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The financial system has undergone far-reaching changes since the global financial crisis of 2008. We cast those changes in terms of shifts in the manner in which financial intermediaries manage their balance sheets. We also discuss the regulatory reform agenda, and we review the impact of regulations on market liquidity and credit availability. The current evidence suggests that the financial system has become safer, at limited unintended cost.

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Liquidity, Leverage, and Regulation Ten Years after the Global Financial Crisis

Tobias Adrian, John Kiff, Hyun Song Shin*

Abstract

The financial system has undergone far-reaching changes since the global financial crisis of 2008. We cast those changes in terms of shifts in the manner in which financial intermediaries manage their balance sheets. We also discuss the regulatory reform agenda, and we review the impact of regulations on market liquidity and credit availability. The current evidence suggests that the financial system has become safer, at limited unintended cost.

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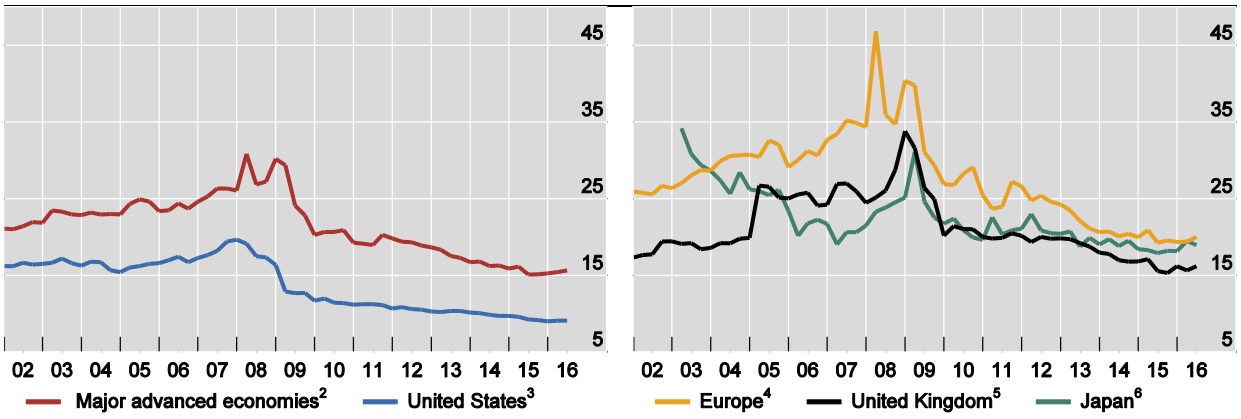
I. INTRODUCTION

Following the great deleveraging of 2008-9, the mood in financial markets changed. The VIX index hovered at low levels for much of the period following the global financial crisis and the overall stock markets rose substantially. Nevertheless, stock indices of the banking sector underperformed, especially for European-headquartered banks. Market-to-book ratios continue to be low, close to the troughs of the aftermath of the global financial crisis. This is all the more striking because, between 2007 and 2016, less than half of banks' cumulative net income was ploughed back into capital, with the remainder paid out in the form of dividends and spent on share buybacks.[1] So what explains the difference between the equity performance of banks and overall indices? What are the pressures on banks' funding and balance sheet capacity?

Figure 1 plots the decline in the overall leverage of the banking sector around the world. Leverage is measured as total assets divided by book equity, with the red line showing the global average. Leverage was well above 25 in the years before the crisis and rising, but – after an initial in-crisis adjustment – it saw a substantial further decrease in the post-crisis years, reaching a leverage of around 15 recently. Nevertheless, leverage continues to exhibit considerable variation across the major jurisdictions. Leverage of U.S. banks has been lower than the global average, while banks in Japan and the euro area have maintained leverage higher than the global average.[2]

Figure 1: Bank Balance Sheet Leverage[1]



[1] Total assets divided by total equity, weighted by asset size. [2] For all the banks showed in this graph. [3] Bank of America, Citigroup, Goldman Sachs, JPMorgan Chase, Lehman Brothers (up to 08Q2), Merrill Lynch & Co, Morgan Stanley, Wachovia Corporation (up to 08Q2) and Wells Fargo & Company. [4] Banco Santander, BNP Paribas, Commerzbank AG, Credit Suisse, Deutsche Bank, UBS, UniCredit SpA. [5] Barclays, HSBC, Lloyds TSB Group, Royal Bank of Scotland. [6] Mitsubishi UFJ Financial Group, Mizuho Financial Group, Sumitomo Mitsui Financial Group.

Sources: Capital IQ; BIS calculations.

[1] See Shin (2016).

[2] Some of the difference between U.S. and European reported leverage ratios is explained by accounting standard differences. For example, according to FDIC (2017) at end-June 2017, the average reported leverage ratio of U.S. globally systemically important banks (G-SIBs) of 12.1 would have been 15.1 under European bank accounting standards. European G-SIBs reported an average leverage ratio of 21.6 at end-June 2017.

The downward trend in observed bank leverage revealed in Figure 1 plays out during a period of tightening post-crisis regulation. However, it would be simplistic to attribute deleveraging of banks to regulation alone. For one, the high leverage of the internationally active banks in the years immediately prior to 2008 reflected special circumstances at the time, associated with booming leverage, that were not sustainable as a long-run outcome. Broader challenges to changing bank business models are apparent after the crisis, such as the low-interest-rate environment, high level of non-performing loans, and new competitors from the fintech universe. Those challenges have been reflected in depressed bank stock prices in spite of the supportive macroeconomic backdrop, the relatively more buoyant performance of stock indices more broadly, and banks' higher capital ratios. The ratio of the market capitalization of banks to their book equity – their market-to-book ratio – dipped below one for part of the post-crisis period in Europe and Japan.[3]

An important distinction is between book leverage and market value leverage. Central banks and regulators have focused on book values, and regulations are written in terms of book values. For the availability of credit, book values are key. For some key purposes, however, market values are important to bear in mind, especially their relationship with book leverage over the cycle. Market capitalization of the bank is a reflection of the market value of the equity holders' stake, and hence an assessment by market participants of the creditworthiness of the bank as a borrower and the present value of the stream of cashflows that derive from the bank's business activities. If market participants have reservations about a bank's business model or creditworthiness, then market capitalization will be correspondingly very thin, and the market-to-book ratio of bank equity will be small. In effect, this means that a greater proportion of the bank's value is held by the creditors, rather than the equity holders, and therefore that the bank has a high market value leverage.

The recently observed low market-to-book ratios indicate that the assessment of market participants is that banks are more leveraged than their books suggest.[4] High market value leverage, in turn, affects the funding environment of the bank. High market value leverage may have knock-on effects and exert downward pressures on the banks' book leverage through tighter funding conditions (Adrian and Shin, 2014).

If only a bank could raise more capital when price-to-book ratios are low, it could remedy the perceptions of reduced creditworthiness. However, raising new equity when the market price of bank stocks is so low entails a high degree of dilution of the incumbent shareholders' interests. There are severe challenges to raising new equity precisely when new equity would be most beneficial to the lending operations of the bank. The argument about dilution is even stronger

[3] See Bogdanova, Fender and Takats (2018).

[4] Also, Breuer (2000) and Singh and Alam (2018) argue that traditional leverage based on accounting standards understate investment bank leverage by not fully reflecting the impact of off-balance-sheet assets and liabilities. Beccalli, Boitani, and Giuliantonio (2015) also document U.S. bank securitization-related leverage overstatement, particularly prior to the amendment of FAS No. 140 by the SFAS 166 in January 2010.

when the bank's price to book ratio is below one. In such cases, the book value of equity is higher than the market value of equity. Paying one dollar of dividends gives the shareholder one dollar in the hand, but incurs a cost of less than one dollar in terms of the share price of the bank. In this sense, Tobin's argument on the q theory of investment applies to the bank, in that reducing investment in the bank's operation is less costly for the owners. Perhaps for this reason, banks have continued to pay out dividends even for those cases where arguably banks would have benefited from a bolstering of capital positions by reducing dividends (Shin, 2016).

II. Bank Leverage Determinants and Drivers

Banks are intermediaries: They borrow from other lenders, combine the borrowed funds with their own funds, and then lend the combined total to ultimate borrowers. Bank capital refers to the bank's own funds. The more capital banks have, the more of their own funds they have to lend out. But bank capital plays a more important role than this for overall lending. As well as lending out their own funds, banks with plentiful own funds are able to borrow *more* from their creditors, and on much better terms than banks that are poorly capitalized. Banks' own funds come from several sources, but the most important source are banks *retained earnings*. This portion of a bank's own funds refers to the accumulated stock of all of the bank's profits since its inception that have not been paid out as dividends to shareholders.

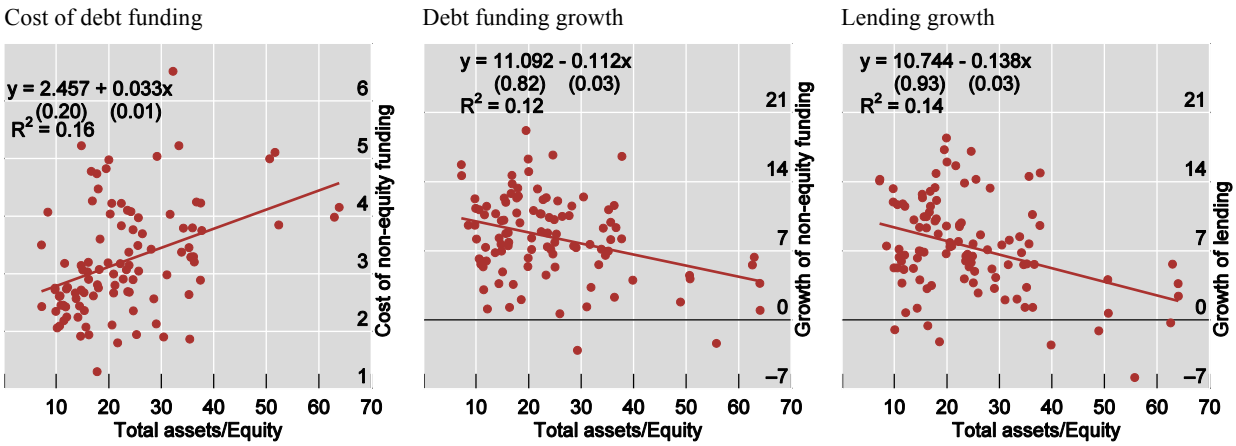
At the same time, bank capital is a loss-absorbing buffer in the sense that banks own funds can absorb losses from lending activity without imposing losses on the creditors to the banks. But solvent banks can sometimes be reluctant to lend, and weakly capitalized banks may seek to improve solvency metrics such as their ratio of capital to risk-weighted assets by cutting back on lending. If banks' solvency metrics are expressed as ratios, there may even be some apparent tension between the objective of unlocking bank lending (which entails expanding credit) and the supervisory imperative of ensuring the soundness of individual banks (which can be achieved by cutting back credit). This is why we sometimes hear calls for the relaxation of bank capital rules.

The left-hand panel of Figure 2 shows a summary scatter chart from Gambacorta and Shin (2016) that plots the relationship between the cost of banks' borrowed funds and their overall leverage. Leverage is again defined as the ratio of a bank's total assets to its equity. The scatter chart is quite dispersed, but it overstates the noise in the relationship, as it is just the simple scatter for the mean values for each bank, without controlling for bank characteristics or macro variables. In their detailed empirical analysis, Gambacorta and Shin (2016) find that a one-percentage-point increase in the equity-to-total-assets ratio is associated with a 4 basis point reduction in the cost of borrowed funds for the bank. This finding sets an important benchmark when considering the benefits of higher bank capital for bank funding cost.[5] For typical levels of

[5] See also Carlson, Shan and Warusawitharana (2013) who found that banks with higher capital ratios had stronger growth from 2008 to 2010. Also Kapan and Minoiu (2018) find that banks with stronger balance sheets and higher levels of common equity were better able to cope with liquidity shocks during the crisis.

bank leverage, it would appear that banks could go a long way toward mitigating their supposedly higher cost of equity funding by retaining more of their profits to build capital.[6]

Figure 2: Bank Capital and Loan Growth[1]



[1] The panels present scatter plots between the leverage of 105 advanced-economy banks and cost of funding in percent (left-hand panel), annual growth rate of debt financing in percent (center) and annual growth rate of lending in percent (right-hand panel). Standard errors are in brackets.

Source: Gambacorta and Shin (2016)

The lower funding cost translates into greater intermediation activity by the bank. The center panel of Figure 2 shows that banks that have more own funds, and hence lower funding costs, tend to raise borrowed funds at a faster pace. The upshot is that banks with lower leverage expand their lending at a faster rate, too: This is the "sound banks lend more" line mentioned earlier. The right-hand panel of Figure 2 shows this for the summary data. Detailed analysis shows that a one-percentage-point increase in the equity to total assets ratio is associated with a 0.6 percentage point uptick in the subsequent growth in lending.

The funding advantage is clearer still when the banks are sorted according to their initial capitalization levels. The cost advantage that comes from higher capital is larger for the banks that are more thinly capitalized.

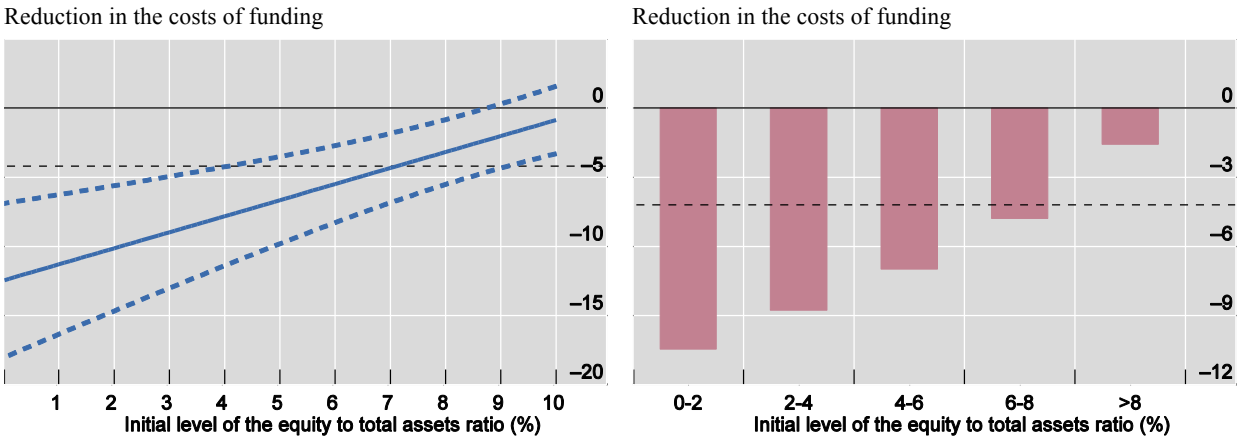
Figure 3 illustrates precisely this effect. Gambacorta and Shin (2016) report how non-equity funding cost reported by banks is lower for better capitalized banks, both in the cross-section and in the time series.[7] The right-hand panel shows that the funding cost advantage from a one percentage point of additional capital to total assets results in a reduction in the cost of funding of 10 basis points for banks that are below 2 percent in their ratio of capital to total assets. The

[6] Consider a balance sheet of size 100, with equity of 10. If equity is raised to 11, a 4 basis point reduction in the cost of borrowed funds results in cost saving of $0.0004 \times 89 = 0.0356$. If the cost of equity is assumed to be 10%, the cost of equity funding is 1 when equity is 10 and 1.1 when equity is 11. The additional cost of equity is 0.1. The reduction in the cost of borrowed funds is 36% of the supposed incremental cost of equity.

[7] The dataset from Gambacorta and Shin (2016) relies mainly on the income statements reported by the banks. The underlying data are retrieved from banks' financial statements. The "funding cost" is the cost of their borrowed funds. Hence, the term "non-equity funding".

cost advantage falls as the bank becomes better capitalized, but, even for banks that have a leverage ratio of above 8 percent, there is still a noticeable reduction of the cost of funding, amounting to 2 basis points.

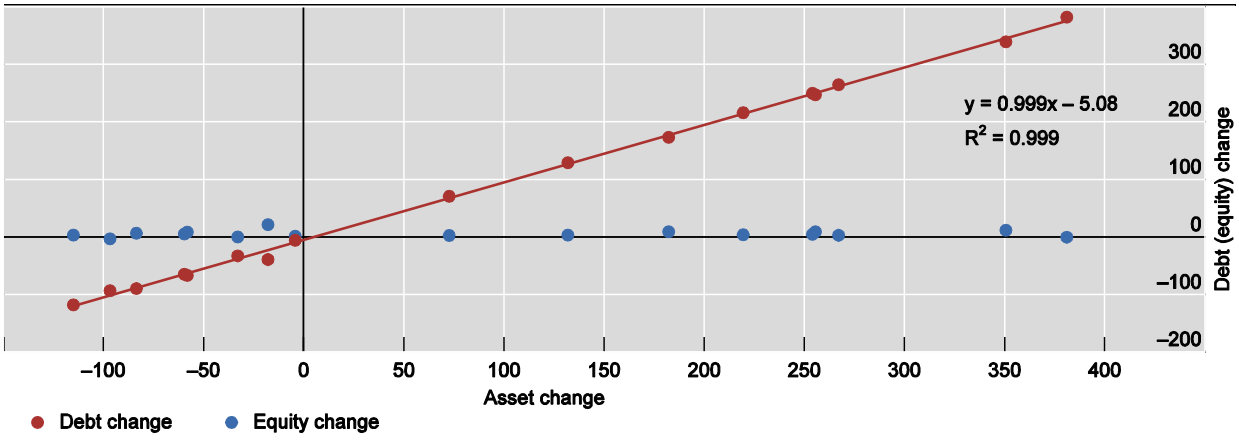
Figure 3: Nonlinear Effect of Higher Bank Capital on the Cost of Funding (basis points)



Source: Gambacorta and Shin (2016).

There is a useful analogy. A bank's lending is to its capital what a building is to its foundations. Concretely, if the bank's capital forms the foundations, its leverage corresponds to the height of the building that stands on the foundations. The size of the building is the total lending done by the bank. The bank can expand lending by using more borrowed funds and increasing its leverage. But it turns out that this kind of lending is not very resilient. It is "fair weather lending", to coin a phrase. As soon as economic conditions turn less favorable for leverage, the bank may have to shrink its lending, with negative consequences for the real economy.

Figure 4: Annual Changes in Assets, Equity and Debt for a Large European Bank (1999–2015, in billions of euros)



Scatter plot showing how much of the change in assets is accounted for by changes in debt and equity, respectively. Annual changes in billions of euros are shown for large European bank (1999–2015).

Sources: S&P Capital IQ; authors' calculations.

Figure 4 illustrates how the cyclical variation of lending plays out for a typical bank. It shows a scatter chart that plots the relationship between the annual change in total assets on the horizontal axis and how the assets are financed as between its own funds (in blue) and in borrowed funds (in red) on the vertical axis.[8]

The fitted line through the scatter plot between the change in assets and change in borrowed funds has a slope that is essentially equal to one, meaning that the change in assets in the short term, over horizons of around one year, are almost all accounted for by the change in debt. The blue scatter for equity is flat, meaning that the bank's own funds do not vary much over the cycle.

This scatter chart reinforces the analogy between equity and the foundations of the building. It suggests that the foundations of the building are pretty much fixed, and what changes is the size of the building that stands on those foundations. The taller the building is, the higher is the leverage and the greater is the amount of lending done by the bank. During boom times, the height of the building increases as the bank adds new floors to the existing structure. In other words, the bank increases its total assets by increasing its leverage atop the same equity base. The boom is associated with greater availability of credit and lower risk weights for the bank's assets. The problems arrive when financial conditions turn for the worse and the bank is no longer able to secure borrowed funds. Then, the lending also grinds to a halt.

What are the reasons for such large fluctuations in leverage? The "Great Deleveraging" of 2008 is clearly an extreme example, during a time of heightened financial stress. Nevertheless, the episode holds lessons for today, by shining a light on the determinants of the risk-taking capacity of the banking sector.

In general, intermediary leverage is influenced by the combination of the perceived creditworthiness of the intermediary as a borrower and how tight overall credit conditions are in the financial system. If the financial system as a whole goes through a period of ample funding liquidity, even thinly capitalized banks can borrow on easy terms. Since banks borrow in order to lend, easier borrowing conditions translate into easier lending conditions, reinforcing the already-easy financial conditions. By the nature of the interactions between liquidity conditions and leverage, the boom phase rides an apparent virtuous circle of greater leverage and easier liquidity. The problem is that this virtuous circle is only apparent, not real. The true nature of the situation is revealed when the easy conditions go into reverse, and the amplification mechanism kicks in as a downward spiral.

One way to approach this issue is to track the implicit maximum leverage achievable by a broker dealer in a repurchase agreement (repo). Repo is a collateralized borrowing arrangement. In a repo transaction, the borrower, here the broker dealer, sells a security today on the understanding that it will buy it back in the future at a pre-agreed price. The difference between the market price today of the pledged security and the amount borrowed by the bank is called the "haircut"

[8] The slopes of the two lines add up to 1 due to the balance sheet identity (Adrian and Shin, 2014).

of the repo, and it is this haircut that determines the leverage of the broker dealer. If the haircut is 2 percent, the borrower can borrow 98 dollars by pledging 100 dollars' worth of securities. Then, to hold 100 dollars' worth of securities, the borrower must come up with only 2 dollars of equity. Thus, if the repo haircut is 2 percent, the maximum permissible leverage (ratio of assets to equity) is 50.

However, when borrowers are stretched to such high levels of leverage on the back of such thin haircuts, any slight shock to the financial system that raises the haircut will leave the bank vulnerable to a sudden tightening of financing conditions from an increase in the haircut. Suppose that the haircut rises to (a still modest) 4%. Then, in this simple example, the broker dealer's leverage halves to 25, from 50. Assuming that the equity stays constant, this means cutting down total assets by half. If the broker dealer had started with a very large balance sheet, the shedding of exposures will be immense, causing repercussions to those entities that were borrowing from the broker-dealer, setting in motion second- and third-round effects in the financial system.[9]

III. Lessons from the "Great Deleveraging" of 2008

We can learn a great deal about the post-crisis environment by recalling the boom and bust in bank leverage associated with the global financial crisis. Figure 5 plots the time path of total assets and leverage of the U.S. security broker-dealer sector from 1990. The left-hand panel shows the total asset series of the broker-dealer sector, scaled to 100 at the start of the period. Figure 5 also plots the total assets of the U.S. non-financial corporate sector and the U.S. household sector for comparison, both scaled to 100 at the start of the period. The right-hand panel shows the leverage of the U.S. broker-dealer sector, where leverage is again defined as the ratio of total assets to equity.

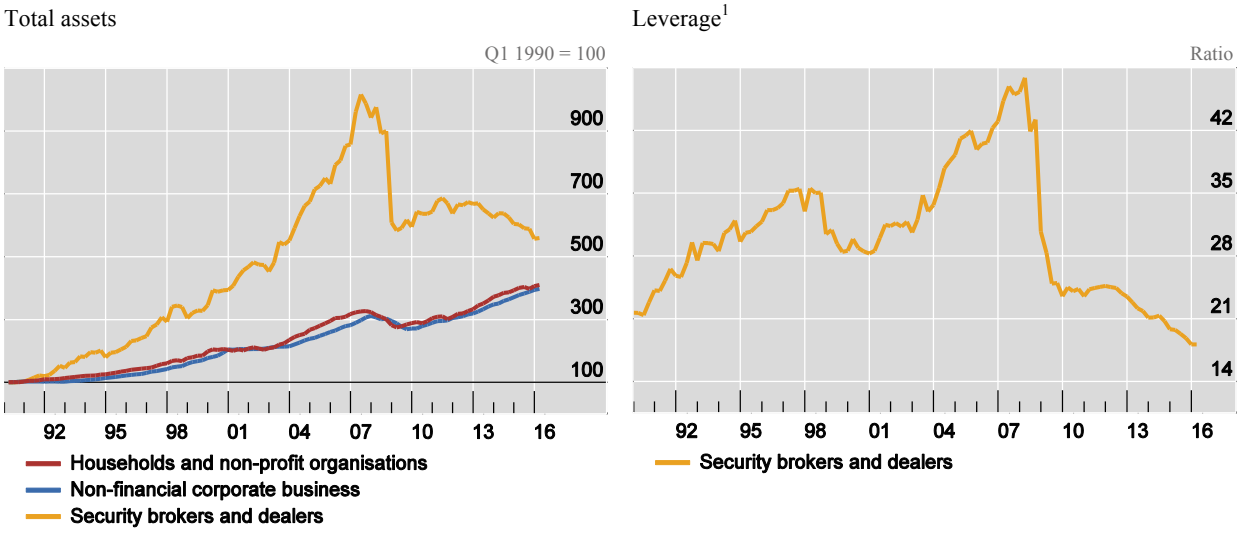
By any standard, these charts for the U.S. broker-dealer sector are dramatic. From the left-hand panel, we see that the sector's total assets grew much faster than the rest of the economy. At the peak of the credit boom in June 2007, these assets had grown nearly tenfold from 1990; the assets of non-financial corporates and households had grown by a more modest factor of three. With the onset of the crisis, however, the balance sheet shrank rapidly.

The large fluctuations in the total assets of the U.S. broker-dealer sector are mirrored by the fluctuations in its leverage, as shown in the right-hand panel. Leverage started out at 22 in 1990, rose to the dizzy height of 48 at the peak, only to collapse with the onset of the crisis in 2008. Leverage rebounded somewhat in the aftermath of the crisis as financial conditions eased. However, we see that the most recent period has seen a further decline in the leverage of the broker-dealer sector. Leverage at the end of December 2017 stood at 18, and is lower than at the beginning of 1990. Post-crisis regulatory reform may explain some of the reversion, but most of

[9] See Adrian and Shin (2010, 2014), Gorton and Metrick (2010) and Geanakoplos (2009).

it preceded the announcement of potentially constraining regulation. More likely, the leverage collapse reflects a combination of reduced expected returns, conservative risk management, the diminished role of securitization, and the growth of nonbank lending and market making.

Figure 5: Total Assets and Leverage of the U.S. Security Broker-dealer Sector



[1] Calculated as total assets divided by equity.

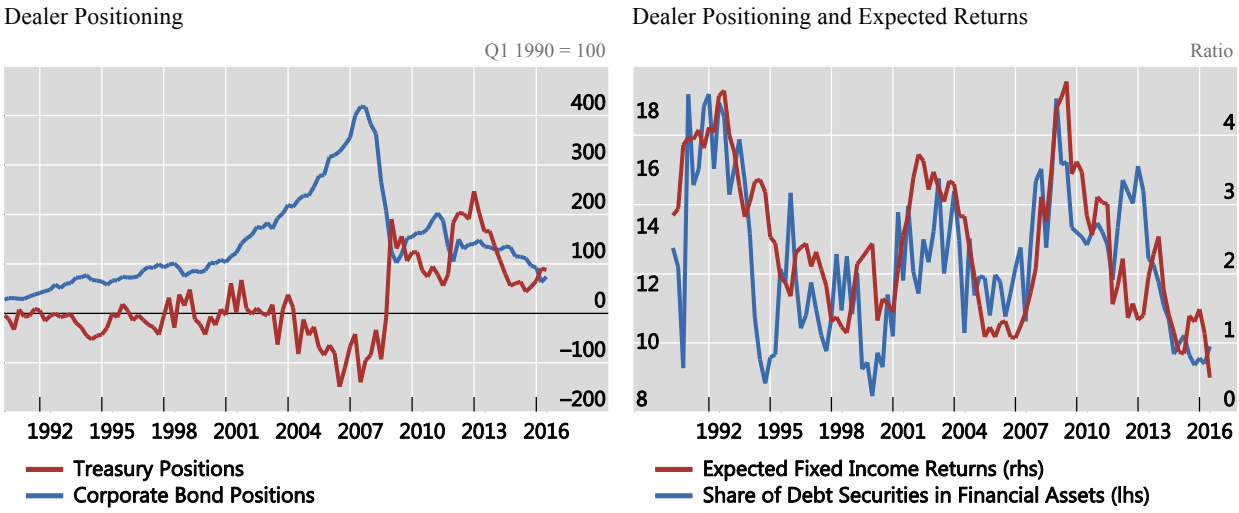
Sources: Federal Reserve, *Flow of Funds*; authors' calculations.

We can look beyond total balance sheet size, at dealer positioning, to gain a more granular understanding of the post-crisis environment. Dealer positioning reflects the proprietary trading and risk-management motives of dealers as well as the positioning of dealer clients. To illustrate dealers' positioning, we examine the composition of dealer assets using data from the Financial Accounts of the U.S. Figure 6 (left plot) shows dealers' net positions in Treasury securities and corporate bonds from 1990 to 2016. The plot reveals three key features. First, dealers' net corporate positions grew quickly in the years preceding the crisis, plunged during the crisis, and stagnated after the crisis. Second, dealers' net Treasury positions fluctuated between positive and negative between 1990 and 2016, and were negative for an extended period from 2004 to 2008. Third, in the roughly 15 years between 2001 and 2016, changes in net Treasury and corporate bond positions were negatively correlated and tended to offset, suggesting that dealers trade the credit spread.

The sharp decline in net corporate positions, in particular, raises the potential concern that dealers have reduced their balance sheet commitment to market making with potentially adverse effects on market liquidity. Traditionally, dealers acted as principal, buying bonds from their customers when they wanted to sell, and holding them on their balance sheet until offsetting trades were found later, thus bearing the risk that prices fell in the interim. More recently, however, they may have shifted toward an agency model, as suggested by Meli and Gupta (2016), Bessembinder et. al. (2016), and Choi and Huh (2017), in which dealers match offsetting orders so as to avoid holding bonds on their balance sheets. While such a shift could explain the

decline in net positions, it leaves open the question of whether liquidity is adversely affected and, if so, whether it has moved below its socially desirable level (CGFS, 2016). There are tens of thousands of outstanding corporate bond issues with varying maturity, seniority, and optionality characteristics, making it difficult to match demand and supply. By their nature, regulations (if they are effective at all) are designed to be binding constraints on banks' behavior.[10] So, the fact that banks' activities are affected by regulations does not mean that the regulations are undesirable. The benefits of regulation in fostering a sounder financial system should be factored into the calculation of any cost-benefit analysis of regulation.

Figure 6: U.S. Dealer Positioning and Expected Returns



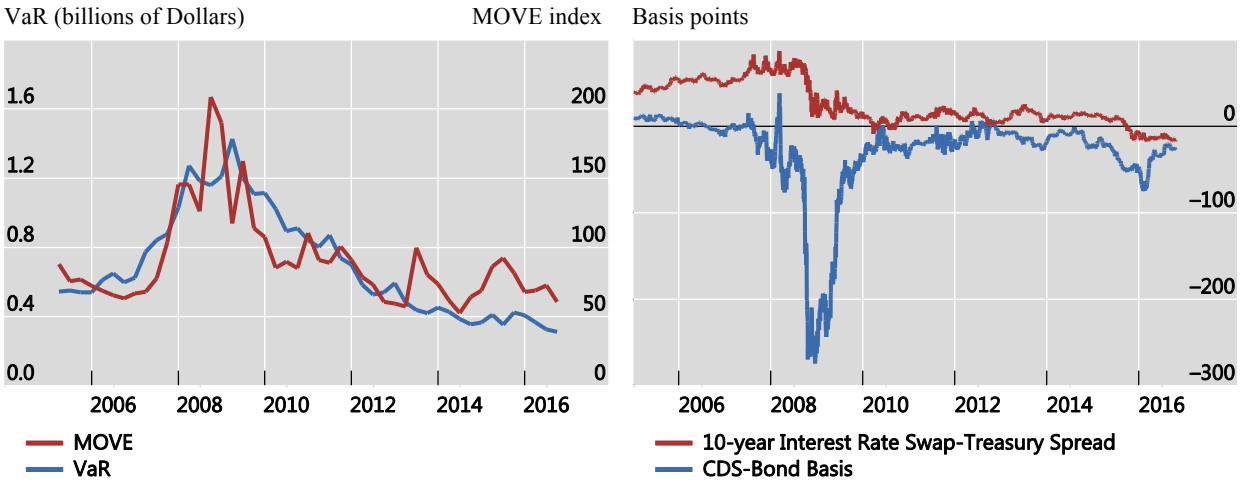
Source: Adrian, Fleming, Shachar, Vogt (2017).

Across all debt securities, dealer positioning is likely managed to maximize expected returns and hence varies over time. In Figure 6 (right plot), we show debt securities as a share of dealer financial assets together with a measure of expected fixed-income returns: the sum of the 10-year Treasury term premium and the credit risk premium. The 10-year Treasury term premium, computed by Adrian, Crump, and Moench (2013), measures the interest rate risk premium embedded in a Treasury bond portfolio with a 10-year duration. The credit risk premium is measured by Moody's Baa-Aaa spread. The figure shows a tight correlation (55%) between expected fixed-income returns and dealer fixed-income positioning, with periods of sharp changes in asset valuations typically accompanied by sharp adjustments in positions. The low level of debt securities as a share of total assets prior to the financial crisis was thus associated with a compression of expected returns at that time. Similarly, the sharp rise in debt securities during the crisis corresponded with a period when expected returns were unusually high.

[10] Goel, Lewrick and Tarashev (2017) show that even "a constraint that does not bind contemporaneously could still influence decisions if financial conditions evolve and imply that this constraint is more or less likely to bind in the future."

Another striking feature of dealers' balance sheet behavior is the covariation of the tightness of risk management constraints with market volatility. Figure 7 (left plot) shows the sum of firm-wide value-at-risk (VaR) across eight large U.S. dealers, and market volatility as proxied by the Merrill Lynch Option Volatility Estimate (MOVE) Index. The chart shows that total balance-sheet capacity of dealers as measured by total VaRs has declined dramatically since the crisis, in hand with the decline in market volatility. The decline in balance-sheet capacity is often linked to a deterioration of funding cost indicators, two of which are shown in the right panel of Figure 7.

Figure 7: U.S. Dealer VaR and Funding Costs



Source: Adrian, Fleming, Shachar, Vogt (2017).

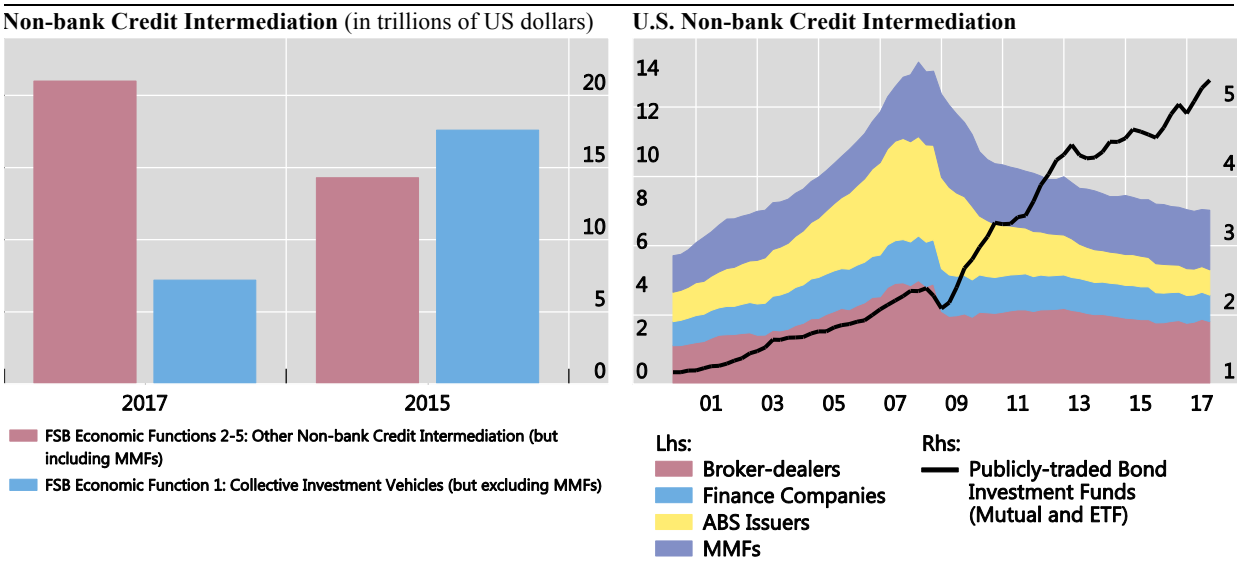
Figure 7 (right plot) shows the spread between the 10-year interest rate swap and the 10-year Treasury yield. Swap rates represent the value of a stream of payments indexed to LIBOR, so their pricing depends on the credit risk of LIBOR-panel banks. Treasuries, in contrast, price in the credit risk of the U.S. government, and should therefore command lower yields. Indeed, the swap spread has typically been positive. However, such spreads were negative at times in 2010, and also turned negative in late 2015 (where they remained through mid-2016). Such negative swap spreads are often cited as evidence of less plentiful funding liquidity (Dudley, 2016), and are sometimes attributed to regulatory balance-sheet constraints on banks, hedging demands, and foreign central bank activities.

Figure 7 (right plot) also shows another measure of market dislocation based on the credit default swap (CDS)-bond basis. The CDS-bond basis is calculated for investment-grade bonds as the average difference between each bond's market CDS spread and the theoretical CDS spread implied by the bond yield. If the CDS spread and bond yields both reflected only the probability of default, then the two series should be identical. However, the different between the CDS contract and the risky bond is that the former is a zero-money-down bet while the latter entails a balance-sheet commitment by the intermediary up to the notional amount. Hence, the CDS-bond basis can be read as signaling the price of bank balance-sheet capacity. When banks are subject to deleveraging pressures, the CDS bond basis will be negative.

In Figure 7 (right plot), we see that the basis was close to zero, but generally positive, before the crisis, plunged to extreme negative values during the crisis before rebounding, and has generally been at moderately negative levels since the crisis. Boyarchenko, Gupta, Steele, and Yen (2016) find that increased funding costs tied to balance-sheet constraints are an important determinant of this apparent arbitrage opportunity, with regulatory changes entailing those dealers to commit more capital resources to back such trades.

Another notable trend has been a reduction in the types of shadow banking activities that amplified the effects of the global financial crisis. This has been reflected in a generalized trend toward simplicity and transparency in the intermediation of nonbank credit, toward market-based finance, spurred by the deleveraging of financial intermediaries, regulatory changes and a reorientation in intermediary business models (FSB, 2017b). Because data inconsistencies and definitional issues at the cross-country level make attempts at precisely quantifying the size of this shift problematic, two sets of data help to make the general point.[11] By one measure—based on the Financial Stability Board's Flow of Funds data—a roughly US$10 trillion swing toward market-based finance (proxied here by standard collective investment vehicles) can be inferred between 2007 and 2015, and a US$6 trillion to US$7 trillion swing against all other types of nonbank credit intermediation, including some forms of shadow banking that created significant problems a decade ago (Figure 8, left plot).[12]

Figure 8: Shadow Credit Intermediation



Source: Financial Stability Board, Federal Reserve.

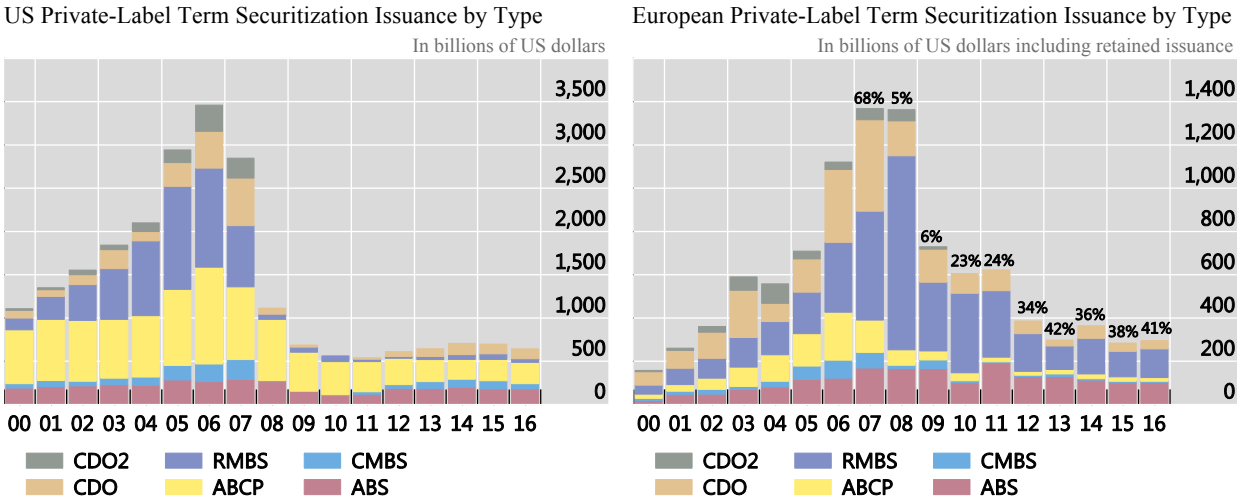
By another measure—focusing exclusively on the U.S. Flow of Funds—a broadly similar trend emerges. This is evident in the fact that assets intermediated through simple, insolvency-remote collective investment vehicles like bond mutual funds and exchange-traded funds have more than doubled since 2007, while the assets of broker dealers, finance companies, asset-backed

[11] Without the implication that either is perfect.

[12] Based on Adrian and Jones (2018).

securities issuers and money market mutual funds have almost halved (Figure 9, right plot).[13] Importantly, interconnectedness has also been reduced. In part, this reflects the emergence of shorter collateral chains. After all, collateral does not flow in a vacuum: It needs a balance sheet to move, and balance-sheet space for key entities has become scarcer (Singh, 2017).

Figure 9: Securitization Activity



Percentages in right hand panel = Percent placed with investors

Sources: Left hand panel: Estimates based on data from JPMorgan Chase & Co., Board of Governors of the Federal Reserve Systems, the CRE Finance Council, Inside Mortgage Finance and the Securities Industry and Financial Markets Association. **Note:** ABS = asset-backed security; CDO = collateralized debt obligation; CDO2 = CDO-squared & CDOs backed by ABS & MBS; MBS = mortgage-backed security; RMBS = residential MBS; CMBS = commercial MBS; ABCP = asset-backed commercial paper

Right hand panel: Estimates based on data from Fitch Ratings, JPMorgan Chase & Co., Merrill Lynch, the CRE Finance Council, and the Association for Financial Markets in Europe. Note: ABS = asset-backed security; CDO = collateralized debt obligation; CDO2 = CDO-squared and CDOs backed by ABS and MBS; MBS = mortgage-backed security; RMBS = residential MBS; CMBS = commercial MBS

Source: Adrian and Jones (2017)

The core of the shadow banking system constituted securitization activity in the sense that securitization was the primary means of generating non-deposit funding for banks and other financial intermediaries, thereby facilitating the increase in leverage (Shin, 2009).[14] Pre-crisis investor demand for securitization products was fueled by low yields on competing fixed income products, and the misperception given by the major credit ratings, that they were "safe" assets (Coval, Jurek and Stafford, 2009). The post-crisis collapse of securitization volumes represent another manifestation of the dramatic post-crisis changes. As can be seen from Figure 9, volumes dropped off sharply from their peaks of 2006, particularly those of mortgage-backed securities and collateralized debt obligations. Where structures and performance dynamics are well understood, and issuer incentives are perceived to be well aligned with investor interests,

[13] See Adrian, Boyarchenko and Shachar (2017) for a discussion of these divergent trends in the context of broker-dealer intermediation of corporate bond trading.

[14] By removing assets from balance sheets, securitization increased banks' risk-taking capacity, thereby increasing their effective leverage (Wenying and Pritsker, 2008; Beccalli, Boitani and Di Giuliantonio, 2015). Under pre-2010 accounting rules, banks could remove most securitized assets off their balance sheets (Box 2.5 in IMF, 2009).

issuance continues. But some securitization activity almost entirely disappeared, such as in private label mortgages.

In the past few decades, peer-to-peer electronic trading platforms have emerged as an intermediation activity outside the formal regulated banking system. To some extent, this activity has also made inroads into the role of broker dealers in many markets. In 2017, 84% of U.S. investment-grade-bond investors and 73% of high-yield investors trade electronically, versus 51% and 18% respectively in 2008 (McPartland, 2017).[15] 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). However, the vast majority of bond trading is still done by phone or chat services, as the relative lack of supply of most corporate bonds makes them too sensitive to price information for electronic trading (Leising and Smith, 2018). And opinions are mixed about whether customer-to-customer platforms can fully supplant the dealer model. Choi and Huh (2017) find that "among trades where customers are demanding liquidity… these customers pay 35 to 50 percent higher spreads than before the crisis."

IV. Post-Crisis Regulatory Reforms

The crisis revealed many weaknesses and fault lines in financial regulation and supervision as well as major deficiencies in firms' risk management systems. Over the past 10 years, the global financial regulatory community has worked to develop and implement a major reform program to correct the identified fault lines. The overarching aim has been to build a more robust and resilient global financial system that can continue to support the real economy in times of stress.

For the internationally active banks, these efforts have been led by the Basel Committee on Banking Supervision (BCBS). However, to the extent that the reform effort involves activities that go beyond the formal banking system, the Financial Stability Board (FSB) has been an important additional body in coordinating the work of national regulators and international standard-setting bodies such as the BCBS, the International Association of Insurance Supervisors, the International Organization of Insurance Commissions, and the Committee on Payments and Market Infrastructures. We review these regulatory changes, and we review the literature on evaluating the impact of reforms. The spirit of these regulatory reforms can be grouped into four main elements:

1) Policies to improve the resilience of the financial system in the event of stress;
2) Initiatives designed to contain the buildup of risks in the financial system;

[15] A survey conducted by Liquidnet found a significant difference in attitude toward electronic fixed-income trading between Europe and the United States, largely due to MiFID II. It found 86% of European traders believe that the regulation is driving more corporate bond trading onto electronic venues, while just 39% of American traders thought the same (Liquidnet, 2017).

3) Measures to strengthen the system-wide focus of financial policymaking and supervision;
4) Reforms to contain moral hazard and lower the costs of handling failure.

We will discuss each of these four areas of reforms in turn. Adrian (2017) and Adrian, Fleming, Shachar, and Vogt (2017) provide a more detailed summary of post-crisis regulatory reforms.

1) Policies to improve the resilience to stress

Reforms to strengthen the resilience of the banking system to stress are the centerpiece of the reform program. At the heart of the reforms is the Basel III initiative to raise the quality and quantity of bank capital and to provide a much stronger and more resilient sector in the event of stress (BCBS, 2010, 2011 and 2017).

The Basel III reforms aim to strengthen the resilience of the banking sector by improving the existing regulatory framework for internationally active banks. The reforms raise both the quality and quantity of the regulatory capital base and enhance the risk coverage of the capital framework. Basel III requires the predominant form of so-called Common Equity Tier 1 (CET1) capital to be in the form of common shares and retained earnings. CET1 must be at least 4.5% of risk-weighted assets at all times. The total risk-weighted tier 1 plus tier 2 capital requirement is 8%. Furthermore, a capital conservation buffer of 2.5% was introduced that can be drawn down in periods of stress – in order to reduce procyclicality. In December 2017, the BCBS members finalized the Basel III package of regulatory reform, after agreeing on rules that limit the potential for unwarranted variability of internal model-based risk weights across jurisdictions so that the capital ratios may be applied more evenly across jurisdictions (BCBS, 2017)).

The Basel III capital requirements are underpinned by a leverage ratio that serves as a backstop to the risk-based capital measures, that is intended to constrain excess leverage in the banking system, and that provides an extra layer of protection against model risk and measurement error (Fender and Lewrick, 2016). The leverage ratio requirement is 3%. The leverage ratio requirement may incentivize banks to reduce low-margin, balance-sheet-intensive businesses such as market-making in highly rated sovereign bonds and repo, likely providing an incentive to move such businesses to central clearing counterparties (CCPs) (CGFS, 2014, Fender and Lewrick, 2016; Goel, Lewrick and Nikola Tarashev, 2017).

The macroprudential surcharge aims to reduce the probability of failure of globally systemically important banks (G-SIBs) by increasing their going-concern loss absorbency. The extent and impact of failure of G-SIBs is further reduced by improving global recovery and resolution frameworks (see BCBS [2013b]).

In addition to the capital regulation improvements described above, Basel III also introduced two pillars of liquidity regulation: the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR) (see BCBS [2013a] and BCBS [2014]). The goal of the LCR is to promote the short-term resilience of the liquidity risk profile of banks by ensuring that banks have an adequate stock of liquid assets that can be used to meet liquidity needs for a 30-day stress scenario, while the NSFR aims to reduce funding risk over a longer time horizon by requiring banks to fund their

activities with sufficiently stable sources of funding in order to mitigate the risk of future funding stress.

In December 2017, the BCBS (2017) finalized the Basel III framework by addressing the issue of unwarranted variability of risk-weights. The December 2017 enhancements address shortcomings of the pre-crisis regulatory framework by aiming to restore credibility in the calculation of risk-weighted assets and by improving the comparability of banks' capital ratios. The robustness and risk sensitivity of the standardized approaches for credit risk, credit valuation adjustment (CVA) risk, and operational risk are enhanced. The use of the internal model approaches is restricted by placing limits on certain inputs used to calculate capital requirements under the internal ratings-based approach for credit risk and by removing the use of the internal model approaches for CVA risk and for operational risk. A leverage ratio buffer is introduced to further limit the leverage of global systemically important banks. The existing Basel II output floor is replaced with a more robust risk-sensitive floor based on the BCBS' revised Basel III standardized approaches.

The regulatory approach to managing market risks has also been significantly overhauled. Basel 2.5 supplemented the BCBS (2006) Basel II VaR-based trading book framework with an incremental risk capital charge which includes default risk as well as migration risk for credit products (BCBS, 2010). It also introduced a stressed VaR requirement. And then in 2019, the Fundamental Review of the Trading Book (FRTB) replaces the VaR methodology with one based on the expected shortfall approach so as to better capture the kind of tail risk events seen during the crisis (BCBS, 2016). This comes with much more rigorous preconditions for implementation that include separate approvals at the trading desk level and combining regulatory stringency with intrusive supervision.

In parallel to the strengthening of regulation, many supervisory authorities now place additional reliance on enhanced stress tests to underpin their assessment of capital and liquidity plans. In the European Union and United States, mandatory stress tests for banks and designated systemically important financial institutions (SIFIs) were introduced between 2009 and 2011. EU-wide annual bank stress tests were launched in 2009, based on scenarios generated by the European Banking Authority (EBA). The U.S. Comprehensive Capital Analysis and Review (CCAR) was launched in 2011, with its annual stress tests based on a hypothetical, severely adverse scenario designed by the Federal Reserve. Stress testing is a tool that helps bank and bank holding company (BHC) supervisors measure whether a financial institution has enough capital to support its operations throughout periods of stress. The CCAR also promotes greater resiliency by requiring each BHC to support its capital management decisions with forward-looking comprehensive analysis that takes into account the BHC's risk profile and activities.

Stress tests are an integral part of the risk management and supervisory toolkit, enabling banks and supervisors to identify areas of potential vulnerability and weakness in a forward-looking context, and to support the formulation of plans to address them. Stress-testing techniques have been enhanced significantly in recent years through improvements in analytical models and better data. Stress-testing techniques are also being extended to support systemic risk analysis

though models focusing on sectoral contributions to systemic risk, the resilience of non-bank institutions, as well as the robustness of the financial network.

Policy measures have also strengthened the resilience and robustness of financial market infrastructures, which play a pivotal role at the heart of the financial system. Many such infrastructures are systemically important institutions and are thus a major supervisory focus. Policymakers have also introduced policies to support the central clearing of standardized derivative contracts through central counterparties (CCPs), with the aim of lowering bilateral counterparty credit risk. One of the remaining ongoing elements of the reform agenda is to introduce plans for CCP recovery and resolution under stress that ensure continued market functioning.

Another main theme of the regulatory reform agenda has been to "transform shadow banking into resilient market-based finance." As highlighted earlier, the growth of non-bank vehicles offering bank-like products and susceptible to bank-like risks played a significant role in the buildup to the global crisis. In concert with the sectoral standard-setting bodies and national authorities, the FSB has made considerable progress in addressing major risks by, for example, strengthening money market funds; improving securitization markets; reducing interconnectedness between the banking and non-bank sectors; and improving securities financing markets. Work is continuing to address liquidity and leverage risks in the asset management industry. Despite the recent progress, it is vital that authorities continue to monitor the non-bank sector closely, paying special attention to the adaptation of the system and the possibility of new systemic risks emerging beyond the regulatory frontier.

2) Initiatives designed to contain the buildup of risks in the financial system

A framework to contain the buildup of systemic risks must take account of both longitudinal and cross-sectional dimensions. The longitudinal element should focus on dampening the inherent procyclicality in the financial system. It requires tools that help contain the rise of system-wide risks in the upswing, which stem from incentives to over-extend leverage and credit and to build up risk concentrations and push up asset prices beyond fundamentals, and tools that help protect the system in the downswing when these forces move into reverse. The cross-sectional elements aim to improve the resilience of the system to help guard against the failure of an institution at any point in time—and aim to consider, in particular, what measures can and should be taken to contain spillover and contagion in such an event.

One of the measures to strengthen the longitudinal element is the introduction by the BCBS of a countercyclical buffer in the banking system—with supervisory authorities requiring banks to hold additional capital at times of excessive credit growth, so that it can be released in a subsequent downswing to cushion deleveraging. Of course, the effectiveness of the countercyclical capital buffer requires regulators with foresight: History will tell how effective the application of the tool proves to be. Strengthened monitoring has also led to more active application of a range of other policies and tools to contain sources of potential systemic risk. Common examples are instruments applied in real estate markets, through loan-to-value and

debt-to-income constraints, or in corporate lending markets, through risk weighting. In addition, a capital conservation buffer that can be run down during times of stress counteracts procyclicality.

Perhaps more important, forward-looking stress tests that have been introduced in the supervisory processes of many jurisdictions directly counteract procyclicality, as they condition on severe stress scenarios many months into the future. That means that risk assessments in those tests are forward-looking, requiring institutions to hold more capital when risks are building. Hence these types of stress tests hardwire an assumption of an extreme form of portfolio illiquidity into the behavioral assumption, overcoming one of the main shortcomings of the VaR methodology. Of course, the severity of stress assumptions needs to be adequate to generate correct levels of capital. The IMF pioneered these types of stress tests starting with the first Financial Sector Assessment Program (FSAP) in 2000, and they were widely adopted by supervisors following the 2008 crisis (IMF, 2014b).

Strengthening the cross-sectional dimension of financial regulation entails close attention to the question of how the design of regulation should take account of an institution's contribution to systemic risk. New analytical tools have been developed to support such an assessment (such as CoVaR) (Adrian and Brunnermeier, 2016). Along with the aforementioned as well as more intrusive and intense supervision, additional steps have been taken to contain the buildup of network or interconnectedness risks. For example, large exposure rules have been toughened (with stronger constraints on exposures between systemically important banks) and measures to mitigate potential spillovers between the banking system and the shadow banking system have been introduced.

3) Strengthening the system-wide dimension

One of the major lessons of the crisis is the need to focus much more attention on the financial sector as a system, recognizing the importance of collective behavior and of the close interconnections and interactions across the financial network. As one example, investors in complex, structured products mistook benign market conditions as an indicator that they would be able to exit positions quickly in the event of an adverse shock. They failed to recognize that there was a concentration of risk and that all other investors were likely to wish to exit their positions at the same time, leading to an evaporation of market liquidity—in the worst case, completely—and thus to a major write-down of value. As another example, many banks had liquidity contingency plans that relied on defenses such as liquefying illiquid assets; bidding for additional deposits; or restricting balance-sheet size. If the bank in question were the only one facing stress and overall market conditions were normal, then such plans might work well. But, in the event that other banks faced similar strains—for example, as a result of increased concern about the quality of their loan book and potential exposure to subprime mortgages—then such defenses would no longer work: Indeed, they would tend to exacerbate system-wide stress. A third example is the reliance of many European banks on a steady rollover of short-term wholesale dollar funding from U.S. money market funds. This motivated the creation of the

Term Auction Facility, where foreign banks were the major borrowers of term money at the Federal Reserve's discount window.

These examples (and many more) highlight the importance of taking a strong system-wide perspective, both in the assessment of risk and in the design and implementation of financial regulation. That is a necessary complement to strong supervision of individual banks. In terms of risk assessment, more attention is now paid by authorities to the assessment of potential systemic risks that could impair the financial system and disrupt the provision of financial services. System-wide risk assessments require much more attention to the buildup of leverage, and of common exposures and concentrated risks through interconnections and interlinkages. Also, it is important that the framework help contain the rise of system-wide risk and that, if the risk crystallizes, the defenses can be used without creating major externalities and spillovers elsewhere in the system.

Many countries have introduced new institutional macroprudential frameworks to strengthen the oversight and containment of systemic risks—a process welcomed and strongly supported by the IMF (2011, 2013, 2014a). Considerable analytical and policy work has been undertaken to help support the design and implementation of effective macroprudential policies (IMF, 2014a; IMF-FSB-BIS, 2016), and to ensure that financial regulation will take into account the precept of protecting the functioning of the system as a whole.

4) Containing moral hazard and managing failure

Taking additional steps to identify and mitigate emerging risk and bolstering the resilience of the financial system should substantially reduce the probability and impact of failures. But the regulatory framework is not aimed at delivering a no-failure regime. Nor should it be. The possibility of failure provides incentives and discipline that strengthen the effective management of financial risks and support the efficiency of financial intermediation.

Because the failure of financial institutions remains inevitable, the final leg of the reform agenda has thus focused on strengthening crisis management arrangements to support the recovery and, if necessary, to enable the orderly resolution of failing firms without major spillovers that would threaten broader financial stability. A clear objective is to eliminate the need for taxpayer support to keep firms afloat because they are seen as too big, too complex, or too interconnected to fail. Such support was a prominent feature of the crisis, generating moral hazard and the unacceptable "privatization of profits and socialization of losses."

Considerable progress has been made internationally to strengthen crisis management arrangements. Special resolution regimes have been introduced in jurisdictions where they were previously absent, and they have been enhanced elsewhere in line with new international standards (FSB, 2014). To address the specific risks of institutions being perceived as too big to fail, authorities have toughened regulations through a combination of measures. Capital surcharges have been applied where firms are viewed as systemically important and thus impose additional externalities, buttressed by more intensive and intrusive supervision. Major financial

institutions are required to introduce explicit recovery and resolution plans, or "living wills," that are subject to supervisory scrutiny and validation. And such arrangements are underpinned in the case of G-SIBs by requirements to hold "total loss absorbent capacity" instruments, which can be written down or converted into equity under stress to ensure that critical functions of such banks can be sustained without taxpayer support. The aim of Total Loss Absorbing Capacity (TLAC), which was finalized in December 2016, is to reduce both the probability and impact of failure of G-SIBs. TLAC provides recapitalization capacity available in resolution in an orderly resolution. See FSB (2015) for an overview.

V. THE IMPACT OF REGULATORY REFORMS

Much of the theoretical literature of the impact of regulations on intermediation activity is focused on banks. Furlong and Keeley (1989) show that mean-variance optimizing banks with deposit insurance will reduce risk-taking when capital regulation is tightened. Similarly, in Keeley (1990), capital regulation limits excessive risk-taking due to deposit insurance. However, increased competition can raise risk-taking incentives, even in the presence of capital regulation, as competition lowers charter value. Thakor (2014) provides a review of the literature on bank capital regulation. Recent literature focuses on the impact of regulation in dynamic, general equilibrium settings.

To the extent that regulations are effective, some impact of regulation on intermediary activity should be expected, and they are intended. In addition, the impact of regulation should be assessed from the point of view of its overall benefit to the financial system and the wider economy, rather than on the narrow interests of financial market participants, especially if their horizon is short. Hence, the overall assessment of the impact of regulation is about the desirability of regulation within the context of the trade-off between trend growth and long-run stability of financial institutions (see Adrian and Boyarchenko, 2012, He, 2013, Brunnermeier, 2014). Fender and Lewrick (2016), updating the analysis of the earlier BIS (2010) Macroeconomic Assessment Group, suggest that Basel III can be expected to generate sizeable net economic benefits, even after the implied changes to bank business models have been taken into account, in a range of 0.5% to 2.0% of GDP per year.

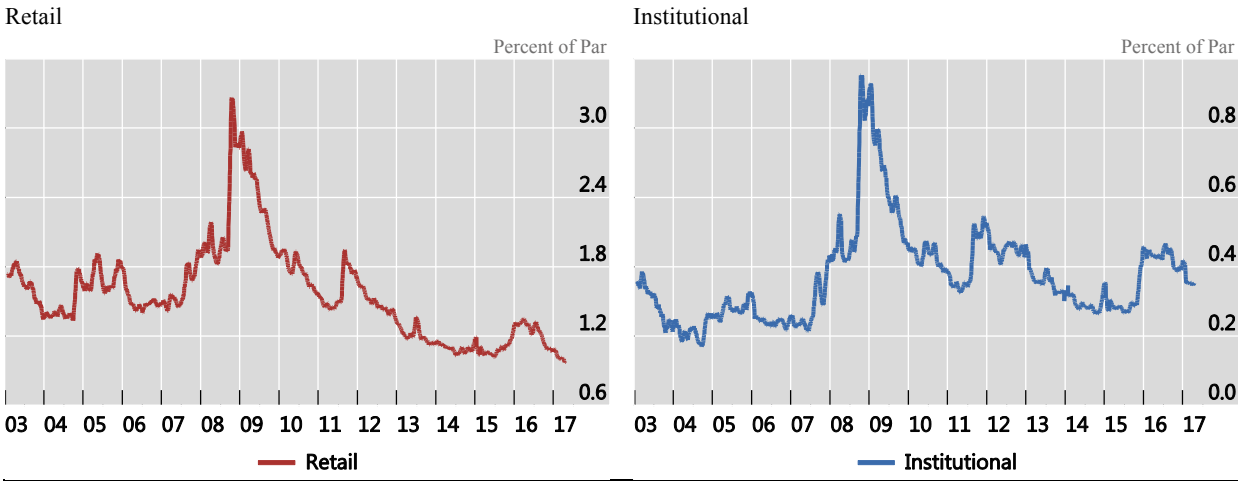
CGFS (2014) takes stock of the impact of the post-crisis regulations for the business model of dealers, and market-making more generally. The regulatory changes since 2010 are likely to affect dealers' balance sheets and profitability. Market participants expect the cost of market-making to rise. New risk weights and credit risk charges make the trading of corporates and credit derivatives more expensive. In particular, the incremental risk capital charge and the stressed VaR add to inventory costs of corporate bonds. Furthermore, less liquid corporate bonds are ineligible for the liquidity coverage ratio, which is expected to reduce the willingness of banks to warehouse these assets. The leverage ratio increases the balance sheet cost of repos, including repos backed by corporates and structured credit. This creates a constraint on dealers' ability to manage inventory risk.

CGFS (2016) provides results of an informal survey of market participants. Survey participants provided estimates of the relative importance of different cost drivers including regulatory capital requirements as well as trading and operational costs using two highly stylized portfolios: one of sovereign bonds and one of corporate bonds. The survey results suggest that the profit and loss impact of recent regulatory changes has been differentiated. For sovereign bonds, both the Basel III leverage ratio and higher risk-weighted capital requirements were considered as having the largest impact on regulatory capital charges and, hence, dealers' profits. For corporate bonds, by comparison, revisions to the Basel II market risk framework (Basel 2.5) were seen to have had the largest impact on regulatory charges. The survey responses imply that the gross revenue required to yield a return on capital of 8% under a fully phased-in Basel III framework would have resulted in returns above 20% given the requirements pertaining under Basel II. For corporate bonds, CGFS (2016) reports that survey respondents indicated that, on average, Basel 2.5 had the largest impact on regulatory charges. In line with this, respondents suggested, on average, that capital charges would have increased significantly for this pricing example, when moving from Basel II to current requirements. The remaining phase-in of the Basel III requirements, in turn, was expected to have only a minor impact. Assuming constant revenues and a return on capital of 8% annually under the fully phased-in Basel III framework, survey responses suggest that for this example the return on capital would have amounted to about 26% annually under Basel II requirements.

Adrian, Boyarchenko, and Shin (2015) and Adrian, Fleming, Shachar, and Vogt (2017) document the dramatic stagnation of post-crisis U.S. dealer balance sheets in the post-crisis period that occurred contemporaneously with dealer deleveraging, as presented in Section I. However, traditional market liquidity metrics in U.S. Treasury and corporate bond markets, where dealers are the most important market-makers, indicate robust market liquidity. The metrics that the authors focus on include bid-ask spreads, price impact, and depth.

For the U.S. corporate bond market, Adrian, Fleming, Shachar, Vogt (2017) document that market liquidity as measured by price impact is at all time highs for retail investors, but did worsen for institutional investors compared to pre-crisis liquidity (see Figure 10). Hence there appears to be a trade off for institutional sized trades: the phase in of tighter regulatory requirements was accompanied by a deleveraging of the dealer sector, making the sector more resilient to adverse shocks. But this might have come at the cost of somewhat higher trading costs for institutional sized corporate bonds in normal times. Mizrach (2015), Bessembinder, Jacobsen, Maxwell, and Venkataraman (2016), and Anderson and Stulz (2017) also find that U.S. corporate bond liquidity overall is better in the post-crisis period than it was in the pre-crisis period, although Anderson and Stulz (2017) confirms find higher transaction costs and price impact for large (over U.S.$100,000) trades.

Figure 10: Corporate bond market liquidity measured by price impact



Source: Adrian, Fleming, Shachar, Vogt (2017)

Adrian, Fleming, Shachar, and Vogt (2017) point out that some funding liquidity metrics show an increase of balance-sheet costs since the crisis (including the interest rate swap spreads and the CDS-bond basis presented above), while others indicate ample liquidity (e.g., yield curve fitting errors). Even three market stress events in the post-crisis era (the 2013 Taper tantrum, the 2014 Treasury flash rally, and the 2015 liquidation of 3rd Avenue) did not trigger widespread liquidity dislocations, and the degree of deterioration in market liquidity was within historical norms.

Boyarchenko, Gupta, Steele, and Yen (2016) examine the evolution of funding liquidity metrics in U.S. corporate bond markets in more detail. They look at three explanations of credit market arbitrage trade dislocations: increased idiosyncratic risks, strategic positioning by some market participants, and regulatory changes. They document increased idiosyncratic risk during the relevant period but limited evidence of asset managers' changing their positioning in derivative products. The relative changes in idiosyncratic risk levels and in asset managers' derivatives positions appear small relative to the post-crisis increase in cost of capital. The authors link the CDS-bond arbitrage trade to return-on-equity (ROE) calculations of a stylized dealer balance sheet and argue that, given current levels of regulatory leverage, the CDS-bond basis would need to be significantly more negative relative to pre-crisis levels to achieve the same ROE target.

Bessembinder, Jacobsen, Maxwell, and Venkataraman (2016) study bond liquidity as a function of dealers' willingness to commit capital to bond trading, and focus on whether post-crisis banking reforms have affected liquidity provision in the corporate bond market by examining results separately for those dealers who are affiliated with a bank holding company and dealers that are not bank-affiliated. They find that capital allocation has shifted from bank-affiliated dealers to independent dealers since the passage of DFA and Basel III. Bao, O'Hara, and Zhou (2016) document that the liquidity of U.S. corporate bonds that were recently downgraded from investment grade to a high-yield rating has decreased since the Volcker Rule took effect. For this subset of bond events, dealers regulated by the Volcker Rule have decreased their market-

making activities while non-Volcker-affected dealers have stepped in to provide some additional liquidity. However, Volcker-affected dealers that are not constrained by Basel III and CCAR also change their behavior, which the authors interpret as inconsistent with the effects being driven by these latter regulations. In contrast, Trebbi and Xiao (2015) find that post-crisis U.S. regulatory intervention does not appear to have produced structural deteriorations in market liquidity.

Adrian, Boyarchenko, and Shachar (2016) study the relationship between bond-level liquidity and financial institutions' balance-sheet constraints in U.S. corporate bond markets. They first document that there is a relationship between institutional constraints and bond liquidity that changes significantly over time. Prior to the crisis, bonds traded by institutions that are akin to investment banks were more liquid. During the rule implementation period (starting in January 2014), these relationships reversed: Bonds traded by institutions with lower leverage, higher risk-weighted assets, more reliance on repo funding, and lower return on assets were more liquid. That is, the relationship between bond liquidity and dealer constraints that we see in the full sample is primarily driven by that same relationship in the post-crisis period. These results hold true across bonds that have different credit ratings, that are issued by companies in different industries, that have different issuance sizes, and that have different levels of liquidity. These findings are consistent with more stringent leverage regulation and greater regulation of dealer banks reducing institutions' ability to provide liquidity to the market overall.

Fender and Lewrick (2015) and IMF (2015) also find little hard evidence of a broad-based rise in trading costs in bond markets, with both finding patterns that are similar to those discussed above. Fender and Lewrick (2015), drawing on the analysis conducted in CGFS (2014), find that executing large bond trades has become more difficult, and that trading has become concentrated in just a few liquid issues. Also, they report that market-makers have become more selective, favoring core clients that generate income in other business lines, and narrowing their scope to smaller ranges of markets, and that in many jurisdictions market-making has shifted away from the principal trading model. IMF (2015) finds that the liquidity of high-yield and emerging market bonds has decreased since the crisis. They also find that growing concentrations of holdings among mutual funds, pension funds, and insurance companies are associated with less resilient liquidity. In addition, there has been a proliferation of small bond issues that tend not to be very liquid. But neither Fender and Lewrick (2015) nor IMF (2015) found conclusive evidence that post-crisis regulatory reform was having a detrimental impact on fixed-income market liquidity. As Fender and Lewrick (2015) put it:

Regulatory reforms are seeking to improve bank capacity to absorb losses by limiting leverage and promoting more stable funding. Having more resilient banks with sufficient capital and liquidity reduces the probability of widespread liquidity crises. That would help make market-making more robust, although possibly at lower levels of activity in normal times. In addition, better capitalization and more limited leverage can help keep banks from building overly extended positions in financial markets, reducing the risks of sudden market reversals with large imbalances in buy and sell orders.

VI. CONCLUSION

Since the global financial crisis, bank balance sheets and leverage have been shrinking. Total balance-sheet capacity of U.S. banks as measured by total balance-sheet size or total VaRs has declined dramatically since the crisis. Dealers' net corporate positions plunged during the crisis and have since stagnated. Post-crisis regulatory reform may explain some of this, but most of it preceded any constraining effect of regulation. It likely reflects a combination of reduced expected returns, expensive and less-plentiful funding, conservative risk management, reduced shadow banking activity, and the growth of nonbank lending and market-making, in addition to the impact of regulatory changes.

More stringent leverage regulation and greater regulation of dealers may have reduced institutions' ability to provide liquidity, but there is only limited evidence that this has led to a widespread deterioration of bond market liquidity since the global financial crisis. More recently, dealers may have shifted toward an agency model, in which they match offsetting orders to avoid holding bonds on their balance sheets. However, traditional market liquidity metrics in the markets where dealers are the most important market-makers tend to indicate robust market liquidity. An exception are institutional sized corporate bond trades for which market liquidity is markedly below pre-crisis levels. Certain funding liquidity cost indicators also signal a higher shadow cost of regulatory constraints in recent years.

The bottom line is that regulatory reform has made the financial system markedly safer, while evidence of adverse unintended consequences is limited to date and needs to be weighed against the broader benefits of regulatory reform. The reforms have increased the quantity and quality of regulatory capital held by banks. It addressed key regulatory loopholes in the Basel II framework by better reflecting the risks. New liquidity requirements enhance the liquidity profile of banks and improve their ability to withstand liquidity shocks arising from financial and economic stress. Stress tests have counteracted the procyclical balance sheet management due to their forward looking nature. Of course, international standard setters are now increasingly focused on evaluating the costs and benefits of the new regulatory regime, and we expect a more granular quantification in coming years.

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