

Policymakers should:

- Be aware of the potential for nonfinancial firms to transmit balance sheet stress to the financial system and to the macro economy.
- Use market-based measures [such as foreign exchange (FX) β] to identify at-risk firms.
- Take currency hedging activities of firms into account when assessing the risk of firms to foreign exchange movements. A firm's susceptibility to exchange rate movements is affected by its hedging activities.

To manage direct channel risks, traditional regulatory (prudential) tools can be employed. They are:

- Sufficient, stringent capital regulations.
- Sufficient, stringent liquidity regulations.
- Sufficient, stringent concentration limits.

CONCEPT CHECKERS

1. Which of the following is not expected to be a result of the reversal of quantitative easing by the Federal Reserve?
 - A. Global borrowing costs will likely increase.
 - B. Emerging market economies will see their balance sheets improve.
 - C. There will be a tighter supply of dollars available in global financial markets.
 - D. The Federal Reserve will reduce the amount of money it injects into the economy.
2. The risk a borrower faces if it finds it difficult to renew a loan is called:
 - A. rollover risk.
 - B. maturity risk.
 - C. speculative risk.
 - D. reinvestment risk.
3. Corporations in emerging markets have an incentive to borrow, then on-lend the funds, because:
 - A. they have highly leveraged balance sheets, making lending a highly profitable venture.
 - B. they are subject to financial regulations, like banks, and are therefore encouraged to on-lend.
 - C. they are not subject to the same financial regulations as banks and can therefore act as intermediaries while avoiding the costs of regulation.
 - D. they are prohibited from borrowing in global financial markets unless they invest a proportion directly in capital markets or make loans to other corporations.
4. Turkey's borrowing in international financial markets:
 - A. has decreased in recent years.
 - B. is made up almost entirely of bonds issued in foreign currencies.
 - C. has generally increased in proportion to the increase in total loans.
 - D. has been prohibited by Turkey's central bank following the 2007–2009 global financial crisis.
5. To combat the potential threat to financial stability that results from excessive corporate debt in emerging markets, increasing the assumed run-off rate would strengthen bank:
 - A. capital.
 - B. liquidity.
 - C. concentration limits.
 - D. off-balance sheet regulations.

CONCEPT CHECKER ANSWERS

1. B When the Federal Reserve reverses quantitative easing, it will taper off and eventually stop injecting money into the economy. Interest rates and borrowing costs will rise, and there will be a tighter supply of dollars available in global markets. Emerging market economies will not see their balance sheets improve as a result of the Fed's actions.
2. A Borrowers may not be able to renew debt, called rollover risk, as lenders may be sensitive to shifts in financial opportunities in other market segments. Lenders may also be sensitive to macroeconomic, sectoral, or firm-level (projection) shocks. Additionally, lenders may be forced to liquidate positions to meet redemption requests.
3. C Corporations in emerging markets have an incentive to borrow then on-lend (i.e., lend money that has been borrowed previously from an organization or person) the funds because they can avoid the high regulatory costs borne by financial institutions.
4. C There has been a major credit boom in Turkey. Foreign currency loans increased eightfold between 2006 and 2015, driven by corporate borrowers (not households). However, the share of FX loans to total loans has increased only 50%. This means Turkey is borrowing significantly more overall, not just in foreign currencies. On average, the share of foreign currency loans to total loans is 52%, and the percent has remained relatively constant, implying that total loans and FX loans are growing at roughly the same rates in Turkey.
5. B Banks must have liquid assets sufficient to cover liquidity needs over a 30-day stress period. Run-off rates, the rate at which various deposits will be withdrawn, must be assumed. There are minimum international standards, but supervisors should set run-off rates higher for corporates with greater foreign exchange exposures, again tying it to the company's FX β .

SELF-TEST: RISK MANAGEMENT AND INVESTMENT MANAGEMENT; CURRENT ISSUES IN FINANCIAL MARKETS

10 Questions: 30 Minutes

1. Given the following information, what is the percent of contribution to VaR from Asset A? There are two assets in a portfolio: A and B.

Asset A marginal VaR:	0.05687
Asset A value:	\$7,000,000
Asset B marginal VaR:	0.17741
Asset B value:	\$4,000,000

- A. 64.06%.
- B. 24.27%.
- C. 35.94%.
- D. 63.64%.

2. A portfolio is composed of two securities and has the following characteristics:

Investment in X:	USD 1.8 million
Investment in Y:	USD 3.2 million
Volatility of X:	8%
Volatility of Y:	4%
Correlation between X and Y:	15%

The portfolio diversified VaR at the 95% confidence level is closest to:

- A. \$14,074.
- B. \$206,500.
- C. \$404,740.
- D. \$340,725.

3. The buy side and sell side of the investment industry have different characteristics when it comes to turnover, investment horizon, leverage, and risk measures used. Which of the following does not characterize the side of the investment industry that would be inclined to use VaR as one of their primary risk measures?
- A. Long-term investment horizon.
 - B. High leverage.
 - C. Fast turnover.
 - D. Stop-loss rules are an important form of risk control.

Book 4**Self-Test: Risk Management and Investment Management; Current Issues in Financial Markets**

4. SkyLine Airways has a defined benefit pension scheme with assets of \$165 million and liabilities of \$150 million. The annual growth of the liabilities is expected to be 4.5% with 2.4% volatility. The annual return on the pension assets has an expected value of 7.8% with 12% volatility. The correlation between asset return and liability growth is 0.35. What is the 95% surplus at risk for SkyLine?
- A. \$24.97 million.
 - B. \$54.81 million.
 - C. \$18.84 million.
 - D. \$6.12 million.
5. Portfolio ACC has an expected return of 10%, volatility of 25%, and a beta of 1.2. Assume that the market has an expected return of 8% and volatility of 15%, and that the risk-free rate of return is 4%. What is Jensen's alpha for Portfolio ACC?
- A. 1.2%.
 - B. 2.0%.
 - C. 3.6%.
 - D. 10.8%.
6. Linda Hernandez, FRM, is a hedge fund analyst for a prominent hedge fund allocation firm. Hernandez is concerned about potential measurement errors and various biases in reported hedge fund returns prior to 1996. Looking at hedge fund returns for the largest hedge funds from 1987 to 1996, how would performance be best characterized, and how would various measurement biases affect the performance?
- A. There were so many hedge fund managers not reporting that performance information is deemed unreliable.
 - B. Large hedge fund returns were on par with equities, accompanied by a much higher standard deviation.
 - C. Selection bias caused large hedge fund returns to have little correlation with the average return of hedge funds in commercial databases.
 - D. Large hedge funds substantially outperformed equities, more than enough to account for any measurement biases.
7. A bond dealer states that given recent regulatory changes, there is now more financing of low-risk assets such as repurchase agreements (repos). In addition, he believes that dealers have now increased their holdings of corporate bonds. The dealer is:
- A. correct with regard to both statements.
 - B. correct with regard to his statement on repos only.
 - C. correct with regard to his statement on corporate bonds only.
 - D. incorrect with regard to both statements.
8. A trader measures liquidity in the U.S. municipal bond market by comparing actual trading prices in the market with median prices over the span of the last 2 years. The measure that he is using to assess liquidity is called:
- A. Amihud's measure.
 - B. the bid-ask spread.
 - C. the effective spread.
 - D. Markit's liquidity score.

9. Segregation of duties is a key issue when it comes to traders developing their own algorithms, testing them, and implementing them. Which of the following statements about the segregation of duties is most accurate?
- A. As a supplement to having ideal controls in place at a firm, compensating controls should be in place as well.
 - B. Strong controls within a firm would ideally separate at least two of the activities to decrease the chances of errors and fraud.
 - C. When trading desks formulate their own processes, management should regularly review the desks' processes and report any problems to the board.
 - D. The trading desk should provide relevant reports to the risk management group, senior management, and the board to allow them to assess the firm's total risk.
10. Central banks have held operational jurisdiction over various global economies for many years. Which of the following statements is incorrect regarding recent negative interest rate policy developments?
- A. Many of the central banks that have deployed negative rate policies have done so to address inflation concerns.
 - B. Some central banks had to alter existing infrastructure in order to accommodate negative policy rates.
 - C. Every country that has instituted negative interest rate policies has done so on a stand-alone basis using existing infrastructure.
 - D. Some central banks have combined negative policy rates with asset purchase programs.

SELF-TEST ANSWERS: RISK MANAGEMENT AND INVESTMENT MANAGEMENT; CURRENT ISSUES IN FINANCIAL MARKETS

1. C The component VaR factors in both the marginal VaR and the asset value.

For Asset A: $0.05687 \times \$7,000,000 = \$398,090$.

For Asset B: $0.17741 \times \$4,000,000 = \$709,640$.

Asset A's percent of contribution to VaR is A's component VaR as a percent of total VaR:
 $\$398,090 / (\$398,090 + \$709,640) = 35.94\%$.

Choice A is incorrect because it is the percent of contribution to VaR from Asset B.

Choice B is incorrect because it is the Marginal VaR weight for Asset A.

Choice D is incorrect because it is just the asset weight for Asset A.

(See Topic 67)

2. D Step 1: Calculate the volatility of the portfolio.

$$\text{Variance}_{X,Y} = w_X^2 \sigma_X^2 + w_Y^2 \sigma_Y^2 + 2 \times w_X \times w_Y \times \sigma_X \times \sigma_Y \times \text{Corr}_{X,Y}$$

$$\text{Variance}_{X,Y} = 0.36^2 \times 0.08^2 + 0.64^2 \times 0.04^2 + 2 \times 0.36 \times 0.64 \times 0.08 \times 0.04 \times 0.15$$

$$\text{Variance}_{X,Y} = 0.00082944 + 0.00065536 + 0.000221184$$

$$\text{Variance}_{X,Y} = 0.001705984$$

$$\text{Standard deviation} = \sqrt{0.001705984} = 4.13\%$$

Step 2: Calculate the VaR.

$$\text{VaR} = 1.65 \times \text{volatility} \times \text{portfolio value}$$

$$\text{VaR} = 1.65 \times 0.0413 \times \$5m$$

$$\text{VaR} = \$340,725$$

(See Topic 67)

3. A The sell side of the investment industry uses VaR and stress tests as their primary risk measures. The buy side of the investment industry uses asset allocation and tracking error. The sell side has a short-term investment horizon, uses high leverage, and has fast turnover. Risk controls used are position limits, VaR limits, and stop-loss limits.

(See Topic 68)

4. A Step 1: Calculate the expected surplus growth.

Expected surplus growth = growth in assets – growth in liabilities

$$\text{Expected surplus growth} = (\$165m \times 0.078) - (\$150m \times 0.045)$$

$$\text{Expected surplus growth} = \$12.87m - \$6.75m = \$6.12m$$

Step 2: Calculate the variance then the standard deviation of the A&L.

$$\text{Var}_{A\&L} = w_A^2 \sigma_A^2 + w_L^2 \sigma_L^2 - 2 \times w_A \times w_L \times \sigma_A \times \sigma_L \times \text{Corr}_{AL}$$

$$\text{Var}_{A\&L} = 165^2 \times 0.12^2 + 150^2 \times 0.024^2 - 2 \times 165 \times 150 \times 0.12 \times 0.024 \times 0.35$$

$$\text{Var}_{A\&L} = 392.04 + 12.96 - 49.896$$

$$\text{Var}_{A\&L} = 355.104$$

$$\text{Standard deviation} = \sqrt{355.104} = 18.84m$$

Step 3: Calculate VaR of the assets.

$$\text{VaR} = Z\text{-Score} \times \text{volatility}$$

$$\text{VaR} = 1.65 \times \$18.84m$$

$$\text{VaR} = \$31,086,000$$

$$\text{Surplus at risk} = \text{expected growth in surplus} - \text{VaR}$$

$$\text{Surplus at risk} = \$6.12m - \$31.086m = -\$24.97m$$

Note: Although it is a negative, it is usually expressed as a positive figure as it is assumed that it is a shortfall.

(See Topic 68)

5. A The Jensen measure of a portfolio is computed as follows:

$$\alpha = E(R_p) - [R_f + \beta[E(R_M) - R_f]]$$

$$\alpha = 10\% - [4\% + 1.2(8\% - 4\%)]$$

$$\alpha = 10\% - 8.8\%$$

$$\alpha = 1.2\%$$

(See Topic 70)

6. D There were concerns about measurement errors and biases, but the hedge fund outperformance was more than enough to account for any such errors. Large hedge fund returns were highly correlated to the average return of hedge funds in commercial databases.

(See Topic 71)

Book 4**Self-Test Answers: Risk Management and Investment Management; Current Issues in Financial Markets**

7. D Capital and liquidity requirements for large dealers have increased substantially following the 2007–2009 financial crisis. For U.S. Treasuries, the key change is a cap in the amount of leverage permitted by dealers. The change resulted in much less financing of low-risk assets such as repos. Changes in the corporate bond space resulted in dealers holding far fewer corporate bonds than they did previously.

(See Topic 74)

8. C The effective spread is the distance between actual trading prices and median prices. Amihud's measure captures market depth by dividing absolute daily return by daily volume. The bid-ask spread subtracts the quoted bid price from the quoted ask price. Markit's liquidity score measures the number of participants in a market (market breadth) and implied liquidity.

(See Topic 75)

9. D The trading desk should provide relevant reports to one or more of the following: the risk management group, senior management, and the board. These reports allow them to assess the firm's total risk. In the *absence* of having the ideal controls in place at a firm (due to cost or lack of resources), compensating controls are necessary to counter both systematic and unsystematic risk. They are not necessary if ideal controls are already in place. Strong controls within a firm would ideally separate *all* the activities to decrease the chances of errors and fraud. Should trading desks be allowed to formulate their own processes, excessive risk may be undertaken by the firm. To mitigate the risk, an *independent risk management group* should regularly review the desks' processes and report any problems to senior management, the board, or both.

(See Topic 76)

10. C Many of the central banks that have instituted negative policy rates have done so to address inflation concerns. In most cases, they needed to make structural changes to the existing central banking framework to permit the customized application of negative policy rates. Some have paired negative policy rate programs with asset purchases as well.

(See Topic 78)

FORMULAS

Risk Management and Investment Management; Current Issues in Financial Markets

Topic 62

investor risk premium: $E(R_M) - R_F = \bar{\gamma} \times \sigma_M^2$

security market line: $E(R_i) - R_F = \frac{\text{cov}(R_i, R_M)}{\text{var}(R_M)} \times [E(R_M) - R_F] = \beta_i \times [E(R_M) - R_F]$

Topic 63

Fama-French three-factor model:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML)$$

Fama-French model with momentum effect:

$$E(R_i) = R_F + \beta_{i,MKT} \times E(R_M - R_F) + \beta_{i,SMB} \times E(SMB) + \beta_{i,HML} \times E(HML) + \beta_{i,WML} \times E(WML)$$

Topic 64

fundamental law of active management: $IR \approx IC \times \sqrt{BR}$

Topic 66

$$\text{risk aversion} = \frac{\text{information ratio}}{2 \times \text{active risk}}$$

marginal contribution to value added = (alpha of asset) - [2 × (risk aversion) × (active risk) × (marginal contribution to active risk of asset)]

Topic 67

diversified VaR: $VaR_p = Z_c \times \sigma_p \times P$

individual VaR: $VaR_i = Z_c \times \sigma_i \times |P_i| = Z_c \times \sigma_i \times |w_i| \times P$

standard deviation of a two-asset portfolio: $\sigma_P = \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$

VaR of a two-asset portfolio: $VaR_P = Z_c P \sqrt{w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2}$

undiversified VaR: $VaR_P = \sqrt{VaR_1^2 + VaR_2^2 + 2 VaR_1 VaR_2} = VaR_1 + VaR_2$

standard deviation of equally weighted portfolio with equal standard deviations and correlations:

$$\sigma_P = \sigma \sqrt{\frac{1}{N} + \left(1 - \frac{1}{N}\right)\rho}$$

marginal VaR: $MVaR_i = \frac{VaR}{P} \times \beta_i$

component VaR: $CVaR_i = (MVaR_i) \times (w_i \times P) = VaR \times \beta_i \times w_i$

Topic 68

surplus = assets – liabilities

Δ surplus = Δ assets – Δ liabilities

return on the surplus:

$$R_{\text{surplus}} = \frac{\Delta \text{Surplus}}{\text{Assets}} = \frac{\Delta \text{Assets}}{\text{Assets}} - \left(\frac{\Delta \text{Liabilities}}{\text{Liabilities}} \right) \left(\frac{\text{Liabilities}}{\text{Assets}} \right) = R_{\text{asset}} - R_{\text{liabilities}} \left(\frac{\text{Liabilities}}{\text{Assets}} \right)$$

Topic 69

liquidity duration: $LD = \frac{Q}{(0.10 \times V)}$

where:

LD = liquidity duration for the security on the assumption that the desired maximum daily volume of any security is 10%

Q = number of shares of the security

V = daily volume of the security

Topic 70

Sharpe ratio: $S_A = \frac{\bar{R}_A - \bar{R}_F}{\sigma_A}$

where:

\bar{R}_A = average account return

\bar{R}_F = average risk-free return

σ_A = standard deviation of account returns

Treynor measure: $T_A = \frac{\bar{R}_A - \bar{R}_F}{\beta_A}$

where:

\bar{R}_A = average account return

\bar{R}_F = average risk-free return

β_A = average beta

Jensen's alpha: $\alpha_A = R_A - E(R_A)$

where:

α_A = alpha

R_A = the return on the account

$E(R_A) = R_F + \beta_A [E(R_M) - R_F]$

information ratio: $IR_A = \frac{\bar{R}_A - \bar{R}_B}{\sigma_{A-B}}$

where:

\bar{R}_A = average account return

\bar{R}_B = average benchmark return

σ_{A-B} = standard deviation of excess returns measured as the difference between account and benchmark returns

statistical significance of alpha returns: $t = \frac{\alpha - 0}{\sigma / \sqrt{N}}$

where:

α = alpha estimate

σ = alpha estimate volatility

N = sample number of observations

standard error of alpha estimate = σ / \sqrt{N}

USING THE CUMULATIVE Z-TABLE

Probability Example

Assume that the annual earnings per share (EPS) for a large sample of firms is normally distributed with a mean of \$5.00 and a standard deviation of \$1.50. What is the approximate probability of an observed EPS value falling between \$3.00 and \$7.25?

If $\text{EPS} = x = \$7.25$, then $z = (x - \mu)/\sigma = (\$7.25 - \$5.00)/\$1.50 = +1.50$

If $\text{EPS} = x = \$3.00$, then $z = (x - \mu)/\sigma = (\$3.00 - \$5.00)/\$1.50 = -1.33$

For z-value of 1.50: Use the row headed 1.5 and the column headed 0 to find the value 0.9332. This represents the area under the curve to the left of the critical value 1.50.

For z-value of -1.33: Use the row headed 1.3 and the column headed 3 to find the value 0.9082. This represents the area under the curve to the left of the critical value +1.33. The area to the left of -1.33 is $1 - 0.9082 = 0.0918$.

The area between these critical values is $0.9332 - 0.0918 = 0.8414$, or 84.14%.

Hypothesis Testing – One-Tailed Test Example

A sample of a stock's returns on 36 non-consecutive days results in a mean return of 2.0%. Assume the population standard deviation is 20.0%. Can we say with 95% confidence that the mean return is greater than 0%?

$$H_0: \mu \leq 0.0\%, H_A: \mu > 0.0\%. \text{ The test statistic } z\text{-statistic} = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}} \\ = (2.0 - 0.0) / (20.0 / 6) = 0.60.$$

The significance level = $1.0 - 0.95 = 0.05$, or 5%.

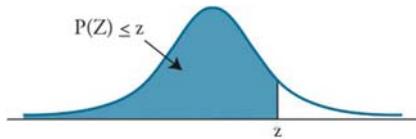
Since this is a one-tailed test with an alpha of 0.05, we need to find the value 0.95 in the cumulative z-table. The closest value is 0.9505, with a corresponding critical z-value of 1.65. Since the test statistic is less than the critical value, we fail to reject H_0 .

Hypothesis Testing – Two-Tailed Test Example

Using the same assumptions as before, suppose that the analyst now wants to determine if he can say with 99% confidence that the stock's return is not equal to 0.0%.

$$H_0: \mu = 0.0\%, H_A: \mu \neq 0.0\%. \text{ The test statistic (z-value)} = (2.0 - 0.0) / (20.0 / 6) = 0.60. \\ \text{The significance level} = 1.0 - 0.99 = 0.01, \text{ or } 1\%.$$

Since this is a two-tailed test with an alpha of 0.01, there is a 0.005 rejection region in both tails. Thus, we need to find the value 0.995 ($1.0 - 0.005$) in the table. The closest value is 0.9951, which corresponds to a critical z-value of 2.58. Since the test statistic is less than the critical value, we fail to reject H_0 and conclude that the stock's return equals 0.0%.

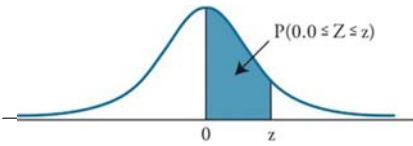


CUMULATIVE Z-TABLE

$P(Z \leq z) = N(z)$ for $z \geq 0$

$P(Z \leq -z) = 1 - N(z)$

z	0	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.937	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.983	0.9834	0.9838	0.9842	0.9846	0.985	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.989
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.994	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990



ALTERNATIVE Z-TABLE

$$P(Z \leq z) = N(z) \text{ for } z \geq 0$$

$$P(Z \leq -z) = 1 - N(z)$$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3356	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4939	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990

STUDENT'S T-DISTRIBUTION

Level of Significance for One-Tailed Test						
df	0.100	0.050	0.025	0.01	0.005	0.0005
Level of Significance for Two-Tailed Test						
df	0.20	0.10	0.05	0.02	0.01	0.001
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.599
3	1.638	2.353	3.182	4.541	5.841	12.294
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.869
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.408
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.768
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.045	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.358	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

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