CHAPTER 2

MARKET LIQUIDITY—RESILIENT OR FLEETING?

SUMMARY

Market participants in advanced and emerging market economies have become worried that both the level of market liquidity and its resilience may be declining, especially for bonds, and that as a result the risks associated with a liquidity shock may be rising. A high *level* of market liquidity—the ability to rapidly buy or sell a sizable volume of securities at a low cost and with a limited price impact—is important to the efficient transfer of funds from savers to borrowers and hence to economic growth. Highly *resilient* market liquidity is critical to financial stability because it is less prone to sharp declines in response to shocks. Market liquidity that is low is also likely to be fragile, but seemingly ample market liquidity can also suddenly drop.

This chapter separately examines the factors that influence the level of market liquidity and those that affect its resilience, and finds that cyclical factors, including monetary policy, play an important role. In particular, the chapter finds that only some markets show obvious signs of worsening market liquidity, although dynamics diverge across bond classes. However, the current levels of market liquidity are being sustained by benign cyclical conditions—and some structural developments may be eroding its resilience. In addition, spillovers of market liquidity across asset classes, including emerging market assets, have increased.

Not enough time has passed for a full evaluation of the impact of recent regulatory changes to be made. Reduced market making seems to have had a detrimental impact on the level of market liquidity, but this decline is likely driven by a variety of factors. In other areas, the impact of regulation is clearer. For example, restrictions on derivatives trading (such as those imposed by the European Union in 2012) have weakened the liquidity of the underlying assets. In contrast, regulations to increase transparency have improved the level of market liquidity.

Changes in market structures appear to have increased the fragility of liquidity. Larger holdings of corporate bonds by mutual funds, and a higher concentration of holdings among mutual funds, pension funds, and insurance companies, are associated with less resilient liquidity. At the same time, the proliferation of small bond issuances has almost certainly lowered liquidity in the bond market and helped build up liquidity mismatches in investment funds.

The chapter recommends measures to bolster both the level of market liquidity and its resilience. Since market liquidity is prone to suddenly drying up, policymakers should adopt preemptive strategies to cope with such shifts in market liquidity. Furthermore, because current market liquidity conditions can provide clues about the risk of liquidity evaporations, policymakers should also carefully monitor market liquidity conditions over a wide range of asset classes. The chapter does not, however, aim to provide "optimal" benchmarks for the level or resilience of market liquidity. Market infrastructure reforms (including equal-access electronic trading platforms and standardization) can help by creating more transparent and open capital markets. Trading restrictions on derivatives should be reevaluated. Regulators should consider using tools to help adequately price in the cost of liquidity at mutual funds. A smooth normalization of monetary policy in the United States is important to avoid disruptions in market liquidity in both advanced and emerging market economies.

Prepared by Luis Brandão-Marques and Brenda González-Hermosillo (team leaders), Antoine Bouveret, Fei Han, David Jones, John Kiff, Frederic Lambert, Win Monroe, Oksana Khadarina, Laura Valderrama, and Kai Yan, with contributions from David Easley (consultant), Yingyuan Chen, Etibar Jafarov, and Tsuyoshi Sasaki, under the overall guidance of Gaston Gelos and Dong He.

Introduction

Market liquidity—the ability to rapidly execute sizable securities transactions at a low cost and with a limited price impact—and its resilience are important for financial stability and real economic activity.[1] A lower level of market liquidity reduces the efficiency with which funds are intermediated from savers to borrowers, and can potentially inhibit economic growth. Market liquidity that is low is also likely to be fragile, that is, prone to evaporation in response to shocks. When liquidity drops sharply, prices become less informative and less aligned with fundamentals, and tend to overreact, leading to increased volatility. In extreme conditions, markets can freeze altogether, with systemic repercussions. Market liquidity is likely to be high if market infrastructures are efficient and transparent, leading to low search and transactions costs; if market participants have easy access to funding; if risk appetite is abundant; and when a diverse investor base ensures that factors affecting certain types of investors do not translate into broader price volatility.

The private provision of market liquidity may not be socially optimal, especially during stress periods. Market participants benefit from abundant and stable market liquidity because it makes transactions less costly and less risky. However, individual traders do not fully internalize the positive externalities for the whole financial system that their participation in the market entails—the more traders trade in a market, the more liquid it becomes. Moreover, because of the network nature of markets, effects tend to be self-reinforcing—high market liquidity tends to attract more traders and so forth. This creates scope for multiple equilibria with different degrees of liquidity (Buiter 2008). To alleviate these problems, in some markets, designated market makers have the obligation to provide liquidity in return for certain advantages.[2] However, in stress situations, other important market failures play a role. For example, market liquidity can be severely impaired as a result of asset price drops, margin calls, and induced fire sales and liquidity feedback loops.[3] Similarly, liquidity contagion across markets can occur.[4] The potentially dramatic effects of sharp declines in liquidity were evident in 2008, during the financial crisis, when market illiquidity amplified shocks originating elsewhere.[5]

Concerns about both a decline in current market liquidity, especially for fixed-income assets, and its resilience have risen lately. Events such as the October 2014 Treasury bond flash rally in the United States, or the April 2015 Bund tantrum in Europe, have reminded us that market liquidity is fickle and that market dislocations can occur even for some of the most liquid assets. Market participants in both advanced and emerging market economies have been expressing worries about a perceived decline in liquidity in a variety of markets. Associated with these worries are concerns about the resilience of market liquidity to larger shocks, such as a "bumpy" normalization of monetary policy in advanced economies. In this context, Chapter 1 of the April 2015 *Global Financial Stability Report* (GFSR) warned of the risk that liquidity could potentially vanish.

In recent years, important transformations in financial markets have had potentially conflicting effects on market liquidity. As banks have been changing their business models and shrinking their inventories, market-making services seem to have become concentrated in fewer clients.[6] In addition, regulations requiring banks to increase capital buffers and restrictions on proprietary trading may have led them to retrench from trading and market-making activities. The introduction of electronic trading platforms and the growing use of automated calculations for computerized trades may have made market liquidity less predictable.

Another key development has been the rise of larger but more homogeneous buy-side institutions, particularly investment funds.[7] Mutual funds have become

[1]Two alternative and widely used concepts of liquidity are funding liquidity—the ease with which financial intermediaries can borrow—and monetary liquidity, typically associated with monetary aggregates. See Box 2.1.

[2]See Bessembinder, Hao, and Lemmon (2011) for a theoretical discussion.

[3]See Brunnermeier and Pedersen (2009).

[4]Externalities caused by market illiquidity during stress periods are well documented in the literature. Specifically, readers can refer to Duarte and Eisenbach (2015) and the references therein.

[5]During the crisis, the effects of the uncertainty surrounding the valuation of asset-backed securities was most likely amplified by a dry-up in liquidity in some markets (Acharya and others 2009).

[6]An intermediary makes a market in a security when it stands ready to sell the instrument at the announced "ask" price and buy it at the announced "bid" price. Market making requires sufficient inventories of the security and large risk-bearing capacity. Under liquid market conditions, market makers (or dealers) execute financial transactions at low bid-ask spreads. See CGFS (2014) for additional explanations and the results of a survey of market participants.

[7]Buy-side institutions are asset managers and other firms that demand "liquidity services," that is, the immediate execution of trades. Sell-side institutions, including many banks, can trade at announced prices, thus providing immediate execution (Hasbrouck 2007).

Box 2.1. How Can Market Liquidity Be Low Despite Abundant Central Bank Liquidity?

As a response to the global financial crisis, several central banks adopted a variety of unconventional monetary policy measures that included asset purchases, or so-called quantitative easing (QE) measures, and the expansion in the availability of central bank liquidity to the financial sector through specific facilities. Various facilities included changes to eligible collateral against which the central bank would extend credit. As a consequence, bank reserves with central banks have soared. Despite this, fears about bouts of market illiquidity have increased. This box tries to explain this apparent contradiction.

Impact on market liquidity

It has long been argued that monetary policy affects market liquidity (Fleming and Remolona 1999). Traditional monetary policy expansions affect market liquidity by reducing the costs of market making and trading. The reduction in market-making costs may be greater if overall uncertainty is reduced. However, the unconventional measures taken by central banks after the global financial crisis have had additional effects on market liquidity. Overall, the above measures affect market liquidity of their targeted markets through the following channels:

The bank funding channel—Like other open-market operations, central banks' purchases of long-term securities increase bank reserves, and therefore funding liquidity. The improved funding liquidity of banks relaxes their funding constraints, making it easier to finance their inventories and thereby supporting market liquidity (Brunnermeier and Pedersen 2009).[1] Indirectly, banks' greater funding liquidity also allows them to continue or increase margin funding to traders or lending to other market makers, with positive effects on the liquidity of securities markets.

However, the link between monetary liquidity and market liquidity is not straightforward, and in recent years, banks have actually retrenched from repo markets. Market participants often attributed this to regulatory changes that have raised the cost of this activity for banks (ICMA 2014). More generally, however, banks may be reluctant to engage in repo or margin lending because of high aggregate uncertainty (Freixas, Martin, and Skeie 2011) or the need to self-insure against funding shocks (Ashcraft, McAndrews, and Skeie 2011).

The market functioning channel—Outright purchases by central banks directly affect the liquidity of the securities being bought by central banks by reducing search frictions that prevent investors from finding counterparties for trades (Lagos, Rocheteau, and Weill 2011).[2] In addition, the presence of a committed and solvent buyer in the market reduces the illiquidity risk for the target securities, and may therefore support market making in these securities and enhance market functioning. As a consequence, the liquidity premium—the compensation investors require to hold a security that cannot easily be sold at a fair market value—is reduced. This market-functioning channel only works for the duration of the QE program or if investors believe the central bank would intervene again in the market should the price of the securities drop too much (Christensen and Gillan 2015).

On the other hand, when certain assets become scarce as a result of central banks' purchases, search costs are raised and those assets' market liquidity is reduced. In particular, outright purchases of high-quality government debt securities may be reducing the total amount of collateralizable securities and contributing to reduced liquidity in repo markets (Singh 2013). Evidence presented in the chapter suggests that this effect may have recently become more important in the United States.

The risk appetite channel—Evidence indicates that accommodative monetary policy increases risk appetite (Bekaert, Hoerova, and Lo Duca 2013; Jiménez and others 2014). When market makers' appetite grows, they are more likely to hold inventories and facilitate trades. Similarly, increased risk appetite implies a higher propensity to engage in trades by other market participants.

Longer-term impact on the investor base and market structure

The prolonged period of easy monetary policies and low interest rates in advanced economies has likely induced a "search for yield" by investors seeking

This box was prepared by Luis Brandão-Marques, Frederic Lambert, and Kai Yan.

[1]For example, the report discusses the role of the European Central Bank's collateral eligibility framework.

[2]These frictions may include dealer failures, communications breakdowns, uncertainty about counterparties' abilities to fulfill trades, and informational asymmetries between dealers and traders. In extreme situations, such frictions may lead to considerable market illiquidity even when funding liquidity is high.

Box 2.1. *(continued)*

higher returns by investing in less-liquid and more risky bonds. Furthermore, it has also boosted the growth of open-end mutual funds and exchange-traded funds investing in longer-term assets while offering daily liquidity, potentially raising liquidity risk (GFSR October 2014, Chapter 2; GFSR April 2015, Chapter 3). Moreover, these developments have resulted in a more homogeneous, and partly more concentrated, ownership structure.

Other forces and overall effects

Overall, this chapter argues that monetary policy has had a positive impact on market liquidity in recent years. On the other hand, as discussed in the text, various structural changes have been working in the opposite direction, reducing market liquidity. The combination of these forces has yielded the mixed picture of market liquidity that we currently observe.

more important for financial intermediation while becoming more sensitive to redemption pressures, more prone to herd behavior (as documented in the April 2015 GFSR), and less likely to absorb order flow imbalances or to make markets. The behavior of hedge funds has become more comparable to that of mutual funds, the role of index-driven and benchmark-driven investment has grown, and the inclination of pension funds and insurance companies to act countercyclically may have declined (Chapter 1 of the October 2014 GFSR).

In addition, unconventional monetary policies involving protracted, large-scale asset purchases are likely to have affected market liquidity in contradictory ways. On the one hand, in some markets the policies have probably enhanced market liquidity by positioning the central bank as a predictably large buyer. On the other hand, the asset purchases have drastically reduced the net supply of certain securities available to investors. Moreover, easy monetary policies have induced a search for yield, prompting funds to invest in bonds with low market liquidity.

These developments call for a better understanding of the factors influencing market liquidity and its resilience, especially in bond markets. Bond prices strongly affect consumption and investment—and hence macroeconomic stability—through interest rate and wealth effects. Bond prices also affect financial stability through their pivotal role in the repo market and their connection to funding liquidity.[8] Moreover, evidence suggests that the bond market is the medium through which monetary policy affects the market liquidity of other asset classes (Goyenko and Ukhov 2009).

[8]Repo markets, for the purposes of this chapter, are considered pertinent mostly to funding liquidity and are not covered by the empirical analyses.

With a special focus on fixed-income assets, this chapter investigates the following questions:

- How has market liquidity evolved in key markets in recent years?
- How has the resilience of market liquidity evolved across markets?
- What factors have driven these developments?

The chapter tackles these issues in three stages, using novel approaches to analyze rich and highly granular data sets. First, the chapter discusses developments in key markets. Next, relying largely on event studies, it sheds light on the different effects of various factors on the level of market liquidity. Finally, the chapter (1) demonstrates that high liquidity can be fragile, and (2) shows how liquidity shocks propagate across markets.

The main findings are as follows:

- *Only some markets show obvious signs of worsening market liquidity.* The evidence, however, points to diverging dynamics across bond classes. Market liquidity indicators for high-yield and emerging market bonds have started to weaken relative to those for investment-grade bonds.
- *Benign cyclical conditions are masking liquidity risks.* Cyclical factors are among the most important drivers of liquidity, and changes in them can help predict shifts in liquidity regimes. Currently, many of these cyclical determinants—investor risk appetite, and macroeconomic and monetary policy conditions—are creating very benign market liquidity conditions, but they can turn quickly, and spillovers of weak liquidity across asset classes (including emerging market assets) have increased.
- *Regulatory changes are likely to have had mixed effects on market liquidity.* Reductions in market making appear to have harmed market liquidity, and banks

now seem to face tighter balance sheet constraints for market making compared with the precrisis period. Nevertheless, conclusive evidence regarding the role of regulation as the driver of this development is still lacking. Restrictions on derivatives trading imposed by the European Union (EU) also have weakened the liquidity of the underlying assets. In contrast, regulations to increase transparency have improved market liquidity by facilitating the matching of buyers and sellers and reducing uncertainty about asset values.

- *Changes in the investor base have likely increased liquidity risk.* Larger holdings by mutual funds, and a higher concentration of holdings among mutual funds, pension funds, and insurance companies, are associated with less resilient liquidity.
- *On balance, monetary policy has had a positive impact on market liquidity in recent years but may have increased liquidity risk*. Monetary policy helped relax funding constraints for financial intermediaries and heighten risk appetite, with important effects on market liquidity. However, outright purchases of some securities have reduced their supply; in the United States, this effect now seems to have started to dominate for those securities, to the detriment of their liquidity. Moreover, accommodative monetary policy has triggered a search for yield, with a rise in holdings of less liquid assets by funds and institutional investors.

The findings suggest the following policy recommendations:

- Policymakers should adopt preemptive strategies to deal with sudden shifts in market liquidity. Since current market liquidity conditions provide information about the risk of liquidity suddenly drying up, policymakers should monitor market liquidity conditions in real time and for a wide range of asset classes using transactions-based metrics.
- Since electronic trading platforms can facilitate the emergence of new market makers, asset managers and other traders should, in principle, have access to these platforms on equal terms.
- Trade transparency in capital markets and instrument standardization should be promoted to improve market liquidity.
- Given their negative effect on market liquidity, restrictions on derivatives trading, such as those implemented by the EU in 2012, should be reevaluated.
- Central banks should be mindful of the side effects on market liquidity arising from their policies on collateral and outright purchases of securities.
- Ways to reduce both liquidity mismatches and the first-mover advantage at mutual funds should be considered (April 2015 GFSR, Chapter 3).
- As the Federal Reserve begins to normalize its monetary policy, a smooth implementation will be critical to avoid disruptions of market liquidity, in both advanced and emerging market economies.

Market Liquidity—Concepts and Drivers

Concept and Measurement

Market liquidity is the ability to rapidly execute sizable securities transactions at a low cost and with a limited price impact. Market liquidity is different from the notions of funding liquidity (the ability by market participants to obtain funding at acceptable conditions) and monetary liquidity (typically used in relation to monetary aggregates). Despite their differences, these three concepts are related. Funding liquidity, for example, is typically a prerequisite for market liquidity, since market makers also use credit to maintain inventories. Market liquidity, for its part, tends to enhance funding liquidity because margin requirements depend on the ease with which securities can be sold (Foucault, Pagano, and Roell 2013). Monetary expansions ease funding conditions for banks, which in turn can facilitate market-making activities (see Box 2.1 for more details). However, the relationship between these three concepts is not one-to-one, and other factors play a role.

Two aspects of market liquidity must be considered: its level and its resilience. Low levels of liquidity may foretell low resistance to shocks. But measures of the level in normal times may be insufficient to assess the risk that a shock will produce if liquidity "freezes." A well-known characteristic of market liquidity is that it can suddenly disappear during periods of market stress, causing asset prices to strongly overreact to unexpected events.

Can market liquidity be too high? It is difficult to envisage adverse effects of market liquidity in the absence of other major distortions. Higher market liquidity in general reduces volatility and speeds up information aggregation. Conceivably, high market liquidity levels that are largely driven by cyclical factors

can foster the "illusion" of resilient market liquidity, inducing excessive risk taking (Clementi 2001). However, in this case it is the lack of resilience in market liquidity, rather than high market liquidity itself, that is harmful for financial stability. When investors are irrationally overconfident, in theory, high market liquidity could favor trading frenzies and amplify asset price bubbles (Scheinkman and Xiong 2003).[9] Yet, in general, it is easier to think of situations in which funding liquidity rather than market liquidity can be excessive. For example, high funding liquidity can lead financial institutions to take on excessive leverage, which can be detrimental to financial stability (Geanakoplos 2010).

A challenge for financial stability policy is to understand and attenuate the forces that, in the presence of a shock, can suddenly transform a state of high liquidity into one of low liquidity. Abundant and stable market liquidity has aspects of a public good—it benefits all the participants in the market and it is difficult to exclude participants from it; moreover, a sharp decline in market liquidity can adversely affect financial stability. These considerations suggest the potential for liquidity underprovisioning and imply a role for public policy in fostering sound market infrastructures and regulations to enhance liquidity. Moreover, the externalities associated with collapses in market liquidity and associated adverse feedback loops provide an argument for monitoring and managing the conditions that affect the resilience of market liquidity to financial shocks. In situations of stress, direct intervention may be needed. The chapter analyzes factors influencing the level of liquidity in the section on "Changes in Drivers of Market Liquidity—Empirical Evidence on Their Impact." The problem of predicting its resilience is examined in the section on "Liquidity Resilience, Liquidity Freezes, and Spillovers."

The level of market liquidity has many dimensions and cannot be captured by any single measure. However, depending on what dimension of market liquidity one is trying to assess—time, cost, or quantity—some measures are more informative than others. Some measures, such as imputed "round-trip costs," effective spreads (actual or estimated), and Amihud's (2002) price impact measure capture the cost dimension. Others, such as quote depth or dealer depth, capture the quantity dimension (see Table 2.1). This chapter emphasizes the following cost measures, which closely correspond to the definition of the level of market liquidity used in this chapter: the round-trip costs of trades (the cost of buying a security and immediately selling it), effective bid-ask spreads (actual or estimated), and price impact measures.[10]

[9]Asset price bubbles also occur in highly illiquid markets such as the real estate market (Shiller 2000).

General Drivers of Market Liquidity Levels and Resilience

The drivers of market liquidity levels and resilience comprise three broad categories (Figure 2.1). These include (1) the risk appetite, funding constraints, and market risks faced by financial intermediaries, all of which affect their inclination to provide liquidity services and correct the mispricing of assets by taking advantage of arbitrage opportunities; (2) search costs, which influence the speed with which buyers and sellers can find each other; and (3) investor characteristics and behavior reflecting different mandates, constraints, and access to information (Vayanos and Wang 2012; Duffie 2012).

- In recent years, structural developments, as well as monetary policy, have probably affected these fundamental drivers.
- Tighter funding constraints for trading—induced by changes in regulations and in business models—have arguably lowered dealers' risk-taking capacity or willingness to make markets and reduced banks' proprietary trading activities (CGFS 2014; Elliott 2015). Less market making impedes the matching of buyers and sellers, thereby increasing search costs.
- New regulations in major jurisdictions have also affected search costs both positively and negatively in various asset markets.[11] For instance, new trade transparency requirements probably reduced search costs, whereas the EU's ban on uncovered sovereign credit default swap (CDS) positions had the opposite effect.

[10]Some commonly used metrics can be misleading. Market turnover is a widely available quantity measure whose high readings during turbulent times are often taken to indicate high liquidity even though market liquidity at such times may, in fact, be very low (that is, transactions have a large price impact). For cost, quoted bid-ask spreads that are not based on actual transactions may not reflect the actual costs of trades.

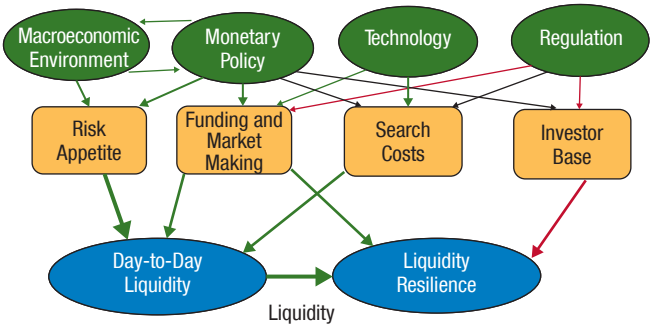
[11]For instance, since 2002 the United States has gradually increased posttrade transparency for corporate bonds by requiring the dissemination of trade information. Also in the United States, the Dodd-Frank Act of 2010 brought greater transparency to over-the-counter derivatives by mandating the disclosure of trades in swap data repositories. In 2017, the Directive on Markets in Financial Instruments (MiFID 2) regulation is scheduled to extend to fixed-income markets many of the pre-and posttrade transparency requirements that currently apply to equities.

Table 2.1. Liquidity Measures

Measures	Data Requirements	Calculation Method	Aspect of Market Liquidity
Bid-ask spread	Quotes	The quoted ask price minus the quoted bid price.	A measure of transaction costs. It shows how much a trader pays by buying and then immediately selling a given security.
Turnover	Volume data	Trade volume divided by market value of outstanding securities.	A measure of trading activity not necessarily related to market liquidity.
Roll's (1984) price reversal	Price data	Covariance between price change in time *t* and time *t*–1.	A measure of bid-ask spreads. It exploits the fact that buy and sell orders arrive randomly and force prices to bounce between ask and bid quotes. This generates a negative autocovariance of returns, under restrictive assumptions.
Corwin and Schultz's (2012) high-low spread	Price data	Nonlinear function of two-day high and low prices.	Similar to Roll's (1984) metric. It measures transaction costs by estimating a bid-ask spread when quote data are not available or unreliable. It uses information on intraday high and low prices.
Effective spread	Price and quotes data	The transaction price minus the quoted mid price (simple average of the best bid and ask quotes).	The actual, round-trip-equivalent, cost of trading to the liquidity demander. It captures how far away from the mid price trades are actually taking place.
Imputed round-trip cost	Price and volume data	The highest price of a security minus the lowest price of the same security with the same trade size within one day.	An indirect measure of the round-trip cost. Captures transaction costs in fixed-income markets by calculating how much it costs if a trader buys and sells the same security at the same day in the same amount. It is useful when there are no quoted prices available.
Price impact	Price and trading volume	Slope coefficient of a regression of price change on signed order flow (buyer-initiated trades minus seller-initiated trades).	A measure of market depth. It estimates the change in price for a given trading volume. In other words, it represents the marginal cost of trading an additional unit of quantity (Holden, Jacobsen, and Subrahmanyam, forthcoming).
Amihud's (2002) measure	Daily price and volume	Absolute daily return divided by daily volume.	A measure of market depth. It shows the daily price change associated with one dollar of trading. Market depth captures the quantity dimension of market liquidity, that is, the ease with which one can trade securities in large amounts.
Quote depth	Quotes	Total number of quotes or sum of quote sizes (total quantities dealers are willing to buy or sell at announced ask and bid prices).	A direct measure of market depth. It documents the depth of the order book and captures the quantity of securities for which dealers are willing to supply liquidity services.
Dealer count	Unique providers of quotes	Number of dealers quoting the security or showing some availability to trade.	An indirect measure of market depth that documents the number of dealer quotes we have on a given security. It also roughly captures the availability of market making.
Markit's liquidity score	Price and quotes data	An instrument-specific index of liquidity calculated by Markit that captures the following aspects: number of dealers; number of quotes; number of price sources; and bid-ask spreads. For bonds, it also takes into account the maturity and whether a benchmark yield curve with liquid bonds exists. For CDS contracts, it also includes volumes, number of price points, and index membership (for single-name CDS).	A composite measure of market liquidity. It provides an ordinal approximation of the many dimensions of liquidity based on observable bond and trade characteristics, with special emphasis on trade costs and data quality. According to Markit, it estimates market breadth—the number of participants in a market—and implied liquidity (useful when data are incomplete or securities do not trade often). A smaller value implies higher liquidity.

Source: IMF staff.
Note: CDS = credit default swap.

Figure 2.1. Drivers of Liquidity and Liquidity Resilience



Source: IMF staff.
Note: Green (red) arrows signify a positive (negative) effect. Black arrows signify an ambiguous or unknown effect. A thicker arrow suggests a stronger effect.

- The growth of electronic trading platforms should have, in principle, reduced search costs. But the implications of the associated advance of automated trades (algorithmic trading) are unclear. They are potentially adverse if such trading is mainly used to demand immediate liquidity or the algorithms are poorly designed. Conceivably, they may have increased the probability and severity of large market dislocations (Box 2.2; Laganá and others 2006).[12]
- Central banks' large-scale purchases of securities under unconventional monetary policy are likely to have affected market liquidity both positively and negatively—positively by relaxing funding constraints, reducing term and default premiums, and raising risk appetite; and negatively by reducing the supply of certain bonds and thereby raising search costs for market participants (Box 2.1). However, the search for yield in a low-interest-rate environment has likely spurred the demand for corporate bonds and stimulated an increase in the number of smaller issues, thus increasing search costs.

These issues are examined empirically in the "Changes in Drivers of Market Liquidity—Empirical Evidence on Their Impact" section.

Changes in other factors have potentially reduced the resilience of liquidity (Box 2.3), while the smaller role of highly leveraged financial intermediaries may have dampened the risk that liquidity might suddenly disappear.

- The growing role in bond markets of mutual funds that offer daily redemptions to retail investors, coupled with signs of increasing herding and concentration among market participants, has made market liquidity more vulnerable to rapid changes in sentiment (CGFS 2014; April 2015 GFSR, Chapter 3).
- This buildup of liquidity risk in the asset management industry was likely encouraged by accommodative monetary policy and the ensuing search for yield (Gungor and Sierra 2014).
- Similarly, the growth of index investors and the more widespread use of benchmarks are likely to have increased commonality in liquidity and thereby systemic liquidity risk.
- At the same time, hedge funds are said to have become more similar to mutual funds in their behavior (October 2014 GFSR, Chapter 1).
- Developments at hedge funds and traditional broker-dealers since the global financial crisis have likely moderated liquidity risk. Although these institutions may have reduced market making by paring back their leverage or their trading activities, they have also reduced the self-reinforcing link between leverage and market liquidity risk.[13]

The issue of predicting the risk of liquidity freezes is examined in the "Liquidity Resilience, Liquidity Freezes, and Spillovers" section.

Market Liquidity—Trends

This section examines the evolution of market liquidity for corporate and sovereign bonds with an emphasis on cost measures of liquidity. The precise choice of market liquidity measure varies according to data availability and market micro-structure; however, all measures try to approximate trade costs.[14]

Among major bond markets, only the U.S. Treasury market appears at first glance to have recently suffered a

[12]Compared with other asset classes, electronic platforms are not prevalent in the trading of corporate bonds (with a share between 10 percent and 20 percent) (McKinsey & Company and Greenwich Associates 2013). Hence, in this chapter, electronic trading does not receive as much attention as other drivers of market liquidity.

[13]See Acharya and Viswanathan (2011) for a theoretical explanation of the link between bank leverage, asset fire sales, and market liquidity spirals.

[14]For instance, for markets in which securities trade infrequently, such as the corporate bond markets, a measure such as Corwin and Schultz's (2012) estimated bid-ask spreads cannot be calculated.

Box 2.2. Electronic Trading and Market Liquidity

In the past few decades, electronic trading platforms have been introduced in a wide variety of markets. This box examines the potential benefits and costs of electronic trading platforms. Using the example from the over-the-counter (OTC) derivatives market, it argues that the introduction of electronic platforms is generally beneficial to market liquidity. However, some recent liquidity episodes also point to the potential vulnerabilities brought about by electronic trading, especially high-frequency trading.

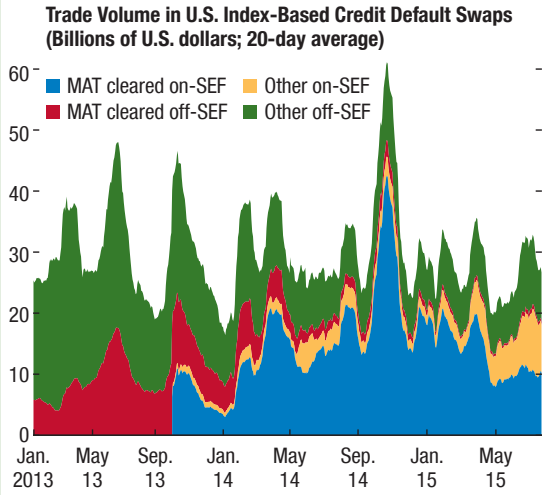
Electronic trading platforms can potentially affect market liquidity in several ways. On the one hand, electronic trading can greatly facilitate matching between buyers and sellers. On the other hand, new trading strategies enabled by electronic trading platforms can potentially cause disruptions to market liquidity in the face of shocks.

Although studies of the impact of electronic trading on the market liquidity of corporate bonds are still scarce, in general they find it to be beneficial. The electronification of fixed-income markets makes it easier to match buyers and sellers by accessing a central limit order book on electronic trading venues. Hendershott and Madhavan (2015) find that electronic auction markets improve the liquidity of thinly traded corporate bonds (although the effects are larger for the most liquid ones). Furthermore, Chaboud and others (2014) find that, in the foreign exchange market, algorithmic trading enhanced price efficiency and average liquidity.

For securities that are originally traded in the OTC markets, the migration to electronic trading platforms can lead to a boost in trading volume and market liquidity, or improve price discovery (Zhu 2012). In the United States, the migration of several OTC derivatives contracts to electronic trading platforms started in October 2013, with the Commodity Futures Trading Commission (CFTC) authorizing the first Swap Execution Facility (SEF). Furthermore, effective in February 2014, the U.S. authorities mandated that all contracts that the CFTC has designated as "made available to trade" with U.S. counterparties be executed on a SEF or exchange market. The first wave of made-available-to-trade designations has focused on highly standardized and centrally cleared contracts, such as certain interest rate swaps and index-based credit default swaps (Figure 2.2.1). Once the implications of these developments for market liquidity in OTC derivatives become clear, important lessons may be drawn for the greater electronification and standardization of the corporate bond markets.

Figure 2.2.1. Trade Volume in U.S. Credit Default Swaps

The volume of trading in interest rate swaps in the United States has greatly increased since the introduction of SEFs.



Sources: ISDA-SwapsInfo; and IMF staff calculations.
Note: MAT = made available to trade; SEF = Swap Execution Facility.

However, electronic trading platforms can also facilitate the growth of high-frequency trading (HFT) firms, with a potential negative impact on the resilience of liquidity. These firms are thought to have been one of the causes of the October 2014 flash rally episode in the U.S. Treasury market. Events such as this, and the May 6, 2010, flash crash in U.S. equity and equity futures markets, show how liquidity can evaporate very quickly even on the most liquid markets in the world and how the lack of liquidity can amplify shocks, resulting in heightened levels of volatility (see Easley, Lopez De Prado, and O'Hara 2011).

The structure of U.S. Treasury markets has experienced significant changes during the past decade, with a declining role for banks and a rise of HFT. The provision of liquidity changed because banks arguably now have less balance sheet space dedicated to market-making strategies, and HFT firms typically operate with very low capital. In normal times, liquidity is ample but when confronted with a shock, the market is more vulnerable because traditional and new market makers are unable or unwilling to provide liquidity.

This box was prepared by Antoine Bouveret, Yingyuan Chen, David Jones, John Kiff, Tsuyoshi Sasaki, and Kai Yan.

Box 2.2. *(continued)*

On October 15, 2014, the U.S. Treasury futures market experienced one of the most volatile episodes of the past 25 years. A disappointing retail sales data release prompted hedge funds to reposition for a delayed Fed rate increase. As prices gradually rose, traditional market makers reduced their provision of liquidity, as shown by the steady decline in order book depth between 8:50 a.m. and 9:33 a.m. of that day (Figure 2.2.2[1]). At the same time, large volumes of algorithmic and other HFT activity were taking place. In the next 12 minutes, liquidity evaporated and a few large trades had a large enough impact on the market to set into motion the dynamics of the flash event. High trading volumes amid very low liquidity resulted in a feedback loop: HFT firms traded aggressively to reduce their risk but given that liquidity was low, the price impact of each trade increased volatility, leading to further trades (Bouveret and others, forthcoming).

A joint report by U.S. authorities (U.S. Department of the Treasury and others 2015) also emphasizes the predominance of HFT and the declining role of broker-dealers. During the flash dynamics, the share of trading done by HFT firms increased markedly to account for 80 percent of trading activity (compared with 50 percent on control days), as HFT firms aggressively bought during the price rise and sold during the decline.

[1]Figure 2.2.2 is available online as a PDF download at IMF.org and elibrary.IMF.org.

deterioration of liquidity (Figure 2.2, panel 2). Nevertheless, that market remains highly liquid compared with most other large markets, and estimated bid-ask spreads are close to their 2004 levels. In the bond markets of the United States, Europe, and emerging market economies, imputed round-trip costs (or similar metrics of liquidity) are generally below their 2007 levels.

The level and resilience of market liquidity for higher-grade corporate bonds appears to be becoming increasingly stronger than that for lower grades. During the past year, quoted spreads of corporate bonds issued in emerging market economies have been rising faster than the spreads for those issued in advanced economies. For investment-grade corporate bonds, the short-term resilience of market liquidity—expressed as the pace at which the level of market liquidity recovers from bad news or unexpected events—seems to be improving faster than that for high-yield issues (Figure 2.3).[15]

Finally, the price impact of trades has risen in some markets. The price impact has increased for various European sovereign bonds and, to a lesser extent, for high-yield corporate bonds. An indication that large trades may now be harder to execute than 10 years ago is that the share of large transactions in trades involving U.S. corporate bonds has fallen (Figure 2.3).[16]

[15]The speed at which liquidity recovers from small perturbations is calculated by regressing the daily changes in aggregate market liquidity on the lagged changes and the lagged level of liquidity. When the coefficient of lagged liquidity is closer to zero, the resilience of liquidity is estimated to be lower.

[16]Likewise, in the futures and equity markets, large trades are more expensive than smaller trades (Kraus and Stoll 1972), and the share of large trades has declined (see the statistics of the World Federation of Exchanges). But as in the corporate bond market, traders now avoid the higher cost of executing a large trade by exploiting technological improvements in risk management and trading platforms to break large trades into many small ones. Hence, the total cost of making what used to be a large trade has probably declined. In addition, the recent increase in corporate bond issuance also reflects a higher share of small issues.

Changes in Drivers of Market Liquidity—Empirical Evidence on Their Impact

This section examines some of the drivers of the level of market liquidity. Because causality between drivers and market liquidity often goes both ways, most of the analyses rely on event studies. Although most (but not all) of the data pertain to securities issued or traded in advanced economies, many implications carry over to emerging market economies.[17]

When considering the extent to which changes in the various drivers have affected liquidity, it is typically difficult to sort out the direction of causality. Thus, the testing of the link between a change in a driver such as market making and a change in the level of market liquidity must take reverse causality into account—that is, the possibility that a change in liquidity can cause a change in the supposed driver. For example, market makers are more willing to provide liquidity services for securities that are more liquid. The approach taken here to overcome problems of reverse causality is to

[17]In addition, for the asset class featured prominently in the section—corporate bonds traded in the United States—some of the securities were issued by entities domiciled in emerging market economies.

Box 2.3. Structural Drivers of the Resilience of Market Liquidity

Several structural drivers have potentially affected the ability of market liquidity to withstand shocks. This box uses two event studies to analyze the contributions of market making, pretrade transparency, and the investor base to the behavior of corporate bond market liquidity in the face of a significant financial shock.

Impact of reduced market marking on liquidity resilience

During the "taper tantrum" episode of 2013, bonds for which there were fewer market makers saw the greatest deterioration of liquidity (Figure 2.3.1). The analysis is based on an examination of a large sample of corporate bonds from across the world, after controlling for various bond characteristics (see Annex 2.2 for details on the methodology). Accordingly, the presence of an additional dealer quoting a bond before the taper tantrum (April 2013) is associated with an improvement in that bond's performance relative to the sample average of roughly 15 percent. The same analysis also shows that higher-credit-quality bonds—thus with lower market-making costs—also experienced smaller declines in liquidity.

Issue size

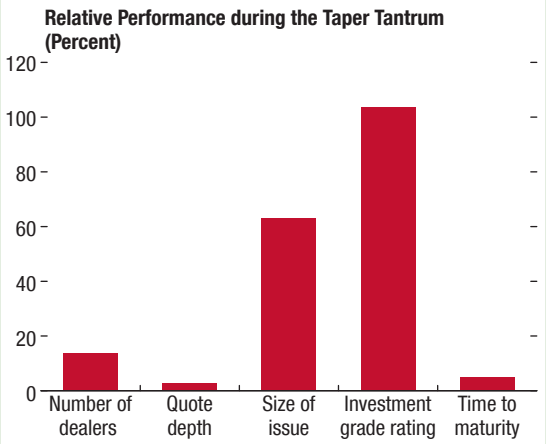
The combination of the proliferation of a variety of smaller issuances and the growth in riskier bonds is likely to have reduced the resilience of liquidity. Bond size or total amount issued by a borrower should be positively related to bond liquidity because larger issues are more likely to have a credit default swap or to belong to an index, or because of economies of scale in gathering information about credit risk. In fact, during the taper tantrum, everything else constant, the liquidity of larger issues exhibited greater resilience.

Trade transparency and liquidity resilience

Pretrade transparency—measured by the number of quotes—is positively related to the resilience of market liquidity.[1] Again for the taper tantrum, the market liquidity of bonds with better pretrade (or quote) transparency performed better than bonds with fewer advertised quotes (Figure 2.3.1). Although the result does not unequivocally establish causality,[2] it suggests that better dissemination of trading interest is associated with smaller declines in liquidity during periods of financial stress, in line with similar findings for the equity market (Boehmer, Saar, and Yu 2005).

Figure 2.3.1. Liquidity during the Taper Tantrum

Relative liquidity performance during the taper tantrum episode was better for bonds with more dealers, larger size, or better credit rating.



Sources: Markit; and IMF staff estimations.
Note: The figure shows the contribution of each factor to a nonfinancial corporate bond's liquidity performance during the taper tantrum episode. Liquidity is measured using Markit's liquidity score, which is a composite index of market liquidity. Solid columns mean statistical significance at least at the 10 percent level. See Annex 2.2.

Investor landscape and liquidity resilience

Empirically, larger holdings by mutual funds, in particular, open-end mutual funds, are associated with more severe liquidity declines during stress periods (Figure 2.3.2). When bonds were more heavily held by mutual funds before the financial crisis or the 2013 taper tantrum, liquidity (imputed round-trip costs) tended to decline more during the event.[3] The result is stronger if the measure of ownership concentration focuses on open-end mutual funds, which is consistent with the view that these funds have a more fickle investor base (Chapter 3 of the April 2015 GFSR). There is no evidence to support the notion that insurance companies or pension funds had a stabilizing impact on liquidity by acting as contrarian investors.

Finally, bond liquidity declines when ownership is more concentrated. During the global financial crisis of 2008, corporate bonds traded in the United States

This box was prepared by Luis Brandão Marques and Kai Yan.

[1]Pretrade transparency refers to the dissemination of quotations or other indications of trading interest (Bessembinder and Maxwell 2008).

[2]It is possible that dealers refrain from posting quotes for bonds that they know to have low resilience.

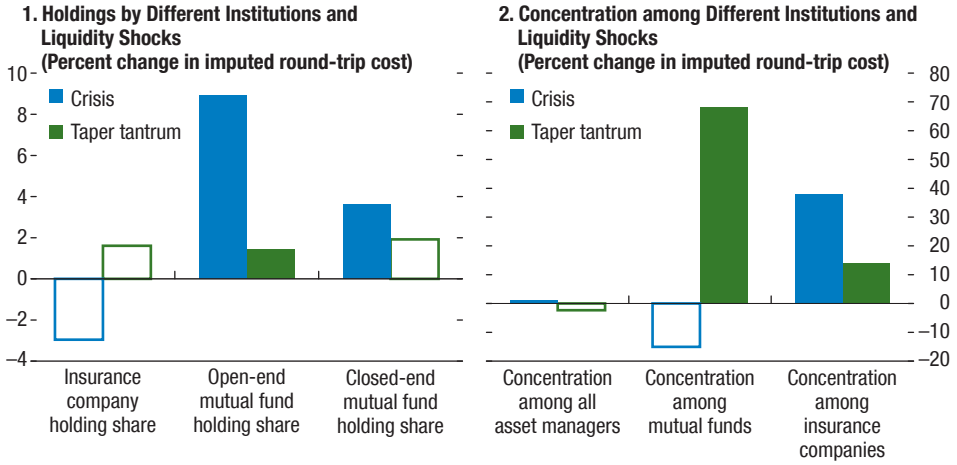
[3]The hypotheses were tested using alternative measures of liquidity such as Amihud's (2002) price impact and Roll's (1984) price reversal, with qualitatively similar results.

Box 2.3. *(continued)*

Figure 2.3.2. Ownership and Market Liquidity

Corporate bond liquidity is more fragile when mutual funds own a larger share.

Concentration of ownership—in particular among mutual funds—makes liquidity more sensitive to financial shocks.



Sources: FINRA Trade Reporting and Compliance Engine; and IMF staff estimations.
Note: The charts show the estimated impact of ownership and ownership concentration on imputed round-trip costs for corporate bonds traded in the United States. A positive value signifies a decline in liquidity. Solid columns mean statistical significance at least at the 10 percent level. See Annex 2.2.

with more concentrated ownership by institutional investors (mutual funds, pension funds, and insurance companies) at the onset of the crisis (first quarter of 2008) experienced a significantly greater decline of liquidity during that year. Similarly, for the 2013 taper tantrum, bonds with more concentrated ownership among mutual funds also saw greater deterioration of liquidity.

use event studies, that is, to identify and examine events in which changes in potential drivers arise from sources independent of the state of liquidity.[18] The event studies are complemented by an econometric analysis of the role of cyclical drivers. The analyses do not, however, aim to quantify the net impact of all the discussed changes on market liquidity.

[18]The empirical work draws information on corporate and sovereign bonds from security-level data and from intraday transactions-level data in three data sets: (1) Financial Industry Regulatory Authority Trade Reporting and Compliance Engine, which covers about 140 million transactions on 100,000 corporate bonds traded in the United States since 2002; (2) MTS, which covers 120 million interdealer transactions in European sovereign bonds since 2005; and (3) Markit's GSAC and CDS databases, which provide liquidity metrics for a large number of bonds and CDS contracts. See Annex 2.1.

Event Studies of Market-Making and Funding Constraints

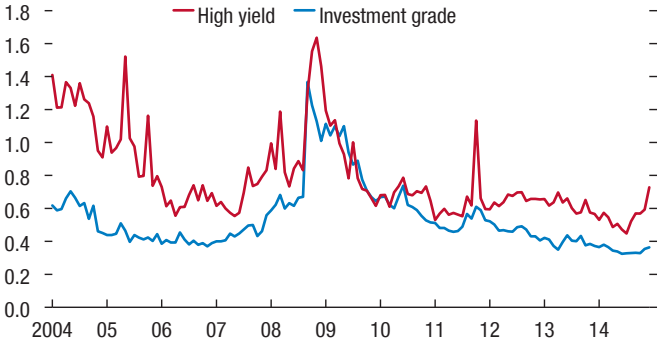
Evidence of reduced market making

Dealer banks in advanced economies show signs of being less active market makers in fixed-income securities (Figure 2.4, panels 3 and 4). In several advanced economies, bank holdings of corporate debt have declined (amid a large increase in total outstanding debt). The evidence on sovereign bonds is more mixed, however, with smaller holdings at U.S. banks and larger holdings at German banks. In addition, surveys by the Federal Reserve and the European Central Bank (ECB) suggest that market making has declined, mostly because of bank balance sheet constraints, internal charges to market making and trading, and regulatory reforms.

Figure 2.2. Trends in Bond Markets—Market Liquidity Level

Imputed round-trip costs for U.S. corporate bonds have declined...

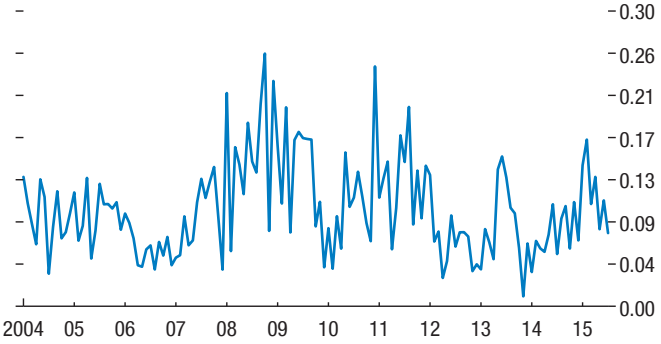
1. Imputed Round-Trip Cost, by Rating
(Percent)



Note: The figure shows the imputed round-trip cost of U.S. corporate bonds, by credit rating.

...while liquidity in the U.S. Treasury market has recently deteriorated.

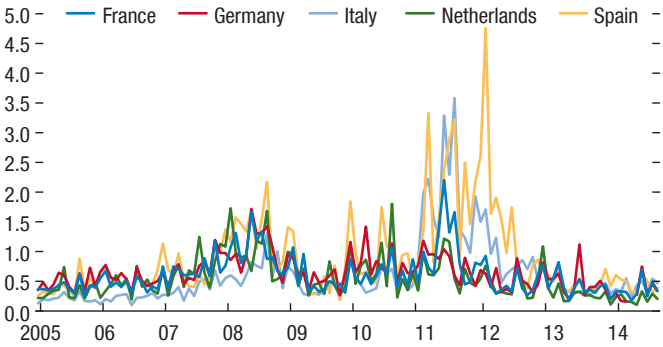
2. Estimated Bid-Ask Spreads for U.S. Treasuries
(Percent)



Note: Bid-ask spread, as a percent of price, for on-the-run 10-year U.S. Treasury bonds, estimated using the high-low spread suggested by Corwin and Schultz (2012).

Liquidity for European sovereign bonds appears to be similar to precrisis levels…

3. Effective Spread for European Sovereign Bonds
(Percent)



Note: The figure shows the effective spread of a two-year on-the-run government bond for the following countries: France, Germany, Italy, Netherlands, and Spain.

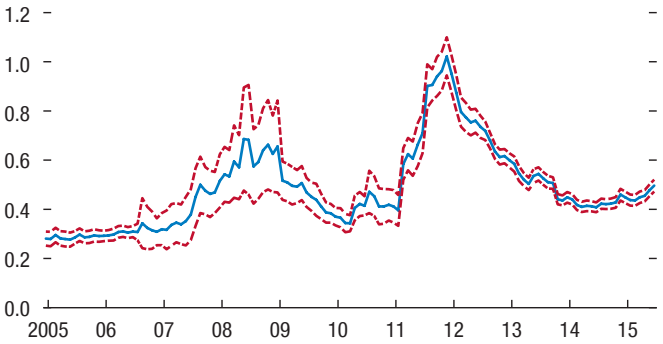
...and the liquidity of emerging market sovereign bonds has been stable.

4. Estimated Bid-Ask Spread for Emerging Market Sovereign Bonds
(Percent)

Note: Bid-ask spread, as a percent of price, for local currency government bonds from Brazil, India, Indonesia, South Africa, and Turkey, with a maturity of at least five years, estimated using the high-low spread suggested by Corwin and Schultz (2012).

European corporate bonds are generally more liquid now...

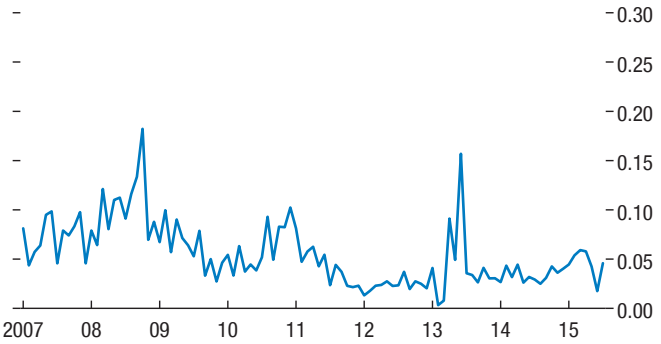
5. Bid-Ask Spreads for European Corporate Bonds
(Percent)



Note: The figure shows average bid-ask spreads for euro-denominated nonfinancial corporate bonds with a maturity greater than one year and all ratings from Belgium, France, Germany, Italy, Netherlands, and Spain. Dashed lines representing 95 percent confidence bands were added to account for increased sample coverage.

...as are Japanese government bonds.

6. Estimated Bid-Ask Spreads for Japanese Government Bonds
(Percent)



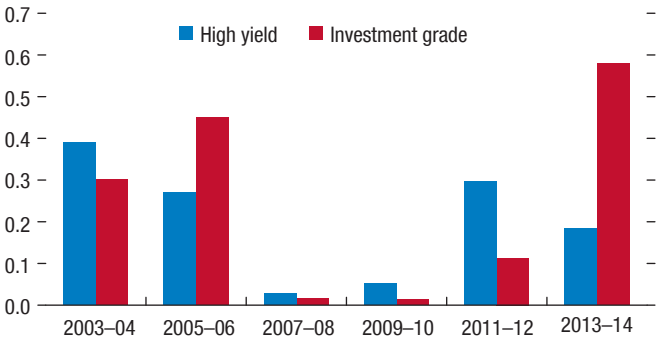
Note: Bid-ask spread, as a percent of price, for on-the-run 10-year Japanese government bonds estimated using the high-low spread suggested by Corwin and Schultz (2012).

Sources: Bloomberg, L.P.; FINRA Trade Reporting and Compliance Engine; MTS; and IMF staff calculations.

Figure 2.3. Bond Market Liquidity—Bifurcation and Price Impact of Transactions

The short-term resilience of liquidity has moved in opposite directions for investment-grade and high-yield U.S. corporate bonds.

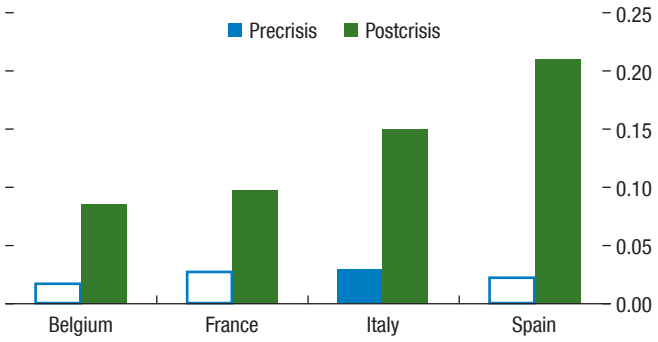
1. Liquidity Mean Reversion Coefficient (Regression coefficient)



Note: The figure shows the coefficients of mean reversion of a measure of market liquidity—imputed round-trip cost—for corporate bonds by credit rating.

The price impact of trades has risen in some European countries.

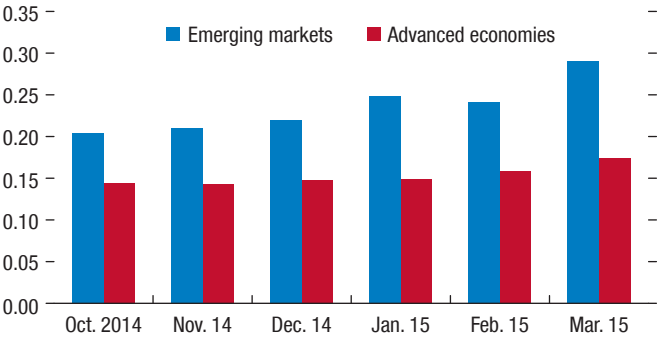
2. Price Impact Coefficient, Five-Year Sovereign Bonds (Coefficient for €100 million in volume; percentage points)



Note: The figure shows the estimated price associated with a €100 million purchase of a five-year on-the-run government bond for the following countries: Belgium, France, Italy, and Spain. Solid bars indicate that the impact is statistically significant at least at the 10 percent level.

Quoted bid-ask spreads have increased faster for emerging market bonds in recent months.

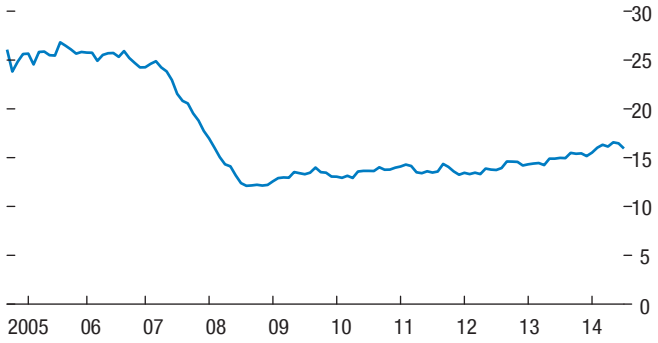
3. Bid-Ask Spreads for Investment-Grade Corporate Bonds (Percent)



Note: The figure shows the average bid-ask spread as a percent of bond par value.

Larger trades are less frequent than before the crisis.

4. Large Transactions in the U.S. Corporate Bond Market (Percent)



Note: The figure shows the fraction of large trades in the U.S. corporate bond market as a percent of total transactions. A large trade is defined as larger than $1 million.

Sources: Bloomberg, L.P.; Markit; MTS; Thomson Reuters Datastream; and IMF staff calculations.

Impact of reduced market making

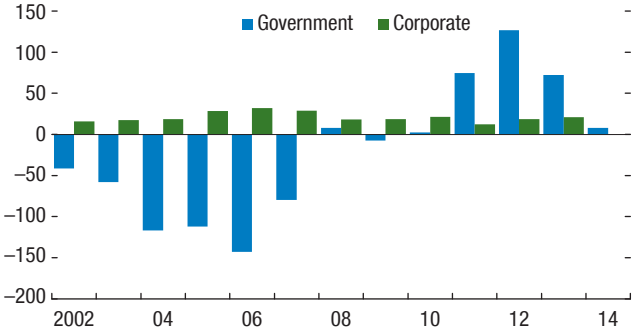
Can reduced market making adversely affect market liquidity? When dealers face constraints in the amount of balance sheet space they can allocate to corporate bonds, market liquidity for those assets deteriorates. To overcome the problem of two-way causality, episodes around U.S. Treasury auctions are examined. When the U.S. Treasury auctions its debt securities, primary dealers must bid for some of the issuance. Assuming that their balance sheet space allocated to fixed-income securities is limited, the auction becomes an exogenous shock to their market-making ability in other markets. In fact, there is evidence that dealers take into their inventory an important share of the issuance, that it takes them several weeks to unload these holdings, and that they mostly do not hedge against them with futures (Fleming and Rosenberg 2008).[19] The analysis in this chapter, based on daily data from 2002 to 2014, shows that on the day after a Treasury auction, aggregate

[19]The dates of the auctions are predictable, but their outcomes are not. See also Duffie (2012) for further considerations and Annex 2.2 for details on the data and method.

Figure 2.4. Trends in Market Making

Bond inventories owned by U.S. banks have declined…

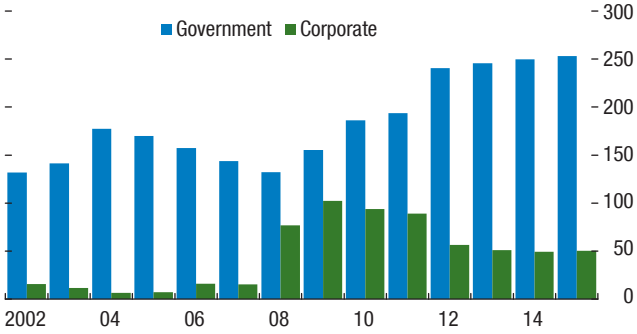
1. Primary Dealer Net Positions, United States (Billions of U.S. dollars)



Note: The figure shows net U.S. Treasury and corporate bond inventories held by primary dealers. Corporate bond figures are adjusted to exclude nonagency mortgage-backed securities and extend through 2013.

...but for German banks, bond inventories remain high.

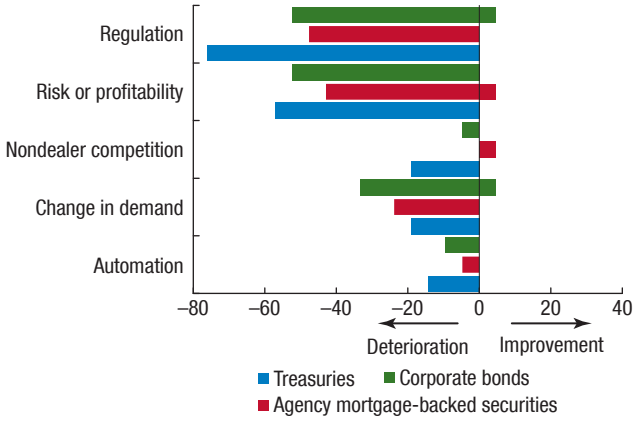
2. Bonds Held by German Banks (Billions of euros)



Note: Total domestic bonds (in gross terms) held by German banks. Data for 2015 are as of March.

A survey of market makers in the United States suggests that dealer balance sheet constraints are a major worry.

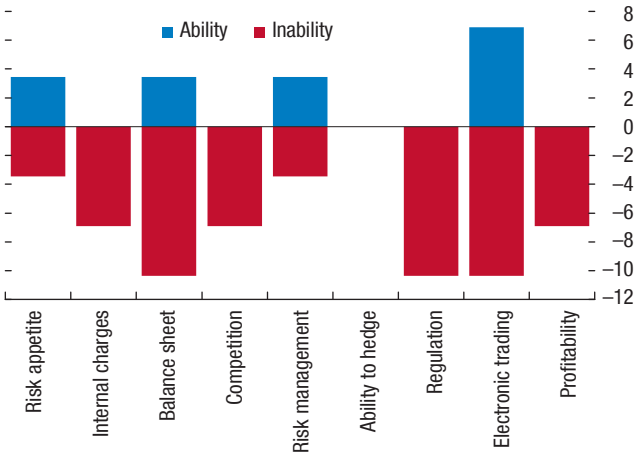
3. Reasons for Changes in Market Liquidity in the United States (Percent)



Note: Survey respondents indicating in top three reasons for change in market liquidity.

A survey of the euro area suggests that lower risk appetite and higher balance sheet constraints are hurting bond market makers.

4. Reasons for Changes in Market Making in Debt Securities (Percent)



Note: Survey respondents indicating in top three reasons for change in their ability to provide market liquidity.

Sources: Deutsche Bundesbank; European Central Bank Survey on Credit Terms and Conditions in Euro-Denominated Securities Financing & OTC Derivatives Markets, December 2014; Federal Reserve Bank of New York; Federal Reserve Senior Credit Officer Opinion Survey on Dealer Financing Terms, June 2015; Haver Analytics; and IMF staff calculations.

market liquidity drops by nearly 13 percent in high-yield bonds but negligibly for investment-grade bonds (Figure 2.5).[20] The same analysis shows that the effect of this measure of banks' balance sheet space has significant explanatory power after 2010, but none for the period before the financial crisis (between 2002 and 2006). This finding suggests that banks now may face tighter balance sheet constraints for market making compared with the precrisis period.

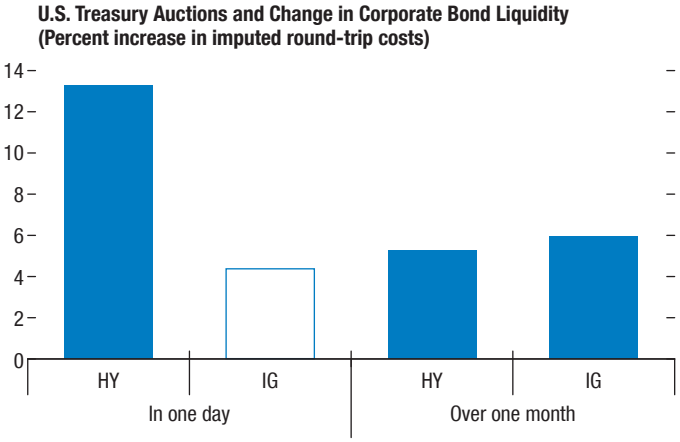
Monetary policy and market making

An analysis of changes in collateral policies supports the notion that central banks can improve liquidity by facilitating market making. One way central banks can relax market makers' funding constraints for certain securities and thereby improve the market liquidity of those assets is to include the instruments in the list of eligible collateral for repurchase operations (repo).

[20]When monthly averages are used instead of daily data (to reduce noise in the data) the statistical significance is increased for both investment-grade and high-yield bonds, but the effects are estimated to be smaller, suggesting they are temporary in nature. See Annex 2.2.

Figure 2.5. Dealers' Balance Sheet Space

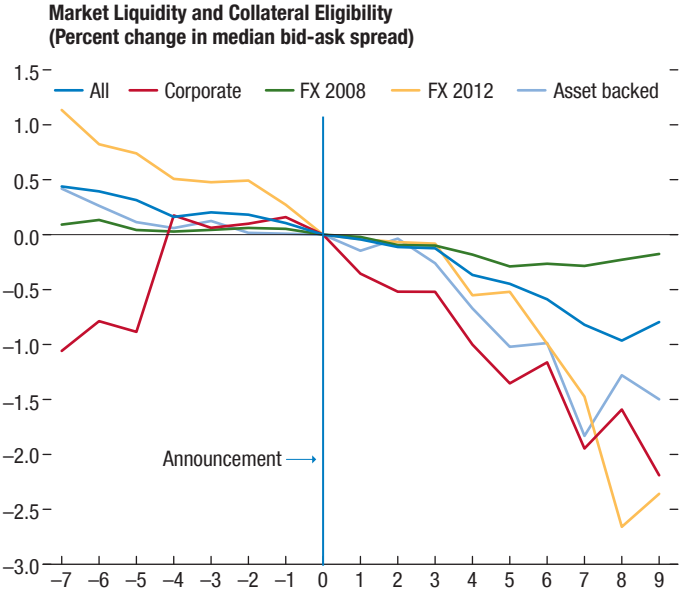
U.S. Treasury debt auctions briefly reduce primary dealers' balance sheet space. As a result, aggregate market liquidity drops for corporate bonds.



Sources: FINRA Trade Reporting and Compliance Engine; U.S. Treasury Department; and IMF staff estimates.
Note: The figure shows the estimated increase in imputed round-trip costs of corporate bonds, in one day (or one month) with one debt auction by the U.S. Treasury. See Annex 2.2 for details. HY = high-yield corporate bonds; IG = investment-grade corporate bonds. Solid bar indicates that the impact is statistically significant at the 10 percent level.

Figure 2.6. Central Bank Collateral Policies

Increasing the range of assets eligible to be posted as collateral for central bank credit increases market liquidity.



Sources: Bloomberg, L.P.; European Central Bank; and IMF staff estimates.
Note: The figure shows the percent change in liquidity for bonds that become eligible as collateral, before and after the announcement. The frequency is daily, and liquidity is measured by quoted bid-ask spreads. See Annex 2.2 for details. FX = foreign currency.

Doing so lowers the cost of holding the instrument as a liquidity buffer asset and can also stimulate issuance in the primary market. To assess the impact of changes in the collateral framework, the analysis focuses on a series of events in which the ECB broadened the eligibility of collateral either by reducing the rating threshold for securities issued in euros, or by accepting securities issued in U.S. dollars, British pounds, and Japanese yen.[21]

When a bond is included in the ECB's list of eligible collateral for credit operations, the liquidity of the security improves (Figure 2.6). For instance, when the ECB in 2008 started accepting European bonds issued in foreign currencies and lower-rated bonds, bid-ask spreads fell by as much as 0.35 percentage points following the announcements. The impact was even larger for decisions lowering the rating threshold.[22] Although the increase in liquidity is persistent for at least the first two weeks, these announcements did not seem to have had a permanent impact on bonds' liquidity.

[21]The authors thank the ECB/DGM/MOA for providing data on eligible securities.

[22]This may be explained by the fact that, relative to securities with a higher rating and denominated in other currencies, securities with lower ratings are less liquid to begin with, because some investors have strict investment guidelines regarding the rating of assets in which they may invest.

Event Studies of Search Costs

Impact of trade transparency

Some studies find that a rise in trade transparency has a small positive effect on bond market liquidity, but for most other assets the literature suggests a negligible or ambiguous effect. On the one hand, greater trade transparency should improve market liquidity because it increases competition, facilitates the valuation of assets, helps enforce rules against unfair trading practices, and improves risk sharing among dealers. On the other hand, increased transparency may erode the willingness of market makers to carry large inventories because it hampers their ability to unwind large positions.[23] Empirical work on posttrade transparency

[23]Increased trade disclosure may discourage market making because dealers will not be able to unwind their positions after a large trade. Once a large trade becomes public information, other traders will be able to predict the market maker's behavior and extract price concessions. The same reasoning applies to equity markets and has ultimately led to the growth of "dark pools"—registered stock trading systems in which the size and price of trades are not disclosed to other participants.

(the disclosure of completed trades) in corporate bonds finds either a positive effect or no effect on price discovery, liquidity, and trade activity (Bessembinder and Maxwell 2008). However, some studies of the equity markets find that pretrade transparency (disclosure of the limit-order books and quotes) reduces liquidity in the equity market (Madhavan, Porter, and Weaver 2005).

For corporate bonds traded in the United States, enhanced transparency has had a positive impact on liquidity—especially for large transactions of lower-rated bonds. Again, the U.S. corporate bond market provides a suitable event study: the Financial Industry Regulatory Authority (FINRA) started collecting data on all bond transactions in 2002 but disseminated that information only gradually. The event study here examines the reaction around four dissemination phases to test whether liquidity improved after transactions data became public (see Annex 2.2 for details).[24] In the first two phases (2a and 2b), the bonds for which transactions data were disseminated were of higher credit quality (at least BBB rating), whereas those in the fourth phase (3b) were speculative grade. Contrary to expectations and views expressed by market participants, the study finds that when the data for large transactions of bonds of lower credit quality were released (phase 3b), market liquidity improved significantly (Figure 2.7).[25] The result suggests that, in this instance, the improvement in price discovery caused by transparency outweighed the potential costs for market makers.

Impact of the EU ban on uncovered credit default swaps

The EU's ban on indirect short selling of sovereign debt via uncovered sovereign credit default swaps (SCDS) reduced the liquidity of those assets (Figure 2.7). Beginning November 1, 2012, the EU banned uncovered CDS positions in EU sovereign debt and required disclosure of short positions in European sovereign bonds. Such restrictions reduce the ability of investors to find counterparties for trades and the ability of market makers to hedge. An analysis of a sample of SCDS contracts shows that in the three months after the ban, EU SCDS contracts became substantially less liquid.[26]

The EU's ban also reduced liquidity in the European sovereign bond market. This chapter compares liquidity—as measured by quoted bid-ask spreads—for a sample of sovereign bonds three months before and after the ban. The findings indicate that liquidity in EU sovereign bonds declined after the ban. The decrease in liquidity for sovereigns was larger for countries with low credit risk (that is, low CDS spreads). Thus, the negative effect on liquidity in the derivatives market (for uncovered CDS on sovereign bonds) spilled over to the cash market (for the sovereigns themselves). The result is in line with predictions from Chapter 2 of the April 2013 GFSR and findings in ISDA (2014), and it is consistent with studies that find a detrimental effect on liquidity and price discovery from temporary bans on short selling in equity markets (Boehmer, Jones, and Zhang 2013; Beber and Pagano 2013).[27]

Monetary policy and scarcity effects

Quantitative easing in the United States at first improved liquidity in the market for mortgage-backed securities (MBS), but then degraded it (Figure 2.8). Since November 2014, Federal Reserve purchases on the secondary market have had a detrimental effect on market liquidity. The effect indicates that the scarcity associated with large central bank purchases then dominates any positive effects (Box 2.1). The magnitude of the impact is, however, relatively small, suggesting that any adverse effects on market liquidity represent a small cost of quantitative easing. The results also point to the increasing importance of capital market depth and liquidity for monetary policy operations in a low-interest-rate environment.[28]

[24]FINRA is the nongovernmental U.S. organization that self-regulates securities firms. The data dissemination dates for the four phases studied are March 3, 2003 (phase 2a); April 14, 2003 (phase 2b); October 1, 2004 (phase 3a); and February 7, 2005 (phase 3b). Data were graciously provided by FINRA.

[25]Asquith, Covert, and Pathak (2013) report similar findings for turnover and price dispersion; and Edwards, Harris, and Piwowar (2007) find a reduction in trading costs after dissemination. See Bessembinder and Maxwell (2008) for a survey of results.

[26]The results show that liquidity decreases significantly for SCDS contracts affected by the ban, relative to other SCDS, when measured by Markit's composite liquidity indicator, market depth, number of valid quotes, and number of dealers quoting the contract. Results on quoted bid-ask spreads estimate a decline that is not statistically significant. See Annex 2.2.

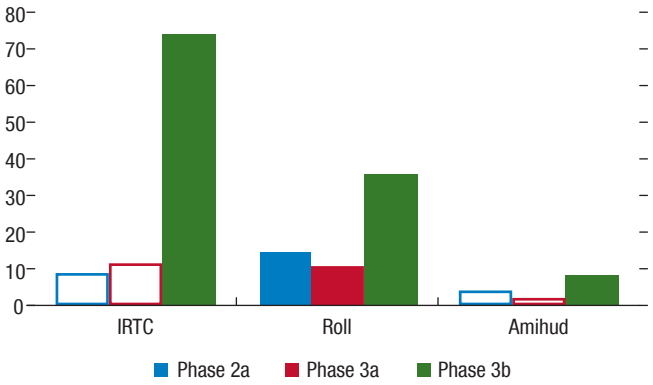
[27]However, ESMA (2013b) does not find a significant impact on SCDS or sovereign bond market liquidity and ESMA (2013a) estimates a decline in SCDS bid-ask spreads.

[28]Gagnon and others (2011) report that in the early stage of the Federal Reserve's large-scale asset purchase programs, older and less liquid Treasury securities were trading at a negative premium compared with more recently issued Treasury securities. Prices went up and yield spreads narrowed after the Federal Reserve started purchasing such bonds. Similarly, Krishnamurthy and Vissing-Jorgensen (2012) find evidence of a decrease in the spread between agency and Treasury bonds' yields, a proxy for the liquidity premium, following

Figure 2.7. Regulation and Market Liquidity: Two Examples

Enhanced posttrade transparency, in some cases, improves market liquidity.

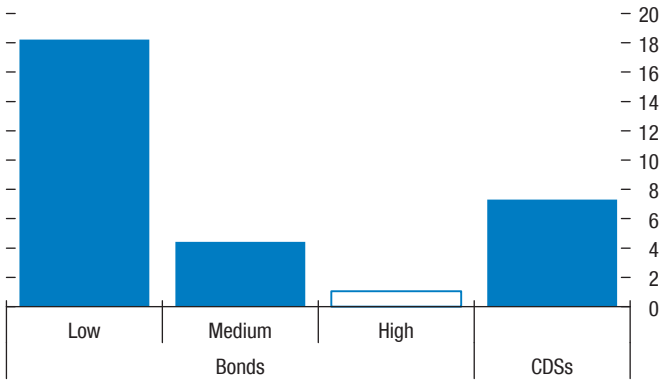
1. Liquidity Improves with Transparency
(Percent improvement in liquidity measure)



Note: The figure shows estimated change in liquidity three months before and after trade dissemination. Dissemination dates are March 3, 2003 (phase 2a); April 14, 2003 (phase 2b, not shown); October 1, 2004 (phase 3a); and February 7, 2005 (phase 3b). A positive value means improved liquidity. Solid columns mean statistical significance at least at the 10 percent level. See Annex 2.2 for details. Amihud = Amihud's (2002) price impact; IRTC =imputed round-trip cost; Roll = Roll's (1984) price reversal.

The European sovereign CDS ban was followed by a deterioration in the liquidity of EU sovereign CDSs and bonds.

2. Decrease in Liquidity due to EU Uncovered CDS Ban
(Percent deterioration in liquidity)



Note: The figure shows the estimated deterioration in liquidity in sovereign bonds and sovereign CDS contracts that can be attributed to the EU ban on uncovered CDS on EU sovereign debt. The effect for bonds is broken down according to the credit risk of the issuer: low, medium, and high signify CDS spreads around the 25th, 50th, and 75th percentiles. Solid columns mean statistical significance at least at the 10 percent level. See Annex 2.2 for details. CDS = credit default swap.

Sources: FINRA Trade Reporting and Compliance Engine; Markit; and IMF staff estimations.

Investor base

Empirical evidence indicates that the decline in the heterogeneity of the investor base may have contributed to a deterioration in liquidity. It is difficult to test for this effect because, when market liquidity deteriorates for a particular asset, some holders may decide to sell it. To overcome this problem, the exercise examines an exogenous shock to demand for some corporate bonds that may have affected banks' willingness to invest.[29] According to a rule adopted in the United States in June 2012 and made effective in January 2013, banks would have to decide for themselves whether a security is investment grade rather than use credit agency ratings. Because U.S. commercial banks are prohibited from investing in below-investment-grade bonds, the rule narrowed the investor base for bonds at the low end of the rating agencies' investment grade (BBB– for Standard & Poor's ratings). In turn, the narrowing of the investor base should raise dealers' inventory costs for those bonds and reduce market making. Indeed, data indicate that the effect took place at the time of the announcement, with the liquidity of BBB– bonds subsequently deteriorating relative to other bonds.

In sum, changes in market making, market structure, regulation, and monetary policy in recent years have had an impact on market liquidity. The observed decline in market making has probably contributed to the reduction in market liquidity in some market segments. Enhanced transparency regulations appear on net to have boosted market liquidity, whereas restrictions on CDS in the EU seem to have reduced it. On the whole, monetary policy in recent years is likely to have had a positive impact on market liquidity. The proliferation of small issuances has likely lowered liquidity in the bond market.

Econometric Evidence for Risk Appetite and Other Cyclical Drivers

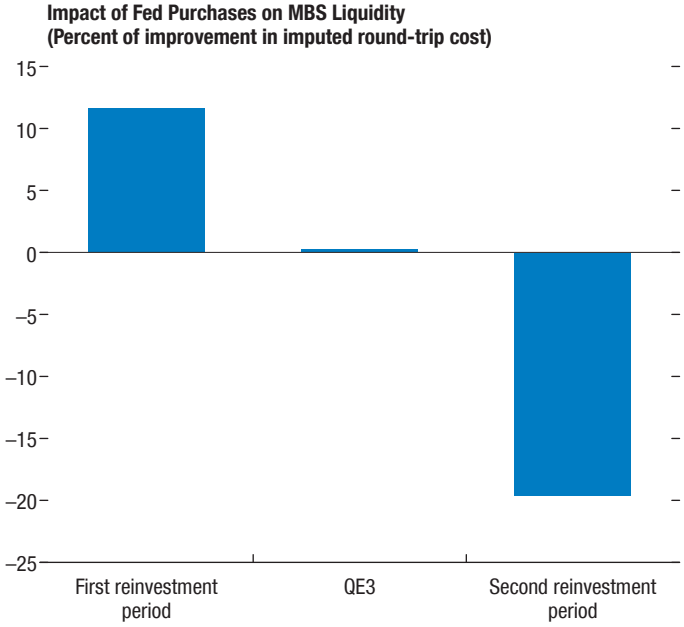
How much has market liquidity been affected by cyclical factors in the postcrisis period? A linear regression

the Federal Reserve's purchases of agency mortgage-backed securities. The liquidity premium of the securities not targeted by quantitative easing was not affected.

[29]The exercise uses the change in regulation only as an example of an exogenous shock to the investor base and should not be understood as a quantification of the positive or negative effects of this aspect of the Dodd-Frank Act.

Figure 2.8. Fed Purchases and Mortgage-Backed Securities Liquidity

Outright purchases improved liquidity of MBS during the first reinvestment program (October 2011–November 2012), had no effect during QE3 (December 2012–October 2014), and was recently decreasing market liquidity (November 2014–March 2015).

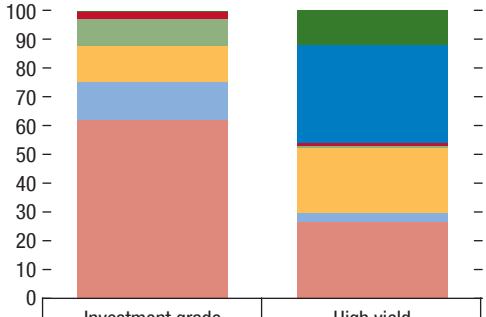


Sources: Federal Reserve Bank of New York; FINRA Trade Reporting and Compliance Engine; and IMF staff estimates.
Note: The figure shows the estimated improvement in liquidity (reduction in round-trip costs) in MBS securities per billion dollars of securities purchased by the Federal Reserve. The effect is normalized by the average imputed round-trip cost in the sample. Solid columns mean statistical significance at least at the 10 percent level. See Annex 2.2 for details. Fed = Federal Reserve; MBS = mortgage-backed security; QE = quantitative easing.

Figure 2.9. Main Drivers of Market Liquidity

Risk appetite has been the main driver of investment-grade U.S. corporate bond market liquidity since 2010, whereas funding liquidity seems more important for high-yield bonds.

Contributions to Market Liquidity of U.S. Corporate Bonds (Percent)



	Investment grade	High yield
Bank holdings	0.1	11.9
Commodity prices	0.3	34.2
Business conditions	2.6	1.0
U.S. monetary policy	9.0	0.5
Funding liquidity	12.8	22.9
Credit spread	13.0	3.1
VIX	62.1	26.5

Source: IMF staff estimates.
Note: The figure and table show the unique contribution of each variable (normalized by total unique contributions) in predicting the variance of aggregate market liquidity by type of bond since 2010. R^2 for investment grade = .79 and R^2 for high yield = .42. See Annex 2.2 for details. The decomposition follows the commonality coefficients approach described in Nathans, Oswald, and Nimon (2012). VIX = Chicago Board Options Exchange Market Volatility Index.

model of market liquidity for both high-yield and investment-grade U.S. corporate bonds since 2010 is used to examine this question. This approach does not, however, overcome the problem of two-way causality. The model includes the credit spread as a proxy for credit conditions; the TED spread (difference between the three-month London interbank offered rate based on the U.S. dollar and the three-month T-bill secondary market rate) as a measure of funding liquidity; corporate bond holdings by large commercial banks as a proxy for inventories; the estimated shadow monetary policy rate for the United States; commodity price changes as a control for the volatility of some important underlying assets; and the Chicago Board Options Exchange Volatility Index (VIX) as a measure of overall uncertainty, which is negatively related to risk appetite.

Risk appetite and funding liquidity seem to be the main drivers, but indirectly the results point to an important role for monetary policy. In fact, the combined contribution of the TED spread, the VIX, and unconventional monetary policy account for most of the liquidity behavior of investment-grade bonds and, to a lesser extent, of high-yield bonds (Figure 2.9). For investment-grade bonds, the cyclical factors explain almost 80 percent of the total variation of aggregate market liquidity, whereas for high-yield bonds the model explains slightly more than 40 percent.

Liquidity Resilience, Liquidity Freezes, and Spillovers

The chapter so far has examined the extent to which changes in various market conditions in recent years

may have eroded the market liquidity of securities, especially bonds. Such erosion has negative implications for the efficiency of capital allocation and for economic growth. From a financial stability point of view, however, the main concern about liquidity is not its level but the risk of disruptive drops in liquidity ("freezes") across markets, and policymakers can help reduce the risk of such events and mitigate their severity if they occur.

This section provides empirical evidence on structural and cyclical factors associated with the resilience of liquidity to shocks. It briefly discusses event studies to examine the role of structural factors and then implements an econometric approach ("regime switching") to measure the likelihood that aggregate market liquidity suddenly evaporates.[30] Although the focus is on corporate bonds traded in the United States, European sovereign bonds and the foreign exchange market, including emerging market currencies, are also examined. The section ends with an analysis of spillovers of liquidity freezes.

Liquidity Regimes and Resilience

Structural factors

Various structural factors are associated with the degree of liquidity resilience in markets. The analysis shows that a lower presence of market makers, a broader range of smaller and more risky bonds, large mutual fund holdings, and concentrated holdings by institutional investors are all associated with higher vulnerability of liquidity to external shocks (see event studies in Box 2.3). Higher leverage at financial firms and their greater use of short-term funding are typically associated with higher liquidity risk (Acharya and Viswanathan 2011). But the feedback loops between leverage and market illiquidity may have been weakened by the postcrisis decline in capital market participation by banks and hedge funds (Figure 2.10). Unfortunately, data limitations prevent a quantitative assessment of these factors and their overall impact from being made.

Cyclical factors

Empirically, market liquidity tends to abruptly switch between different states (Figure 2.11; Flood, Liechty, and Piontek 2015). To study the importance of cyclical factors for the resilience of market liquidity, a regime-switching model is used in which liquidity may take on two or more regimes (for example, low, medium, and high). In this approach, the resilience of liquidity is measured by the one-day-ahead or one-month-ahead probability of a given market being in a low-liquidity regime. The model uses aggregate measures of market liquidity for corporate bonds traded in the United States, U.S. Treasury bonds, European sovereign bonds, and foreign currencies (Figure 2.11).[31]

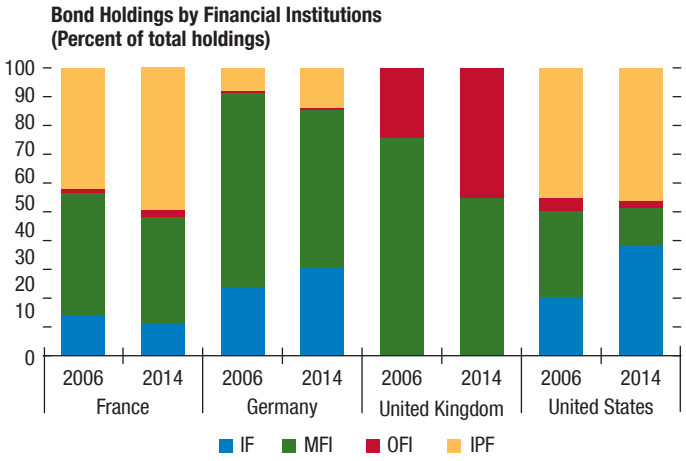
To some extent, liquidity resilience in the corporate bond market can be predicted by cyclical factors

[30]In this section, aggregate market liquidity is defined as a measure of market liquidity averaged across all securities in an asset class.

[31]Figure 2.11 shows estimates of one-day-ahead probabilities of a given market being in the low-liquidity regime, except U.S. Treasury bonds for which, because of data constraints, one-month-ahead probabilities are presented. The determination of such regimes is, however, asset specific. In other words, the regimes are not comparable across assets but only depict the estimated state of market liquidity in one day or one month's time relative to the asset's historical behavior. For instance, the liquidity of currencies has improved compared with the levels in the late 1990s. In particular, the average frequency of developed economies' currencies being in the low-liquidity regime declined from greater than 99 percent during 1995–99 to 34 percent in the past five years. See Annex 2.3 for details.

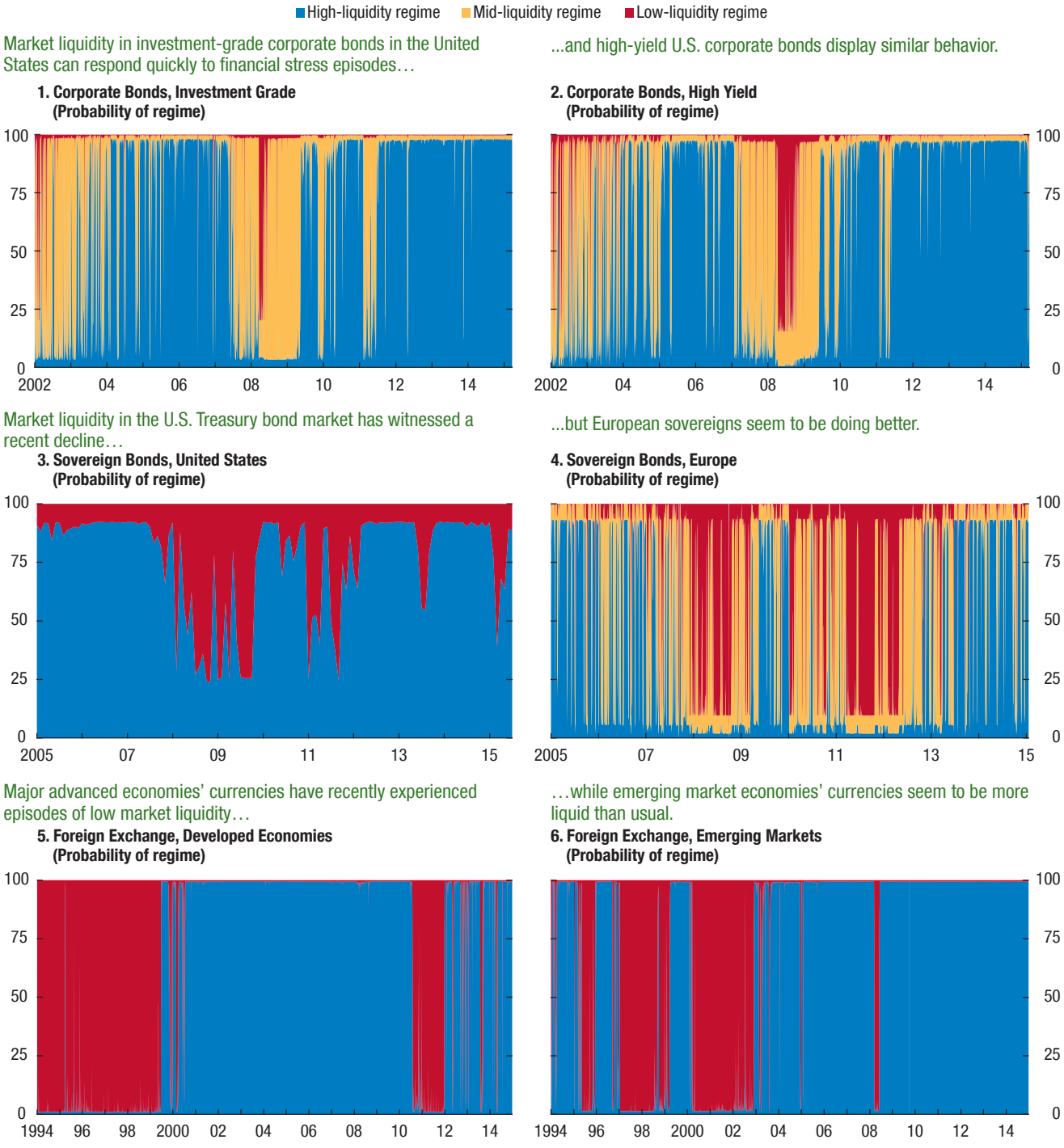
Figure 2.10. Financial Sector Bond Holdings

Bond holdings by investment funds have been growing in various advanced economies.



Sources: European Central Bank; Board of Governors of the Federal Reserve System; and IMF staff calculations.
Note: Bond holdings in European countries refer to long-term debt securities; bond holdings in the United States refer to corporate and foreign bonds. Data for the United Kingdom do not discriminate among nonbank financial institutions. IF = investment funds excluding money market mutual funds (MMMFs); IPF = insurance and pension funds; MFI = monetary financial institutions (including MMMFs and, for the United States, securities brokers and dealers); OFI = other financial institutions.

Figure 2.11. Probability of Liquidity Regimes



Sources: Bloomberg, L.P.; FINRA Trade Reporting and Compliance Engine; MTS; Thomson Reuters Datastream; and IMF staff estimates.

Table 2.2. Determinants of Low-Liquidity Regime Probability in the U.S. Corporate Bond Market

	One-Day Ahead		One-Month Ahead	
	U.S. Corporate Bonds		U.S. Corporate Bonds	
	Investment Grade	High Yield	Investment Grade	High Yield
U.S. Business Conditions	.	−**	−**	−**
VIX	+***	+***	.	.
Moody's Credit Spread	+***	+***	+***	.
TED Spread	+***	+***	.	.
Dealers' Holdings	…	…	−***	−***
Treasury Auctions	.	.	+**	+**
Fed Quantitative Easing	−**	.	−**	.

Sources: Board of Governors of the Federal Reserve System; FINRA Trade Reporting and Compliance Engine; Haver Analytics; Thomson Reuters Datastream; the United States Department of the Treasury; and IMF staff calculations.

Note: The table shows the estimated sign of ordinary least squares (OLS) estimates of a regression of the probabilities of being in the low-liquidity regime on a set of macroeconomic and financial variables for both investment-grade and high-yield corporate bonds. When the estimate is not statistically different from zero, a "." is used. "..." means the variable in the first column was not included. See Annex 2.3 for details on methodology and data. ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively.

(Table 2.2).[32] These factors include business conditions, financial volatility, and risk appetite (as measured by the VIX); the price of credit risk; and, to some degree, monetary policy measures. The current level of liquidity also matters for liquidity resilience.[33] The analysis summarized in Table 2.2 shows that high-yield bonds seem to be especially sensitive to business conditions and credit market developments, whereas unconventional monetary policy only affects the liquidity of investment-grade bonds.[34] However, an analysis of the response of market liquidity to changes in the VIX over time does not suggest that liquidity is now more sensitive to financial volatility compared with the precrisis period.

Evidence from the U.S. bond market indicates that when inventories at dealers are low or when dealers' ability to make markets is impaired, aggregate liquidity is more likely to drop sharply. Measures of dealers' inventories or of their ability to make markets are empirically associated with liquidity regimes. For instance, the ratio of total corporate securities to commercial banks' total assets is negatively associated with a low-liquidity regime in the corporate bond market. Similarly, when funding liquidity is low (that is, when the TED spread is high), the probability of the corporate bond market being in a low-liquidity regime increases (Table 2.2).

In the markets for foreign exchange and European sovereign bonds, business conditions in key advanced economies seem to be the main drivers of liquidity regimes (Table 2.3). The resilience of liquidity of foreign exchange markets in emerging market economies and smaller advanced economies seems to be driven by external conditions, and does not appear to depend on business conditions in those markets. This dependence on external conditions may be due to the fact that these markets are strongly influenced by global investors. Overall, unconventional monetary policy measures by advanced economy central banks have had a positive impact on the liquidity resilience of foreign currency markets, including those in emerging markets.[35]

Given that the VIX is still at historical lows, the picture of benign market liquidity conditions may be deceiving. Cyclical factors like global uncertainty and risk aversion can change quickly, for example, as a result of a "bumpy" normalization of U.S. monetary

[32]The results on liquidity regimes presented in this section rely on measures of the cost dimension of market liquidity such as imputed round-trip costs, Corwin and Schultz's (2012) high-low spread, quoted bid-ask spreads, or effective spreads. However, for U.S. corporate bonds, results were tested using alternative measures of liquidity such as Amihud's (2002) price impact and Roll's (1984) price reversal, with qualitatively similar results. The estimates for U.S. Treasury bonds and foreign currencies suggest only two regimes instead of three.

[33]Bao, Pan, and Wang (2011) also find that normal-time liquidity can help predict crisis-time liquidity.

[34]Although the VIX plays a broader role, its significance in this estimation is consistent with the finding that it is a key driver of mutual fund redemptions (see the April 2015 GFSR, Chapter 3)—and large mutual fund holdings are associated with higher liquidity risk (Box 2.3).

[35]The behavior of equity markets is not analyzed here, but Flood, Liechty, and Piontek (2015) also identify three liquidity regimes for those markets and similar determinants for the probability of them being in a low-liquidity state.

Table 2.3. Determinants of Low-Liquidity Regime in the Foreign Exchange and European Sovereign Bond Markets

	FX Markets			European Sovereign Bonds
	Major AEs	Other AEs	EMs	Euro-6
U.S. Business Conditions	.	–***	–***	.
Major AE Business Conditions	–***	–**	–**	–***
Other AE Business Conditions	…	.	…	…
EM Business Conditions	.	.	.	…
VIX	+***	.	.	+***
Moody's Credit Spread	–***	+***	+***	.
Domestic Short-Term Interest Rate	–***	.	.	+*
Fed Quantitative Easing	–*	.	.	.
Major AE Quantitative Easing	.	–**	–***	.

Sources: Board of Governors of the Federal Reserve System; FINRA Trade Reporting and Compliance Engine; Haver Analytics; Thomson Reuters Datastream; the United States Department of the Treasury; and IMF staff calculations.

Note: The table shows the estimated sign of ordinary least squares (OLS) estimates of a regression of the probabilities of being in the low-liquidity regime on a set of macroeconomic and financial variables in the foreign currency and European sovereign bond markets. When the estimate is not statistically different from zero, a "." is used. "..." means the variable in the first column was not included. Major advanced economies (AEs) = euro, Japanese yen, Swiss franc, and British pound. Other AEs = Australian dollar, Canadian dollar, Danish krone, New Zealand dollar, Norwegian krone, and Swedish krona. Emerging markets (EMs) = Brazilian *real*, Indonesian rupiah, Indian rupee, Russian ruble, South African rand, and Turkish lira. Euro-6 = Belgium, France, Germany, Italy, Netherlands, and Spain. ***, **, * denote significance at the 1, 5, and 10 percent levels, respectively. FX = foreign exchange.

policy, unexpected developments in the euro area, or geopolitical events. To illustrate, should the VIX, the TED spread, and other cyclical factors (excluding monetary policy variables) deteriorate in the same way they did between December 2006 and August 2008, the probability of the U.S. corporate bond market switching from a high-liquidity to a low-liquidity regime would rise to about 75 percent for investment-grade bonds and 96 percent for high-yield ones.

The fact that investors require higher returns on illiquid assets only during periods of stress indicates that they pay little attention to the possibility that liquidity can suddenly vanish during normal times (Table 2.4). In principle, when holding securities, investors require compensation for different types of risk, including the risk of sharp drops in liquidity. However, in the U.S. corporate bond market, bond returns react to liquidity shocks only when volatility is high and returns are low (that is, stress periods), and not in tranquil periods.[36] This suggests that during periods in which liquidity is abundant, investors tend to neglect the risk that liquidity may suddenly vanish. Moreover, the chapter finds significant evidence that illiquidity shocks from the equity market spill over to the high-yield market and cause bond returns to fall.

[36]In principle, only large, systematic, and persistent shocks to liquidity should be priced (Korajczyk and Sadka 2008). Conceivably, such shocks are more frequent in the low-liquidity regime.

Table 2.4. Bond Returns and Liquidity Risk

	Investment Grade	High Yield
Constant Parameters		
Term Spread	+	+
Moody's Credit Spread	+*	+*
Equity Illiquidity	–	–*
Regime-Switching Parameters		
Regime 1 (tranquil period)		
Bond Illiquidity	+	–
Regime 2 (stress period)		
Bond Illiquidity	–***	–***

Source: IMF staff estimates.

Note: The table shows the estimated sign of the coefficients of a regression of monthly corporate bond excess returns (relative to 30-day U.S. Treasury bills) on the term spread, credit spread, and illiquidity measures for the equity and bond markets. The latter is based on imputed round-trip costs averaged across all securities. Equity illiquidity is based on the measure proposed by Corwin and Schultz (2012). The regression coefficients for the bond illiquidity measure are allowed to vary according to a regime-switching regression, while the rest are assumed constant. See Annex 2.3 for details. *, **, and *** signify statistical significance at the 10, 5, and 1 percent levels, respectively.

Spillovers

Market illiquidity and the associated financial stress can spill over to other asset classes. Liquidity shocks may propagate to other assets, including those with unrelated fundamentals, for a variety of reasons. These reasons include market participants' need to mark to market and rebalance portfolios, which can affect their ability to trade and hold other assets. The propagation of liquidity shocks (known as liquidity spillovers) could be amplified when market participants are

highly leveraged. In addition, when asset fundamentals are correlated, spillovers can be larger: investors may perceive a sharp price correction in certain assets as conveying information about the valuations of their own securities. As a result, they may start fire sales and cause liquidity to freeze up.

Empirically, liquidity spillovers are larger during stress periods, and spillovers have become more prevalent in recent years. When returns are low and more volatile, liquidity shocks tend to propagate from one asset class to others. A measure of liquidity spillovers over several asset classes, including emerging markets equities, shows considerable time variation—but spillovers have become more frequent since the crisis (Figure 2.12).[37] This increase in frequency is in line with concerns expressed about rising comovements in prices across asset classes (April 2015 GFSR, Chapter 1). Furthermore, total liquidity spillovers across assets rise in periods of financial market stress (that is, when asset returns are low, volatile, and display significant comovement). See Annex 2.3 for details on the methodology.

Although common factors may play a role in the comovement of liquidity across asset classes, shocks often propagate from the investment-grade bond market to other markets. Statistical analysis of temporal spillover patterns (so-called Granger causality) suggests that liquidity shocks to investment-grade bonds significantly affect liquidity in other asset classes but that those bonds' liquidity is not much affected by that of other classes. This outcome suggests that monitoring investment-grade corporate bonds as a source of liquidity spillovers should be part of the market surveillance toolkit.

Summary of Findings on Liquidity Resilience, Liquidity Freezes, and Spillovers

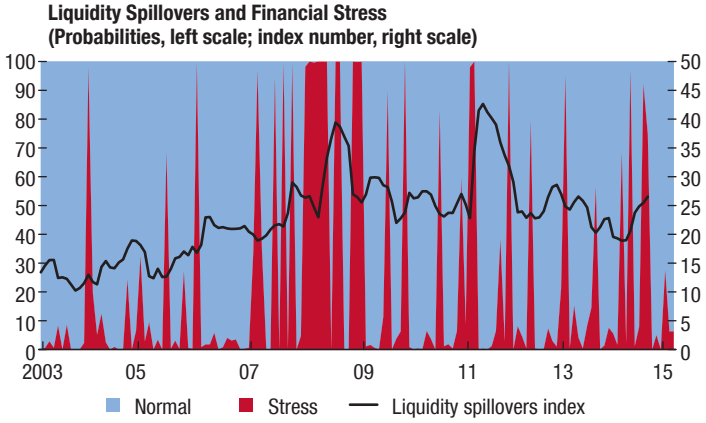
Market liquidity can quickly disappear when volatility increases or funding conditions deteriorate, and monitoring day-to-day liquidity conditions has merit. In fact, having high liquidity today, all else equal, reduces the probability of being in a low-liquidity regime tomorrow, with the associated systemic stress repercussions. Dealers' inventories and their overall balance sheet capacity are negatively associated with illiquidity spells. The regime-switching approach used in this chapter also finds that unconventional monetary policy can reduce the likelihood that markets will be in a low-liquidity regime. Furthermore, liquidity risk seems to be priced only in periods of financial stress.

Liquidity comovement across asset classes has increased in recent years. Spillovers are particularly pronounced during periods of financial stress. In those periods, asset returns are low and volatile, and the comovement of liquidity across asset classes is stronger. Even though common factors may generate some of these liquidity spillovers, shocks often originate in investment-grade bonds traded in the United States.

[37]The asset classes are equities in the United States, the EU, and emerging market economies; U.S. Treasury bonds; high-yield and investment-grade corporate bonds traded in the United States; and an index of market liquidity for the four major currency pairs (the U.S. dollar paired with the British pound, the euro, the Japanese yen, and the Swiss franc). The analysis controls for common factors.

Figure 2.12. Liquidity Spillovers and Market Stress

Liquidity spillovers across asset classes seem to intensify in periods of financial stress.



Sources: Bloomberg, L.P.; FINRA Trade Reporting and Compliance Engine; Thomson Reuters Datastream; and IMF staff estimates.
Note: The figure shows (1) the monthly average of an index of liquidity spillovers (measured as in Diebold and Yilmaz 2014) across the following asset classes: U.S. equities; U.S. Treasuries; U.S. high-yield corporate bonds; U.S. investment-grade corporate bonds; European equities; emerging market equities; and an index of liquidity in the foreign exchange market; and (2) probabilities of being in a low-return and high-volatility regime as given by a Markov-Switching Bayesian vector autoregression model of monthly returns for the same asset classes as in (1).

Policy Discussion

Market liquidity is prone to sudden evaporation, and the private provision of market liquidity is likely to be insufficient during stress periods; hence, policymakers need to constantly monitor liquidity developments and have a preemptive strategy in place to confront episodes of market illiquidity. Monitoring market

liquidity conditions using transactions-based measures, especially in the investment-grade bond market, should be part of regular financial sector surveillance. Although current levels of market liquidity are not clearly and significantly lower than they were before the crisis, that appearance may be an artifact of the extraordinarily accommodative monetary policies of key central banks.[38] The risk of a sudden reduction in market liquidity has been heightened by the larger role of mutual funds and by other structural changes combined with the impending normalization of monetary policy in advanced economies.

Regulatory changes aimed at curbing risk taking by banks can impair their capacity to make markets, but the evidence so far is not sufficient to support revisions to the regulatory reform agenda. Indeed, the reforms have made the core of the financial system safer. The empirical findings of this chapter suggest that constraints on dealers' balance sheets may impair market liquidity, and that these constraints have become tighter—but it is difficult to link such developments to specific regulatory changes. In particular, not enough time has passed to assess the impact of many Basel III innovations, such as the leverage ratio requirement, the net stable funding ratio, the increase in capital requirements, and restrictions on proprietary trading by banks.[39] Finally, independently of regulations, traditional market makers have also changed their business models by moving from risk warehousing (acting as dealers) to risk distribution (acting as brokers), in part because of technological changes and more efficient balance sheet management (see Goldman Sachs 2015).[40] These developments should continue to be monitored.

Trade transparency, standardization, and the use of equal-access electronic trading could dampen the impact of reduced market making at banks. For a variety of reasons, traditional market makers may have reduced their presence in the marketplace, but the emergence of new players and trading platforms may help fill the void. For example, in the United States, the standardization that will come from moving most index-CDS trading to swap execution facilities (Box 2.2) should enhance liquidity by introducing incentives for market-making activities and enhancing transparency.

Important obstacles to trade automation and the emergence of new market makers remain. New U.S. regulations for over-the-counter (OTC) derivatives markets require that trading platforms provide impartial and open "all-to-all" access. However, some interdealer platforms have resisted inviting nondealers to participate or have required high fees, which may act as a barrier to entry for alternative market makers.[41]

Smooth normalization of monetary policy is crucial. Given the empirical results on the direct and indirect effects of monetary policy on liquidity, it is important that normalization of monetary policy avoid disruptive effects on market liquidity. The empirical results on the effects in MBS markets suggest that liquidity in these markets will likely vary according to the modalities of the normalization (for example, whether it involves outright sales or simply allowing the securities in possession of the central bank to mature). Similarly, a "choppy" normalization process may lead to a sudden drop in risk appetite, with ensuing adverse effects on market liquidity. Although data constraints prevent a more in-depth evaluation of the market liquidity of emerging markets assets from being undertaken, the findings for emerging market foreign currency markets suggest that monetary policy actions in advanced economies greatly affect their resilience.

These general observations and the empirical results discussed in the chapter suggest the following policy options for strengthening market design, enhancing the role of central banks, improving

[38]The long period of monetary accommodation by major central banks has further discouraged dealers from market making or risk warehousing. In a low-volatility and low-risk environment, it is often most profitable to act as a broker since the premium paid to warehouse risk is correspondingly low.

[39]As argued by banks, it is possible that by linking capital requirements to all assets irrespective of risk, the Basel III leverage ratio requirement has lowered the attractiveness of high-volume, low-margin activities such as market making and collateralized lending. The net stable funding ratio, once fully implemented, could also have an adverse impact on market making by raising the relative cost of short-term repo transactions. The rise in capital requirements may also encourage banks to operate closer to the minimum required capital levels and, hence, render them unable or unwilling to take large trading positions.

[40]Banks' changes in their business models following the financial crisis have also led them to focus more on their most profitable activities. Since market making is a high-volume, low-profit activity, banks have been reconsidering their presence in fixed-income and credit markets.

[41]Some platforms are reportedly insisting on posttrade identification of counterparties—even for centrally cleared trades—on order book trades, to which nondealers object because of the potential for information leakage.

financial market regulation, and reducing market liquidity risks.

On market microstructure design:

- *Reforming the design of markets should be encouraged.* Objectives would include creating incentives for instrument standardization,[42] designing circuit breakers based on liquidity conditions rather than prices, and enhancing transparency.
- *Open access to electronic platforms should become the norm.* The analysis of the introduction of electronic platform trading of OTC derivatives underscores the importance of product standardization and of equal access to trading venues to allow buy-side firms to act as alternative market makers. However, the introduction of electronic platforms can attract new players, such as high-frequency trading firms, to the market, whose impact still needs to be further understood.
- *Restrictions on the use of financial derivatives should be reevaluated.* The analysis of the after-effects of the EU ban on uncovered CDS confirms the view expressed in the April 2013 GFSR that regulations on derivatives can distort markets and reduce liquidity in the associated cash market.

On the role of central banks:

- *Central banks should take into account the effects on market liquidity when making policy.* For example, to counteract the potential scarcity created by large-scale asset purchases, central banks could set up securities-lending facilities.
- *Central banks and financial supervisors should routinely monitor market liquidity in real time across several asset classes, but especially in the investment-grade bond market.* They should use a wide range of market liquidity measures with an emphasis on metrics derived from transactions-level data.
- *In periods of financial market stress, central banks could use various instruments, including their collateral policies, to enhance market liquidity*. In particular, they can do so by accepting, with appropriate haircuts, a wide range of assets as collateral for repo transactions.

On the regulation and supervision of financial intermediaries:

- *Liquidity stress testing for banks and investment funds should be conducted taking into account the systemic effects of market illiquidity.* Liquidity stress testing can incorporate the externalities created by illiquid market conditions such as asset fire sales and funding risks (Box 2.4, and Chapter 3 of the April 2015 GFSR).
- *Liquidity mismatches in the asset management industry should be mitigated.* Liquidity mismatches characterize funds that invest in relatively illiquid and infrequently traded assets but allow investors to easily redeem their shares. The evidence presented in this chapter reinforces the recommendation of the April 2015 GFSR to consider the use of tools that adequately price in the cost of liquidity, including minimum redemption fees, improvements in illiquid asset valuation, and mutual fund share-pricing rules.

Conclusion

Even seemingly plentiful market liquidity can suddenly evaporate and lead to systemic financial disruptions. Therefore, market participants and policymakers need to set up policies in advance that will maintain market functioning during periods of stress. For example, the return to conventional monetary policy by the key central banks will inevitably boost volatility as market price discovery adjusts to new monetary conditions. The smooth adjustment of asset prices to their new equilibrium levels will require ample levels of market liquidity. In contrast, a low-liquidity regime would be more likely to produce market freezes, price dislocations, contagion, and spillovers.

This chapter explores developments in market liquidity and the role of liquidity drivers, with a focus on bond markets (Table 2.5). Structural changes, such as reductions in market making, appear to have reduced the level and resilience of market liquidity. Changes in market structures—including growing bond holdings by mutual funds and a higher concentration of holdings—appear to have increased the fragility of liquidity. At the same time, the proliferation of small bond issuances has likely lowered liquidity in the bond market and helped build up liquidity mismatches in investment funds. Standardization and enhanced transparency appear to improve securities liquidity.

Overall, current levels of market liquidity do not seem alarmingly low, but underlying risks are masked by unusually benign cyclical factors. On the one hand,

[42]The standardization of bond terms and conditions, such as call options and coupon and maturity payment dates, would reduce the effective dimensions of the market. Moreover, larger and more frequent borrowers could issue bonds in larger sizes and reopen old issues. See BlackRock (2014).

Box 2.4. Market Liquidity and Bank Stress Testing

Market illiquidity episodes can become systemic events when banks' balance sheets become impaired. Therefore, bank stress testing should take into account scenarios of market liquidity shocks. This box describes a stylized agent-based model approach to dynamic macro stress testing that can be used to obtain a prediction of market behavior under stress and simulate its impact on credit provision and economic growth.

Liquidity crises in one market can become systemic macroeconomic crises by damaging banks' balance sheets. When a market suddenly becomes illiquid, investors will require higher returns on their assets. As a result, asset prices of that market can drop dramatically. If banks own a large amount of assets in that market, a liquidity shock in that market can affect bank solvency, tightening bank regulatory constraints and limiting access to funding markets. Facing weakened balance sheets, banks react by unwinding their portfolio at distressed prices, withdrawing liquidity from financial intermediaries, or cutting back credit to the real economy, with negative consequences for financial stability and economic growth.

Building an integrated stress test for solvency and market liquidity is challenging. This is in part due to the difficulty in defining possible channels through which these interactions can occur. In addition, from a methodological point of view, it is difficult to analyze the effect of high-frequency changes in market liquidity with low-frequency information on bank solvency.

The model described here is an attempt to provide a stylized stress-testing framework of solvency and liquidity incorporating the interactions between banks, asset managers, and equity investors. The mechanism through which agents interact with one another is threefold. First, both banks and asset managers participate in the securities market to purchase or sell assets.[1] Second, banks can lend to each other in the credit markets. Third, banks interact with investors in equity markets through capital injections or withdrawals. The shock on market liquidity comes from redemption pressures on asset managers. Banks are value investors, that is, they buy undervalued assets, and are subject to regulatory constraints. In normal times, their behavior stabilizes markets. But a large market liquidity shock reduces their capital buffers, weakens their balance sheets, and tightens regulatory constraints. Banks react by re-optimizing their balance sheets, thereby becoming positive feedback traders, amplifying market shocks, and constraining credit supply.

The model analyzes a baseline scenario and a market liquidity shock (Figure 2.4.1). It is calibrated on two levels. The micro approach works to individually calibrate agents to their specific behavior rules, reflecting heterogeneous optimization problems. The macro approach parameterizes the global variables shared by agents to fit the aggregate variable outcomes of all the agents' behaviors. In the baseline scenario, initial low credit growth depresses real GDP growth, increases credit risk and risk-weighted assets, lowers maximum available leverage, and erodes banks' capital adequacy ratios. As banks optimize over their credit supply, GDP growth recovers, asset prices return to fundamentals, banks' capital adequacy ratios increase, and the economy transitions toward the steady state.

In the market liquidity shock scenario, redemption pressures force asset managers to unwind their holdings of securities. This market shock generates a drop in asset prices and an abrupt surge in market volatility, which triggers a funding shock, morphs into a credit shock that softens GDP growth, and erodes banks' capital ratios.

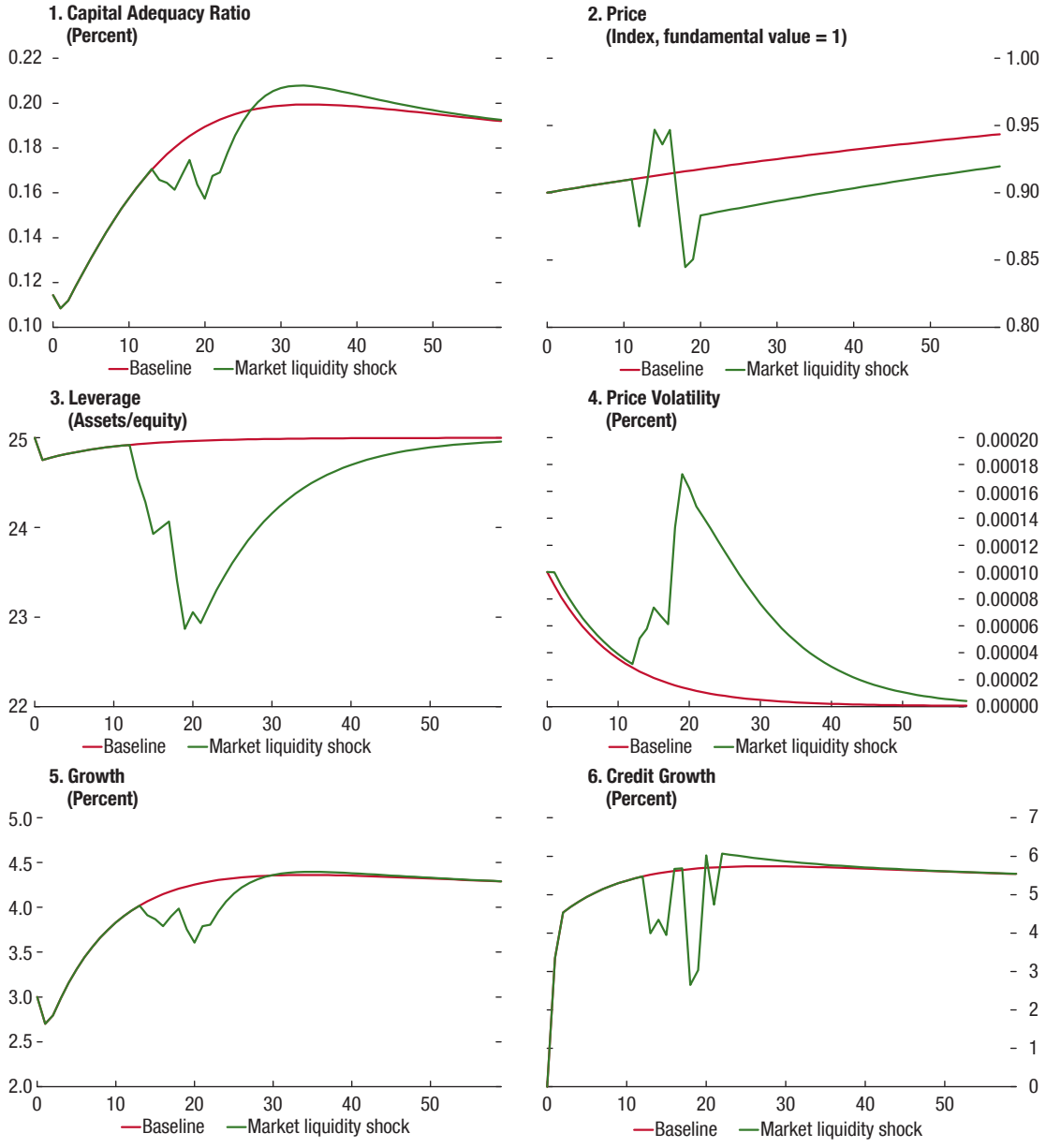
Overall, the model shows the mechanism through which a market liquidity event amplifies, spreads, and outlives the initial shock, affecting financial stability. Banks' deleveraging contributes to a downward spiral in asset prices triggering a fire sale mechanism, which further erodes their balance sheet capacity, weakens their capacity to sustain markets and provide credit, and depresses GDP growth. Banks' soundness, credit provision, and GDP growth remain subdued for a prolonged period because of feedback effects between the banking sector and the real economy.

The box was prepared by Laura Valderrama.

[1]The model does not focus on high-quality liquid assets.

Box 2.4. *(continued)*

Figure 2.4.1. Stress Test of the Financial System and the Real Economy



Source: IMF staff estimates.

Note: This figure illustrates the dynamics of the banking sector, the securities market, and the real economy under a baseline scenario and a market liquidity shock scenario. The following variables are shown: *Capital adequacy ratio* of the banking system subject to a risk-based capital regulatory framework. *Price* reflects the market price of securities with a fundamental value of 1. *Leverage* denotes the equilibrium leverage of the banking system under a time-varying market-funding constraint that is tighter the higher the asset price volatility. *Price volatility* shows the volatility of the security, which follows a stochastic process with an autoregression coefficient of 0.9. *Growth* denotes GDP growth. *Credit growth* represents aggregate credit growth. The dynamics of the system are triggered by initial subdued credit growth at $t = 0$. Low initial credit growth depresses real GDP, increases credit risk, pushes up risk-weighted assets, lowers maximum available leverage, and erodes banks' capital adequacy ratios. As banks optimize credit supply, GDP growth recovers, asset prices trend up toward fundamentals, banks' capital adequacy ratios increase, and the economy shifts toward a steady state. The market liquidity shock is prompted by redemption pressure mounting on asset managers who are forced to sell their asset holdings over the time period t from 12 to 20. Asset managers' impaired liquidity leads to higher asset price volatility (market shock), decreases banks' maximum allowable leverage (funding shock), leads to a credit squeeze (credit shock), and depresses GDP growth (macro shock).

current liquidity levels partly reflect important cyclical drivers of liquidity, monetary accommodation, and risk appetite that are in a supportive phase: monetary policy is unusually benign, and investors in most advanced economies currently have a high appetite for risk. On the other hand, they are concealing the buildup of structural fragilities that can bring them down. When the cyclical factors at some point reverse—most likely in conjunction with the normalization of monetary policies in advanced economies—the resulting exposure to the underlying fragilities can produce a sudden deterioration in market liquidity and an increase in liquidity spillovers across asset classes. This chapter has made some progress toward a framework that helps anticipate these risks.

The chapter offers five main policy recommendations:

- During normal times, policymakers should ensure through preventive policies that liquidity is resilient. Moreover, they need to monitor liquidity developments with a policy strategy in hand to deal with episodes of market illiquidity.
- Market infrastructure reforms (equal-access electronic trading platforms, standardization) should continue with the goal of creating more transparent and open capital markets.
- Trading restrictions on derivatives should be reevaluated.
- In the process of normalization of monetary policy in the United States, good communication and attention to liquidity developments across markets will be important to avoid disruptions in market liquidity in both advanced and emerging market economies. Central banks should take market liquidity into account when conducting monetary policy.
- Regulators should develop measures to reduce liquidity mismatches and the first-mover advantage at mutual funds.

Table 2.5. Summary of Findings and Policy Implications

Characteristics	Markets	Findings	Tentative Policy Implications
		Improving the Level of Liquidity	
Transparency	U.S. Corporate Bond	Posttrade transparency is beneficial to market liquidity.	Promote posttrade transparency.
Cost of Holding Inventory	U.S. Corporate Bond	Increase in dealers' inventory costs or reduced balance sheet space decreases their ability to provide market liquidity.	Encourage entry of new market makers by promoting standardization and equal access to trading venues.
Central Bank Purchases	U.S. MBS	Central bank purchases, over time, degrade market liquidity for the underlying asset.	Take into account market liquidity when implementing monetary policy.
Short-Sell Ban	CDS	Short-sell bans decrease market liquidity.	Consider revoking the ban.
		Improving the Resilience of Liquidity	
Ownership by Mutual Funds and Concentration of Ownership	U.S. Corporate Bond	Ownership by mutual funds and concentration makes market liquidity evaporate more quickly during severe market downturns.	Contain liquidity risks associated with mutual fund ownership and redemption pressures.
Collateral Eligibility	European Sovereign Bond	Including an asset as eligible for collateral temporarily increases market liquidity.	During crisis, support market liquidity of certain markets by including the assets in collateral pools.
Cyclical Factors, including Monetary Policy	U.S. Corporate Bond; U.S. and EU Sovereign Debt; FX	Explains most of the behavior of the level of liquidity and an important part of the resilience of liquidity, when taken in conjunction with funding liquidity and risk appetite.	Reversal of current monetary stance should pay special attention to the possibility of a rapid deterioration of market liquidity.
Liquidity Regimes	U.S. Corporate Bond; U.S. and EU Sovereign Debt; FX	Market liquidity evaporates during crises.	Have a preemptive strategy to deal with liquidity dry-ups. Monitor liquidity in real time.
Liquidity Spillovers	U.S. Corporate Bond; U.S. Sovereign Debt; EME, EU, and U.S. Equity; FX	Market liquidity spillovers across asset classes increase in periods of financial stress and are now more elevated than before the financial crisis.	Monitor liquidity over a wide range of asset classes.

Source: IMF staff
Note: CDS = credit default swaps; EME = emerging market economy; EU = European Union; FX = foreign exchange; MBS = mortgage-backed securities.

Annex 2.1. Data and Liquidity Measures

The analyses in this chapter—both the ones at the security level and the aggregate ones—use several data sets:

- *U.S. corporate bond data*—The TRACE (Trade Reporting and Compliance Engine) data set contains trade-by-trade analysis for corporate bonds, structured products, and agency bonds traded in the United States since 2002.
- *Global corporate, agency, and sovereign bonds*—The Markit GSAC data set contains quote-by-quote information on four categories of bonds around the world (government, sovereign, agency, and corporate). The data set contains more than 40 percent of observations denominated in developing economy currencies and quote-level information for more than 950,000 bonds. The analysis uses the time periods of April–September 2013 and October 2014–March 2015 to document the "taper tantrum" and recent liquidity events.
- *European sovereign bonds*—The MTS data set contains the top of the order book for all European sovereign bonds traded on the MTS platform from 2005 to 2014. The MTS platform is an interdealer trading platform that trades more than 1,100 government bonds in 18 countries. For each security, the chapter observes quote-by-quote information of the top three bid and ask prices, as well as trades, generating more than 30,000 observations on an average day.
- *Over-the-counter derivatives*—High-level trading volume data were retrieved from the International Swaps and Derivatives Association *SwapsInfo* portal (http://www.swapsinfo.org). Credit default swap liquidity metrics, such as bid-ask spreads and number of quoting dealers, were retrieved from Markit (http://www.markit.com).
- *Quoted spreads and prices*—Information was also gathered on daily bid, ask, high, and low prices on bonds from Thomson Reuters Datastream and Bloomberg, L.P. for a series of bonds, currencies, and stocks, as well as transaction volumes, whenever available.
- *Ownership by institutional investors*—The data are sourced from Thomson Reuters eMaxx data set, which contains each institutional investor's holdings of different fixed-income securities at the quarterly frequency. The sample covers 2008 and 2013.

Annex 2.2. Event Studies of Market Liquidity

The methodology employed in the event studies described in this chapter uses two main approaches: (1) a differences-in-differences approach using panel data and (2) simple cross-section regressions. The first approach can be implemented when it is possible to identify a specific change in regulation or policy that may have affected the behavior of a group of investors or financial intermediaries (the treatment group), while leaving the other group unaffected (the control group). The approach uses the following generic specification:

$$LIQ_{it} = \beta_0 + \beta_1 D_i + \beta_2 T_t + \beta_3 D_i \times T_t + \varepsilon_{it}$$

where the effect of a given determinant is measured with a dummy variable D_i, which takes value one if security i is affected by it, and zero otherwise, multiplied by another dummy variable T_t, which takes value one after the regulatory or policy change is either announced or implemented. The coefficient of interest is β_3, which can be interpreted as the impact the regulatory change has on the treatment group, after removing all the possible aggregate trends that affect both the treatment and the control groups. The equation is estimated using panel fixed effects and robust standard errors. The approach is used to estimate the effect of the following episodes:

- *Increasing posttrade transparency*—Between 2003 and 2005, FINRA forced the disclosure of bond trades of different types of corporate bonds: March 3, 2003 (phase 2a), April 14, 2003 (phase 2b), October 1, 2004 (phase 3a), and February 7, 2005 (phase 3b).
- *Ban of uncovered European sovereign CDS*—The analysis estimates the impact of the November 2012 EU ban by measuring liquidity of about 80 sovereign CDS contracts three months before and after its approval (from August 1, 2012 to January 31, 2013). The metrics used are quoted bid-ask spreads, market depth, number of dealers quoting the CDS, number of quotes, and Markit's liquidity score. The analysis is repeated using quoted bid-ask spreads for roughly 3,400 sovereign bonds from a variety of countries (including EU countries). Since credit risk may be an important time-varying determinant of bond liquidity, the chapter uses a specification with an interaction of the treatment effect with the value of the issuer's CDS spread between May and July 2012.[43]

[43]The CDS spread is in logarithms because the effect of credit risk is likely not linear and the variable has fat tails.

- *Investor base and U.S. corporate bond liquidity*—The security-level analysis compares the imputed round-trip cost of U.S. corporate bonds rated as BBB–, relative to that of other bonds, six months before and after the adoption by the Office of the Comptroller of the Currency of a rule removing references to credit agency ratings as a standard for investment grade.
- *Outright purchases and MBS liquidity*—The analysis displayed in Figure 2.8 follows Kandrac (2014). The dependent variable is the imputed round-trip cost calculated using security-level TRACE data for 30-year MBS and the explanatory variable is the dollar value of outright purchases of each security, as reported by the Federal Reserve Bank of New York. The controls also include issuance and distance to coupon, sourced from JP Morgan.

The cross-section approach uses the following specification:

$$\Delta LIQ_i = \delta_0 + \delta_1 X_{i,-1} + \mathbf{z}_i\Gamma + u_i,$$

where X_i is the value of the variable of interest before liquidity is affected by an exogenous shock (such as the global financial crisis or the taper tantrum), $\mathbf{z}_i$ is a set of additional controls, and ΔLIQ_i is the change in liquidity of security i during the episode under consideration. The coefficient of interest is δ_1 and is estimated using a pooled ordinary least squares regression. Statistical inference is based on robust standard errors. The approach is used to study the following:

- *Ownership composition and concentration*—The study focuses on corporate bond liquidity and relates it to the types of investors and their concentration, as reported by eMaxx. It controls for ratings, age, total issue amount, and other bond-level characteristics.
- *Greater pretrade transparency and other bond characteristics*—The study measures the contribution to the change in liquidity of the number of dealers (pretrade transparency), issue size, credit rating, quote depth, time to maturity, and number of issues by the same issuer.

The impact of changes in the collateral framework is assessed by looking at changes in the bid-ask spread for aforementioned securities, available from Bloomberg, L.P. The analysis focuses on a series of events in which the ECB broadened the eligibility of collateral either by reducing the rating threshold for securities issued in euros (October 15, 2008, for all securities except asset-backed securities, and December 8, 2011, June 20, 2012, and July 9, 2014) or by accepting securities issued in U.S. dollars, British pounds, and Japanese yen as collateral (October 15, 2008, and September 6, 2012).

The analysis of the impact of market making on market liquidity uses time-series regressions of aggregate liquidity for U.S. corporate bonds on the frequency of U.S. Treasury auctions—an instrument for dealers' ability to make markets. The following equation is estimated for investment-grade and high-yield corporate bonds at the daily and monthly frequencies:

$$LIQ_t = \gamma_0 + \gamma_1 \, Auction_{t-1} + \Gamma_2 X_{t-1} + \nu_t$$

where *Auction* is a dummy variable that equals one in any day when there is at least one U.S. Treasury auction, and zero otherwise. X denotes a set of macroeconomic and financial variables as specified in Annex 2.3 except for the variable *Dealer's inventory*. The monthly variables are constructed by averaging the daily values over the month, including the dummy. The coefficient of interest is γ_1. The effect in a day is computed by dividing the γ_1 from daily regressions by the average imputed round-trip cost. The effect over one month is computed by dividing the γ_1 from monthly regressions first by 30 and then by the average imputed round-trip cost. A similar specification is used in Figure 2.9, where imputed round-trip costs are regressed on the lagged VIX, credit spread, TED spread, business conditions index, commodity prices, and commercial bank holdings of corporate bonds, as well as on the U.S. shadow policy rate (sourced from Leo Krippner's webpage at the Reserve Bank of New Zealand).

Annex 2.3. Markov Regime-Switching Models for Market Liquidity and the Liquidity Premium

Data for U.S. corporate bonds and European sovereign bonds suggest the existence of three liquidity regimes—low, intermediate, and high liquidity. The probabilities of being in each of the three distinct liquidity regimes (low, intermediate, and high) for U.S. corporate bonds or European sovereign bonds are estimated using a Markov regime-switching model:

$$LIQ_t = \alpha_0^k + \varepsilon_t^k, \qquad \text{(A.2.1)}$$

where *LIQ* is the liquidity measure at either daily or monthly frequency, and k indicates the liquidity regime. The model allows both the level and the volatility of liquidity to change among the regimes and is estimated by the maximum likelihood method. Three trade-based measures are used to measure the market liquidity of U.S. corporate bonds: the imputed round-trip cost (IRTC), the Amihud measure, and the Roll measure.[44]

[44]All liquidity measures are available at a monthly frequency. The IRTC is also available at daily frequency. Results based on the Amihud and Roll measures are similar to those based on IRTC.

For European sovereign bonds, equally weighted effective spreads are used (aggregated over six euro area sovereign bonds—Belgium, France, Germany, Italy, Netherlands, and Spain).

A similar regime-switching behavior is also identified in the foreign exchange and U.S. Treasury bond markets, but only two regimes are found. Model (A.2.1) is estimated using equally weighted bid-ask spreads (normalized by mid prices) in three currency aggregates: the major advanced markets (euro, British pound, Japanese yen, and Swiss franc), other advanced markets (Australian dollar, Canadian dollar, Danish krone, New Zealand dollar, Norwegian krone, and Swedish krona), and emerging markets (Brazilian *real*, Indonesian rupiah, Indian rupee, Russian ruble, South African rand, and Turkish lira). For U.S. Treasury bonds, the Corwin and Schultz (2012) measure is used.

The probability of being in the low-liquidity regime can be explained by a set of lagged macroeconomic and financial variables. Following Acharya, Amihud, and Bharath (2013), we apply a standard logit transformation to the probability:

$$\log\left(\frac{Probability + c}{1 - Probability + c}\right)$$

where c is a constant added to accommodate the cases in which *Probability* = 1 or 0. The explanatory variables are as follows:

- *Citigroup economic surprise index*—Measures the actual outcome of economic releases relative to consensus estimates at the daily frequency.
- *Business condition index*—Real business conditions are tracked using Aruoba, Diebold, and Scotti's (2009) index of business conditions at the monthly frequency.
- *VIX*—The Chicago Board Options Exchange Volatility Index, which measures the market's expectation of stock market volatility over the next month.
- *Commodity price inflation*—The daily (monthly) percentage change in the commodity price index from the Commodity Research Bureau for the daily (monthly) regressions.
- *Moody's credit spread*—The yield spread between Moody's Baa- and Aaa-rated corporate bonds.
- *TED spread*—The difference between the three-month London interbank offered rate (LIBOR) based on the U.S. dollar and the three-month T-bill secondary market rate (orthogonalized with respect to the credit spread).
- *Unconventional monetary policy*—The number of positive minus negative announcements by the Federal Reserve of large-scale asset purchases during the previous 30 days. The monthly variable is constructed by averaging the daily values over the month.
- *Dealers' inventory*—Dealers' inventory is approximated by the U.S. commercial banks' holdings of total corporate securities in percent of their total assets.
- *U.S. Treasury auctions*—A dummy variable that equals one if there is a U.S. Treasury auction in any day. The monthly variable is constructed by averaging the daily values over the month.

The analysis estimates the liquidity premium for investment-grade and high-yield bond returns using the following Markov regime-switching model as in Acharya, Amihud, and Bharath (2013).

- Investment grade-bond returns (in excess of the 30-day T-bill return):

$$r_{IG,t} = \beta_{IG,0} + \beta_{IG,1} TERM_t + \beta_{IG,2} CREDIT_t + \beta_{IG,3} Sillq_t + \beta^s_{IG,4} Billq_{IG,t} + \varepsilon^s_{IG,t}$$

- High-yield bond returns (in excess of the 30-day T-bill return):

$$r_{HY,t} = \beta_{HY,0} + \beta_{HY,1} TERM_t + \beta_{HY,2} CREDIT_t + \beta_{HY,3} Sillq_t + \beta^s_{HY,4} Billq_{HY,t} + \varepsilon^s_{HY,t}$$

- Regime-dependent variance-covariance matrix:

$$\Omega_s = \begin{pmatrix} \sigma^2_{IG,s} & \rho_s \sigma_{IG,s} \sigma_{HY,s} \\ \rho_s \sigma_{IG,s} \sigma_{HY,s} & \sigma^2_{IG,s} \end{pmatrix}, \qquad (A.2.2)$$

where s is the regime, r_{IG} and r_{HY} are the returns on Barclay's investment-grade and high-yield corporate bond indices in excess of the 30-day T-bill return. *TERM* is measured by the difference between the monthly 30-year Treasury bond yield and one-month T-bill yield. *CREDIT* is Moody's credit spread measure. $Sillq_t$ is a liquidity risk measure of the stock market based on Corwin and Schultz (2012). $Billq_{IG}$ and $Billq_{HY}$ are liquidity risk measures of investment-grade and high-yield corporate bonds, respectively, based on imputed round-trip costs, and their coefficients are assumed to differ across regimes.[45] Liquidity risk is measured by the residuals of autoregressive models of the liquidity measures.

The spillover analysis calculates an index of market-wide liquidity spillovers and relates it to regimes of high asset-returns volatility and comovement. Financial market stress is identified by running a regime-switching Bayesian vector autoregression (VAR) for monthly returns of equities in advanced and emerging market economies, U.S. and European sovereign bonds, high-yield and investment-grade corporate bonds, and com-

[45]Allowing stock market liquidity risk to change across regimes does not qualitatively change results.

modities. Market liquidity spillovers are measured by decomposing the generalized forecast error variance for a VAR of liquidity measures in a 200-day rolling window and then calculating for each day the total contribution of each asset class to the other asset classes' market liquidity. See Diebold and Yilmaz (2014).

References

Acharya, Viral, Yakov Amihud, and Sreedhar Bharath. 2013. "Liquidity Risk of Corporate Bond Returns: Conditional Approach." *Journal of Financial Economics* 110 (2): 358–86.

Acharya, Viral, and S. Viswanathan. 2011. "Leverage, Moral Hazard, and Liquidity." *Journal of Finance* 66 (1): 99–138.

Acharya, Viral, Thomas Philippon, Matthew Richardson, and Nouriel Roubini. 2009. "A Birds-Eye View. The Financial Crisis of 2007–09: Causes and Remedies." *Financial Markets, Institutions and Instruments* 18 (2): 89–137.

Amihud, Yakov. 2002. "Illiquidity and Stock Returns: Cross-Section and Time-Series Effects." *Journal of Financial Markets* (5): 31–56.

Aruoba, S. Borağan, Francis X. Diebold, and Chiara Scotti. 2009. "Real-Time Measurement of Business Conditions." *Journal of Business and Economic Statistics* 27 (4): 417–27.

Ashcraft, Adam, James McAndrews, and David Skeie. 2011. "Precautionary Reserves and the Interbank Market." *Journal of Money, Credit and Banking* 43 (2): 311–48.

Asquith, Paul, Thom Covert, and Parag Pathak. 2013. "The Effects of Mandatory Transparency in Financial Market Design: Evidence from the Corporate Bond Market." NBER Working Paper 19417, National Bureau of Economic Research, Cambridge, Massachusetts.

Bao, Jack, Jun Pan, and Jiang Wang. 2011. "The Illiquidity of Corporate Bonds." *Journal of Finance* 66 (3): 911–46.

Beber, Alessandro, and Marco Pagano. 2013. "Short-Selling Bans around the World: Evidence from the 2007–09 Crisis." *Journal of Finance* 68 (1): 343–81.

Bekaert, Geert, Marie Hoerova, and Marco Lo Duca. 2013. "Risk, Uncertainty, and Monetary Policy." *Journal of Monetary Economics* 60 (7): 771–88.

Bessembinder, Hendrik, Jia Hao, and Michael L. Lemmon. 2011. "Why Designate Market Makers? Affirmative Obligations and Market Quality." http://ssrn.com/abstract=989061 or http://dx.doi.org/10.2139/ssrn.989061.

Bessembinder, Hendrik, and William Maxwell. 2008. "Markets: Transparency and the Corporate Bond Market." *Journal of Economic Perspectives* 22 (2): 217–34.

BlackRock. 2014. "Corporate Bond Market Structure: The Time for Reform Is Now." *ViewPoints*, London.

Boehmer, Ekkehart, Charles M. Jones, and Xiaoyan Zhang. 2013. "Shackling Short Sellers: The 2008 Shorting Ban." *Review of Financial Studies* 26 (6): 1363–1400.

Boehmer, Ekkehart, Gideon Saar, and Lei Yu. 2005. "Lifting the Veil: An Analysis of Pre-Trade Transparency at the NYSE." *Journal of Finance* 60 (2): 783–815.

Bouveret, Antoine, Peter Breuer, Chen Yingyuan, David Jones, and Tsuyoshi Sasaki. Forthcoming. "Fragilities in U.S. Treasury Markets and Lessons from the Flash Rally of October 15, 2014." Working Paper, International Monetary Fund, Washington.

Brunnermeier, Markus K., and Lasse Heje Pedersen. 2009. "Market Liquidity and Funding Liquidity." *Review of Financial Studies* 22 (6): 2201–38.

Buiter, Willem H. 2008. "Central Banks and Financial Crises." Jackson Hole Symposium on Maintaining Stability in a Changing Financial System. Jackson Hole, Wyoming, August 21–23.

Chaboud, Alain P., Benjamin Chiquoine, Erik Hjalmarsson, and Clara Vega. 2014. "Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market." *Journal of Finance* 69 (5): 2045–84.

Christensen, Jens, and James Gillan. 2015. "Does Quantitative Easing Affect Market Liquidity?" Federal Reserve Bank of San Francisco Working Paper 26, San Francisco.

Clementi, David. 2001. "Financial Markets: Implications for Financial Stability." *Balance Sheet* 9 (3): 7–12.

Committee on the Global Financial System (CGFS). 2014. "Market-Making and Proprietary Trading: Industry Trends, Drivers and Policy Implications." CGFS Working Paper 52, Bank for International Settlements, Basel.

Corwin, Shane, and Paul Schultz. 2012. "A Simple Way to Estimate Bid-Ask Spreads from Daily High and Low Prices." *Journal of Finance* 67 (2): 719–60.

Diebold, Francis X., and Kamil Yılmaz. 2014. "On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms." *Journal of Econometrics* 182 (1): 119–34.

Duarte, Fernando, and Thomas M. Eisenbach. 2015. "Fire-Sale Spillovers and Systemic Risk." FRB of New York Staff Report 645, Federal Reserve Bank of New York, New York. http://ssrn.com/abstract=2340669 or http://dx.doi.org/10.2139/ssrn.2340669.

Duffie, Darrell. 2012. "Market Making under the Proposed Volcker Rule." Working Paper 106, Rock Center for Corporate Governance at Stanford University, Palo Alto, California.

——. 2010. "Presidential Address: Asset Pricing with Slow-Moving Capital." *Journal of Finance* 65 (4): 1237–67.

Easley, David, Marcos Lopez de Prado, and Maureen O'Hara. 2011. "The Microstructure of the Flash Crash: Flow Toxicity, Liquidity Crashes, and the Probability of Informed Trading." *Journal of Portfolio Management* 37 (2): 118–28.

Edwards, Amy, Lawrence Harris, and Michael Piwowar. 2007. "Corporate Bond Market Transaction Costs and Transparency." *Journal of Finance* 64 (3): 1421–51.

Elliott, Douglas J. 2015. "Market Liquidity: A Primer." Economic Studies at Brookings Paper, The Brookings Institution, Washington.

European Securities Market Authority (ESMA). 2013a. "Short Selling in the EU: Initial Evidence after Entry into Force of the Regulation." In *ESMA Report on Trends, Risks and Vulnerabilities*, Paris.

——. 2013b. *Final Report ESMA's Technical Advice on the Evaluation of the Regulation (EU) 236/2012 of the European Parliament and of the Council on Short Selling and Certain Aspects of Credit Default Swaps.* Paris.

Fleming, Michael J., and Eli M. Remolona. 1999. "Price Formation and Liquidity in the U.S. Treasury Market: The Response to Public Information." *Journal of Finance* 54 (5): 1901–15.

Fleming, Michael J., and Joshua V. Rosenberg. 2008. "How Do Treasury Dealers Manage Their Positions?" Staff Report 299, Federal Reserve Bank of New York, New York.

Flood, Mark, J. Liechty, and T. Piontek. 2015. "Systemwide Commonalities in Market Liquidity." OFR Working Paper 15–11, Office of Financial Research, Washington.

Foucault, Thierry, Marco Pagano, and Ailsa Roell. 2013. *Market Liquidity: Theory, Evidence, and Policy.* New York: Oxford University Press.

Freixas, Xavier, Antoine Martin, and David Skeie. 2011. "Bank Liquidity, Interbank Markets, and Monetary Policy." *Review of Financial Studies* 24 (8): 2656–92.

Gagnon, Joseph, Matthew Raskin, Julie Remache, and Brian Sack. 2011. "The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases." *International Journal of Central Banking* 7 (1): 3–43.

Gai, Prasanna, and Nicolas Vause. 2005. "Measuring Investors' Risk Appetite." Bank of England Working Paper 283, London.

Geanakoplos, John. 2010. "The Leverage Cycle." In *NBER Macroeconomics Annual 2009*, Volume 24, edited by Daron Acemoglu, Kenneth Rogoff, and Michael Woodford. Chicago: University of Chicago Press, 1–65

Goldman Sachs. 2015. "A Look at Liquidity." *Top of Mind*. Global Macro Research. Goldman Sachs Global Investment Research, New York.

Goyenko, Ruslan Y., and Andrey D. Ukhov. 2009. "Stock and Bond Market Liquidity: A Long-Run Empirical Analysis." *Journal of Financial and Quantitative Analysis* 44 (1): 189–212.

Gungor, Sermin, and Jesús Sierra. 2014. "Search-for-Yield in Canadian Fixed Income Mutual Funds and Monetary Policy." Bank of Canada Working Paper 3, Ottawa.

Hasbrouck, Joel. 2007. *Empirical Market Microstructure.* New York: Oxford University Press.

Hendershott, Terrence, and Ananth Madhavan. 2015. "Click or Call? Auction versus Search in the Over-the-Counter Market." *Journal of Finance* 70 (1): 419–47.

Holden, Craig W., Stacey E. Jacobsen, and Avanidhar Subrahmanyam. Forthcoming. "The Empirical Analysis of Liquidity." *Foundations and Trends in Finance.* http:// ssrn.com/ abstract=2402215 or http://dx.doi.org/10.2139/ssrn.2402215.

International Capital Market Association (ICMA). 2014. European Repo Market Survey No. 28, Zurich.

International Swaps and Derivatives Association (ISDA). 2014. "Adverse Liquidity Effects of the EU Uncovered Sovereign CDS Ban." ISDA Research Note, New York.

Jiménez, Gabriel, Steven Ongena, Jose-Luis Peydró, and Jesús Saurina. 2014. "Hazardous Times for Monetary Policy: What Do Twenty-Three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk-Taking?" *Econometrica* 82 (2): 463–505.

Kandrac, John. 2014. "The Costs of Quantitative Easing: Liquidity and Market Functioning Effects of Federal Reserve MBS Purchases." Board of Governors of the Federal Reserve System, Washington.

Korajczyk, Robert A., and Ronnie Sadka. 2008. "Pricing the Commonality across Alternative Measures of Liquidity." *Journal of Financial Economics* 87 (1): 45–72.

Kraus, Alan, and Hans R. Stoll. 1972. "Price Impact of Block Trading on the New York Stock Exchange." *Journal of Finance* 27 (3): 569–88.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen. 2012. "The Aggregate Demand for Treasury Debt." *Journal of Political Economy* 120 (2): 233–67.

Laganá, Marco, Martin Perina, Isabel von Köppen-Mertes, and Avinash D. Persaud. 2006. "Implications for Liquidity from Innovation and Transparency in the European Corporate Bond Market." ECB Occasional Paper 50, European Central Bank, Frankfurt.

Lagos, Ricardo, Guillaume Rocheteau, and Pierre-Olivier Weill. 2011. "Crises and Liquidity in Over-the-Counter Markets." *Journal of Financial Economics* 146 (6): 2169–205.

Madhavan, Ananth, David Porter, and Daniel Weaver. 2005. "Should Securities Markets be Transparent?" *Journal of Financial Markets* 8 (3): 265–87.

McKinsey & Company and Greenwich Associates. 2013. *Corporate Bond E-Trading: Same Game, New Playing Field.* New York.

Nathans, Laura L., Frederick L. Oswald, and Kim Nimon. 2012. "Interpreting Multiple Linear Regression: A Guidebook of Variable Importance." *Practical Assessment, Research and Evaluation* 17 (9): 1–19.

Roll, Richard. 1984. "A Simple Implicit Measure of the Effective Bid – Ask Spread in an Efficient Market." *Journal of Finance* 39 (4): 1127–39.

Scheinkman, Jose A., and Wei Xiong. 2003. "Overconfidence and Speculative Bubbles." *Journal of Political Economy* 111 (6): 1183–220.

Shiller, Robert J. 2000. *Irrational Exuberance.* Princeton, New Jersey: Princeton University Press.

Singh, Manmohan. 2013. "The Changing Collateral Space." IMF Working Paper 13/25, International Monetary Fund, Washington.

U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission. 2015. *The U.S. Treasury Market on October 15, 2014*. Joint Report, Washington.

Vayanos, Dimitri, and Jiang Wang. 2012. "Market Liquidity: Theory and Evidence." NBER Working Paper 1825, National Bureau of Economic Research, Cambridge, Massachusetts.

Zhu, Haoxiang. 2012. "Finding a Good Price in Opaque Over-the-Counter Markets." *Review of Financial Studies* 25 (4): 1255–85.

CHAPTER 3

CORPORATE LEVERAGE IN EMERGING MARKETS—A CONCERN?

SUMMARY

The corporate debt of nonfinancial firms across major emerging market economies quadrupled between 2004 and 2014. At the same time, the composition of that corporate debt has been shifting away from loans and toward bonds. Although greater leverage can be used for investment, thereby boosting growth, the upward trend in recent years naturally raises concerns because many financial crises in emerging markets have been preceded by rapid leverage growth.

This chapter examines the evolving influence of firm, country, and global factors on emerging market leverage, issuance, and spread patterns during the past decade. For this purpose, it uses large, rich databases. Although the chapter does not aim to provide a quantitative assessment of whether leverage in certain sectors or countries is excessive, the analysis of the drivers of leverage growth can help shed light on potential risks.

The three key results of the chapter are as follows: First, the relative contributions of firm- and country-specific characteristics in explaining leverage growth, issuance, and spreads in emerging markets seem to have diminished in recent years, with global drivers playing a larger role. Second, leverage has risen more in more cyclical sectors, and it has grown most in construction. Higher leverage has also been associated with, on average, rising foreign currency exposures. Third, despite weaker balance sheets, emerging market firms have managed to issue bonds at better terms (lower yields and longer maturities), with many issuers taking advantage of favorable financial conditions to refinance their debt.

The greater role of global factors during a period when they have been exceptionally favorable suggests that emerging markets must prepare for the implications of global financial tightening. The main policy recommendations are the following: First, monitoring vulnerable and systemically important firms, as well as banks and other sectors closely linked to them, is crucial. Second, such expanded monitoring requires that the collection of data on corporate sector finances, including foreign currency exposures, be improved. Third, macro- and microprudential policies could help limit a further buildup of foreign exchange balance sheet exposures and contain excessive increases in corporate leverage. Fourth, as advanced economies normalize monetary policy, emerging markets should prepare for an increase in corporate failures and, where needed, reform corporate insolvency regimes.

Prepared by Selim Elekdag (team leader), Adrian Alter, Nicolas Arregui, Hibiki Ichiue, Oksana Khadarina, Ayumu Ken Kikkawa, Suchitra Kumarapathy, Machiko Narita, and Jinfan Zhang, with contributions from Raphael Lam and Christian Saborowski, under the overall guidance of Gaston Gelos and Dong He.

Introduction

Corporate debt in emerging market economies has risen significantly during the past decade. The corporate debt of nonfinancial firms across major emerging market economies increased from about $4 trillion in 2004 to well over $18 trillion in 2014 (Figure 3.1). The average emerging market corporate debt-to-GDP ratio has also grown by 26 percentage points in the same period, but with notable heterogeneity across countries. Likewise, comparable firm-level measures of leverage show an upward trend, with some readings still below historical peaks (Figure 3.2). Greater emerging market corporate leverage can confer important benefits, such as facilitating productive investment, and thereby faster growth. However, the upward trend in recent years naturally raises concerns because many emerging market financial crises have been preceded by rapid leverage growth.[1]

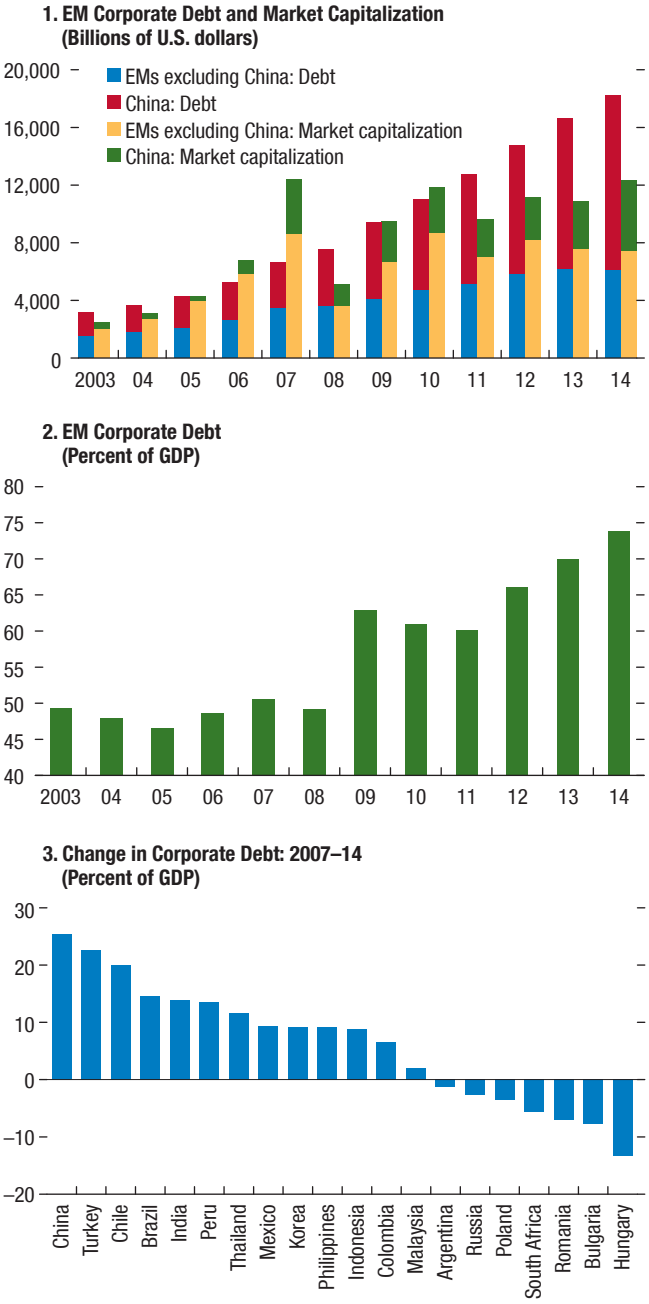
The composition of emerging market corporate debt has also changed. Although loans are still the largest component of that corporate debt, the share of bonds has been growing rapidly, from 9 percent of total debt in 2004 to 17 percent of total debt in 2014, with most of the increase materializing after 2008, including via offshore financial centers, as discussed in Shin (2013) and BIS (2014c) (Figure 3.3).[2]

The growth and changing nature of emerging market corporate debt has occurred amid an unprecedented monetary expansion in advanced economies and a shifting global financial landscape. Monetary policy has been exceptionally accommodative across major advanced economies. Firms in emerging markets have faced greater incentives and opportunities to increase leverage as a result of the ensuing unusually favorable global financial conditions. For example, the U.S. "shadow rate"—a useful indicator of the monetary policy stance when the federal funds rate is at the zero lower bound—dropped to about minus 5 percent in the first half of 2013 and is still negative

[1]As noted in Mendoza and Terrones (2008), the buildup of corporate leverage is often associated with boom-bust cycles. On the link between rapid growth in credit to the private sector and financial turbulence more generally, see Schularick and Taylor (2012) and Elekdag and Wu (2011); see also BIS (2014a).

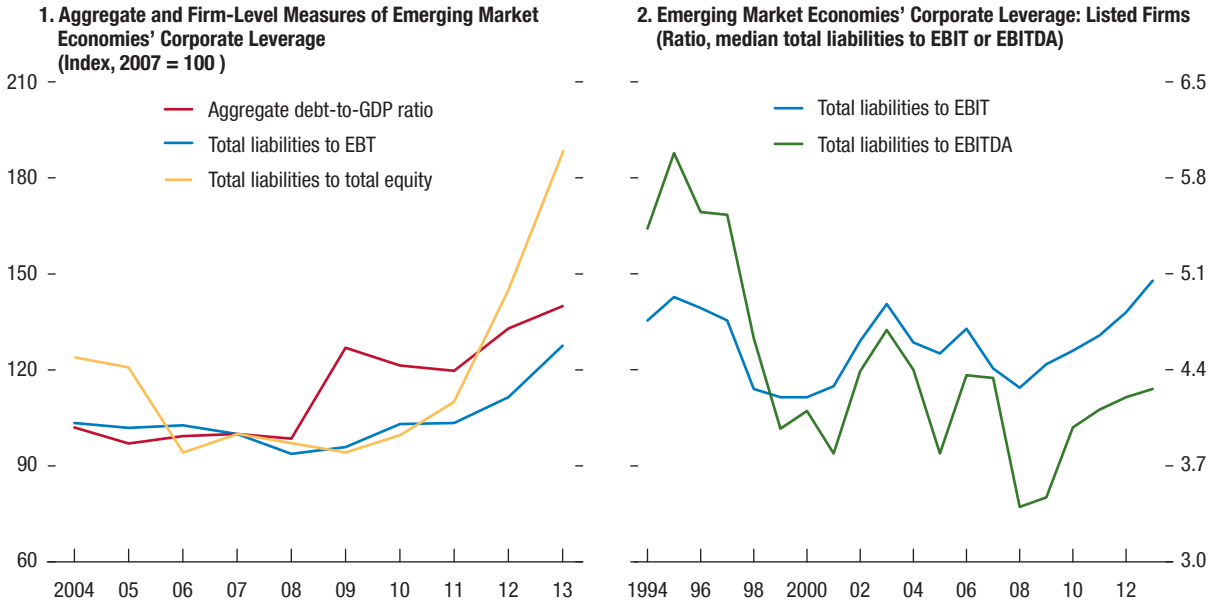
[2]The stock of outstanding bonds denominated in foreign currency has risen from $168 billion in 2003 to $855 billion in 2014, but their overall share has remained broadly stable (discussed below); see also Gelos (2003) and BIS (2014b).

Figure 3.1. Emerging Market Economies: Evolving Capital Structure



Sources: Ayala, Nedeljkovic, and Saborowski 2015; Bank for International Settlements; Dealogic; IMF, International Financial Statistics database; national authorities; and IMF staff calculations.
Note: EM = emerging market economy; figure depicts major EMs. Debt includes bank credit and bond financing. Credit by nonbanks is excluded, possibly leading to a significant underestimation of corporate debt in countries with large nonbanking sectors such as China. At the same time, in China, the bulk of fiscal borrowing occurs off budget through local government financing vehicles and is recorded as private credit, although most of it is fiscal (see Arslanalp and others, forthcoming).

Figure 3.2. Emerging Market Economies: Selected Leverage Ratios



Sources: Orbis; Thomson Reuters Worldscope; and IMF staff calculations.
Note: EBT = earnings before taxes; EBIT = earnings before interest and taxes; EBITDA = earnings before interest, taxes, depreciation, and amortization.

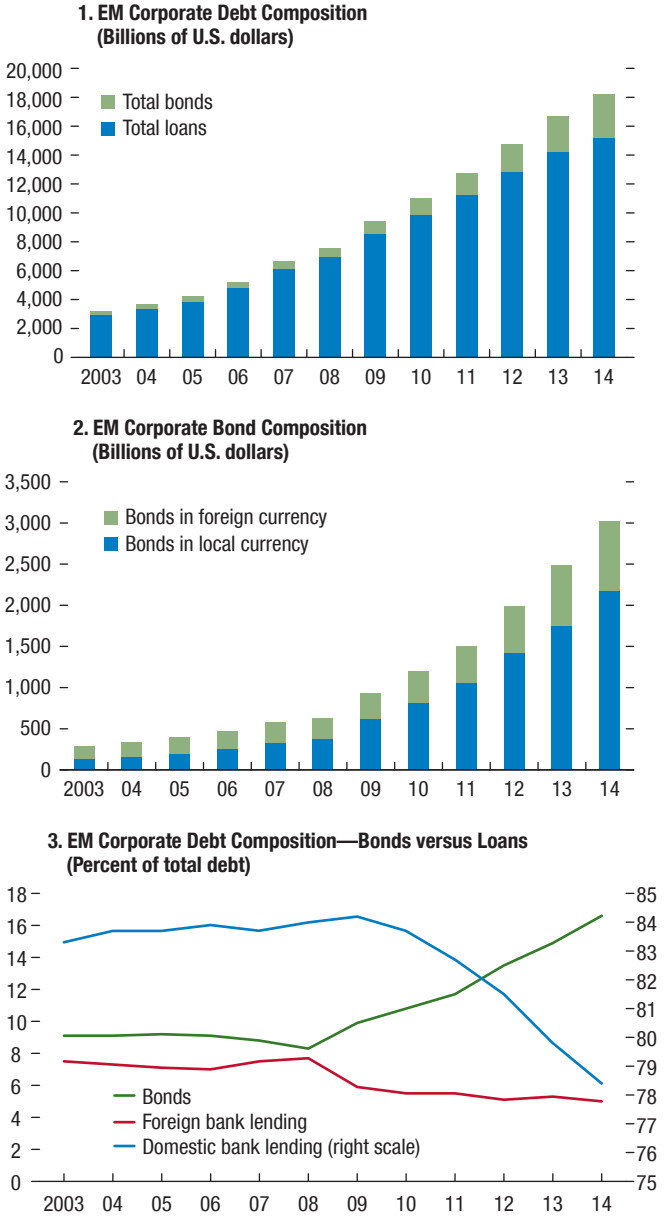
(Box 3.1). Another important recent development has been the decline in cross-border bank lending, largely driven by supply-side factors, specifically banks' efforts to strengthen their balance sheets and satisfy new supervisory and regulatory requirements (see Chapter 2 of the April 2015 *Global Financial Stability Report* [GFSR]).

Accommodative global monetary conditions can encourage leverage growth in emerging markets through several channels. In line with Caruana (2012) and He and McCauley (2013), three transmission channels are worth highlighting (see also Bruno and Shin 2015). First, emerging market central banks set lower policy rates than they would otherwise in response to the prevailing low interest rates in advanced economies to alleviate currency appreciation pressures. Second, large-scale bond purchases in advanced economies reduce bond yields not only in their own bond markets, but also to varying degrees in emerging market bond markets through portfolio balancing effects. Likewise, accommodative monetary policies in advanced economies are typically accompanied by greater capital flows into emerging markets, seeking higher returns. Third, changes in policy rates in advanced economies are promptly reflected in the debt-servicing burden on outstanding emerging market foreign currency-denominated debt with variable rates. Through these channels, expansionary global monetary conditions can facilitate greater corporate leverage through the relaxation of emerging market borrowing constraints owing to the widespread availability of lower-cost funding and appreciated collateral values.[3]

A key risk for the emerging market corporate sector is a reversal of postcrisis accommodative global financial conditions. Firms that are most leveraged stand to endure the sharpest rise in their debt-service costs once monetary policy rates in some key advanced economies begin to rise. Furthermore, interest rate risk can be aggravated by rollover and currency risks. Although bond finance tends to have longer maturities than bank finance, it exposes firms more to volatile financial market conditions (Shin 2014b). In addition, local currency depreciations

[3]Moreover, expectations of continued local currency appreciation are likely to have created incentives to incur foreign currency debt in certain regions and sectors.

Figure 3.3. Emerging Market Economies: Changing Composition of Corporate Debt



Sources: Ayala, Nedeljkovic, and Saborowski 2015; Bank for International Settlements; Dealogic; IMF, International Financial Statistics database; national authorities; and IMF staff calculations.
Note: EM = emerging market economy; figure depicts major EMs.

associated with rising policy rates in the advanced economies would make it increasingly difficult for emerging market firms to service their foreign currency-denominated debts if they are not hedged adequately.

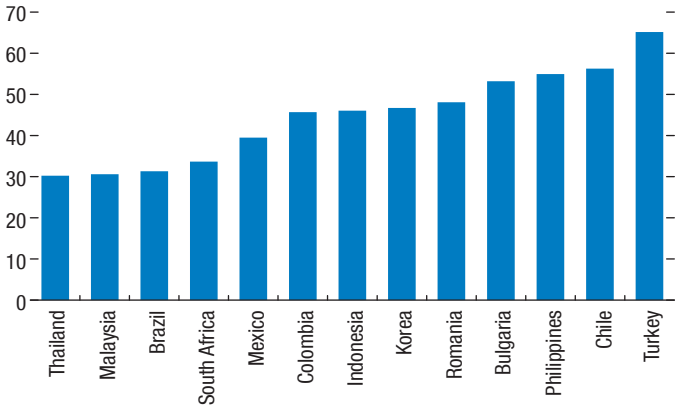
Corporate distress could be readily transmitted to the financial sector and contribute to adverse feedback loops. Greater corporate leverage can render firms less able to withstand negative shocks to income or asset values. This vulnerability has important implications for the financial system, in part because corporate debt constitutes a significant share of emerging market banks' assets (Figure 3.4). Therefore, shocks to the corporate sector could quickly spill over to the financial sector and generate a vicious cycle as banks curtail lending. Decreased loan supply would then lower aggregate demand and collateral values, further reducing access to finance and thereby economic activity, and in turn, increasing losses to the financial sector (Gertler and Kiyotaki 2010).

This chapter highlights the financial stability implications of recent patterns in emerging market corporate finance by disentangling the role of domestic and external factors. The focus is on nonfinancial firms' corporate leverage, bond issuance, and spreads. Key external factors include measures of global economic and financial conditions. Domestic factors considered include bond-, firm-, and country-level characteristics. Although the chapter does not aim to provide a quantitative assessment of whether leverage in certain sectors or countries is excessive, the analysis of the key drivers of leverage growth can still help shed light on potential risks.[4]

If rising leverage and issuance have recently been predominantly influenced by external factors, then firms are rendered more vulnerable to a tightening of global financial conditions. Similarly, a decline in the role of firm- and country-level factors in recent years would be consistent with the view that markets may have been underestimating risks. In contrast, if firms issuing foreign currency debt have been reducing their net foreign exchange exposure through hedging or other means, simply focusing on the volume of foreign currency bond issuance would tend to overstate risks related to local depreciations.

[4]Scenario analysis to assess emerging market corporate vulnerabilities has been discussed in various IMF studies, including Chapter 1 of the April 2014 GFSR and in the latest IMF *Spillover Report* (IMF 2015a); see also Chow (forthcoming).

Figure 3.4. Domestic Banks: Ratio of Total Corporate Loans to Total Loans in 2014
(Percent)



Sources: IMF, International Financial Statistics database; and IMF staff calculations.

This chapter addresses these issues by considering the following questions:

- How have corporate leverage and bond issuance in the emerging market nonfinancial sector changed over time and across regions, sectors, and firms? How have these funds been used? Has higher leverage or bond issuance been accompanied by an increase in net foreign exchange exposure?
- What is the relative role of domestic factors compared with that of external factors—such as accommodative global financial and monetary conditions—in the change in leverage, issuance, and corporate spread patterns? Is there evidence of a smaller role for firm- and country-level factors during the postcrisis period?

The chapter goes beyond existing studies by jointly analyzing firm, country, and global factors as determinants of emerging market corporate leverage, issuance, and spreads. Starting with Rajan and Zingales (1995), many papers have concluded that both firm- and country-specific factors influence corporate capital structure internationally.[5] However, these papers do not focus on the way in which global financial and monetary conditions may have influenced firms' capital structure decisions. Relatedly, some studies have examined recent developments in bond issuance by emerging markets, mostly relying on aggregated issuance data.[6] The chapter builds upon the literature by examining how global factors affect firms' decisions to issue bonds while explicitly accounting for bond- and firm-specific characteristics using large, rich, and relatively underexploited databases.[7] Finally, the chapter also considers emerging market corporate spreads; a novel feature of that analysis is the use of relatively unexplored data on secondary market corporate spreads.

The main results of the chapter can be summarized as follows:

- *The relative roles of firm- and country-specific factors as drivers of leverage, issuance, and spreads in emerging markets have declined in recent years.* Global factors appear to have become relatively more important determinants in the postcrisis period. In some cases, evidence of a structural break appears in these relationships, with a reduced role for firm- and country-level factors in the postcrisis period.
- *Leverage has risen relatively more in vulnerable sectors and has tended to be accompanied by worsening firm-level characteristics.* For example, higher leverage has been associated with, on average, rising foreign exchange exposures. Moreover, leverage has grown most in the cyclical construction sector, but also in the oil and gas subsector. Funds have largely been used to invest, but there are indica-

[5]Emerging market corporate capital structure, including leverage, has been studied in the context of Asia in IMF (2014a) and for central, eastern, and southeastern Europe in IMF (2015c). Kalemli-Ozcan, Sorensen, and Yesiltas (2012) present novel stylized facts using bank- and firm-level data, with a focus on advanced economies.

[6]For instance, Lo Duca, Nicoletti, and Vidal Martinez (2014) and Feyen and others (2015) focus on bond issuance data aggregated at the country and country-industry level, respectively. Likewise, Rodriguez Bastos, Kamil, and Sutton (2015) study issuance in five Latin American countries.

[7]This chapter is also related to a large literature on emerging market capital flows. Various studies find that unconventional monetary policy in advanced economies has had a significant impact on emerging market asset prices, yields, and corporate bond issuance (Chen and others 2014; Chen, Mancini-Griffoli, and Sahay 2014; Fratzscher, Lo Duca, and Straub 2013; Gilchrist, Yue, and Zakrajsek 2014; Lo Duca, Nicoletti, and Vidal Martinez 2014). IMF (2014b) identifies that global liquidity conditions drive cross-border bank lending and portfolio flows, but are affected by country-specific policies. Other studies find that the exit from unconventional monetary policy appears to have differentiated effects across emerging markets, depending on their initial conditions (Aizenman, Binici, and Hutchison 2014; Eichengreen and Gupta 2014; Sahay and others 2015); see also Nier, Saadi Sedik, and Mondino (2014).

Box 3.1. Shadow Rates

Shadow rates are indicators of the monetary policy stance and can be particularly useful once the policy rate has reached the zero lower bound (ZLB). A shadow rate is essentially equal to the policy interest rate when the policy rate is greater than zero, but it can take on negative values when the policy rate is at the ZLB. This property makes the shadow rate a useful gauge of the monetary policy stance in conventional and unconventional policy regimes in a consistent manner. Shadow rates are estimated using shadow rate term structure models, which take the ZLB into account, as originally proposed by Black (1995).[1]

Although shadow rate models are not easy to estimate because of the nonlinearity arising from the ZLB, the literature began to estimate shadow rates with Japan's data by applying nonlinear filtering techniques (Ichiue and Ueno 2006, 2007). Recently, the shadow rates of other countries also have been estimated by many researchers (for example, Wu and Xia, forthcoming) and discussed by policymakers (for example, Bullard 2012).[2]

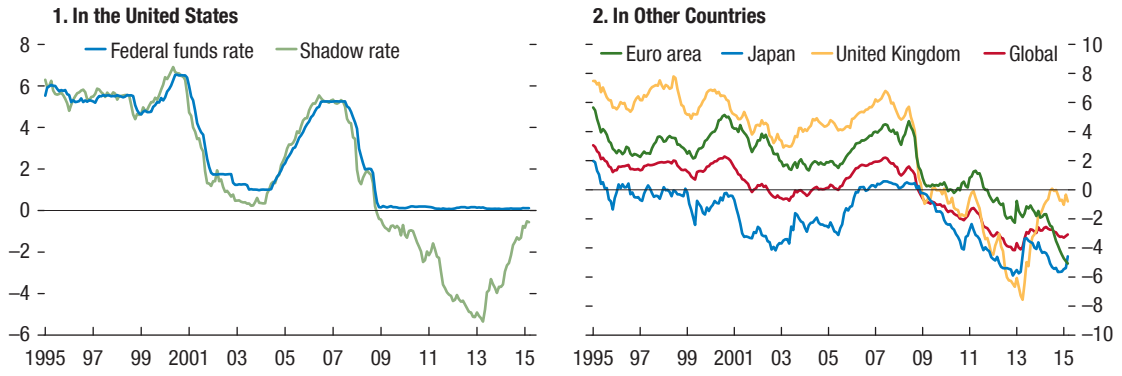
Estimated shadow rates reasonably reflect monetary policy events in unconventional policy regimes. The U.S. shadow rate estimated by Krippner (2014) turned negative in November 2008, when the Federal Reserve started the Large Scale Asset Purchases program (Figure 3.1.1, panel 1). The shadow rate further declined as the Fed adopted additional unconventional policies. However, it bottomed out in May 2013, when the Fed raised the possibility of tapering its purchases of Treasury and agency bonds, and has continued to increase since then. The current level of the shadow rate is only slightly negative. The shadow rate estimates in the euro area, Japan, and the United Kingdom are consistent with their respective monetary policies (Figure 3.1.1, panel 2). These observations support the utility of shadow rates, although their limitations should be recognized. The global shadow rate, which is calculated as the first principal component, has been virtually flat in recent years, reflecting that the tighter stances in the United States and the United Kingdom have been offset by accommodative stances in Japan and the euro area.

This box was prepared by Hibiki Ichiue.

[1]In term structure models, interest rates of various maturities are represented as a function of a small set of common factors. This function is derived from a no-arbitrage condition.

[2]There are limited papers that estimate shadow rates without using term structure models. Kamada and Sugo (2006) and Lombardi and Zhu (2014) summarize multiple financial indicators, such as monetary aggregates.

Figure 3.1.1. Shadow Rates
(Percent)



Sources: Reserve Bank of New Zealand; and IMF staff calculations.
Note: The global shadow rate is the first principal component of the shadow rates of the four central banks (Bank of England, Bank of Japan, European Central Bank, and U.S. Federal Reserve).

tions that the quality of investment has declined recently. These findings point to increased vulnerability to changes in global financial conditions and associated capital flow reversals—a point reinforced by the fact that during the 2013 "taper tantrum," more leveraged firms saw their corporate spreads rise more sharply.

- *Despite weaker balance sheets, emerging market firms have managed to issue bonds at better terms (lower yields, longer maturities) with many issuers taking advantage of favorable financial conditions to refinance their debt.* No conclusive evidence has been found that greater foreign currency-denominated debt has increased overall net foreign exchange exposures.

These results suggest that policy action is warranted to guard against the risks associated with the tightening of global financial conditions as monetary policy in advanced markets begins to normalize. The chapter makes the following five policy recommendations:

- Careful monitoring of vulnerable sectors of the economy and systemically important firms as well as their linkages to the financial sector is vital.
- The collection of financial data on the corporate sector, including foreign exchange exposures, needs improvement.
- Macroprudential policies can be deployed to limit excessive increases in corporate sector leverage intermediated by banks. Possible tools include higher capital requirements (for example, implemented via risk weights) for foreign exchange exposures and caps on the share of such exposures on banks' balance sheets.
- Microprudential measures should also be considered. For instance, regulators can conduct bank stress tests related to foreign currency risks, including derivatives positions.
- Emerging markets should be prepared for corporate distress and sporadic failures in the wake of monetary policy normalization in advanced economies, and where needed and feasible, should reform insolvency regimes.

The Evolving Nature of Emerging Market Corporate Leverage

This section documents the main patterns of corporate leverage across emerging market regions and sectors. A formal empirical analysis focuses on the changing relationship between corporate leverage and key firm, country, and global factors.

The Evolution of Emerging Market Corporate Leverage

Two complementary data sets indicate noteworthy differences in the evolution of emerging market leverage across regions and sectors.[8]

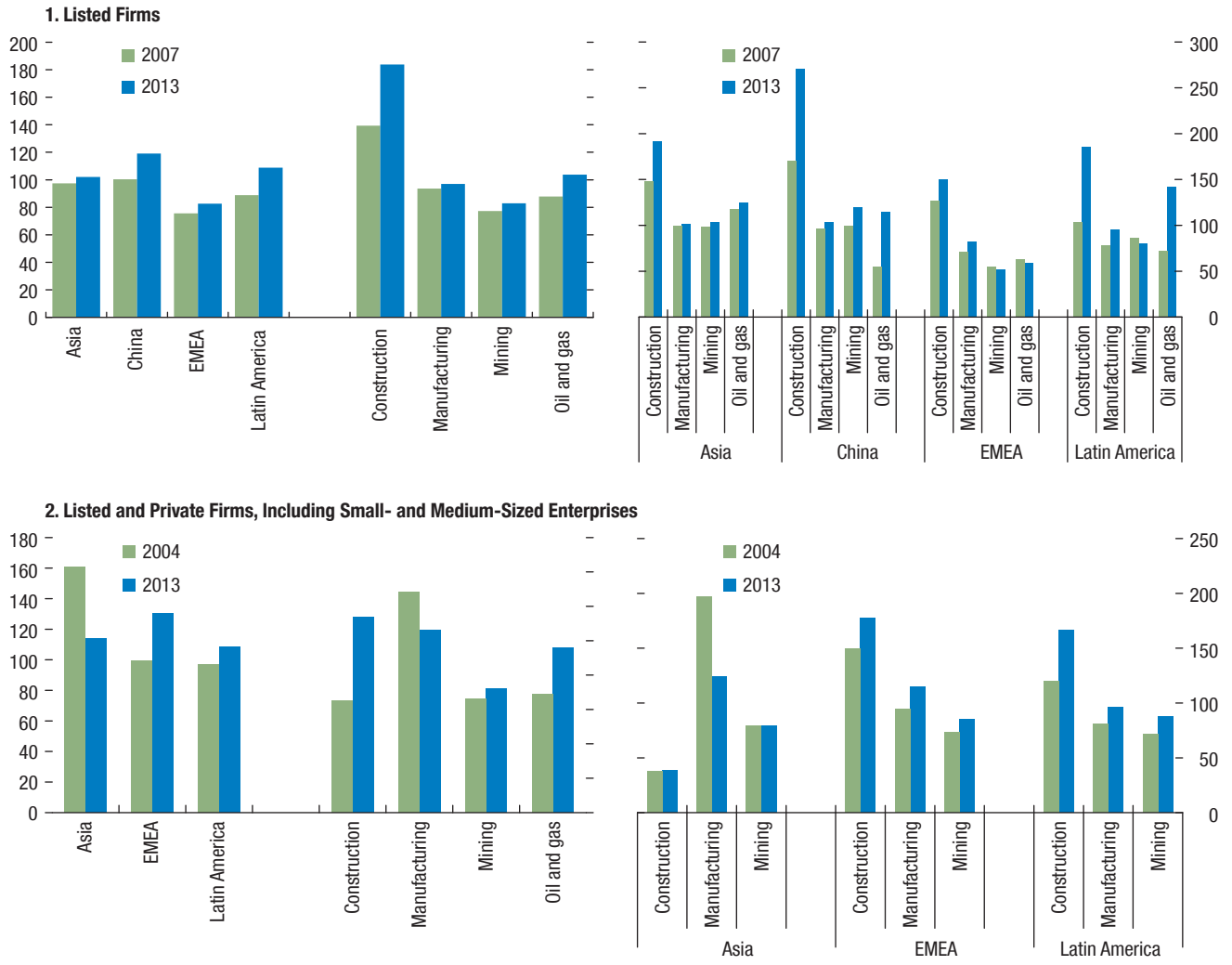
- For publicly listed firms, leverage has risen in emerging Asia; in the emerging Europe, Middle East, and Africa (EMEA) region; in Latin America; and across key sectors (Figure 3.5).
- The striking leverage increase in the construction sector is most notable in China and in Latin America. This increase relates to concerns expressed in recent years about the connection between global financial conditions, capital flows, and real estate price developments in some emerging markets (Cesa-Bianchi, Céspedes, and Rebucci 2015).[9]
- Leverage has grown in mining, and even more so in the oil and gas subsector. These sectors are particularly sensitive to changes in global growth and commodity price fluctuations. In particular, oil price declines can cut into the profitability of energy firms and strain their debt-repayment capacity (see Chapter 1 of the April 2015 GFSR).
- The patterns shift somewhat in relation to small- and medium-sized enterprises (SMEs). For instance, SME leverage seems to have declined in emerging Asia and in the manufacturing sector during the past decade. One reason for such contrasts is the differences in country composition across the two data sets. A key similarity across both data sets is the increase in construction-sector leverage, particularly across EMEA and Latin America.

Both firm- and country-specific factors appear, on average, to have deteriorated across emerging markets in the postcrisis period. At the country level, lower real GDP growth and higher current account and fiscal deficits are examples of worsening postcrisis macroeconomic conditions (Table 3.1). The

[8]One data set, Thomson Reuters Worldscope, contains publicly listed firms, which tend to be larger and have received greater attention. The other, Orbis, predominantly includes unlisted small- and medium-sized enterprises and has been relatively underutilized.

[9]See also http://blog-imfdirect.imf.org/2014/06/11/era-of-benign-neglect-of-house-price-booms-is-over/.

Figure 3.5. Emerging Market Economies: Corporate Leverage by Selected Regions and Sectors
(Percent; ratio of total liabilities to total equity)



Sources: Orbis; Thomson Reuters Worldscope; and IMF staff calculations.
Note: Total liabilities refer to total (nonequity) liabilities. Mining includes oil and gas. Panel 1 begins in 2007 to account for the relative scarcity of Chinese firms in the beginning of the sample period; a balanced sample is used to highlight trends across larger firms. The relative scarcity of data, particularly in the first few years of the sample, is the main reason Chinese patterns are not shown individually in the bottom panels. The regional breakdown of the oil and gas subsector is also excluded for similar reasons. EMEA = Europe, Middle East, and Africa.

International Country Risk Guide (ICRG) index summarizes these and other key macroeconomic fundamentals and corroborates the bleaker domestic conditions in 2010–13. Even though liquidity has edged up at the firm level since the crisis, profitability, solvency, and a measure of asset quality have deteriorated.

Firms that took on more leverage have, on average, also increased their foreign exchange exposures.

- Net foreign exchange exposures are indirectly estimated for listed firms using the sensitivity of their stock returns to changes in trade-weighted exchange rates (Box 3.2).[10]
- The estimated foreign exchange exposures highlight sectoral differences (Figure 3.6). Firms in nontradable sectors, such as construction, tend to have

[10]See also Acharya and others (2015).

Table 3.1. Worsening Emerging Market Firm-Level and Macroeconomic Fundamentals
(Percent, unless otherwise noted)

	Precrisis (2004–07)	Postcrisis (2010–13)
Firm-Level Fundamentals		
Profitability		
Return on Assets	3.6	3.3
Liquidity		
Quick Ratio	0.9	1.0
Solvency		
Interest Coverage Ratio	3.4	2.8
Asset Quality		
Tangible Asset Ratio	30.5	22.9
Macroeconomic Fundamentals		
Real GDP Growth	6.2	3.9
CPI Inflation	4.8	3.9
Short-Term Interest Rate	4.2	3.6
Current Account Balance[1]	0.6	–0.9
External Debt[1]	35.9	35.6
Fiscal Balance[1]	–0.9	–2.8
Public Debt[1]	38.1	39.2
ICRG (macroeconomic fundamentals summary) Index[2]	38.7	38.2

Source: IMF staff.
Note: Historical averages of median firm-level fundamentals reported for all countries in the sample. Interest coverage ratio is EBITDA (earnings before interest, taxes, depreciation, and amortization) to interest expenses; the quick ratio is cash, cash equivalents, short-term investments, and accounts receivables to current liabilities; the tangible asset ratio is the ratio of fixed assets (which include property, plant, and equipment) to total assets.
[1]Percent of GDP.
[2]The average of the International Country Risk Guide (ICRG) Economic and Financial Risk Ratings, which aim to provide an overall assessment of a country's economic situation and ability to finance its debt obligations, respectively. The ICRG index is fairly stable, indicating that small changes can be meaningful: the decline in the index between the two periods is about one-half standard deviation.

positive foreign exchange exposures, reflecting their need for imports. Firms in tradable sectors, such as mining, tend to have negative foreign exchange exposures, because exporting firms benefit from a depreciation of the local currency.[11] The evolution of foreign exchange exposures after the global financial crisis differs across regions. Outside of Asia, the fraction of firms with positive foreign exchange exposures increased across all sectors after the crisis.

- Interestingly, the construction sector, where leverage grew rapidly, is among the sectors perceived by stock markets in emerging market economies as having strongly increased their exposure to exchange rate fluctuations in recent years (Figure 3.7).

[11]These results are consistent with the literature (for example, Bodnar and Gentry 1993; Griffin and Stulz 2001).

The data suggest a growing concentration of indebtedness in the weaker tail of the corporate sector. The share of liabilities held by listed firms is split according to a measure of their solvency, that is, the interest coverage ratio (ICR) (Figure 3.8). An ICR lower than 2 often means that a firm is in arrears on its interest payments. Note that the share of liabilities held by firms with ICRs lower than 2 has grown during the past decade, and is now greater than the 2008 level. The rise of corporate leverage amassed at the tail end of the distribution also raises concerns about China (Box 3.3).

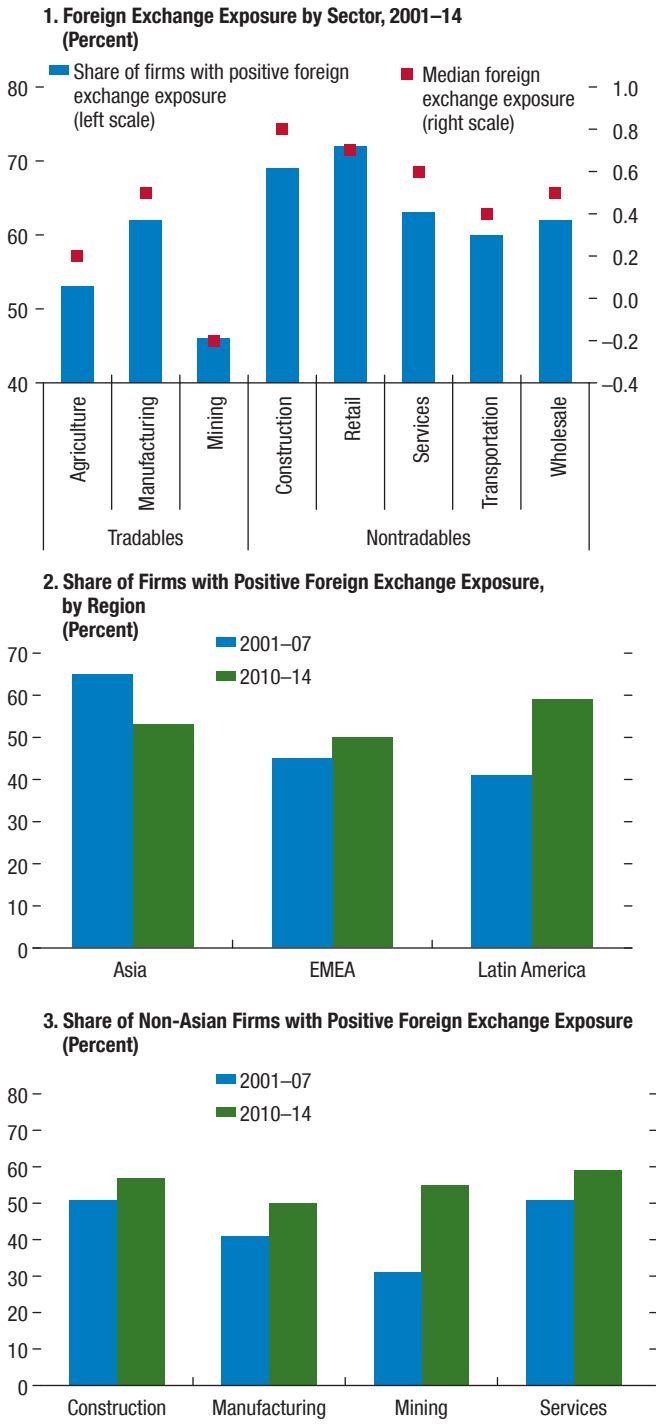
Firm-Level Dynamics of Emerging Market Corporate Leverage

The empirical analysis focuses on the firm-level dynamics of emerging market corporate leverage. The corporate finance literature (focusing mostly on advanced economies) has converged to a set of variables that are considered reliable drivers of corporate leverage: firm size, collateral, profitability, and the market-to-book ratio. The literature's selection of these variables can be traced to various corporate finance theories on departures from the Modigliani-Miller irrelevance proposition, which holds that the specific proportions of debt and equity in a firm's capital structure are irrelevant to its market value (Box 3.4). Building on these studies, this chapter considers both domestic (firm-specific and macroeconomic) factors and global economic and financial conditions as potential determinants of corporate leverage. The focus is on the change in the leverage ratio.

The rise of global factors

The increase in emerging market corporate leverage appears to be closely associated with favorable global conditions. Econometric analysis confirms that firm- and country-specific characteristics are key determinants of emerging market corporate leverage growth: these terms have the expected signs and are statistically significant (Figure 3.9, panel 1). In particular, profitability, tangibility, and the measure of macroeconomic conditions are positively correlated with leverage growth. These positive relationships would imply that leverage should have declined given the deterioration in these determinants in the postcrisis period discussed above (Table 3.1). However, the fact that the opposite happened suggests that global

Figure 3.6. Foreign Exchange Exposures in Emerging Market Economies (Listed Firms)



Sources: IMF, Information Notice System; Thomson Reuters Datastream; Thomson Reuters Worldscope; and IMF staff estimates.
Note: EMEA = Europe, Middle East, and Africa.

factors may be behind the rise in emerging market corporate leverage. Precisely identifying the role of individual global factors is difficult, however; therefore, the analysis initially captures global economic and financial conditions using time dummies—which can be thought of as unobservable global factors. The time dummies indeed suggest that global factors are becoming more important as drivers of emerging market corporate leverage growth in the postcrisis period.

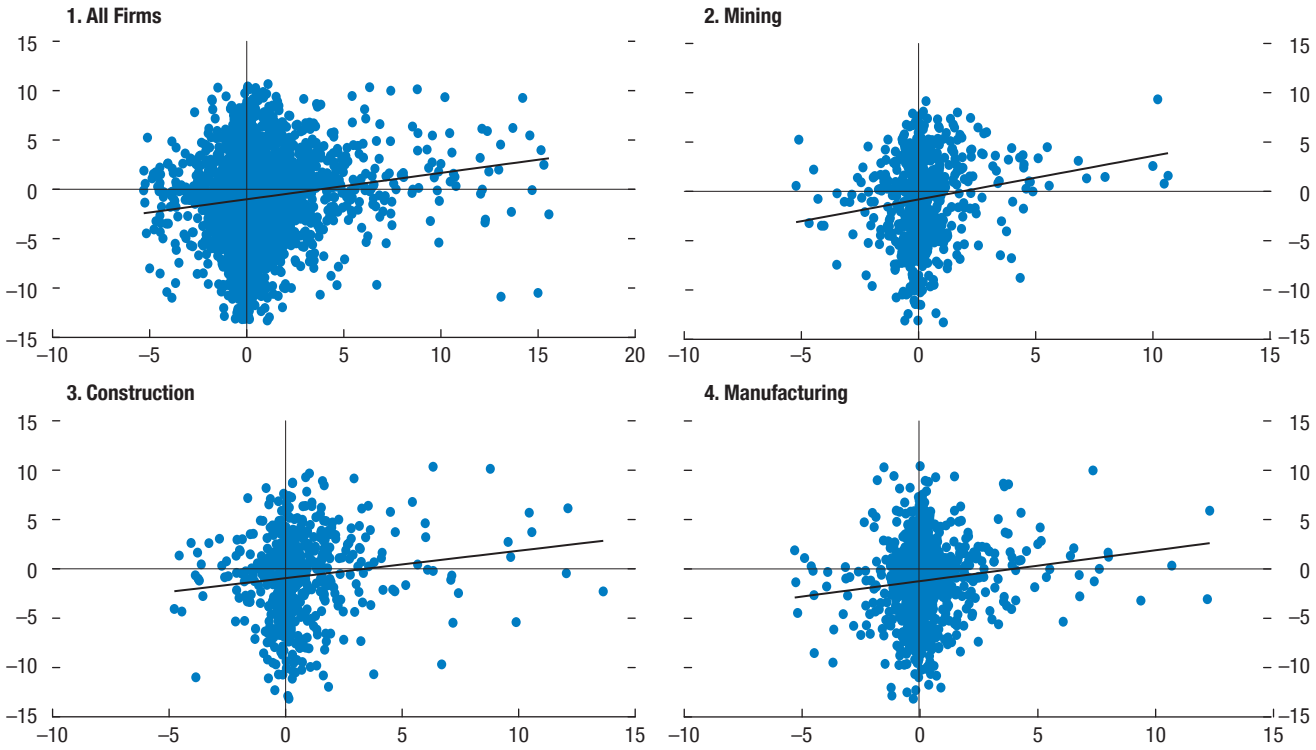
When specific global factors are considered, the inverse of the U.S. shadow rate and, to a lesser extent, global oil prices seem to be particularly associated with leverage growth. This result emerges when including various global factors simultaneously in the regression.[12] Further econometric analysis points to a greater role for global factors, in particular the shadow rate, in the postcrisis rise of leverage. Their influence during the period was examined through two complementary regression models. The first explicitly accounts for possible structural breaks, and suggests that the U.S. shadow rate became a more significant postcrisis determinant of emerging market leverage growth.[13] The second model contrasts the precrisis (2004–07) and postcrisis (2010–13) periods, and finds a significant positive postcrisis correlation between the shadow rate and no significant role for country-specific factors.

The role of easier global financial conditions is corroborated through evidence on the relaxation of financing constraints. The relevance of relaxed financing constraints for leverage can be assessed by focusing on SMEs and weaker firms, which typically have more limited access to finance. Similarly, a closer look can be taken at sectors that are intrinsically more dependent on external finance (Rajan and Zingales

[12]In the baseline regression model, the inverse of the U.S. shadow rate and the change in global oil prices are the main global factors. The results hold if the U.S. shadow rate is replaced with the global shadow rate. The results are also robust to the inclusion of other global factors such as changes in the Chicago Board Options Exchange Volatility Index (VIX), global commodity prices, and global GDP, as well as other controls, and to GDP weighting (Annex 3.1). Although robustness of these alternative specifications is encouraging, longer time series would be needed to make more definitive statements on the precise relationship between emerging market leverage growth and specific global factors.

[13]The analysis of a longer sample (1994–2013) of listed firms reveals a positive and statistically significant correlation between the inverse shadow rate and emerging market leverage growth even after controlling for other global factors. Evidence based on this longer sample also confirms the presence of a postcrisis structural break.

Figure 3.7. Change in Foreign Exchange Exposures and Corporate Leverage, by Sector
(Percentage points)



Source: IMF staff estimates.
Note: The vertical axes depict the changes (from 2001–07 to 2010–14) in estimated foreign exchange exposure and the horizontal axes depict the changes in the leverage ratio (total liabilities to market equity) for listed firms. The slopes are statistically significant at least at the 5 percent level. The results are robust to outliers and to other measures of leverage.

1998). Evidence indicates that leverage for all these types of firms is more responsive than for other firms to prevailing global monetary conditions. Moreover, in countries that have more open capital accounts and that received larger capital inflows, firms' leverage growth tends to be more responsive to global financial conditions.

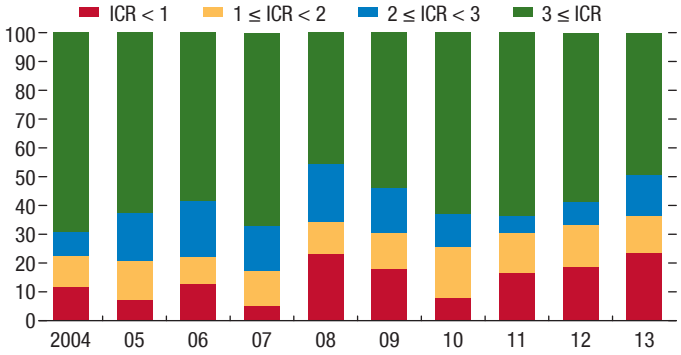
How have firms been using borrowed funds?

Estimates based on listed firms' balance sheets suggest that greater borrowing has been used more for net investment than for the accumulation of cash (Figure 3.10).[14] The results also suggest that in the postcrisis period, financing availability has become more important than profitability in driving investment. For example, during 2010–13, the relationship between investment and leverage strengthened, but it weakened for cash flows, and became statistically insignificant for a forward-looking measure of profitability (Tobin's Q). Possibly, the more favorable postcrisis global financial conditions relaxed financing constraints, allowing more debt-financed capital expenditure for less profitable projects.[15]

[14]Although these estimates are indicative, it is possible, for example, that net investment in any one year may have been financed with working capital or retained earnings (captured in the "other" term), including from earlier years. The close association between changes in leverage and investment are confirmed by firm-level investment equations. As expected, the level of leverage is negatively associated with investment (see also IMF 2015d).

[15]As in Magud and Sosa (2015), the classic Fazzari, Hubbard, and Petersen (1988) model—which builds on the standard Q theory of investment—is augmented by a measure of leverage. In addition to leverage growth, the other main determinants of investment are Tobin's Q (to capture marginal profitability and growth opportunities), cash flow measures (a proxy for financing constraints), and the cost of capital. A positive and statistically significant cash flow coefficient suggests that firms face financial constraints because they would need to rely on internal funds to finance investment projects. Estimates using the full and precrisis (2004–07) samples reveal that all variables are statistically significant and have the expected signs.

Figure 3.8. Corporate Liabilities and Solvency
(Percent; solvency measured using the ICR)



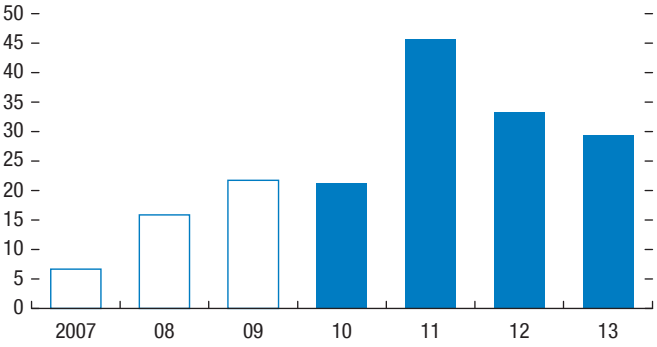
Sources: Thomson Reuters Worldscope; and IMF staff estimates.
Note: The figure shows the share of liabilities held by firms according to their interest coverage ratio (ICR). The ICR is a measure of firms' solvency, calculated as the ratio of earnings (before interest and taxes) to interest expenses.

Figure 3.9. Key Determinants of Emerging Market Economies' Corporate Leverage

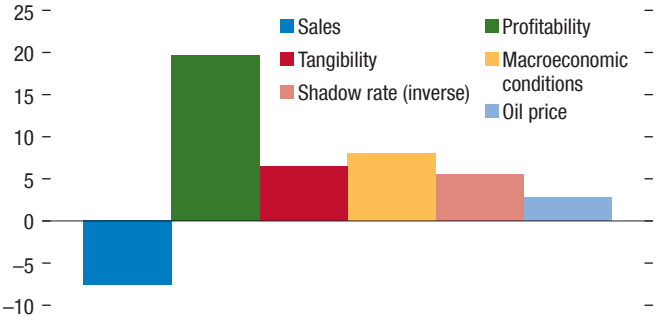
1. Determinants of Leverage Growth

Baseline Determinants	Expected Sign
Firm Level	
Sales	+/–
Profitability	+
Tangibility	+
Country Level	
Macroeconomic Conditions	+
Global	
Shadow Rate (inverse)	+
Oil Prices	+

2. The Changing Relationship between Leverage and Global Factors (Percentage points)



3. Specific Determinants of Leverage Growth (Percentage points)



Sources: Orbis; and IMF staff calculations.
Note: Sample period: 2004–13. An empty bar (panel 2) denotes that the time dummy is not statistically significant at the 10 percent level. The standardized coefficients (panel 3) are statistically significant at the 1 percent level. Firm-level variables are lagged; sales and tangibility are changes. See Annex 3.1 for further details.

Summary

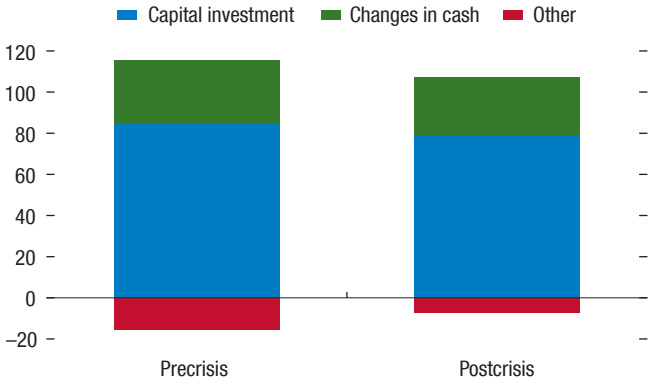
Overall, the relative role of global factors as key drivers of emerging market corporate leverage dynamics has increased in recent years. The evidence shows some signs of elevated corporate exposure to a potential worsening in global financial conditions. The buildup in leverage in the construction sector and the related rise in net foreign exchange exposure as well as growing concentration of indebtedness in the weaker tail of the corporate sector provide particular reasons for concern. However, the growth in leverage appears to have fostered investment, although investment projects may have become less profitable more recently.

Emerging Market Corporate Bond Finance

The growth in emerging market corporate leverage has been accompanied by a change in its composition. In particular, the importance of bond finance has grown rapidly in recent years. Therefore, this section examines the role of firm, country, and global factors in explaining patterns of bond issuance to help determine whether the patterns are associated with rising vulnerabilities.

Emerging market corporate bond issuance has risen sharply since 2009, becoming an increasingly important source of corporate financing in those economies. Starting from a low base, the share of corporate finance accounted for by bonds has nearly doubled since the crisis, and totaled more than $900 billion in 2014 (Figure 3.11, panel 1). Likewise, issuance via subsidiaries in offshore financial centers has increased significantly since the crisis, driven primarily by borrowers headquartered in Brazil and China

Figure 3.10. Leverage, Cash Holdings, and Corporate Investment
(Percent contributions to the change in debt as a share of total assets)



Sources: Thomson Reuters Worldscope; and IMF staff calculations.
Note: "Other" refers to other net assets and retained earnings. All variables were normalized by lagged total assets. Firms with an increase in leverage above the first quartile of the leverage distribution were included.

(McCauley, Upper, and Villar 2013; see also Shin 2013; Avdjiev, Chui, and Shin 2014).[16] Issuance is most notable in the oil and gas sector (with a sizable foreign exchange component) and in construction, especially since 2010.[17] Although China has been an important part of this development, the uptrend in issuance is broad based across emerging markets. In particular, emerging markets other than China have on average returned to the rapid pace of issuance observed before the global financial crisis. Within countries, however, the postcrisis growth in access has not been even. One-third of emerging markets have seen aggregate increases in the total amount issued alongside *declines* in the total number of issuers. To a significant extent, the growth in international bond issuance can be traced to the decline in cross-border lending, which in turn appears to be largely driven by a retrenchment on the part of banks (Chapter 2 of the April 2015 GFSR).

A shift to bond financing has benefits and drawbacks from both firm and macroeconomic perspectives. A key benefit of greater access to bond finance is that it can provide financing to the real economy even when banks are distressed, but it also exposes companies to more volatile funding conditions. Since bond financing is unsecured, it does not entail the macroeconomic amplification mechanisms associated with collateral valuations (whereby an economic downturn depresses collateral values, thus constraining borrowing capacity and investment even more [Kiyotaki and Moore 1997]).[18] Compared with cross-border bank lending, the participation by international investors in local markets can also have advantages in dampening the impact of global financial conditions—for example, if foreign lenders want to withdraw, part of the balance of payments impact is cushioned by bond valuation effects. On the other hand, bond financing tends to be associated with weaker monitoring standards due to a larger pool of bond investors who may "choose" not to monitor the business activities of the bond issuers. This can create incentives for excessive risk-taking behavior by firms. Moreover, the growing intermediation through bond mutual funds can entail its own risks, as extensively discussed in Chapter 3 of the April 2015 GFSR.

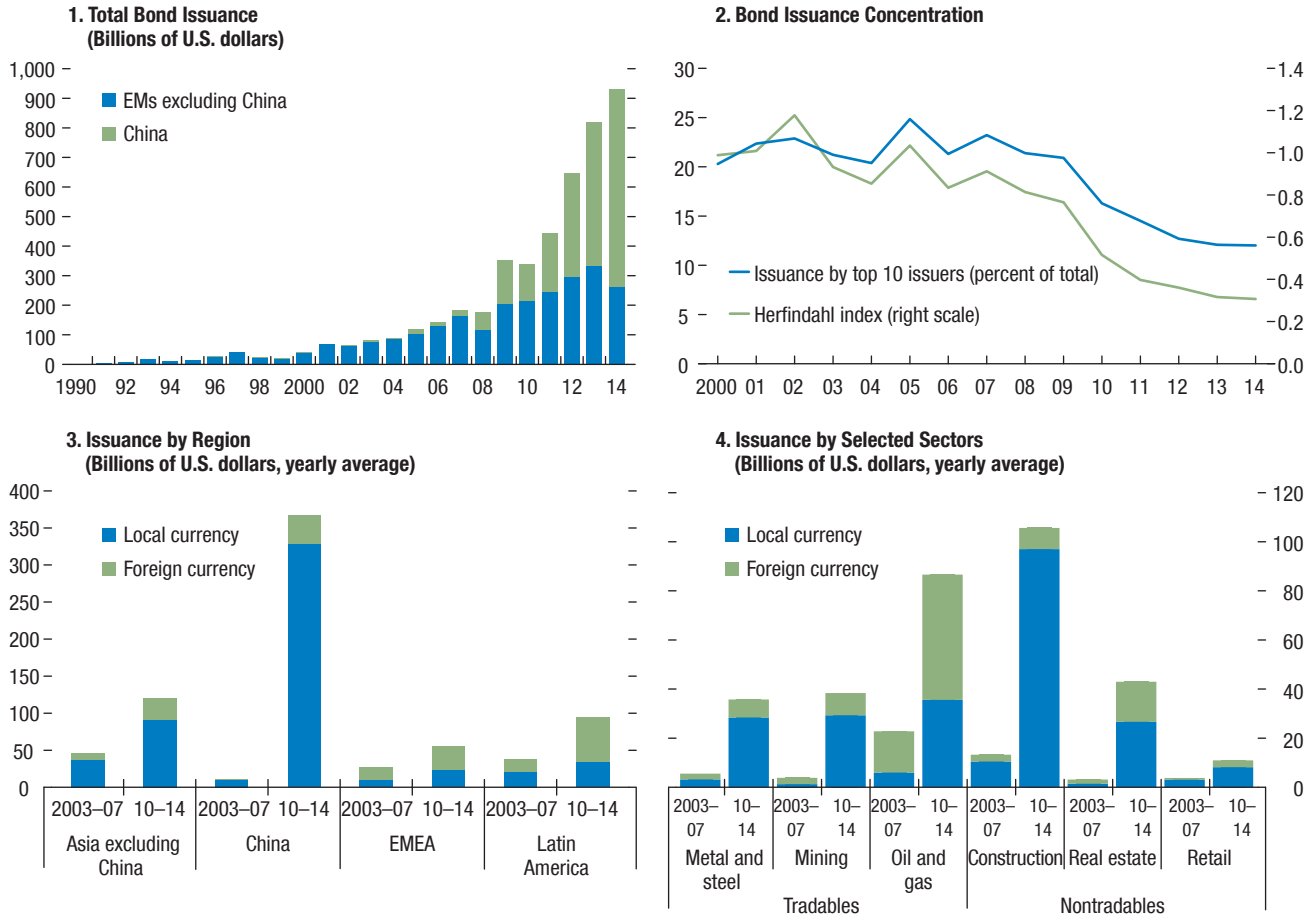
The share of bond issuance denominated in euros has grown appreciably in recent years (Figure 3.12). Although foreign currency issuance continues to be dominated by U.S. dollar bonds, the rise in euro denominations likely reflects expectations of tighter U.S. monetary conditions and more accommodative monetary policy by the European Central Bank, and associated exchange rate expectations. For all emerging markets, the share of bonds issued in foreign currency has declined by more than 10 percentage points relative to the precrisis period. However, that reading is mainly driven by the sharp rise in bond issuance by China, which is predominantly in local currency. Although firms in some emerging markets, such as Colombia, Malaysia, the Philippines, Russia, and Thailand, have issued relatively more in local currency, firms in many other emerging markets have increased their bond financing in foreign currency. However, tentative evidence indicates that listed firms that have issued in foreign currency do not appear to have raised their foreign exchange exposures, possibly because of higher exports,

[16]The general trends discussed in this section, are, however, robust to the use of alternative notions of nationality, such as issuers' nationality of risk, country of incorporation, or ultimate parent nationality.

[17]Although currency mismatches are likely to be smaller in the oil and gas sector than in other sectors to the extent that export receipts are denominated in dollars, this sector is still vulnerable to oil price declines (see, for example, BIS 2015).

[18]In line with this, the effects of banking crises on the economy are found to be worse than in other types of crises (see Cardarelli, Elekdag, and Lall 2011; Giesecke and others 2014).

Figure 3.11. Bond Issuance by Regions and Sectors



Sources: Dealogic; and IMF staff calculations.
Note: Nationality is based on a firm's country of risk. The general trends in these charts are robust to alternative notions of nationality, such as issuer's nationality of incorporation or ultimate parent nationality. A lower value of the Herfindahl index value indicates a lower degree of concentration. EMs = emerging market economies; EMEA = Europe, Middle East, and Africa.

increased hedging, or a substitution of foreign currency bank loans.[19]

The financial conditions of issuing firms appear to have broadly deteriorated in recent years. Since the crisis, bonds have been issued by more leveraged and less profitable firms on average (Figure 3.13). Indices of solvency (ICR) and liquidity (quick ratio) have also generally deteriorated among issuing firms.[20] Since 2010, firms have used bond issuance less for investment and more to refinance debt, most likely to take advantage of the favorable financing conditions (see also Rodríguez Bastos, Kamil, and Sutton 2015).[21] Indeed, the share of issuers reporting refinancing as their intended use of proceeds has been rising.

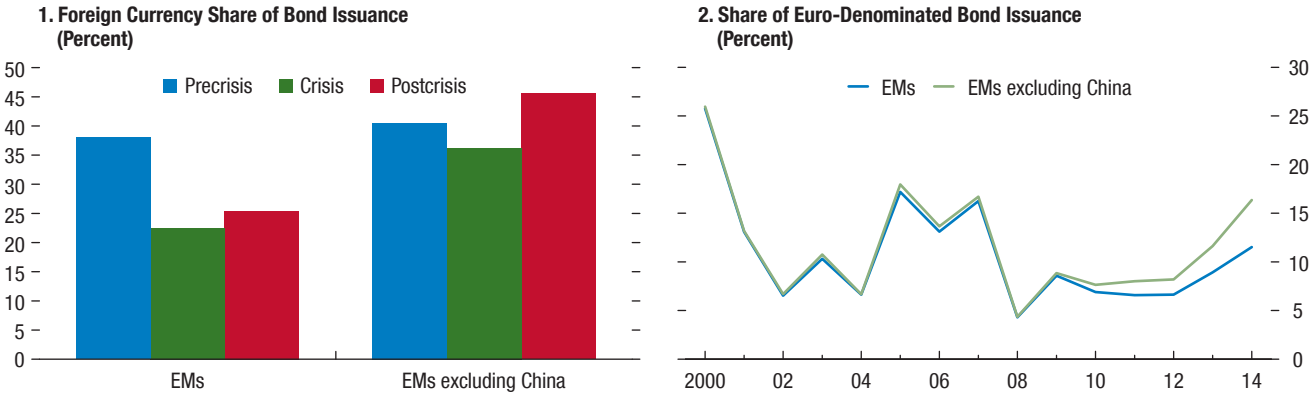
Emerging market firms have managed to issue at better terms (Figure 3.14). Average maturity at issuance for domestic and external bonds has generally lengthened by more than one year relative to the precrisis average, mitigating rollover risk for

[19]The correlation between foreign currency bond issuance and the change in foreign exchange exposure is statistically insignificant in the postcrisis period; however, the sample of firms considered was relatively small.

[20]See Fuertes and Serena (2014) for a description of balance sheet trends in a broad range of emerging markets for firms tapping international bond markets.

[21]The fact that firms report lower use of proceeds for investment purposes is not inconsistent with the information presented earlier that more leverage had been associated with higher investment (for example, firms may have used proceeds to pay off bank debt while increasing their overall leverage and investment).

Figure 3.12. Bond Issuance: Currency Composition



Sources: Dealogic; and IMF staff calculations.
Note: EMs = emerging market economies. Precrisis: 2003–07, crisis: 2008–09, postcrisis: 2010–14. Nationality is based on a firm's country of risk. The general trends in these charts are robust to alternative notions of nationality, such as issuer's nationality of incorporation or ultimate parent nationality. The share of euro-denominated bond issuance (panel 2) is computed relative to the total amount of dollar and euro issuance.

borrowers at the expense of increased duration risk for investors. Yields to maturity have also fallen. The fact that firms have been able to issue at better terms against a background of worsening balance sheets suggests that global factors may have played an important role in facilitating firms' access to finance.

Changes in firms' access to bond markets

The role of firm-level factors in explaining issuance since the crisis has decreased (Figure 3.15). In line with the literature, the analysis indicates that larger, more-leveraged, and seasoned-issuer firms have a greater tendency to issue bonds.[22] Although higher real GDP growth is related to a higher probability of issuance, macroeconomic variables are generally not reliable predictors of firm-level bond issuance.[23] Although the inverse of the U.S. shadow rate is generally not statistically significant over the entire sample, in the postcrisis period it is a key determinant of the change in the postcrisis probability of issuance.[24] In line with this result, using country-level data focusing on the composition of emerging market corporate leverage, Ayala, Nedeljkovic, and Saborowski (2015) conclude that global factors have taken center stage in explaining changes since the crisis (Box 3.5).[25]

Changes in bond maturity

The crisis seems to have brought about a structural change in the relationship between bond maturity and its determinants. Regression analysis shows that bond- and firm-level characteristics, as well as global factors, are important determinants of bond matu-

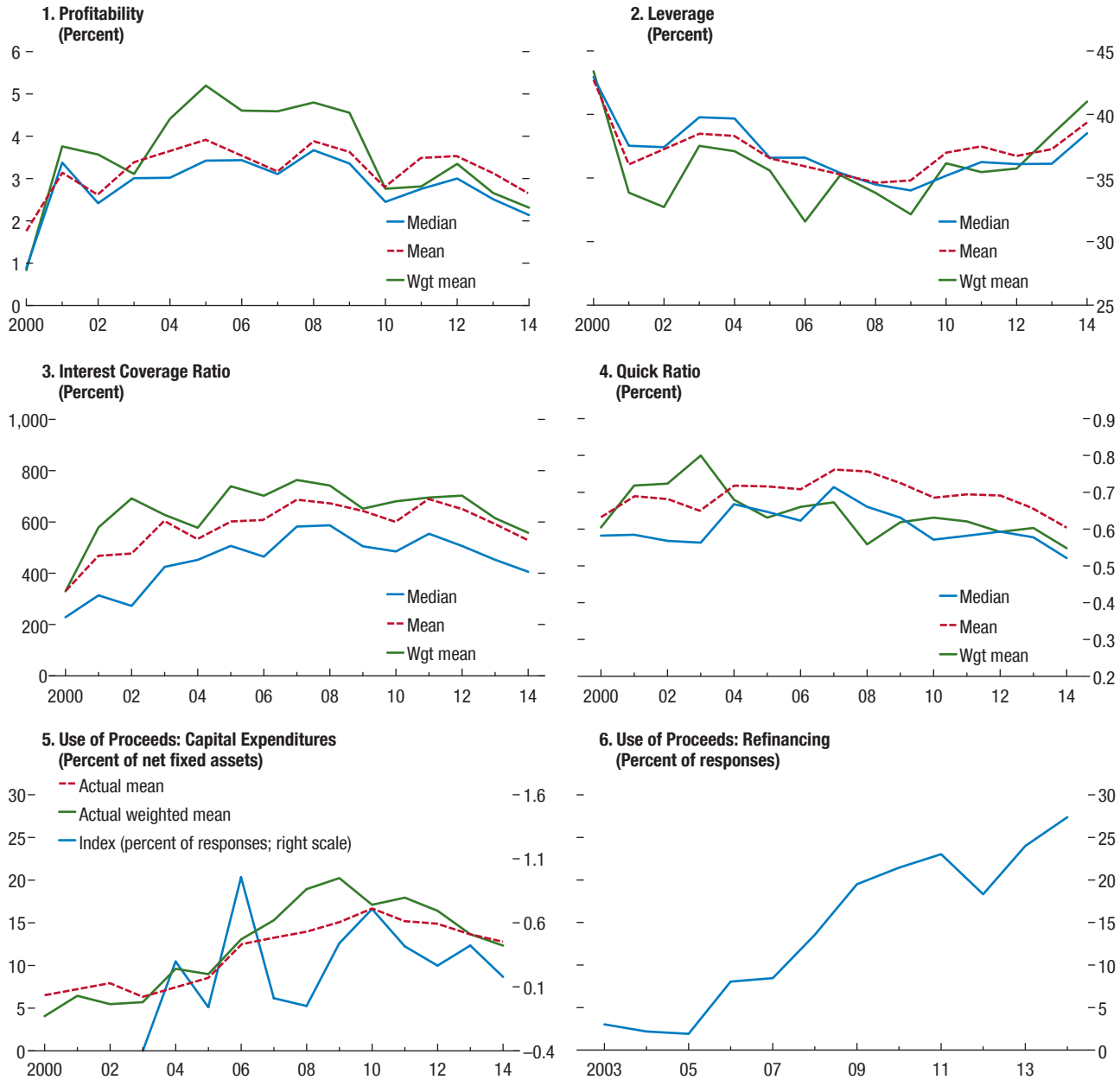
[22]Using firm-level data, a pooled probit model was used to estimate the probability of bond issuance controlling for firm characteristics as well as macroeconomic and global factors (see Annex 3.2). These results are consistent with the notion that issuing a bond entails significant fixed costs (Borensztein and others 2008). To the extent that it serves as a proxy for healthier financial conditions, profitability might be expected to have a positive influence on the decision to issue bonds. However, profitable firms may use internal funds instead of external financing. The findings in the empirical literature are mixed (Borensztein and others 2008; Didier, Levine, and Schmukler 2014).

[23]Using aggregate data and spanning a broader set of emerging markets, Feyen and others (2015) find that issuance is greater in countries with higher per capita GDP, growth, or current account deficits. Lo Duca, Nicoletti, and Vidal Martinez (2014) show that domestic financial variables such as the domestic interest rate, equity returns, and equity volatility are not statistically significant when global factors are included. Policies to promote bond market development may have also played a role in greater issuance, for example, the Asian Bond Market Initiative, an initiative of 12 central banks in the Asia-Pacific region administered by the Bank for International Settlements.

[24]The VIX (used to capture global investor sentiment) is negatively related to the probability of crisis over the full sample period. However, the relationship is no longer statistically significant in the postcrisis period. More generally, similar results are obtained when estimating the probability of first-time bond issuance.

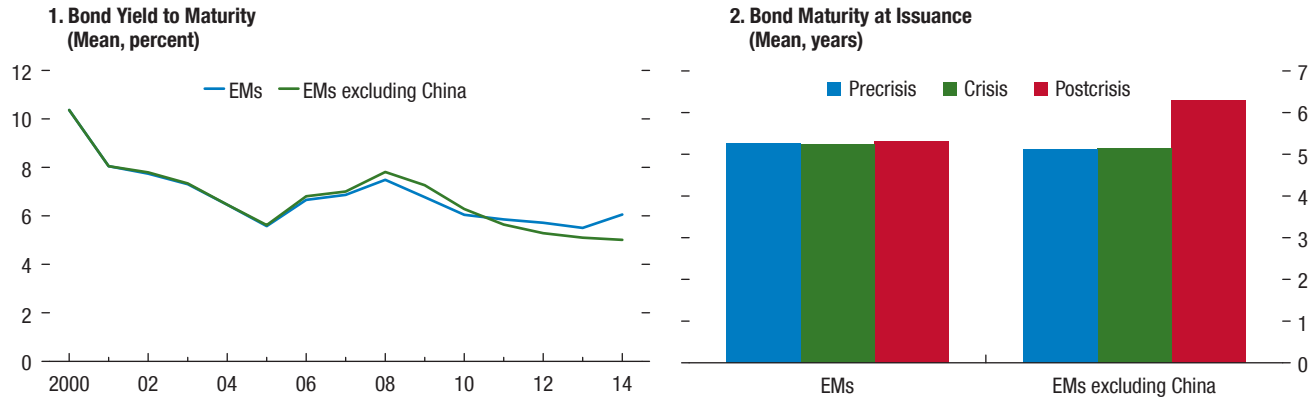
[25]Also in line with these results, Lo Duca, Nicoletti, and Vidal Martinez (2014) and Feyen and others (2015) find, using aggregate issuance data, that global monetary conditions have had a significant positive effect on emerging market corporate issuance during the postcrisis period.

Figure 3.13. Deteriorating Firm-Specific Fundamentals for Bond-Issuing Firms



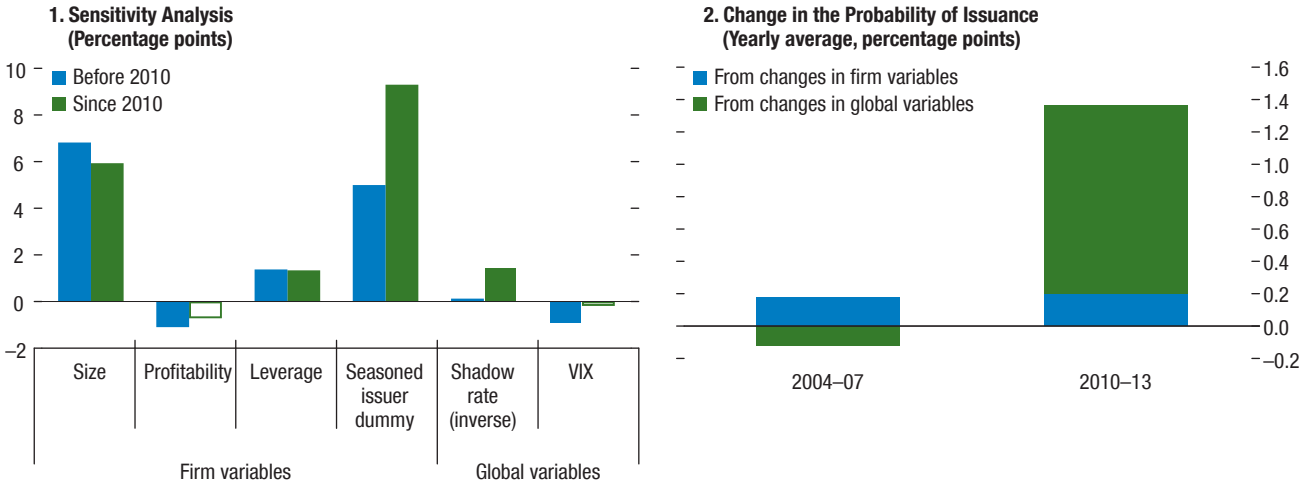
Sources: Bloomberg, L.P.; Dealogic; and IMF staff calculations.
Note: Profitability is the return on assets. Leverage is total debt to total assets. Interest coverage ratio is EBITDA (earnings before interest, taxes, depreciation, and amortization) to interest expenses. Liquidity is measured by the quick ratio (cash, cash equivalents, short-term investments, and receivables to current liabilities). All variables correspond to the year prior to issuance. Nationality is based on the country of risk. Listed and nonlisted firms are included (although coverage is limited for the latter). Panel 5 shows the actual capital expenditures in percent of net fixed assets on the year of issuance. Index constructed based on intended use of proceeds as reported to Dealogic, as percentage of total responses per year. The index in panel 6 includes the categories "Refinancing," "Debt repayment," and "Restructuring." Wgt mean = mean weighted by deal value.

Figure 3.14. Bond Issuance: Yields and Maturity



Sources: Dealogic; and IMF staff calculations.
Note: Precrisis: 2003–07, crisis: 2008–09, postcrisis: 2010–14. Nationality is based on a firm's country of risk. These general trends are robust to alternative notions of nationality, such as issuer's nationality of incorporation or ultimate parent nationality. EMs = emerging market economies.

Figure 3.15. Factors Influencing the Probability of Bond Issuance



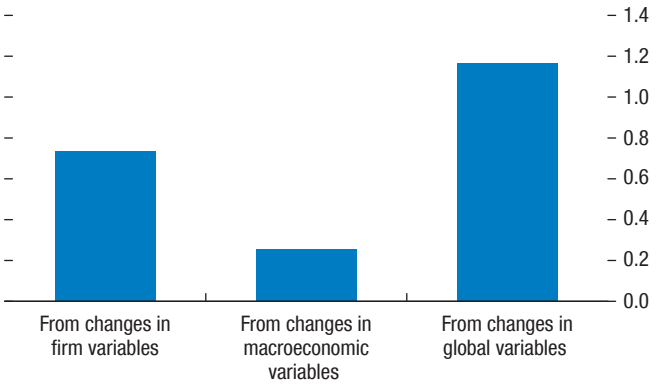
Sources: Bloomberg, L.P.; Thomson Reuters Worldscope; and IMF staff calculations.
Note: The shaded bars denote statistical significance at least at the 5 percent level. The probability of issuance is estimated using a pooled probit model with a time trend and country and sector dummies. Standard errors are clustered at the country level. Nationality is based on firms' country of risk. The attribution analysis shown in panel 2 is computed using the coefficients of the pre- and postcrisis estimates and is not standard because of the nonlinear nature of the probit model. The analysis decomposes the average yearly change in probability of issuance into that explained by changes in firm or global variables. For each annual change, all variables are kept at their initial mean, except firm- and global-level variables, which are assigned their initial and end-period means to obtain their contributions. The pre- and postcrisis contributions are obtained by averaging yearly contributions for 2004–07 and 2010–13, respectively. The calculation is done for nonseasoned issuers and for the median country and sector fixed effects. A seasoned issuer is a firm that has issued before. See Annex 3.2. VIX = Chicago Board Options Exchange Volatility Index.

Figure 3.16. Factors Influencing Bond Maturity

1. Bond Maturity at Issuance

Variable	Expected Sign	Estimates	
Issuance in Local Currency	–	–	**
Investment Grade	+	+	**
Firm Size	+	+	***
Profitability	+	–	
Leverage	–	–	**
Inverse Shadow Rate[1]	+	+	**
VIX	–	–	***
Currency Depreciation	–	–	**
Size of Government Debt	+	+	**

2. Changes in Maturity at Issuance, 2009–13 (Years)



Sources: Bloomberg L.P.; and IMF staff calculations.
Note: The baseline specification estimates bond maturity at issuance as a function of bond, firm, macro, and global factors, with country and sector fixed effects and a time trend. Firm factors include a measure of size (total assets), profitability (return on assets), and leverage (debt-to-assets), all at the year prior to issuance. Bond factors include dummies for bond currency denomination; investment grade; and put, call, and sink options. Global factors are the VIX and the inverse shadow rate (three-month average prior to issuance) interacted with a postcrisis dummy. Macro factors include the government debt and exchange rate depreciation relative to the U.S. dollar. Standard errors are clustered at the country level. Nationality is based on country of risk; Chinese firms are excluded. VIX = Chicago Board Options Exchange Volatility Index. See Annex 3.2. ** and *** denote statistical significance at the 5 and 1 percent levels, respectively.
[1]Refers to the coefficient in the postcrisis period.

rity.[26] In particular, larger and less leveraged firms, firms in countries with smaller government debt-to-GDP ratios and with depreciating exchange rates, and companies facing lower investor uncertainty (measured by the Chicago Board Options Exchange Volatility Index [VIX]) tend to issue at longer maturities.[27] Favorable global financial conditions have been a key determinant of the lengthening of maturity in the postcrisis period. Indeed, in recent years, accommodative U.S. monetary policy explains more of the recent lengthening in maturities than do firm characteristics (Figure 3.16).[28] Moreover, U.S. shadow rate fluctuations have a greater impact on maturity for external issuances and for non-investment-grade issuances.

[26]Fuertes and Serena (2014) and Shin (2014a) document a lengthening in maturities for external bond issuances by nonfinancial corporations and nonbank financial corporations in a broad range of emerging markets.

[27]The finding that maturities tend to be longer in countries with larger government debt is in line with the idea that a large, liquid government bond market can have a positive effect on the development of corporate debt markets.

[28]Feyen and others (2015) show that global factors have an impact on maturity structure of emerging market financial and nonfinancial corporate bond issuance. The specification in this section is similar to theirs, but it focuses only on nonfinancial firms and controls for firm-level characteristics, as is standard in the literature (Annex 3.2).

Summary

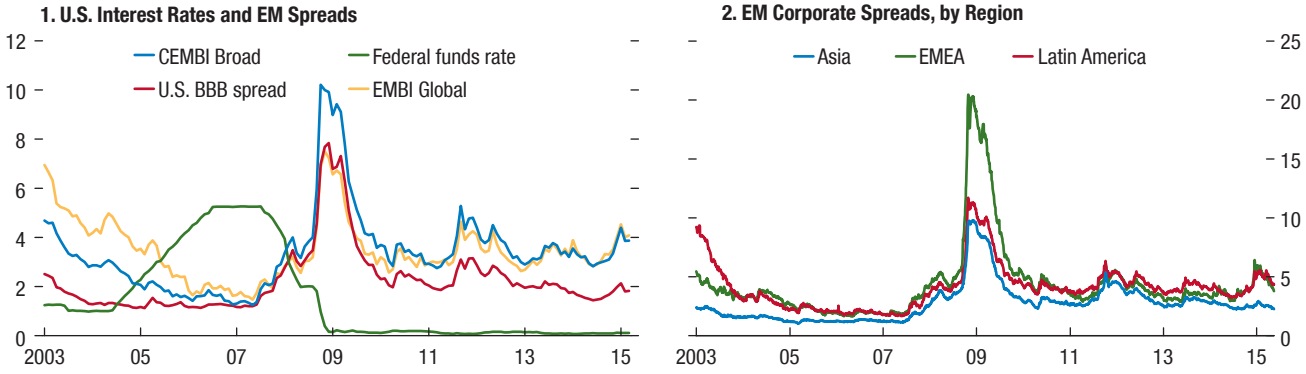
Global factors seem to have become relatively more important determinants of bond issuance and maturity in the postcrisis period. Emerging market corporate bond issuance has grown on a broad basis since 2009. The decline in the share of foreign currency issuance in emerging markets reflects activity in China, where firms have issued mostly in local currency. Despite weaker domestic fundamentals, emerging market firms have managed to issue bonds with lower yields and longer maturities.

Emerging Market Corporate Spreads

This section examines changes in the balance between domestic and global factors in the behavior of emerging market corporate spreads. Extending the approach of the preceding sections, it uses a price-based analysis in which spreads are linked to firm-level, country-level, and global characteristics. A novel feature of this analysis is the use of data on secondary market spreads.[29]

[29]The literature on emerging market corporate spreads mainly uses issuance-level launch yield data. The approach gives rise to endogeneity issues (Eichengreen and Mody 1998) because during poor market conditions, when secondary spreads rise, primary

Figure 3.17. Emerging Market Economies: Secondary Market Corporate Spreads
(Percent)



Sources: Bloomberg, L.P.; Federal Reserve Bank of St. Louis FRED Economic Data; and J.P. Morgan Chase.
Note: CEMBI = Corporate Emerging Markets Bond Index; EM = emerging market economies; EMBI = Emerging Markets Bond Index; EMEA = Europe, Middle East, and Africa.

In recent years, emerging market corporate spreads have been hovering above the average of the precrisis period (Figure 3.17). The secondary-market corporate (Corporate Emerging Markets Bond Index [CEMBI]) spreads move in unison with their sovereign counterpart (the Emerging Market Bond Index spread) and the U.S. BBB corporate spread (a gauge of global credit conditions), but inversely with the U.S. policy rate (the federal funds rate).[30] More recently, U.S. corporate and CEMBI spreads have been diverging, mainly because of relatively better U.S. economic conditions; corporate spreads also differ across some regions.

How has the relationship between spreads and fundamentals changed over time?

Regression analysis confirms that CEMBI spreads are closely linked to country-specific and global factors. Cross-country panel regressions reveal a strong statistical relationship between CEMBI spreads, leverage, and macroeconomic factors (Figure 3.18).

The behavior of emerging market corporate spreads is also closely linked to the U.S. corporate spread. Although not reported, similar results are found using individual-issuance-level data covering more than 1,000 issuances for 20 emerging markets from 1990 to 2015.

The empirical analysis suggests that the relationship between corporate spreads and their determinants has also changed, with domestic factors becoming less influential in the postcrisis period. For instance, the significantly positive precrisis correlation between spreads and leverage broke down since 2010. Furthermore, the negative correlation between spreads and country-level factors has also declined in the postcrisis period. This breakdown suggests firms would be relatively more susceptible to a worsening in global financial conditions—a case in point is the 2013 "taper tantrum" episode, in which spreads for more leveraged firms rose sharply (Box 3.6).

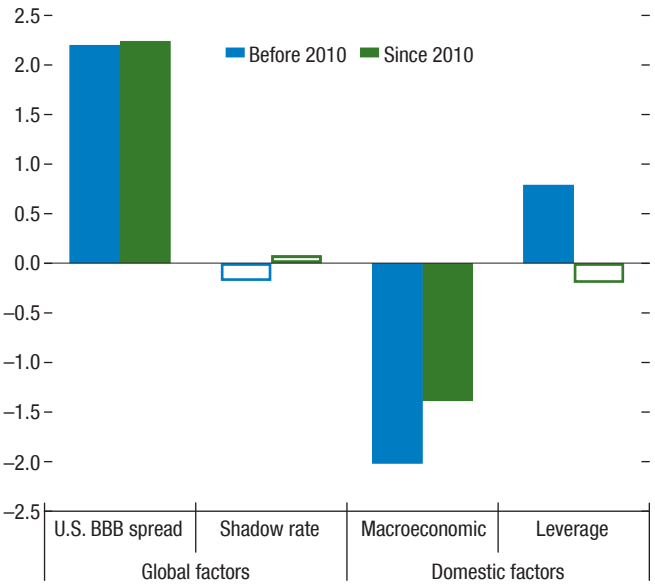
Policy Implications

Emerging markets should prepare for the eventual reversal of postcrisis accommodative global financial conditions because those conditions have become more influential determinants of emerging market corporate finance. Weaker firms and cyclical sectors, such as construction, are likely to be especially susceptible to such global changes. Once market access declines, elevated debt-servicing costs (resulting from the combination of higher interest rates and depreciating currencies) and

spreads do not rise proportionately (and can indeed sometimes fall), a reflection of the tendency for only the most creditworthy borrowers to remain in the market. Although Eichengreen and Mody (1998) and other studies attempt to correct for the bias, the model can be unstable if not properly specified. Only a few studies use secondary market data, and then only with a limited scope; for instance, Dittmar and Yuan (2008) and Zinna (2014) focus on the relationship between sovereign and corporate spreads.

[30]The secondary-market spreads are from J.P. Morgan's CEMBI. The CEMBI tracks U.S. dollar-denominated debt instruments issued by emerging market firms; the spread is calculated against the U.S. Treasury yield.

Figure 3.18. Emerging Market Economies: Effects of Domestic and Global Factors on Corporate Spreads
(Percentage points)



Source: IMF staff calculations.
Note: The figure is based on country-level panel regressions (see Annex 3.3 for details). The dependent variable is the CEMBI spreads for 20 emerging markets over December 2001–December 2014. Explanatory variables include global factors (U.S. BBB spread and the U.S. shadow rate) as well as domestic factors (macroeconomic conditions [based on the International Country Risk Guide index] and leverage [median across firms]). The bars show the effects of a one standard deviation increase in each variable on the CEMBI spread before 2010 and in the postcrisis period (2010–14). These effects are calculated by multiplying the estimated coefficient of regression by the standard deviation of the corresponding independent variable over all country-month observations. Nonshaded bars are statistically insignificant at the 5 percent level. CEMBI = Corporate Emerging Markets Bond Index.

rollover problems may hit some firms especially hard. Therefore, it is important to closely monitor sectors and systemically important firms most exposed to risks and the sectors and large firms closely connected to them, including across the financial system, and to prepare for contingencies. Emerging markets should also be prepared for the eventuality of corporate failures; where needed, insolvency regimes should be reformed to enable rapid resolution of both failed and salvageable firms. This section further discusses (1) measures that could be taken relatively quickly and that would help contain the further buildup of vulnerabilities or their impact, although they would not eliminate these vulnerabilities in the short term; (2) medium-term recommendations; and (3) actions to be taken in the event of large capital outflows.

Measures that could be taken now

Macroprudential measures could be used to limit risks from a further buildup of foreign exchange exposures and leverage in emerging markets with latent vulnerabilities. Potential instruments include higher bank capital requirements for corporate exposures, as well as risk weights and caps on the share of foreign currency exposures on banks' balance sheets. Active provisioning and increasing equity capital can also bolster financial system resilience. Where relevant, loan-to-value and debt-service-coverage ratios can be introduced to address risks related to commercial real estate.[31] However, risks associated with market-based funding may prove difficult to manage. This may require an even greater emphasis on macroprudential measures to enhance the resilience of banks and other important nonbank classes of intermediaries (IMF 2014d). For example, securities regulators should adopt a macroprudential orientation in their supervision of asset managers and the funds they manage that have significant corporate bond exposures (see Chapter 3 of the April 2015 GFSR).

Microprudential and other tools can play a complementary role. Regulators can conduct bank stress tests related to foreign currency risks, including derivatives positions. Hedging foreign exchange exposures could also be more actively encouraged. Nevertheless, the hedges used by some corporations to limit their exposure risks may be compromised when most needed, so they should be assessed conservatively by regulators.[32]

Financial turbulence in emerging markets could also have important implications for advanced economies. Some evidence indicates that if shocks from advanced economies generate financial volatility in emerging markets, significant "spillbacks" of that volatility to the advanced economies could ensue in periods of financial stress.[33] Such risks are particularly relevant for banks, mutual funds, and other investors in advanced economies that have increased their emerging market

[31]However, it should be recognized that corporate borrowers can substitute borrowing from unregulated financial institutions or in capital markets for domestic bank credit, especially in emerging markets in which capital markets are well developed and globally integrated.

[32]As noted in Chui, Fender, and Sushko (2014), although derivatives with "knock-in, knock-out" features can insure against modest foreign exchange movements, they leave the firm exposed to large losses if the domestic currency were to depreciate sharply.

[33]Spillbacks are often underestimated because they tend to flow through channels that are inadequately tracked owing to their complexity—for instance, in the financial sector. See *2014 Spillover Report* (IMF 2014a).

Box 3.2. Corporate Foreign Exchange Rate Exposures

Foreign exchange exposures are indirectly measured using stock returns. Following a seminal paper by Adler and Dumas (1984), the foreign exchange exposure of firm i is estimated as the value of β_i in the following augmented capital asset pricing model (CAPM):

$$R_{it} = \alpha_i + \gamma_i R_t^M + \beta_i R_t^{FX} + \varepsilon_{it}$$

in which R_{it} is firm i's stock return, R_t^M is the market return, and R_t^{FX} is the percentage change in the trade-weighted nominal exchange rate (an increase indicates an appreciation). A positive foreign exchange exposure means that the firm's return falls when its local currency depreciates. The value of β_i can be interpreted as firm i's foreign exchange exposure net of financial and operational ("natural") hedging, after accounting for market conditions (Bartram and Bodnar 2005). The foreign exchange exposures are estimated for about 5,000 listed nonfinancial firms in 31 emerging market economies over 2001–14.

This box was prepared by Machiko Narita.

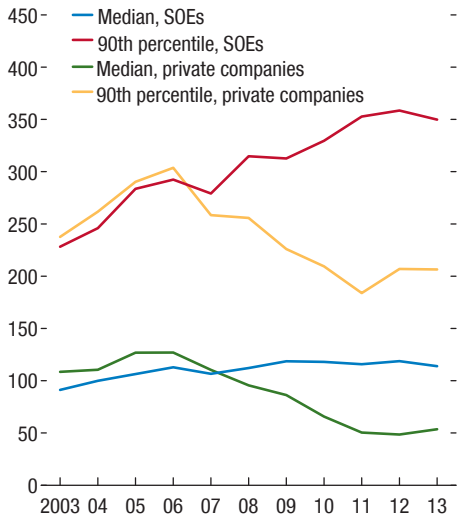
Box 3.3. Corporate Leverage in China

Corporate leverage is high in China. China has relied on investment to drive growth in recent years. The rapid increase in investment has been financed by credit, leading to a sharp increase in corporate debt. Total social financing, a measure of overall credit to the economy in China, has risen dramatically (32 percentage points of GDP) since the global financial crisis.[1] The credit-to-GDP ratio remains high and exceeds the level implied by economic factors and cross-country comparisons.[2]

External corporate debt has also risen, albeit from a low level relative to GDP, international reserves, and domestic credit. Onshore banks have served as intermediaries for corporate borrowing overseas through the provision of bank guarantees and letters of credit. Chinese firms have also taken advantage of low global interest rates through offshore bond issuance, which has increased substantially since 2010. Half of the debt issued abroad has been for operations in China. Since 2009, real estate developers have been the largest issuers of offshore bonds among nonfinancial firms.

The increase in corporate leverage is largely concentrated at the tail end of the distribution of firms' liabilities, as well as in state-owned enterprises (SOEs) and the real estate sector (Chivakul and Lam 2015). Total liabilities of listed firms have risen dramatically and become more concentrated. Although the median leverage ratio—measured by the ratio of total liabilities to total equity—has largely stayed flat since 2006, leverage has significantly increased at the tail end (the 90th percentile) of the distribution of firms (see Figure 3.3.1). In addition, highly leveraged firms account for a growing share of total debt and liabilities in the corporate sector.

Figure 3.3.1. China: Leverage Ratios
(Percent)



Sources: Wind Info Inc. database; and IMF staff estimates.
Note: SOE = state-owned enterprise.

This box was prepared by Raphael Lam.

[1]The Bank for International Settlements "credit gap" measure, defined as the gap between the credit-to-GDP ratio relative to its trend, is used to assess whether credit is greater than the levels implied by fundamentals (see Arslanalp and others, forthcoming).

[2]Offshore issuance is generally conducted by an offshore entity, and, as a result, the borrowing is not captured by official external debt statistics.

Box 3.3. *(continued)*

Across industries, most of the buildup in leverage was in the real estate and construction sector and, to a lesser extent, in mining and utilities. Across ownership types, SOEs—mainly local ones—account for a large share of increased borrowing. For instance, in the real estate and construction sector, only about 60 firms with high leverage ratios account for more than two-thirds of the sector's liabilities, a rise of nearly three times over the decade. This elevated concentration of debt in the most leveraged tail of the leverage distribution raises corporate vulnerabilities to shocks.

The high level of credit could weigh on China's growth and financial stability. The efficiency of the investment financed by credit has been falling, with a commensurate drop in corporate sector profitability. This situation makes servicing debt obligations more difficult. In particular, the interest coverage ratio has fallen in SOEs, which have contributed to the bulk of the rise in credit. At the same time, deleveraging by firms could weigh on growth, while mounting corporate defaults would have adverse effects on bank balance sheets and credit availability, and thereby further weaken growth.

The Chinese corporate sector is vulnerable to a slowdown in the real estate and construction sector. Sensitivity analysis finds that although on average firms can withstand a moderate 1 percent interest rate increase, SOEs appear to be relatively exposed to an interest rate shock because of their low interest coverage and relatively higher leverage. Taking into account the value-added linkages of each sector to real estate and construction, a severe slowdown in the real estate sector (a 20 percent profit decline) would have a significant impact on the corporate sector, including a drop in the median interest coverage ratio to only 2½ times profits, with nearly 20 percent of firms in the real estate sector (accounting for 11 percent of total corporate debt) in financial distress.

In the future, some debt write-offs would help improve credit flow and investment efficiency and reduce risks in China. Write-offs—combined with the restructuring of viable companies and steps to facilitate greater tolerance of defaults, exit, and bankruptcy of nonviable firms—could reduce the burden on banks and allow them to reallocate credit to more efficient sectors. Banks can embark on rigorous quality assessments of their loan portfolios, setting the stage for addressing nonperforming loans and the potential need for bank recapitalization. Continuing reforms to promote capital market development would help provide an alternative financing channel for healthy firms.

exposures, warranting preparation for possible illiquidity in certain asset markets.

Medium-term measures

In the medium term, preventive policies could help avert the buildup of excessive risks. For example, consideration should be given to changes in the tax code that remove fiscal incentives in favor of debt or that encourage foreign currency debt.[34] Measures to reduce liquidity risks could be gradually phased in for domestic open-end mutual funds holding debt and offering daily redemptions (see Chapter 2 of this report and Chapter 3 of the April 2015 GFSR). In addition, governments can promote specific forms of financial deepening, such as development of a local investor base (both banks and nonbanks) to help dampen global financial shocks. The move toward more flexible exchange rates may enable emerging markets to adjust more readily to shocks, could facilitate an independent monetary response to financial imbalances, and may discourage banks and corporations from building up large foreign exchange exposures in the first place.

Significant data gaps need to be addressed to enhance the effectiveness of surveillance. Data gaps prevent a full assessment of the financial stability risks posed by corporate balance sheets from being made. For instance, firm-level data on foreign currency exposures and the degree to which they are hedged are generally unavailable. Offshore bond issuance introduces another complication because the true external exposure of firms with cross-border activities may not be fully captured by using only residence-based statistics. Renewed global efforts by authorities to collect and provide better information on foreign currency corporate indebtedness and offsetting factors (such as hedges) are desirable (see IMF 2015b). Investing in

[34]Other policies that may encourage rapid leverage growth, such as implicit or explicit government guarantees, should also be reconsidered.

Box 3.4. Firm Capital Structure, the Business Cycle, and Monetary Policy

This box summarizes the theoretical and empirical literature on capital structure.

The capital structure of a firm is defined as the mixture of debt and equity the firm uses to finance its operations. The term is often used in conjunction with various measures of borrowing such as the debt-to-equity ratio (one measure of the leverage ratio). In a seminal paper, Modigliani and Miller (1958) put forth the capital structure irrelevance proposition: the market value of the firm is independent of its capital structure.

Departures from the Modigliani-Miller proposition

Subsequent research has shown that the Modigliani-Miller proposition fails under a variety of circumstances.[1] This finding has led to three broad alternative theories of firms' decisions on their capital structure: The first is the trade-off theory in which firms issue debt until the benefits (tax incentives) and costs (bankruptcy) of debt are balanced. The second is the pecking order theory (Myers and Majluf 1984), which governs the order of financing sources and not the amount of debt a firm issues—firms prefer to finance themselves first by using internal funds, then by issuing debt, and last by issuing equity. The third is the market timing theory, in which managers are more likely to tap markets with the most favorable conditions (for example, during asset price rallies).

The role of business cycles

Another strand of the literature examines the aggregate determinants of corporate capital structure. Empirical papers provide differing evidence regarding the cyclicality of leverage.[2] For example, in Covas and Den Haan (2011), firm-level leverage is procyclical. Fernández and Gulan (2015) find that leverage is countercyclical for emerging markets. With regard to theory, Hackbarth, Miao, and Morellec (2006) argue that leverage is countercyclical; Kiyotaki and Moore (1997) argue that it is procyclical, and Bhamra, Kuehu, and Strebulaev (2010) argue that these opposing views are reconcilable.

The role of monetary conditions

Monetary policy can be transmitted to the nonfinancial corporate sector through several channels, and thereby influence firms' capital structure. The traditional interest rate channel stimulates aggregate demand by lowering interest rates and thereby encouraging firms to borrow. Barry and others (2008) find that firm leverage increases when interest rates are low. Based on a survey of chief financial officers, Graham and Harvey (2001) report that the level of interest rates is one of the most important factors influencing the decision to issue debt.

In addition to the interest rate channel, many papers have investigated the credit channel (Bernanke 2007). The credit channel focuses on the change in the availability of credit and has two dimensions: (1) the balance sheet channel, which focuses on bank loan demand; and (2) the bank lending channel, which is more about the supply of bank loans (Kashyap, Stein, and Wilcox 1993). Bernanke, Gertler, and Gilchrist (1996) develop a model of the balance sheet channel, in which lower monetary policy rates raise equity prices and a firm's net worth, and thereby lower the cost of external (debt) financing. This generates a virtuous cycle (or financial accelerator) as firms use debt to finance investment, which boosts aggregate demand and raises equity prices again, allowing for even greater debt-financed investment.

This box was prepared by Ayumu Ken Kikkawa.

[1]Such as taxes, transaction and bankruptcy costs, agency conflicts, adverse selection, and time-varying market opportunities, among others (Frank and Goyal 2003; de Mooij 2012).

[2]Many papers have looked at how other aspects of business cycles affect capital structures. Beaudry, Caglayan, and Schiantarelli (2001) and Baum and others (2006) find that at times of high macroeconomic volatility, firms' investment and financing decisions become more alike as uncertainty constrains managers' ability to make decisions based on firm-specific information.

reporting systems to help more effectively monitor the corporate sector—including foreign currency exposures—is therefore warranted.

Measures to address disruptive outflows

In the event of rapid capital outflows, macroeconomic and financial sector policies can be deployed. Worsening global financial conditions can induce investors to reassess emerging market risks; therefore, the likelihood of sudden outflows is considerably higher in the presence of latent corporate sector vulnerabilities. In fact, mounting emerging market leverage has typically been associated with a subsequent reversal of capital flows (for instance, Mendoza and Terrones 2008; Elekdag and Wu 2011). In such a scenario, nontradable sectors are likely to be

Box 3.5. The Shift from Bank to Bond Financing of Emerging Market Corporate Debt

The role of bond market finance has grown notably as a share of corporate debt in emerging market economies since the global financial crisis. Although the development of equity markets picked up pace in the 1990s, private bond market development was initially limited to a subset of industries in a few emerging market economies. The recent boom allowed a wider set of borrowers to diversify their funding sources while also contributing to growing leverage and foreign exchange exposure. Ayala, Nedeljkovic, and Saborowski (2015) propose a measure of corporate debt at the country level that can be decomposed into local and foreign currency and into bank loans and bonds, and document that the share of bonds in total debt has, on average, grown since the crisis.

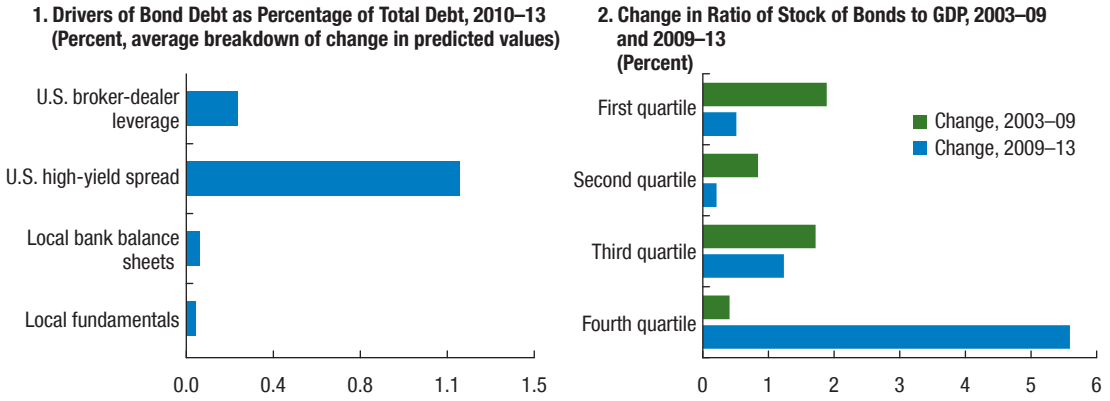
It is important to understand whether the factors that drove the boom in bond finance relative to bank loans were structural or cyclical. Ayala, Nedeljkovic, and Saborowski (2015) examine whether emerging markets that experienced the largest booms relative to bank lending were those with strong fundamentals or whether cyclical factors drove flows into the largest and most liquid markets.

This box was prepared by Christian Saborowski.

The empirical findings confirm that domestic factors do not explain much of the variation in growing bond shares during the postcrisis period. Macroeconomic and institutional variables are shown to be important determinants of bond market development throughout the sample period, but their relative role declined substantially during the postcrisis period as global factors took center stage. The search for yield in global financial markets (proxied by the U.S. high-yield spread) explains the bulk of the boom in bond finance relative to bank loans (Figure 3.5.1, panel 1).

The search for yield accounts for most of the increase in bond shares, with differences across emerging markets explained by market size rather than domestic factors. Dividing emerging markets according to the degree of bond market access in 2009 shows that the largest bond markets (fourth quartile) grew the most since the crisis (Figure 3.5.1, panel 2). Quartile regressions confirm that the impact of the U.S. high-yield spread on bond market shares was substantially larger for emerging markets with initially larger bond markets. This finding suggests that the bond market boom was mostly driven by favorable liquidity conditions, with investor interest in specific emerging markets dependent on market size and the associated ease of entry and exit.

Figure 3.5.1. Changes in the Stock of Bonds by Initial Quartile



Source: Ayala, Nedeljkovic, and Saborowski 2015.
Note: Quartiles in panel 2 defined by stock in 2009.

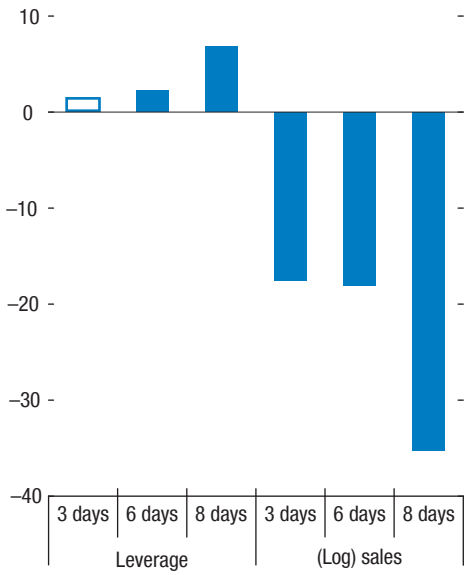
Box 3.6. Taper Tantrum: Did Firm-Level Factors Matter?

This box investigates the impact of the "taper tantrum" on corporate spreads across emerging market economies. On May 22, 2013, during testimony to Congress, the chairman of the U.S. Federal Reserve raised the possibility of tapering its purchases of Treasury and agency bonds. Following this "tapering talk," there were sharp corrections in emerging market economies' asset prices and a reversal of capital flows (Sahay and others 2015).

An event study is used to investigate how emerging market corporate spreads reacted to the tapering shock. Firm-level factors (leverage, size, profitability, and growth prospects) are used to explain the change in corporate credit default swap (CDS) spreads three, six, and eight days after May 21. The analysis covers 309 firms from 21 emerging markets.

Borrowing costs increased disproportionately for more leveraged and smaller firms following the tapering shock. Moreover, these effects tended to become stronger over time as investors digested fundamentals and differentiated across emerging market firms accordingly (Figure 3.6.1). For example, after eight days, a one standard deviation increase in the leverage ratio (corresponding to 16 percentage points) is associated with a 7 basis point increase (corresponding to an annualized rate of 3.3 percent) in the CDS spread. These effects are substantial, given that the firms experienced an increase in spreads of 18 basis points on average. In other words, a one standard deviation increase in the leverage ratio of a firm pushes up its borrowing cost by 40 percent relative to its average peer. In sum, the results suggest that when search-for-yield effects reverse, firms with weaker fundamentals may disproportionately suffer from greater exposure to credit risk.

Figure 3.6.1. Effects of the Shock on Credit Default Swap Spreads
(Basis points; for one standard deviation increase)



Sources: Bloomberg, L.P.; and IMF staff estimates.
Note: The shaded bars denote statistical significance at least at the 10 percent level. The explanatory variables are leverage ratio (total debt to total assets), log sales, income-to-sales ratio, and Tobin's Q. Country and sector fixed effects are included.

This box was prepared by Ayumu Ken Kikkawa.

hit disproportionately. To dampen adverse macroeconomic consequences, the policy response could include, if warranted, exchange rate depreciation and the use of monetary policy and reserves. The public provision of emergency foreign exchange hedging facilities could also be considered. The combination of policies would be based on macroeconomic conditions, taking into consideration financial stability risks such as foreign exchange exposures. Fiscal policy may need to be adjusted depending on macroeconomic circumstances and available policy space. If the financial system comes under stress, liquidity provision may be required.

Conclusion

This chapter considers the evolving influence of firm-level, country-level, and global factors in driving leverage patterns, bond issuance, and corporate spreads. Three key results emerge from the investigation:

- The relative contributions of firm- and country-specific characteristics in explaining leverage growth, issuance, and spreads seem to have diminished in recent years. In contrast, global financial factors appear to have become relatively more important determinants in the postcrisis period.
- Leverage has risen more in sectors that are more vulnerable to cyclical and financial conditions, and it

has grown most in construction. Higher leverage has also been associated with, on average, rising foreign currency exposures.
- Despite weaker balance sheets, emerging market firms have managed to issue at better terms (lower yields, longer maturities); on the positive side, many issuers have taken advantage of favorable financial conditions to refinance their debt.

The expanded role of global financial factors during a period when they have been extraordinarily accommodative means that emerging markets must prepare for the adverse domestic stability implications of global financial tightening:
- Monitoring vulnerable and systemically important firms as well as banks and other parts of the economy closely linked to them is crucial.
- Such expanded monitoring requires that collection of data on corporate sector finances, including foreign currency exposures, be improved.
- Macroprudential policies can be deployed to limit excessive increases in corporate sector leverage. Possible tools include higher bank capital requirements (for instance, implemented via risk weights) for corporate foreign currency exposures and caps on the share of such exposures on banks' balance sheets. Managing risks associated with market-based funding may be challenging, however, potentially requiring an even greater emphasis on macroprudential measures to enhance the resilience of the financial system.
- Microprudential measures should also be considered. Regulators can conduct bank stress tests related to foreign currency risks.
- Finally, as advanced economies normalize monetary policy, emerging markets should prepare for an increase in corporate failures and, where needed, should reform corporate insolvency regimes.

Annex 3.1. Emerging Market Corporate Leverage: Data and Empirics

This annex discusses the data and the empirical methodology used to analyze the main determinants of emerging market corporate leverage. Data sources and definitions are summarized in Table 3.1.1.[35]

The author of this annex is Adrian Alter.

[35]Emerging market economies included in the analysis comprise Argentina, Bahrain, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Egypt, Hungary, India, Indonesia, Jordan, Kazakhstan, Korea, Kuwait, Lebanon, Lithuania, Malaysia, Mauritius, Mexico, Morocco, Nigeria, Oman, Pakistan, Peru, Philippines, Poland, Qatar, Romania, Russia, Saudi Arabia, Serbia, South Africa, Sri Lanka, Thailand, Turkey, Ukraine, United Arab Emirates, and Venezuela.

Measures of leverage

Leverage, or financial leverage, is the degree to which a company uses debt. Leverage is usually presented as a ratio, such as debt to capital. The broadest definitions of leverage consider total nonequity liabilities. An advantage of using total liabilities is that it implicitly recognizes that some firms can use trade credit as a means of financing, rather than purely for transactions (Rajan and Zingales 1995). Another benefit of using total liabilities is its availability. In contrast, debt may not be reported in larger data sets that include nonlisted firms.

Data

Although firm-level databases contain an abundance of information, they do have limitations, particularly in the context of emerging market corporate leverage. For example, data can vary greatly over the time period covered. Accounting standards and reporting requirements vary widely across countries, so it is important to use databases with harmonized definitions. Worldscope (Thomson Reuters) and Orbis (Bureau van Dijk) are two examples of such cross-country harmonized databases that provide annual firm-level balance sheet and income statement information. Worldscope contains publicly listed firms; the main advantage of the Orbis database is its wide coverage of both listed and nonlisted firms—including SMEs—which enrich the cross-sectional information in the data set. To avoid double counting, unconsolidated accounts are considered.[36] Firm-level data are merged with country-specific indicators of macroeconomic conditions and global factors. The firm-country-global data set used comprises more than 1 million active nonfinancial firms (with assets of more than $1 million) and 4.3 million firm-year observations for 24 emerging market economies during 2004–13.

Methodology

Panel regressions link firm-level leverage growth with key firm- and country-specific as well as global determinants. For firm *i,* in sector *s*, country *c,* at time *t,*

[36]Orbis has the advantage of being more comprehensive, with millions of firms represented in the database, but more granular balance sheet data can be incomplete. For example, debt is not reported for many emerging market firms in Orbis. More detailed information on financial statements is even harder to come by.

Annex Table 3.1.1. Definition of Variables

Variable	Description	Source
Firm-Level Variables		
Leverage Metrics		
Ratio of Liabilities to Book Equity	Total liabilities divided by book equity	Orbis, Worldscope
Ratio of Liabilities to Book Assets	Total liabilities divided by book assets	Bloomberg, L.P., Orbis, Worldscope
Ratio of Liabilities to Market Equity	Total liabilities divided by market capitalization	Worldscope
Ratio of Liabilities to Market Assets	Total liabilities divided by the sum of total liabilities and market capitalization	Worldscope
Ratio of Debt to Book Assets	Total debt divided by book assets	Orbis, Worldscope
Ratio of Debt to Market Assets	Total debt divided by the sum of total liabilities and market capitalization	Worldscope
Ratio of Debt to EBIT	Total debt divided by earnings before interest and taxes	Orbis, Worldscope
Ratio of Debt to EBITDA	Total debt divided by earnings before interest, taxes, depreciation, and amortization	Orbis, Worldscope
Fundamental Variables		
Sales	Total sales (Worldscope code WC01001)	Orbis, Worldscope
Tobin's Q	Sum of market value of equity and book value of debt divided by book value of assets	Worldscope
Return on Assets	Net income divided by total assets	Bloomberg, L.P., Orbis, Worldscope
Return on Equity	Net income divided by shareholders' equity	Orbis, Worldscope
Interest Coverage Ratio	Earnings before EBITDA or earnings before EBIT divided by interest expense	Orbis, Worldscope
Tangibility	Tangible fixed assets (or net PPE in Worldscope) divided by total assets	Orbis, Worldscope
Tradable and Nontradable Sectors	Tradable sectors: agriculture, mining, and manufacturing; nontradable sectors: construction, transportation, communications, utilities, wholesale/retail trade, services	
Seasoned Issuer Dummy	Dummy equal to 1 if firm has issued a bond before a given year	Bloomberg, L.P., Dealogic
Firm Size Definitions		
Size	Total assets in logs	Bloomberg, L.P., Orbis, Worldscope
Very Large[1]	Operating revenue ≥ $130 million; total assets ≥ $260 million; employees ≥ 1,000	
Large[1]	Operating revenue ≥ $13 million; total assets ≥ $26 million; employees ≥ 150	
Medium[1]	Operating revenue ≥ $1.3 million; total assets ≥ $2.6 million; employees ≥ 15	
Small	Not included in any of the categories listed above	
Bond-Level Variables		
Local Currency	Dummy equal to 1 if bond is denominated in country of risk's local currency	Bloomberg, L.P., Dealogic
External	Dummy equal to 1 if market type is not domestic	Dealogic
Investment Grade	Dummy equal to 1 if rating is equal to or higher than BBB	Bloomberg, L.P.
Call/Put/Sink	Dummy equal to 1 if maturity type includes call/put/sink option	Bloomberg, L.P.
Country-Level Variables		
ICRG Economic and Financial Risk Rating	The average of ICRG Economic and Financial Risk Ratings, following Bekeart and others (2014)	PRS Group
Corporate Spread	J.P. Morgan CEMBI Broad	Bloomberg, L.P.
Ratio of Government Debt to GDP	General government debt-to-GDP ratio	WEO
Exchange Rate	EM currency per U.S. dollar	WEO
Financial Openness Index	The Chinn-Ito index (KAOPEN) is an index measuring a country's degree of capital account openness.	http://web.pdx.edu/~ito/Chinn-Ito_website.htm
Financial Development Index	Index that summarizes information regarding financial institutions (banks and non-banks), and financial markets across three dimensions: depth, access, and efficiency	Sahay and others (2015)
Financial Integration	Total portfolio investment liabilities from an emerging market economy toward a subset of advanced economies (euro area, Japan, United Kingdom, and United States) scaled by nominal GDP	CPIS
Exchange Rate Regime	De facto exchange rate regime classification, in which a higher value indicates greater exchange rate flexibility	Ilzetzki, Reinhart, and Rogoff (2008)
Global-Level Variables		
VIX	Chicago Board Options Exchange Market Volatility Index	Datastream
U.S. BBB Spread	Bank of America Merrill Lynch U.S. Corporate BBB Option-Adjusted Spread©	FRED®
U.S. Shadow Rate	Estimated from a term-structure model (see Krippner 2014)	RBNZ
U.S. Real Shadow Rate	The U.S. shadow rate minus the approximately one-year-ahead U.S. inflation forecast (Blue Chip Economic Indicators)	RBNZ, Haver Analytics
U.S. GDP Growth	Annual average growth rate	WEO
Global Shadow Rate	Principal component of the shadow rates of the euro area, Japan, and United States	RBNZ and authors' calculations
Commodity Price Index	Commodity price index	WEO
Global Real GDP Growth	Global real GDP growth	WEO

Source: IMF staff.

Note: CEMBI = Corporate Emerging Markets Bond Index; CPIS = Coordinated Portfolio Investment Survey; EBIT = earnings before interest and taxes; EBITDA = earnings before interest, taxes, depreciation, and amortization; EM = emerging market economy; EMBI = Emerging Markets Bond Index; FRED = Federal Reserve Economic Data; ICRG = International Country Risk Guide; PPE = property, plant, and equipment; RBNZ = Reserve Bank of New Zealand; WEO = *World Economic Outlook*.

[1]At least one of the criteria is met.

a general specification of the regression model can be written as follows:

$$\Delta Leverage_{isc,t} = \beta_1 FIRM_{isc,t-1} + \beta_2 MACRO_{c,t} + \beta_3 GLOBAL_t + \theta\ INTERACTION_{isc,t} + OTHER,$$

in which the dependent variable, $\Delta Leverage$, is the change in the ratio of total liabilities to book equity. The term *FIRM* includes measures of size (sales), profitability (return on assets), and asset tangibility (to reflect collateral availability and asset quality). *MACRO* refers to, among others, the ICRG Economic and Financial Risk Rating, which captures country-level macroeconomic factors.[37] The *GLOBAL* factors include the oil price index, the U.S. shadow rate, a proxy for monetary policy conditions in advanced economies, the change in the VIX (a proxy for investors' sentiment and global risk aversion), and global GDP growth. Various interactions between the shadow rate and firm-, sector-, or country-specific characteristics are captured with the term *INTERACTION*. The panel regressions include firm fixed effects (*OTHER*), and standard errors are clustered at the country level.

Main Results

Estimation results suggest a statistically significant relationship between the inverse of the U.S. shadow rate and emerging market corporate leverage growth: a 1 percent decrease in the shadow rate is associated with about 2 percentage point faster leverage growth.

The results remain broadly consistent when other leverage ratios (such as net total liabilities to book equity, total liabilities to total assets, or total debt to total assets) are considered. Subsample analysis is also conducted, and the impact of the shadow rate on leverage is larger (and still statistically significant) during 2010–13. For another robustness check, the models are estimated with standard errors clustered at the country and sector levels, and the results remain broadly unaltered.

[37]Other macro controls include the financial development index (Sahay and others 2015), which captures the financial sector's depth, access, and efficiency; the financial openness index (Chinn and Ito 2006), which measures the degree of capital account openness; and financial integration, which is proxied by total portfolio liabilities to advanced economies, net capital flows, and the exchange rate regime.

Annex 3.2. Bond Issuance Analysis

This annex describes the data and the firm-level regression models used to examine the determinants of the probability of emerging market corporate bond issuance and bond maturity at issuance.

Data

Data on emerging market nonfinancial corporate bond issuance were obtained from Dealogic and Bloomberg, L.P. (see Table 3.1.1). In Dealogic, nonfinancial firms are identified if their general industry classification flag differs from government or finance. In Bloomberg, L.P., nonfinancial firms are identified as corporations excluding financials. Coverage differs across the two data sources, but country aggregates and general trends are similar. Issuers' nationality was determined based on country of risk, which depends on (in order of importance) management location, country of primary listing, country of revenue, and reporting currency of the issuer.

Each data set was used according to its comparative strength. For instance, Dealogic data were used to span a broader set of countries (40 emerging markets) and a longer period (starting in 1980), and to compare different notions of firm nationality (country of incorporation, country of risk, and parent nationality of operation). Bloomberg, L.P., allowed firm's balance sheet information for the year before issuance to be obtained, but, because of data downloading limitations, such information was obtained for only 20 major emerging markets, starting in 1990.

For the analysis of the probability of bond issuance, balance sheet data on issuers and nonissuers are required. For this purpose, two matching exercises were conducted. First, with the help of Bureau van Dijk representatives, issuers in the Dealogic database were matched to the corresponding firm-level balance sheet data in the Orbis database using information on the issuer company name, industry sector, and country of incorporation. The final sample was restricted to listed firms. Second, issuers in the Bloomberg, L.P., database were matched to Thomson Reuters Worldscope. The two merged data sets are complementary given that their coverage differs substantially.

Probability of bond issuance

The probability of issuance at the firm level is modeled as a function of firm and macroeconomic characteristics,

The author of this annex is Nicolas Arregui.

global factors, and bank lending conditions. A probit model is estimated with standard errors clustered at the country level, with country and sector dummies, as well as a time trend. The baseline model is estimated using the Bloomberg, L.P.–Thomson Reuters Worldscope matched database described above. The full sample begins in 1995. The postcrisis estimation starts in 2010, but the findings are robust to starting in 2009. For an additional robustness check, the exercise is repeated using the Dealogic-Orbis matched database, also described above. The model takes the following form:

$$\text{Prob}(Issuance_{it} = 1) = F(\alpha + \beta_1\, firm_{it-1} + \beta_2 macro_{it-1} + \beta_3 bank_{it-1} + \beta_4\, global_{it} + \varepsilon_{it}),$$

in which *Issuance*, a dummy variable, is 1 if firm *i* issued at least once in a given year *t*.

A wide range of macroeconomic (*macro*) and bank lending (*bank*) variables are considered, including rule of law index; exchange rate regime; real GDP growth; per capita GDP; ICRG political, financial, and economic indexes; inflation; inflation volatility; current account and fiscal balances; external, public, and corporate debt; exchange rate changes; and domestic and cross-border bank claims to the private sector. However, these variables are generally not statistically significant.

Firm (*firm*) characteristics are generally robust across time and databases considered.

Global (*global*) factors included are the inverse shadow rate and the VIX. A higher VIX reading is related to a lower probability of issuance over the entire sample.

Bond Maturity at Issuance

The analysis of bond maturity at issuance excludes Chinese firms, and includes bonds issued both domestically and externally. Issuances are related to bond- and firm-level, macroeconomic, bank lending, and global variables. The model is estimated using ordinary least squares with standard errors clustered at the country level, and it includes country and sector dummies, as well as a time trend. The model takes the following form:

$$Maturity_i = \alpha + \beta_0 bond_i + \beta_1 firm_i + \beta_2 macro_i + \beta_3 bank_i + \beta_4 global_i + \varepsilon_i,$$

in which *Maturity* is each bond's maturity at issuance measured in years. Bond characteristics (*bond*) include dummies for local currency denomination; investment grade; and put, call, and sink options. Firm-level variables (*firm*) include size, profitability, leverage, and a dummy for firms that have issued in the past. All bond and firm characteristics (except for profitability) are significant with the expected sign. As above, a wide range of macroeconomic and bank-level variables are considered but are generally not statistically significant.

Global controls include the inverse shadow rate and the VIX. Bonds tend to be issued with shorter maturity in times of financial uncertainty (measured by the VIX). The inverse shadow rate is not significant over the entire sample, but becomes strongly statistically significant in the postcrisis period (defined as starting either in 2009 or 2010). The addition of interaction terms shows that the effect of the inverse shadow rate on maturity was stronger for bonds issued in foreign currency and for non-investment-grade bonds.

Annex 3.3. Regression Analysis of Determinants of Emerging Market Corporate Spreads

This annex describes the data and the country-level regression model used to examine determinants of emerging market corporate spreads.

The regression model takes the following form:

$$spread_{it} = \alpha_i + \beta_1\, global_t + \beta_2\, domestic_{it} + \beta_3\, post_t + \beta_4\, post_t \times global_t + \beta_5\, post_t \times domestic_{it} + \varepsilon_{it},$$

in which *spread* denotes the corporate spread of emerging market country *i* in month *t*. This analysis uses secondary market spread data, which are not susceptible to endogeneity of issuance decisions. The term *global* is a vector of a U.S. corporate spread and real shadow rate. The term *domestic* is a vector of a macroeconomic fundamentals index (the ICRG risk rating), and a leverage indicator (debt-to-book assets, the median of firms within each country). These variables are demeaned. The term *post* is a postcrisis dummy that takes the value of one from January 2010 onward. End-of-month market variables are used for 20 emerging markets; the previous year's leverage is used.

The results are generally robust to using a global real shadow rate or the U.S. one-year real Treasury rate instead of the U.S. real shadow rate.

The author of this annex is Hibiki Ichiue.

References

Acharya, Viral, Stephen Cecchetti, José De Gregario, Sebnem Kalemli-Özcan, Philip R. Lane, and Ugo Panizza. 2015. "Corporate Debt in Emerging Economies: A Threat to Financial Stability." Committee on International Economic Policy and Reform, Washington.

Adler, Michael, and Bernard Dumas. 1984. "Exposure to Currency Risk: Definition and Measurement." *Financial Management* 13: 41–50.

Aizenman, Joshua, Mahir Binici, and Michael M. Hutchison. 2014. "The Transmission of Federal Reserve Tapering News to Emerging Financial Markets." NBER Working Paper 19980, National Bureau of Economic Research, Cambridge, Massachusetts.

Arslanalp, Serkan, Raphael Lam, Wei Liao, and Wojciech Maliszewski. Forthcoming. "Deleverage China." IMF Working Paper, International Monetary Fund, Washington.

Avdjiev, Stefan, Michael Chui, and Hyun Song Shin. 2014. "Non-Financial Corporations from Emerging Market Economies and Capital Flows." *BIS Quarterly Review* (December).

Ayala, Diana, Milan Nedeljkovic, and Christian Saborowski. 2015. "What Slice of the Pie? The Corporate Bond Market Boom in Emerging Economies." IMF Working Paper 15/148, International Monetary Fund, Washington.

Bank for International Settlements (BIS). 2014a. *84th Annual Report*. Basel.

———. 2014b. *BIS Quarterly Review* (September) Basel.

———. 2014c. *BIS Quarterly Review* (December) Basel.

———. 2015. *85th Annual Report*. Basel.

Barry, Christopher B., Steven C. Mann, Vassil T. Mihov, and Mauricio Rodriguez. 2008. "Corporate Debt Issuance and the Historical Level of Interest Rates." *Financial Management* 37 (3): 413–30.

Bartram, Söhnke M., and Gordon Bodnar. 2005. "The Exchange Rate Exposure Puzzle." MPRA Paper 6482. http://mpra.ub.uni-muenchen.de/6482/.

Baum, Christopher F., Mustafa Caglayan, Neslihan Ozkan, and Oleksandr Talavera. 2006. "The Impact of Macroeconomic Uncertainty on Non-Financial Firms' Demand for Liquidity." *Review of Financial Economics* 15 (4): 289–304.

Beaudry, Paul, Mustafa Caglayan, and Fabio Schiantarelli. 2001. "Monetary Instability, the Predictability of Prices, and the Allocation of Investment: An Empirical Investigation Using U.K. Panel Data." *American Economic Review* 91: 648–62.

Bekaert, Geert, Campbell Harvey, Christian Lundblad, and Stephan Siegel. 2014. "Political Risk Spreads." *Journal of International Business Studies* 45 (4): 471–93.

Bernanke, Ben S. 2007. "The Financial Accelerator and the Credit Channel." Paper presented at The Credit Channel of Monetary Policy in the Twenty-first Century Conference, Federal Reserve Bank of Atlanta, Atlanta, June 15.

———, Mark Gertler, and Simon Gilchrist. 1996. "The Financial Accelerator and the Flight to Quality." *Review of Economics and Statistics* 78 (1): 1–15.

Bhamra, Harjoat S., Lars-Alexander Kuehu, and Ilya A. Strebulaev. 2010. "The Aggregate Dynamics of Capital Structure and Macroeconomic Risk." *Review of Financial Studies* 23: 4187–241.

Black, Fischer. 1995. "Interest Rates as Options." *Journal of Finance* 50 (5): 1371–76.

Bodnar, Gordon M., and William M. Gentry. 1993. "Exchange Rate Exposure and Industry Characteristics: Evidence from Canada, Japan, and the USA." *Journal of International Money and Finance* 12 (1): 29–45.

Borensztein, Eduardo, Kevin Cowan, Barry Eichengreen, and Ugo Panizza. 2008. *Bond Markets in Latin America: On the Verge of a Big Bang?* Cambridge, Massachusetts: The MIT Press.

Bruno, Valentina, and Hyun Song Shin. 2015. "Capital Flows and the Risk-Taking Channel of Monetary Policy." *Journal of Monetary Economics* 71 (C): 119–32.

Bullard, James. 2012. "Shadow Interest Rates and the Stance of U.S. Monetary Policy." Presentation at the Center for Finance and Accounting Research Annual Corporate Finance Conference, Olin Business School, Washington University, St. Louis, November 8.

Cardarelli, Roberto, Selim Elekdag, and Subir Lall. 2011."Financial Stress and Economic Contractions." *Journal of Financial Stability* 7 (2): 78–97.

Caruana, Jaime. 2012. "International Monetary Policy Interactions: Challenges and Prospects." Speech at the CEMLA-SEACEN Conference, Punta del Este, Uruguay, November 16.

Cesa-Bianchi, Ambrogio, Luis Felipe Céspedes, and Alessandro Rebucci. 2015. "Global Liquidity, House Prices and the Macroeconomy: Evidence from Advanced and Emerging Economies." BOE Working Paper 522, Bank of England, London.

Chen, Jiaqian, Tommaso Mancini-Griffoli, and Ratna Sahay. 2014. "Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?" IMF Working Paper 14/240, International Monetary Fund, Washington.

Chen, Qianying, Andrew Filardo, Dong He, and Feng Zhu. 2014. "Financial Crisis, Unconventional Monetary Policy and International Spillovers." Working Paper 494, Bank for International Settlements, Basel.

Chinn, Menzie D., and Hiro Ito. 2006. "What Matters for Financial Development? Capital Controls, Institutions, and Interactions." *Journal of Development Economics* 81 (1): 163–92.

Chivakul, Mali, and Raphael Lam. 2015. "Assessing China's Corporate Sector Vulnerabilities." IMF Working Paper 15/75, International Monetary Fund, Washington.

Chow, Julian. Forthcoming. "Stress Testing Corporate Balance Sheets in Emerging Economies." IMF Working Paper, International Monetary Fund, Washington.

Chui, Michael, Ingo Fender, and Vladyslav Sushko. 2014. "Risks Related to EME Corporate Balance Sheets: The Role of Leverage and Currency Mismatch." *BIS Quarterly Review* (September).

Covas, Francisco, and Wouter J. Den Haan. 2011. "The Cyclical Behavior of Debt and Equity Finance." *American Economic Review* 101 (2): 877–99.

de Mooij, Ruud A. 2012. "Tax Biases to Debt Finance: Assessing the Problem, Finding Solutions." *Fiscal Studies* 33 (4): 489–512.

Didier, Tatiana, Ross Levine, and Sergio Schmukler. 2014. "Capital Market Financing, Firm Growth, Firm Size Distribution." NBER Working Paper 20336, National Bureau of Economic Research, Cambridge, Massachusetts.

Dittmar, Robert F., and Kathy Yuan. 2008. "Do Sovereign Bonds Benefit Corporate Bonds in Emerging Markets?" *Review of Financial Studies* 21 (5): 1983–2014.

Driscoll, John C., and Aart C. Kraay. 1998. "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data." *Review of Economics and Statistics* 80 (4): 549–60.

Eichengreen, Barry, and Poonam Gupta. 2014. "Tapering Talk: The Impact of Expectations of Reduced Federal Reserve Security Purchases on Emerging Markets." World Bank Policy Research Working Paper 6754, World Bank, Washington.

Eichengreen, Barry, and Ashoka Mody. 1998. "What Explains Changing Spreads on Emerging Market Debt: Fundamentals or Market Sentiment?" Working Paper 6408, National Bureau of Economic Research, Cambridge, Massachusetts.

Elekdag, Selim, and Yiqun Wu. 2011. "Rapid Credit Growth: Boon or Boom-Bust?" IMF Working Paper 11/241, International Monetary Fund, Washington.

Fazzari, Steven M., R. Glenn Hubbard, and Bruce C. Petersen. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity* 19 (1): 141–206.

Fernández, Andrés, and Adam Gulan. 2015. "Interest Rates, Leverage, and Business Cycles in Emerging Economies: The Role of Financial Frictions." *American Economic Journal: Macroeconomics* 7 (3): 153–88.

Feyen, Erik H. B., Swati R. Ghosh, Katie Kibuuka, and Subika Farazi. 2015. "Global Liquidity and External Bond Issuance in Emerging Markets and Developing Economies." World Bank Policy Research Working Paper 7363, World Bank, Washington.

Frank, Murray Z., and Vidhan K. Goyal. 2003. "Testing the Pecking Order Theory of Capital Structure." *Journal of Financial Economics* 67 (2): 217–48.

Fratzscher, Marcel, Marco Lo Duca, and Roland Straub. 2013. "On the International Spillovers of U.S. Quantitative Easing." ECB Working Paper 1557, European Central Bank, Frankfurt.

Fuertes, Alberto, and José María Serena. 2014. "Firms' Financial Soundness and Access to Capital Markets." *Financial Stability Journal* 27: 112–32.

Gelos, R. Gaston. 2003. "Foreign Currency Debt in Emerging Markets: Firm-Level Evidence from Mexico." *Economic Letters* 78 (3): 323–27.

Gertler, Mark, and Nobuhiro Kiyotaki. 2010. "Financial Intermediation and Credit Policy in Business Cycle Analysis." In *Handbook of Monetary Economics*, edited by Benjamin M. Friedman and Michael Woodford. Amsterdam: Elsevier.

Giesecke, Kay, Francis A. Longstaff, Stephen Schaefer, and Ilya A. Strebulaev. 2014. "Macroeconomic Effects of Corporate Default Crisis: A Long-Term Perspective." *Journal of Financial Economics* 111 (2): 297–310.

Gilchrist, Simon, Vivian Yue, and Egon Zakrajsek. 2014. "U.S. Monetary Policy and Foreign Bond Yields." Paper presented at the 15th Jacques Polak Annual Research Conference, Washington, November 13–14.

Graham, John R., and Campbell R. Harvey. 2001. "The Theory and Practice of Corporate Finance: Evidence from the Field." *Journal of Financial Economics* 60 (2/3): 187–243.

Griffin, John M., and Rene M. Stulz. 2001. "International Competition and Exchange Rate Shocks: A Cross-Country Industry Analysis of Stock Returns." *Review of Financial Studies* 14 (1): 215–41.

Hackbarth, Dirk, Jianjun Miao, and Erwan Morellec. 2006. "Capital Structure, Credit Risk and Macroeconomic Conditions." *Journal of Financial Economics* 82 (3): 519–50.

He, Dong, and Robert N. McCauley. 2013. "Transmitting Global Liquidity to East Asia: Policy Rates, Bond Yields, Currencies and Dollar Credit." BIS Working Paper 431, Bank for International Settlements, Basel.

Ichiue, Hibiki, and Yoichi Ueno. 2006. "Monetary Policy and the Yield Curve at Zero Interest: The Macro-Finance Model of Interest Rates as Options." Bank of Japan Working Paper 06-E-14, Bank of Japan, Tokyo.

———. 2007. "Equilibrium Interest Rate and the Yield Curve in a Low Interest Rate Environment." Bank of Japan Working Paper 07-E-18, Bank of Japan, Tokyo.

Ilzetzki, Ethan, Carmen Reinhart, and Kenneth Rogoff. 2008. "Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?" Unpublished manuscript and data. http://personal.lse.ac.uk/ilzetzki/data.htm.

International Monetary Fund (IMF). 2014a. *2014 Spillover Report*. Washington: International Monetary Fund.

———. 2014b. "Asia-Pacific Regional Economic Outlook." In *Corporate Leverage in Asia: A Fault Line?* Washington: International Monetary Fund.

———. 2014c. "Global Liquidity–Issues for Surveillance." IMF Policy Paper, International Monetary Fund, Washington.

———. 2014d. "Staff Guidance Note on Macroprudential Policy—Detailed Guidance on Instruments." IMF Policy Paper, International Monetary Fund, Washington.

———. 2015a. *2015 Spillover Report*. Washington: International Monetary Fund.

———. 2015b. "Balance Sheet Analysis in Fund Surveillance." IMF Policy Paper, International Monetary Fund, Washington.

———. 2015c. *Central, Eastern, and Southeastern Europe: Regional Economic Issues.* Washington: International Monetary Fund.

———. 2015d. "Recent Investment Weakness in Latin America: Is There a Puzzle?" In *Western Hemisphere: Regional Economic Outlook*. Washington: International Monetary Fund.

Kalemli-Ozcan, Sebnem, Bent Sorensen, and Sevcan Yesiltas. 2012. "Leverage across Firms, Banks, and Countries." *Journal of International Economics* 88 (2): 284–98.

Kamada, Koichiro, and Tomohiro Sugo. 2006. "Evaluating Japanese Monetary Policy under the Non-Negativity Constraint on Nominal Short-Term Interest Rates." Bank of Japan Working Paper 06-E-17, Bank of Japan, Tokyo.

Kashyap, Anil K., Jeremy C. Stein, and David W. Wilcox. 1993. "Monetary Policy and Credit Conditions: Evidence from the Composition of External Finance." *American Economic Review* 83 (1): 78–98.

Kiyotaki, Nobuhiro, and John Moore. 1997. "Credit Cycles." *Journal of Political Economy* 105 (2): 211–48.

Krippner, Leo. 2014. "Documentation for United States Measures of Monetary Policy." Reserve Bank of New Zealand and Centre for Applied Macroeconomic Analysis. http://www.rbnz.govt.nz/research_and_publications/research_programme/additional_research/5892888.pdf.

Lo Duca, Marco, Giulio Nicoletti, and Adriana Vidal Martinez. 2014. "Global Corporate Bond Issuance—What Role for US Quantitative Easing?" ECB Working Paper 1649, European Central Bank, Frankfurt.

Lombardi, Marco, and Feng Zhu. 2014. "A Shadow Policy Rate to Calibrate US Monetary Policy at the Zero Lower Bound." BIS Working Paper 452, Bank for International Settlements, Basel.

Magud, Nicolás E., and Sebastián Sosa. 2015. "Investment in Emerging Markets: We Are Not in Kansas Anymore…Or Are We?" IMF Working Paper 15/77, International Monetary Fund, Washington.

McCauley, Robert, Christian Upper, and Agustín Villar. 2013. "Emerging Market Debt Securities Issuance in Offshore Centres." *BIS Quarterly Review* (September) 22–23.

Mendoza, Enrique G., and Marco E. Terrones. 2008. "An Anatomy of Credit Booms: Evidence from Macro Aggregates and Micro Data." NBER Working Paper 14049, National Bureau of Economic Research, Cambridge, Massachusetts.

Modigliani, Franco, and Merton Miller. 1958. "The Cost of Capital, Corporation Finance and the Theory of Investment." *American Economic Review* 48 (3): 261–97.

Myers, Stewart C., and Nicholas S. Majluf. 1984. "Corporate Financing and Investment Decisions when Firms Have Information that Investors Do Not Have." *Journal of Financial Economics* 13 (2): 187–221.

Nier, Erlend, Tahsin Saadi Sedik, and Tomas Mondi. 2014. "Gross Private Capital Flows to Emerging Markets: Can the Global Financial Cycle Be Tamed?" IMF Working Paper 14/196, International Monetary Fund, Washington.

Rajan, Raghuram G., and Luigi Zingales. 1995. "What Do We Know about Capital Structure? Some Evidence from International Data." *Journal of Finance* 50 (5): 1421–60.

———. 1998. "Financial Dependence and Growth." *American Economic Review* 88 (3): 559–86.

Rodríguez Bastos, Fabiano, Herman Kamil, and Bennett Sutton. 2015. "Corporate Financing Trends and Balance Sheet Risks in Latin America: Taking Stock of 'The Bon(d)anza.'" IMF Working Paper 15/10, International Monetary Fund, Washington.

Sahay, Ratna, Martin Cihak, Papa N'Diaye, and Adolfo Barahas. 2015. "Rethinking Financial Deepening: Stability and Growth in Emerging Markets." IMF Staff Discussion Note 15/08, International Monetary Fund, Washington.

Schularick, Moritz, and Alan M. Taylor. 2012. "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870–2008." *American Economic Review* 102 (2): 1029–61.

Shin, Hyun Song. 2013. "The Second Phase of Global Liquidity and Its Impact on Emerging Economies." Presentation at the Federal Reserve Bank of San Francisco Asia Economic Policy Conference, San Francisco, November 3–5.

———. 2014a. "The Changing Face of Financial Intermediation." Presentation at 84th Annual General Meeting, Bank for International Settlements, Basel, June 29.

———. 2014b. "Financial Stability Risks: Old and New." Presentation at the Brookings Institution, Washington, December 4.

Wu, Jing Cynthia, and Fan Dora Xia. Forthcoming. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit, and Banking.*

Zinna, Gabriele. 2014. "Identifying Risks in Emerging Market Sovereign and Corporate Bond Spreads." *Emerging Markets Review* 20 (September): 1–22.