Report to Congress

Access to Capital and Market Liquidity

As Directed by the Explanatory Statement to the
Consolidated Appropriations Act, 2016 (P.L. 114-113)

MCMXXXIV

This is a report by the Staff of the Division of Economic and Risk Analysis of the U.S. Securities and Exchange Commission. The Commission has expressed no view regarding the analysis, findings, or conclusions contained herein.

August 2017

Executive Summary

In December 2015,[1] Congress directed the Commission's Division of Economic and Risk Analysis (DERA or we) to report on the impacts of the Dodd-Frank Act,[2] especially the Volcker Rule, as well as other financial regulations, such as Basel III,[3] on: (1) access to capital for consumers, investors, and businesses; and (2) market liquidity, including U.S. Treasury and corporate debt markets.[4] The Report responds to the Congressional directive.

Quantifying the effects of the regulatory reforms is challenging for several reasons. Most notably, overlapping implementations make it difficult to isolate the effect of any single rule or requirement. When the post-implementation period of one reform coincides with a pre-implementation period of another, there is no clear baseline against which to separately measure the potential economic impacts. This issue is particularly acute when market participants change their behaviors in anticipation of future rules, the content of which is frequently signaled in advance by the notice and comment rulemaking process. Thus, compliance may occur in advance of the effective dates.

It is also possible that many of the observed changes in market participant behaviors would have occurred absent the reforms. In particular, the immediate effects of the financial crisis—including the failures of many institutions and business models—provided strong

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[1] Consolidated Appropriations Act, Pub. L. 114–113, H.R. 2029.

[2] The Dodd–Frank Wall Street Reform and Consumer Protection Act, Pub.L. 111–203, H.R. 4173 (Dodd–Frank Act).

[3] Basel Committee on Banking Supervision "Basel III: A global regulatory framework for more resilient banks and banking systems," Dec 2010, (Rev Jun 2011); "Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools," Jan 2013; "Basel III: the net stable funding ratio," Oct 2014. For more, see http://www.bis.org/bcbs/basel3.htm

[4] Because the markets for single-name credit default swaps and investment funds may interact with the U.S. Treasury and corporate debt markets, this report also analyzes those two markets.

incentives to change market practices in ways that may have simultaneously shaped the ensuing reforms.

Finally, post reform macroeconomic conditions, such as the economic recovery and the low interest rate environment, are different from those leading up to and right after the financial crisis. Therefore, it is difficult to quantify the benchmark levels of primary issuance and market liquidity that would have been observed following the financial crisis and absent the ensuing reforms. For example, some market participants have noted that evidence of liquidity deterioration can be found in the number of trades that have *not* occurred. However, such data are not available, so we are not able to explore this metric.

Although the above factors significantly limit our ability to analyze whether specific regulatory reforms *caused* any particular changes, DERA's analysis provides a comprehensive and detailed review of capital raising through primary issuance and secondary market liquidity over time and in ways that allow an assessment of whether observed trends could be *consistent* with the effects of regulatory reforms, or with one or more of the other potential explanations. Where possible, we highlight when multiple factors could be impacting trends in issuance and/or market liquidity in either amplifying or offsetting ways. We recognize that liquidity may interact with other market characteristics, such as informational efficiency and market stability. In the Report, we do not estimate the optimal amount of liquidity for corporate bond or Treasury markets, but document the evolution of different dimensions of liquidity over time and consider whether observed changes are consistent with a variety of proposed explanations.

A distinguishing feature of DERA's Report is that it includes a comprehensive assessment of a large body of recent research in addition to original analysis performed by DERA staff. To this end, the Report's scope differs from other existing studies, and we focus on primary securities issuance and secondary market liquidity across fixed income markets. For example, the U.S. Department of the Treasury recently issued a report that included policy recommendations, based on certain conclusions regarding secondary market liquidity.[5] As this report uses a different methodology than that considered in the Treasury Report, the conclusions reached in this Report may differ from those stated in the Treasury Report.

We note, however, that because some Basel III requirements are still being implemented, most available evidence on potential regulatory effects centers on the Dodd-Frank Act, including the Volcker Rule, and the JOBS Act. There is comparatively little research on the impacts of Basel III reforms. We nevertheless consider the regulatory timeline for Basel III reforms in addition to the implementation of the Dodd-Frank Act and JOBS Act, and document changes in issuance and market liquidity metrics over time, including all relevant dates. However, due to the lack of available evidence, we do not specifically address the effects of Basel III reforms in Part A and Part B.VI.

Main Results

Part A. Primary Issuance

DERA analyzed primary issuance of debt, equity, and asset-backed securities (ABS). The total capital formation from the signing of the Dodd-Frank Act into law in 2010 through the end of 2016 is approximately $20.20 trillion, of which $8.8 trillion was raised through registered offerings, and $11.38 trillion was raised through unregistered offerings.[6] We do not find that total primary market security issuance is lower after the enactment of the Dodd-Frank Act

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[5] *See* U.S. Department of the Treasury, "A Financial System that Creates Economic Opportunities: Banks and Credit Unions" (June 2017) (hereinafter "Treasury Report").

[6] *See* Part A.II and Part A.III of the Report for the analysis of registered and unregistered offerings.

(including during the implementation of the Volcker Rule) and during the implementation of Basel III, and it may have increased around the implementation of the JOBS Act.[7] DERA has not attempted to establish a counterfactual level of primary securities issuance that would have been attained in the absence of the Dodd-Frank Act, Basel III, and other regulatory reforms. These results are also generally consistent with active issuance in strong macroeconomic conditions and a low interest rate environment. Some of the findings we discuss in the Report are as follows:

- Capital raised through initial public offerings (IPOs) ebbs and flows over time, reaching highs in 1999, 2007 and 2014, and lows in 2003, 2008, and 2016.[8] It is difficult to disentangle the many contributing factors that influence IPO dynamics.
- Recent years have seen an increase in the number of small company IPOs. IPOs with proceeds up to $30 million accounted for approximately 17% of the total number of IPOs in the period 2007-2011 and 22% in the period 2012-2016, following the passage of the JOBS Act in 2012.[9] In 2016, more than 75% of IPOs were classified as Emerging Growth Companies (EGCs) under Title I of the JOBS Act (Title I).[10]
- Private market issuance of debt and equity (unregistered offering activity) has increased substantially from $1.16 trillion in 2009 to $1.87 trillion in 2015, amounting to $1.68 trillion in 2016.[11] Amounts raised through exempt securities offerings of debt and equity for 2012 through 2016 combined exceeded amounts raised through registered offerings of

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[7] The Jumpstart Our Business Startups Act, Pub. L. 112-106, H.R. 3606 (JOBS Act).

[8] *See* Part A.II. of the Report for the analysis of registered offerings.

[9] We note that IPO activity has experienced significant declines in 2015 and 2016, and explore this development in Part A.II.

[10] *See* Proskauer (2017).

[11] *See* Part A.III of the Report for the analysis of exempt offering activity.

debt and equity over the same time period by approximately 26%. In comparison, the same figure for 2009 through 2011 was 21.6%. Amounts raised in reliance on the general solicitation rules under Title II of the JOBS Act, which were implemented in September 2013, remain low, representing only 3% of total amounts raised pursuant to Rule 506.

- Amendments to Regulation A[12] initiated by Title IV of the JOBS Act were followed by a large increase in Regulation A offering activity over the initial 18 months post effectiveness, with 97 qualified offerings seeking to raise $1.8 billion (compared with about 14 qualified offerings seeking to raise approximately $163.3 million in a typical year during 2005-2016). Based on issuer reports of amounts raised filed during 2005-2016, 56 issuers reported positive proceeds in Regulation A offerings, totaling approximately $314.6 million. Initial evidence on JOBS Act Title III crowdfunding activity suggests that some small pre-revenue growth firms are beginning to use crowdfunding as a securities offering method.[13]

Part B. Market Liquidity

Evidence for the impact of regulatory reforms on market liquidity is mixed, with different measures of market liquidity showing different trends. Moreover, many of the observed changes in these measures are consistent with the combined impacts of several factors besides new rules and regulations, including, among others, electronification of markets, changes in macroeconomic conditions, and post-crisis changes in dealer risk preferences that pre-date the

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[12] Rel. No. 33-9741, Amendments to Regulation A (Mar. 25, 2015) 80 FR 21805 (Regulation A+ Adopting Release)

[13] *See* Part A.III.G of the Report for initial evidence on crowdfunding activity.

passage of either the Dodd-Frank Act or Basel III. As noted above with respect to primary securities issuance, DERA has not attempted to estimate a counterfactual level of trading activity or average transaction costs in the absence of the recent regulatory reforms.

- In U.S. Treasury markets, we find no empirical evidence consistent with the hypothesis that liquidity has deteriorated after regulatory reforms. More specifically, there is no support for a causal link between the Volcker Rule and U.S. Treasury market liquidity conditions. Changes in Treasury market liquidity are unlikely to be directly attributable to the Volcker Rule because U.S. cash Treasuries are exempt from the Volcker Rule's prohibitions on proprietary trading.
- In corporate bond markets, trading activity and average transaction costs have generally improved or remained flat. More corporate bond issues traded after regulatory changes than in any prior sample period.[14] In the post-regulatory period, we estimate that transaction costs have decreased (by 31 basis points (bps), to 55.4 bps round-trip) for smaller trade sizes ($20,000) and remain low for larger trade sizes relative to the pre-crisis period (estimated at 5.7 bps round-trip for trades of $5,000,000, compared to 5.8 bps pre-crisis).

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[14] *See* Table D.4, Panel B, which reports estimated half spreads for transactions of 5,000,000 (round-trip costs are double half-spreads). For the purposes of our transaction cost analysis, we split the sample into 6 sub-periods. We define January 2006 through June 2007 as the "Pre-crisis" sub-period. We designate July 2012 through May 2014 as the "Regulatory" sub-period, and June 2014 through September 2016 as the "Post-regulatory" sub-period. As discussed in Part B.IV.C, our sample period cutoffs are aligned with existing research, such as Bessembinder et al. (2016) and Bao et al. (2016). *See* Part B.IV.C of the Report for a more detailed analysis.

  - Although estimated transaction costs have decreased, corporate bond trading activity in recent years has also become somewhat more concentrated in less complex bonds and bonds with larger issue sizes.[15]
  - For some subgroups of corporate bonds, such as larger bonds (i.e., issue size greater than $500 million), certain investment grade bonds, younger bonds (i.e., less than 2 years since issuance), and longer maturity bonds (i.e., original maturity longer than 20 years), the estimated transaction costs for large trades are slightly higher than those in the pre-crisis period.[16]

- Dealers in the corporate bond markets have, in aggregate, reduced their capital commitment since the 2007 peak.[17] This is consistent with the Volcker Rule and other reforms potentially reducing the liquidity provision in corporate bonds. It is also consistent with alternative explanations, such as an enhanced ability of dealers to manage corporate bond inventory, shorter dealer intermediation chains associated with electronification of bond markets, crisis-induced changes in dealer assessment of risks and returns of traditional market making, and the effects of a low interest rate environment. These alternative explanations are not mutually exclusive or necessarily fully independent of regulatory reforms, so distinguishing between these potential explanations from the market trends data is not possible.
- Although capital commitments have fallen, there has not been a commensurate decrease in the number of dealers participating in the market. We observe no notable changes in

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[15] *See* Part B.IV.B.1a) and Part B.IV.C.1 for the analysis of trends in trading activity over time and for bonds with different characteristics.

[16] *See* Part B.IV.B, Part B.IV.C.1 and Part B.IV.C.2 for more analysis of trends in trading activity and transaction costs.

[17] *See* Part B.IV.B and Part B.IV.C.3 for more analysis of trends in dealer activity.

the number of dealers providing liquidity per corporate bond issue over time, and we do not detect notable changes in trade sizes around regulatory reforms.

- The evidence on dealer activity in times of stress is mixed and varies with the definition of stress.
    - Some existing research suggests that during times of *localized* market stress under strong macroeconomic conditions there may be greater adverse price impacts from trading activity (a sign of deteriorating liquidity) associated with the decline in dealer capital commitments for a small subset of bonds. Other evidence on localized stress selling does not support the finding of a deterioration in liquidity around firm specific events.
    - Evidence from the crisis suggests that during times of *severe* market stress, dealers may not lean into the wind, but instead make larger cuts in inventory of bonds that are aggressively sold by their customers.[18] Such evidence supports a finding that dealers decrease liquidity provision in times of severe market stress.
- Trading of corporate bonds on alternative trading systems (ATS) may partly account for the lower estimated average transaction costs for small trades and observed reductions in dealer capital commitments.[19]
    - Electronic trading may facilitate efficient management of dealer inventory and reduce counterparty search costs. In addition, electronic trading could enable customers to seek liquidity directly from other customers.

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[18] *See* Part B.IV.B.2 and Part B.IV.B.3a) for a further discussion of liquidity conditions and dealer activity in times of stress.

[19] *See* Part B.IV.C.4 for our data analysis of ATS activity.

  - The majority of interdealer trades enjoy positive price improvement, whereas small customer trades experience negative price improvement, on average.

- Trading in single-name credit-default swaps (CDS) provides an alternative channel for investors to gain exposure to corporate bond credit risk. Some measures of CDS market liquidity—total number of participants transacting in a given reference entity and various trading activity metrics—have remained stable or point to improvements. Other measures show a reduction in activity: trade sizes have decreased, quoting activity has declined, and quoted spreads for the least liquid high yield underliers have risen. Interdealer trade activity has declined after 2010, but dealer-customer activity has remained stable.[20]

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[20] *See* Part B.V.D for our analysis of activity in single-name CDS.

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Introduction

Congressional Directive

The Consolidated Appropriations Act, 2016 was signed into law on December 18, 2015.[21] The Explanatory Statement to the Appropriations Act[22] directed the Division of Economic and Risk Analysis (DERA or we) of the U.S. Securities and Exchange Commission (Commission or SEC) to report to the Committees on Appropriations of the House and Senate, the Committee on Financial Services in the House and the Committee on Banking, Housing, and Urban Affairs in the Senate, on:

> the combined impacts that the Dodd-Frank Act--especially Section 619--and other financial regulations, such as Basel III, have had on: (1) access to capital for consumers, investors, and businesses, and (2) market liquidity, to include U.S. Treasury markets and corporate debt. DERA shall provide an update to the Committees on their work no later than August 1, 2016.

This Report represents the considered views of staff in DERA, as informed by the processes described below, but the views expressed in this Report do not necessarily reflect those of the Commission or the individual Commissioners, or of staff of other Commission Offices or Divisions.

To effectuate Congress's direction, DERA studied (1) capital raising in the primary markets, and (2) secondary market liquidity. With regard to the first topic, DERA analyzed evidence on the evolution of the issuance of debt, equity, and ABS across registered and exempt offerings. With regard to the second topic, DERA analyzed market activity and liquidity in U.S. Government obligations (U.S. Treasuries or Treasuries) and corporate bonds, but also single-name CDS and investment companies, such as open-end mutual funds and exchange-traded

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[21] Consolidated Appropriations Act, Pub. L. 114–113, H.R. 2029.

[22] 161 Cong. Rec. H9693 (Dec. 17, 2015) (statement of Chairman of the House Committee on Appropriations) https://www.congress.gov/crec/2015/12/17/CREC-2015-12-17-pt2-PgH9693.pdf

funds (ETF), that invest in corporate bonds and Treasuries, for reasons we describe below. DERA considered the hypothesis that regulatory reform efforts, including the Volcker Rule and Basel III, as well as other regulations including those adopted by the Commission pursuant to the JOBS Act mandates, were impacting primary market activity, or secondary market liquidity, or both. DERA also considered whether factors other than regulatory reforms, including market structure changes,[23] evolution of market participants' preferences after the financial crisis, or aggregate macroeconomic conditions could be contributing to observed changes in the primary and secondary markets.

Because DERA is not the first to analyze and assess these economic issues, the Report begins with a critical review of the results of the body of research to date. The Report then complements the findings from existing research with original analysis by DERA staff using market information obtained from SEC filings and other public data, subscription databases, and regulatory data feeds.

Broad Economic Considerations

DERA has examined the evolution of the volume and structure of primary market issuances and secondary liquidity over time. The availability of different types and channels of primary issuance, such as registered and exempt issues of debt, equity, and ABS, impact how businesses access capital and influence the scope and riskiness of securities available to consumers, businesses, and investors. Five broad considerations inform our analysis.

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[23] We recognize that these and other confounding phenomena are not necessarily mutually exclusive or fully exogenous. For instance, we cannot distinguish between bond market electronification arising out of technological advances, market response to the financial crisis, or market response to the regulations in the immediate aftermath of the financial crisis.

First, capital raising in primary markets and liquidity in secondary markets are inextricably intertwined. For example, liquid secondary markets that enable investors to exit large positions quickly and at low cost can facilitate primary market issuance and placement. At the same time, if high-risk issuers select into certain forms of issuance or if primary issuance becomes split across many different forms of issuance, secondary market liquidity can decrease. Most studies focus on either the issuance of new securities or the secondary market trading and liquidity. One of the distinguishing features of DERA's analysis is a comprehensive and simultaneous exploration of both primary issuance and secondary liquidity issues across markets.

Second, the existence of substitutes for exposure to credit risk may impact activity and liquidity in bond markets. Market participants seeking exposure to the credit risk of bond issuers can choose to transact directly in the market for corporate bonds or to trade in alternative credit risk products. The existence of single-name CDS and bond funds as alternative instruments for capital allocation and cross-market arbitrage may spill over into activity and liquidity in bond markets. As a result, it is important to consider how single-name CDS and fund liquidity may interact with activity in markets for Treasuries and corporate bonds.

Third, liquidity is an important characteristic of a capital market and affects the ability of investors to execute trades of different sizes, quickly, and at low cost. We recognize that liquidity may interact with other market characteristics, such as informational efficiency of capital markets and market stability. The Dodd-Frank Act was intended, among others, to promote the financial stability of the United States.[24] In the Report, we do not perform a cost-benefit analysis of various regulatory changes, and do not estimate the optimal amount of securities issuance or liquidity in corporate bond or Treasury markets. Instead, we document the

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[24] *See* Pub. L. No. 111-203, Preamble.

evolution in different dimensions of capital raising and market liquidity over time and consider whether observed changes are consistent with a variety of proposed explanations.

Fourth, large sample evidence enables us to examine the issuance and trading activity of large groups of market participants using thousands, millions, and billions of observations. We explore cross-sectional heterogeneity in capital raising and trading activity by analyzing various subgroups of issuers and transactions, and report different distributional parameters (e.g., median, 25th, 75th, 99th percentiles, etc.). Statistics produced from large sample analysis may not always reflect the behaviors and experiences of market participants in smaller segments of the markets. Therefore, where we observe improvements in issuance or liquidity metrics, the findings do not necessarily imply that all market participants experienced such improvements, and vice versa.

Finally, we recognize that the regulations that serve as the focus for this Report impose costs on certain groups of market participants. To the extent that such costs have a significant impact on the behavior of affected market participants, they may result in changes to issuance and liquidity. However, affected market participants may alter their business practices in response to regulatory impacts and unaffected market participants may change their activity in compensating ways, even as the regulations have their intended effect. These responses to regulation, along with other factors such as changing macroeconomic conditions may dampen observed changes in market indicators and weaken our ability to link changes in issuance and liquidity with regulatory reforms.

The Report endeavors to analyze relevant research and data through the fourth quarter of 2016, where available. Our analysis focuses on evidence to date, and we recognize various related studies may be ongoing. Evidence on the impacts of the implementation of Basel III on bond liquidity is relatively scarce, possibly because elements of the Basel III regime are still being implemented in the United States, and this remains a fruitful area for future research. We also note that many of the studies discussed below are working papers, representing preliminary work that has not been fully vetted by the peer review process.

Summary of Results

As a result of this analysis, DERA observes that the evidence as to the direction and magnitude of changes in primary issuance and secondary market liquidity after the financial crisis and ensuing regulatory reforms is mixed. The observed changes are consistent with a number of explanations, including the combined effect of various regulations, non-regulatory market structure changes, crisis-related changes to market participants' preferences that pre-date the passage of regulatory reforms, and aggregate macroeconomic conditions (such as a low interest rate environment), among others. We also note that these explanations need not be mutually exclusive or independent. For instance, to the extent that market structure changes may have contributed to observed changes in liquidity metrics, we cannot assess whether such market structure developments occurred because of technological advances, as a result of the crisis, regulatory reforms, or some combination thereof.

DERA's analysis is focused on areas within the scope of the Commission's jurisdiction as the primary securities regulator in the United States, i.e. having regulatory responsibilities that span both primary and secondary securities markets.

Our analysis of primary issuance considers changes in the volume and structure of issuance of equity, debt, and ABS. This includes changes in IPOs, seasoned offerings, and exempt offerings of debt and equity, including offerings under Regulation D and Regulation A.[25] We also present preliminary evidence on offerings pursuant to Regulation Crowdfunding,[26] which the Commission adopted as part of its implementation of the JOBS Act. In addition, ABS issuance supports a large volume of primary issuance, and we consider the evolution and structure of ABS issuance activity over time.

We do not find that total primary market security issuance is lower after the enactment of the Dodd-Frank Act (including during the implementation of the Volcker Rule) and during the implementation of Basel III, and it may have increased around the implementation of the JOBS Act.[27] DERA has not attempted to establish a counterfactual level of primary securities issuance that would have attained in the absence of the Dodd-Frank Act, Basel III, and other regulatory reforms. These observed increases are also generally consistent with active issuance in strong macroeconomic conditions and a low interest rate environment.

With respect to primary issuance, capital raised through initial public offerings (IPOs) during the period of 1996 through 2016 reached highs in 1999, 2007 and 2014, and lows in 2003, 2008, and 2016.[28] The post-crisis dynamics of IPO issuance are consistent with several IPO waves observed during this time period. Capital raised through secondary equity offerings (SEOs) during the 1996-2016 sample period peaked in 2009, and in recent years has been exceeding pre-crisis issuance volume. Registered debt issuance has been growing during the sample period (1996 through 2016), reaching a peak in 2016. Regulation D offerings have more than doubled since 2009, the time for which data is available. Rule 144A offerings remaining

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[25] *See* 17 CFR 230.500 through 230.508; Rel. No. 33-9415 (Jul. 10, 2013), Eliminating the Prohibition Against General Solicitation and General Advertising in Rule 506 and Rule 144A Offerings, 78 FR 44771; Rel. No. 33-9741, Amendments to Regulation A (Mar. 25, 2015) (Regulation A+ Adopting Release) 80 FR 21805.

[26] Rel. No. 33-9974, Crowdfunding (Oct. 30, 2015) 80 FR 71387 (Crowdfunding Adopting Release).

[27] The Jumpstart Our Business Startups Act, Pub. L. 112-106, H.R. 3606 (JOBS Act).

[28] *See* Part A.II. for further analysis of registered offerings.

stable post-crisis and comparable to pre-crisis levels. Although the volume of ABS issuance declined dramatically during the financial crisis and has been on the rise since, it is still a fraction of pre-crisis levels (our ABS sample spans 2005 through 2016). Further, we do not find evidence that costs of various types of offerings have changed notably during our sample period.

Our study of liquidity in secondary markets emphasizes Treasury and corporate bond market liquidity. Following a large body of research that points to the importance of different measures of liquidity, we construct and examine a number of measures reflecting various facets of liquidity, provide a critical analysis of existing findings, and perform additional data analysis to supplement prior work. The analysis below explores different potential drivers of changes in liquidity, many of which may not be mutually exclusive or fully independent of regulatory effects. Our data analysis examines changes in secondary market liquidity metrics around regulatory reforms, the evolving role of some dealers from principal to agency trading,[29] and evidence from electronic trading.

With respect to Treasury markets, as we discuss below, U.S. cash Treasuries are exempt from the Volcker Rule's prohibitions on proprietary trading. Therefore, changes in Treasury market liquidity are unlikely to be directly attributable to the Volcker Rule. Instead, the Volcker Rule may indirectly affect this market as a result of spillover effects from other markets.[30] An analysis of evidence on a wide range of liquidity measures quantifying different dimensions of liquidity does not allow us to conclude that post-crisis regulations caused a reduction in Treasury market liquidity. None of the existing studies provides empirical support for a causal link

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[29] Generally, dealers can trade as agents, matching customer buys to customer sells, or as principals, absorbing customer buys and customer sells into inventory and committing the requisite capital. *See* Li and Li (2017).

[30] For instance, Treasury futures are not exempt, and the Volcker Rule could indirectly impact cash Treasuries through intermarket cash-futures basis trading.

between various regulations, and in particular the Volcker Rule, and changing Treasury market liquidity conditions.

In our analysis of market liquidity in corporate bonds, we evaluate the evidence from existing research on the evolution of corporate bond market liquidity and find that some liquidity metrics have been reported to have improved, others have remained flat, and yet others have worsened after various regulations.[31] While there is little consensus in existing work concerning the direction, causal attribution, and mechanisms behind observed changes, evidence suggests that in recent years dealers have been less likely to engage in risky principal transactions. In addition, dealers generally decrease liquidity provision in times of severe market stress, such as during the financial crisis.[32]

With respect to the potential regulatory factors behind observed liquidity changes, there is a lack of agreement in research regarding the direction and magnitude of regulatory impacts. Moreover, studies with different measurement and empirical design often present different or conflicting conclusions.[33] Most research does not find that post-trade transparency leads to a deterioration in bond market liquidity.[34] Existing research on the role of electronic trading is limited,[35] and there is competing evidence on the interplay between CDS and corporate bond market liquidity.[36] In the sections that follow we critically assess these and other studies and discuss their implications.

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[31] *See* Part B.IV.B.3a) for a discussion of evidence of changes in market liquidity around regulatory reforms.

[32] *See* Part B.IV.B.2 and Part B.IV.B.3a) for a discussion of evidence on dealer provision of liquidity in normal times and in times of stress before and after various regulatory reforms.

[33] *See* Part B.IV.B.3a) for a detailed analysis.

[34] *See* Part B.IV.B.3c) for a discussion of existing research on post-trade transparency.

[35] *See* Part B.IV.B.3b) for an analysis of existing findings on electronic trading.

[36] *See* Part B.V.C for a discussion of research on spillovers between single-name CDS and reference security markets.

Empirical analysis by DERA staff on corporate bond market liquidity conditions yields similarly mixed results. Following other studies, we segment the sample period into several sub-periods, including the phase-in of the Trade Reporting And Compliance Engine (TRACE), pre-crisis, crisis, post-crisis, regulatory, and post-regulatory time periods.[37] We present four main results. First, during the time periods after the crisis period we find an increase in the fraction of corporate bond issues with trades, higher levels of trading activity when traded, and greater par dollar volume traded compared to any other period except post-crisis.

Second, we find that transaction costs have generally decreased or remained flat, with particularly strong declines for small trade sizes and relatively riskier investment grade (IG) bonds. However, because transaction costs can be estimated only for trades that *occur*, we are unable to observe how regulation and other market influencing factors may have had an effect on the ability of counterparties to find liquidity and successfully engage in a trade. In other words, trades sought but not executed cannot be empirically measured. Hence, interpreting the reported decline in transaction costs as an improvement in market liquidity requires consideration of the above evidence on changes in trading activity over time.

Third, we consider changes in dealer activity as a proxy for changes in the availability of liquidity through market making activity. We find that the median number of dealers providing liquidity per corporate bond issue has remained stable across all sample periods. Moreover, we do not observe notable changes in the number of dealers providing liquidity per bond issue

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[37] Our sample period cutoffs are aligned with Bessembinder et al. (2016) and Bao et al. (2016). We designate the January 2003 through December 2005 as the "TRACE Phase-in" sub-period. We define January 2006 through June 2007 as the "Pre-crisis" sub-period. We designate July 2007 through April 2009 as the "Crisis" sub-period and May 2009 through June 2012 as the "Post-crisis" sub-period. Lastly, we divide the rest of our sample into two additional sub-periods. We designate July 2012 through May 2014 as the "Regulatory" sub-period[37] and June 2014 through September 2016 as the "Post-regulatory" sub-period. We discuss these issues in great detail in Part B.IV.C.

around the changes in regulation. Across sub-periods, more dealers trade in small trade sizes. In particular, while the fraction of large size (greater than $5,000,000) principal trades is similar across sub-periods, the portion of medium size ($100,000 - $1,000,000) principal trades is larger during the "Regulatory" and the "Post-regulatory" sub-periods.

Finally, we explore cross-sectional evidence on recent corporate bond quotation activity on ATS, which sheds light on the current use of electronic trading in corporate bonds. We document large cross-sectional heterogeneity in ATS activity for different types of bond issues. We find that electronification may be associated with lower trade sizes. We also find that the majority of interdealer trades enjoy positive price improvement, whereas small customer trades experience negative price improvement, on average.

Overall, it is not clear that corporate bond market liquidity has deteriorated following the enactment of the Dodd-Frank Act, the implementation of the Volcker Rule, and the implementation of the Basel III reforms. As discussed below, the observed trends in market liquidity metrics are consistent with multiple alternative explanations.

In addition to Treasury and corporate bond markets, we have considered changes in liquidity in other markets. Specifically, we explore: (1) potential diffusion of liquidity to single-name CDS, and (2) the evolution of fund liquidity. A recent CFA Institute survey addresses both as potential drivers of changes in secondary corporate bond market liquidity.[38] Academic research also examines spillovers between single-name CDS and corporate bonds and the interaction between fund and bond liquidity.[39] We consider whether these potential explanations may be consistent with observed changes in liquidity metrics.

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[38] *See* CFA Institute (2016).

[39] *See* Parts B.V and B.VI of this report.

The Report critically re-examines findings regarding the effect of the CDS market on bond liquidity. Existing literature finds evidence of two competing effects of trading activity in single-name CDS on bond liquidity. In particular, some evidence suggests that access to hedges of credit risk can enhance liquidity in riskier bond issues. Other evidence indicates that participants may be looking for liquidity across markets, and CDS liquidity may be crowding out bond market liquidity. That is, CDS is an alternative means by which market participants gain exposure to the credit risk of debt issuers.[40] The analysis below documents changes in the volume of the market, participants, transaction and quotation activity in single-name CDS using public, commercial, and regulatory data.[41]

We examine three groups of measures: (1) metrics of transaction activity, including notionals, market values, and participants by credit, industry, and tenor; (2) measures of single-name CDS trading activity using a regulatory feed, including interdealer and dealer-customer notionals, trade sizes, counts, and zero trading days; and (3) quotation activity, including number of quoted underliers, quotes per underlier, quoted spreads, etc., from a commercial database. We find that interdealer trade activity has declined after 2010, but dealer-customer activity has remained stable, a result that is consistent with two competing explanations: (1) a reduced ability by dealers to find liquidity on the interdealer market; and (2) greater efficiency in dealer intermediation chains matching buyers to sellers. Consistent with the latter, the number of participants transacting in a given underlier has remained relatively constant, the fraction of zero trading days has decreased, and the frequency of trading for active underliers has remained flat

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[40] *See* Part B.V.C of this report.
[41] *See* Part B.V.D of this report.

or elevated after the financial crisis and reforms that have been enacted to date.[42] However, quoting activity has declined, and quoted spreads for the least liquid high yield underliers have risen. Overall, our time series and cross-sectional results are consistent with several alternative explanations which are not mutually exclusive.

Lastly, the analysis that follows explores fund liquidity, which contributes to a holistic picture of changes in secondary market liquidity and potential structural changes in corporate bond and Treasury markets during the past decade. In particular, research suggests that liquidity can flow from bond markets into investment companies (such as mutual funds and ETFs), and vice versa. For instance, market participants seeking exposure to the credit risk of issuers may choose to allocate into bond funds instead of underlying bonds. In this way, bond funds, particularly open-end funds and ETFs, can serve as a substitute instrument that investors can use if and when the underlying bond markets are illiquid. We find that the evidence on the interplay between fund activity and bond liquidity is mixed, that fund ownership of corporate bonds has increased over this Report's period of interest, and that fund activity could impact liquidity measures in underlying bonds in multiple ways.

Methodological Considerations

DERA staff analyzed existing economic research and performed novel data analysis. Throughout this Report we discuss a number of data and experimental design issues that limit our ability to make causal determinations as to the effect of reforms on access to capital and

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[42] As discussed in Part B.V.B, many of the substantive Title VII rules governing the single-name CDS market have been proposed but not adopted (e.g., capital and margin requirements for dealers and major participants, swap execution facilities), and compliance with many adopted rules is not yet required (e.g., dealer registration, cross-border activity, business conduct standards etc.).

market liquidity. In this section we introduce some of the broad methodological considerations and limitations of the analysis.

As discussed above, the Report examines primary issuance and secondary market liquidity across many markets from the early 2000s through 2016. Any study of such scope and magnitude faces challenges, and two are most salient: baselining and identification. First, Dodd-Frank, Volcker, and Basel III reforms followed a historic financial crisis and the ensuing market rally. As a result, the pre-regulatory period includes the recession and the bull market that follows. Using this period as a baseline could bias estimates for many capital raising and liquidity metrics. To address this challenge, subject to data constraints and where practicable, we have extended our samples to the early/mid 2000s to capture a longer time period prior to the enactment of regulatory reforms. Where such analysis is not possible or practicable, we recognize the sensitivity of our conclusions to the selection of the baseline period.

Similarly, regulatory reforms of interest coincided with a portfolio of other policies, market structure changes, demand shifts, and types of market participants. For instance, electronic trading, low interest rates, and market participants reevaluating the risks and returns of various business models in the aftermath of the financial crisis contaminate the comparison of liquidity measures before and after regulatory reforms of interest. As a result, the direct impact of regulatory reforms on liquidity in corporate bond and Treasury markets is likely confounded with the effects of these innovations and shocks.

Second, we are limited in our ability to make causal inferences. The prevalent econometric techniques used to test for causality, such as event study methodology, differences-in-differences estimation, instrumental variables, or regression discontinuity design, are not feasible for many of the analyses performed. As illustrated in Appendix A, the rules implementing the Dodd-Frank Act and Basel III reforms were proposed, enacted, and adopted over several years, and in some cases have not yet been fully implemented as of this writing. Market participants widely anticipated and responded to many of these reforms years ahead of the compliance or effective dates across markets. As a result, event study evidence on the impact of reforms on transaction activity and dealer supply of liquidity is difficult to interpret. In addition, many regulatory reforms impacted large groups of participants at the same time, so we lack cleanly identified and otherwise comparable "treatment" and "control" groups of market participants. Absent well-defined treatment and control groups, the validity of differences-in-differences estimation is questionable.

Where we cannot draw causal inferences, we engage in a comprehensive exploration of the current state and recent changes in primary issuance and secondary market liquidity and consider whether the observed trends and statistics are consistent with a variety of proposed explanations.

Some additional limitations of the analysis include the following:

- The analysis of offerings relying on the JOBS Act provisions is qualified by small sample sizes and relatively short observation periods. Thus, it is unclear to what extent it can be extrapolated to future years or periods with different aggregate conditions. Medium- and long-term success of such placements remains an area for future study.
- We are cautious in using crisis or post-crisis figures as benchmarks for activity levels in normal times. Where the available data do not permit us to examine market activity for the early to mid-2000s period (e.g., single-name CDS), trend analysis is limited.
- The analysis of dealer balance sheets using Financial and Operational Combined Uniform Single (FOCUS) data is limited by the exclusion of Alternative Net Capital (ANC) filers,

owing to a lack of comparable data for those filers during our sample period. To the extent that ANC filers may have been more affected by regulations, our estimates of changes in activity may be conservative.

- Because of the unavailability of relevant data, we are unable to examine changes in dropped (unexecuted) orders, order splitting, and difficulty in executing large block orders on liquidity, among other things.

The rest of the Report is structured as follows. Part A analyzes primary issuance of equity, debt, and ABS; and Part B evaluates changes in secondary market liquidity in Treasuries, corporate bonds, single-name CDS, and funds.

Part A. Access to Capital: Primary Issuance

I. Introduction

In the United States, companies can use a wide variety of securities offerings to raise capital. Securities laws require that all offers and sales of securities be either registered with the SEC under the Securities Act of 1933 (the Securities Act) or conducted under an exemption from registration. When raising capital through the sale of securities to any potential investors in the public capital market, unless the transaction qualifies for an exemption from registration,[43] the issuer must register the offer and sale of securities with the SEC, a process that is accompanied by extensive disclosure at the time of the offering and subsequent reporting (a "registered" offering). Alternatively, a company can raise capital by accessing the capital markets through a transaction exempt from registration (an "exempt" or "unregistered" offering). This path allows issuers to avoid certain regulatory burdens and the increased oversight that comes with a registered offering, with the intended effect of reducing issuance costs and the time required to raise new capital. Exempt offerings may be particularly attractive to smaller firms, for whom conducting registered offerings and becoming subject to reporting requirements may generally be too costly. However, because exempt offering alternatives require issuers to disclose less information and are accompanied by less oversight, they are generally subject to investor restrictions and/or offering limits. The investor protection provisions of the exemption claimed must be met to qualify for the exemption from registration.

Companies that are willing to register their transactions can access the public equity market via registered equity offerings such as IPOs and SEOs, or the public debt market via registered debt offerings. Companies with or without a registered offering or a registered class

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[43] *See* the discussion of Rule 506(c) of Regulation D, Regulation A and Regulation Crowdfunding below.

of securities can raise capital via exempt debt and equity offerings, such as Regulation D offerings or Rule 144A offerings.

Recent changes to the securities laws made by the JOBS Act, which was enacted in 2012, and its implementing regulations, were designed to promote both registered and exempt offerings. Title I of the JOBS Act streamlined the registered offering process for a class of issuers called emerging growth companies (EGCs).[44] Other provisions of the JOBS Act expanded options for exempt securities issuance: Title II required that the SEC permit general solicitation under Rule 506 of Regulation D and Rule 144A (subject to certain conditions); Title III required that the SEC create a new method of raising capital (crowdfunding); and Title IV required that the SEC update a little-used exempt offering provision (Regulation A). It is thus reasonable to expect that these changes may have important effects on the amount of capital being raised in exempt offerings.

Since the JOBS Act is specifically focused on the primary capital markets, in this section we explore whether any developments in these markets may be linked to the JOBS Act. Where relevant, we also discuss whether observed changes can be linked to the Dodd-Frank Act. It is challenging to establish causality with respect to either regulation, however, because so many other factors could affect the primary capital markets—factors for which we cannot control. The JOBS Act was signed into law on April 5, 2012, and the several titles that comprise it went into

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[44] The JOBS Act defines EGCs as an issuer with less than $1 billion in total annual gross revenues during its most recently completed fiscal year. If an issuer qualifies as an EGC on the first day of its fiscal year, it maintains that status until the earliest of (1) the last day of the fiscal year of the issuer during which it has total annual gross revenues of $1 billion or more; (2) the last day of its fiscal year following the fifth anniversary of the first sale of its common equity securities pursuant to an effective registration statement; (3) the date on which the issuer has, during the previous 3-year period, issued more than $1 billion in nonconvertible debt; or (4) the date on which the issuer is deemed to be a "large accelerated filer" (as defined in Exchange Act Rule 12b-2). *See* also Rel. No. 33-10332, *Inflation Adjustments and Other Technical Amendments Under Titles I and III of the JOBS Act* (Mar. 31, 2017), available at https://www.sec.gov/rules/final/2017/33-10332.pdf (raising the $1 billion limit to $1.07 billion to adjust for inflation) (JOBS Act Technical Amendments Release).

effect in the period from 2012 (Title I) through 2016 (Title III). Since these changes took effect over several years, it is difficult to pinpoint any causal relationship between the passage of either regulation as a whole or the implementation of different provisions, and developments in the capital markets.

More generally, it is important to note that issuers will choose the type of offering that is optimal from their point of view in terms of costs and benefits. Those costs and benefits may depend on the current regulatory environment but will also depend on various other factors such as the general state of the economy, interest rate cycles, etc. For example, prior economic studies document the presence of hot and cold markets for registered equity offerings.[45] These hot and cold markets are driven by macroeconomic factors, changes in the level of information asymmetry between investors and issuers, and changes in investor sentiment. It is also possible that registered and exempt capital markets will respond differently to these factors, and may function as either substitutes or complements. For example, it is possible that when registered markets are cold companies switch to exempt capital markets, and vice versa. Alternatively, a hot registered market could prompt companies to seek additional financing from exempt markets in preparation of future public offerings.

Finally, while our analysis focuses on securities issuance, we recognize that bank lending is an important source of financing for issuers, and consumer lending is a valuable source of consumer access to capital. However, such lending falls within the statutory authority of banking regulators and the Consumer Financial Protection Bureau (CFPB), and the Commission is a primary regulator of capital markets. The analysis below, therefore, does not examine

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[45] See, e.g., Lowry and Schwert (2002), Helwege and Liang (2004), Gao et al. (2013), and Arikan and Stulz (2016)

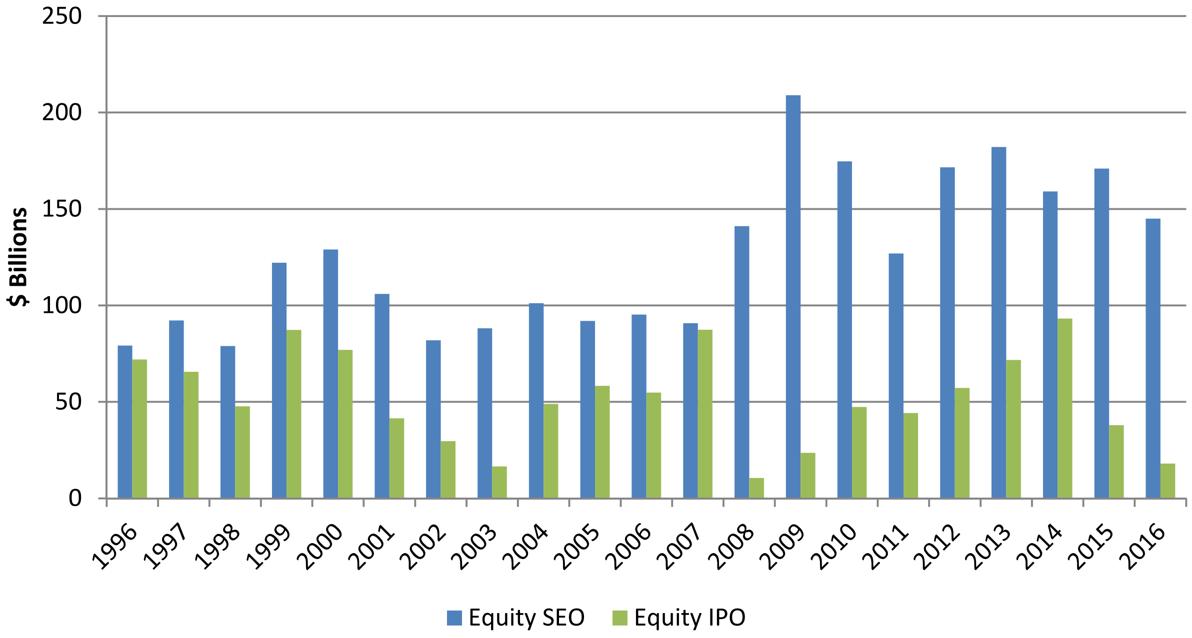
lending markets directly, but considers asset-backed securitization markets, which support a large volume of primary lending in an originate-to-distribute model.

II. Capital Markets for Registered Offerings

One of the channels through which businesses can raise capital in the United States is a registered offering. In this section, we consider the issuance of equity and debt in the registered market, and document the evolution in the volume and structure of such issuance over time. Total registered issuance in the United States has increased steadily from 2011 through 2016, as shown in Figure C.1. It grew from $1.42 trillion in 2015 to $1.49 trillion in 2016. The period 2013-2016 witnessed the largest registered issuance in the US for the last 11 years.

Figure 1 plots capital raising in the IPO and SEO markets during the period 1996-2016. The data suggests that IPO activity reached highs in 1999, 2007 and 2014, and lows in 2003, 2008, and 2016.

Figure 1. Capital raising through registered equity offerings (in $ billions), 1996-2016



Source: DERA analysis

Figure 1 illustrates the cyclicality of issuance activity and shows the dynamics of IPO issuance through economic booms and busts. We cannot determine whether the Dodd-Frank Act, which was enacted in 2010, notably affected IPO activity since we are unable to identify mechanisms through which the Dodd-Frank Act would have impacted, positively or negatively, IPO activity. For example, several of the Dodd-Frank Act's executive compensation provisions were not implemented in the sample period, and several other provisions of the Act did not apply to EGCs following the enactment of the JOBS Act. In contrast, as can be seen from Figure 1 the JOBS Act, which was enacted on April 5, 2012 and included provisions concerning IPOs and exempt offerings, may have had a positive effect on IPO activity. However, the observed effects are also generally consistent with higher issuance in strong macroeconomic conditions.

Further, we also observe a decline in IPOs in 2015 and 2016. We recognize that certain provisions of the JOBS Act concerning various types of exempt offerings were implemented in 2015 and 2016. However, given the overall size of those markets documented below, a shift in capital raising from traditional IPOs to Regulation A or crowdfunding offerings cannot explain the decline in IPO activity in recent years. At the same time, the 2015-2016 decline in IPOs is consistent with changes in investor demand, market saturation and the increased availability of private funding and other alternatives for exit. A recent industry analysis has also identified a market correction stemming from historically high market valuations, political and macroeconomic uncertainty, and the availability of private capital enabling firms to selectively time IPOs as potential contributing factors.[46] Post-crisis evolution in IPO issuance is broadly consistent with historical patterns of IPO waves.

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[46] Ernst & Young, May 2017, "Looking behind the declining number of public companies: An analysis of trends in US capital markets," https://www.sec.gov/spotlight/investor-advisory-committee-2012/ey-an-analysis-of-trends-in-the-us-capital-markets.pdf

IPOs by EGCs may be becoming the prevailing form of issuance in some sectors. For example, Proskauer (2017) finds that 78% of IPO issuers in 2016 were EGCs, with a particularly high concentration of EGC IPOs in health care, telecommunications, energy and power, and financial service sectors (between 86% and 95%). At the same time, EGCs represented only 17% and 43% of IPOs in industrial and consumer/retail sectors respectively. Proskauer (2017) also estimates that 90% of EGC issuers between 2013 and 2016 that disclosed testing-the-waters communications operated in the health care and telecommunications and media sectors. Issuers in those sectors often have shorter operating histories and lack revenue or net income, which is consistent with greater opacity and risk of EGC issuers.

Title I of the JOBS Act was intended to make it less costly for EGCs to go public. Research by Dambra et al. (2015) finds that the number of IPOs, and especially those by small issuers, has increased notably over pre-JOBS Act levels. However, another study, Chaplinsky et al. (2016), finds no reduction of direct issuance costs, accounting, legal, or underwriting fees for EGCs, and observes an increase in indirect issuance costs in the form of underpricing.[47] Proskauer (2017) estimates average IPO expenses as a percentage of base deal for 2016 placements, and finds that EGCs incur higher total IPO expenses (difference of 2.21%). However, unlike Dambra et al. (2015) and Chaplinsky et al. (2016), this statistic is descriptive and does not account for the potential selection of opaque and risky issuers into EGC status, or control for differences in EGC and non-EGC issuer growth, profitability, sector and other fundamentals.[48]

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[47] Underpricing is typically defined as the percentage difference between the market closing price on the day of the initial public offering and the offer price at which underwriters sell shares to investors.

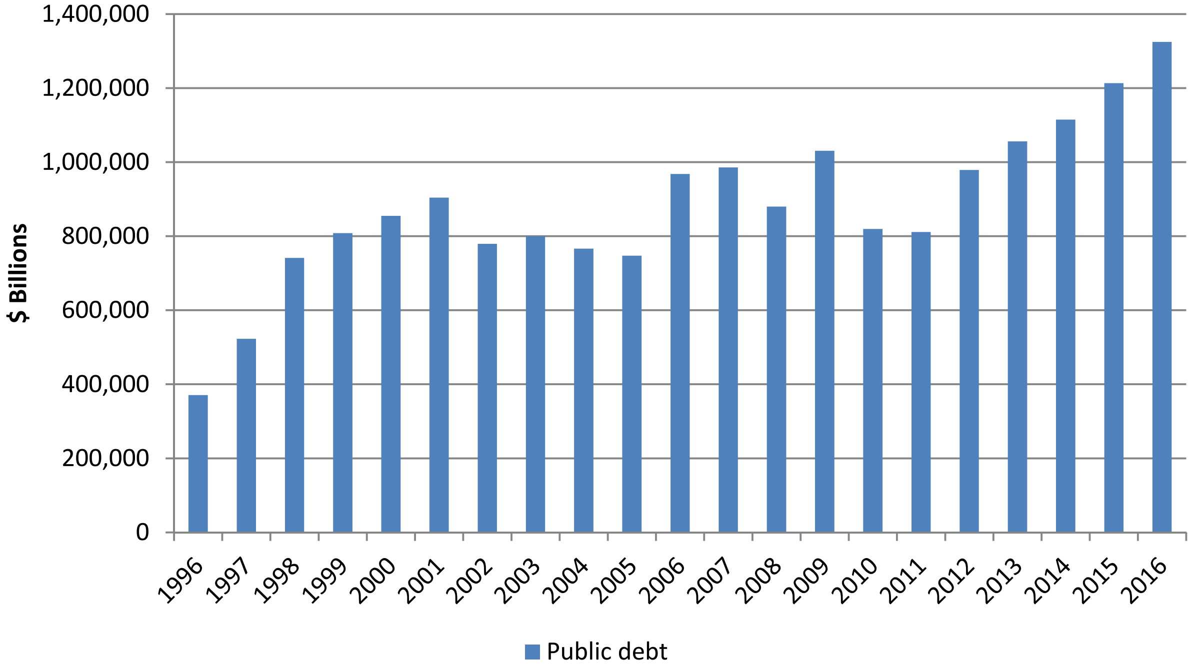
[48] *See* Lowry et al. (2017) for a comprehensive overview of finance research on IPOs since 2000.

More generally, it is difficult to disentangle the above effects of the JOBS Act from the effect of the general improvement in macroeconomic activity during this period. Prospective registered equity issuers are exposed to aggregate economic and industry-level risks. Negative macroeconomic shocks that reduce cash flows or increase the level of risk can reduce valuations making offerings appear less attractive to investors and leading to a decrease in the number of deals and/or deal sizes. Such aggregate trends similarly affect cycles in registered offering activity. Small issuers may be relatively more affected by downturns if their cash flows are lower and less diversified and if they lack sufficient collateral to obtain debt financing when their internal cash flow declines.

Table 1 lists the number of offerings, the average and median offer size, and the average and median gross spreads for both IPOs and SEOs. Consistent with Figure 1, these statistics show that the average and median offering sizes for IPOs are close to what they were prior to the crisis. There has also been an increase in small company IPOs—IPOs with proceeds up to $30 million were approximately 17 percent of the total number of IPOs in the period 2007-2011 and 22 percent in the period 2012-2016.

Figure 2 presents capital raising activity in the registered debt market for 2005-2016. Consistent with findings in other studies, the amount of funding obtained through the registered debt market on an annual basis is much larger than that obtained through the registered equity market. The dollar volume of registered debt appears to have increased in recent years, which may be a result of improving macroeconomic conditions and a low interest rate environment. As economic prospects for companies improve, companies tend to increase investment, increasing their demand for financing. Table 2 presents summary statistics for registered debt offerings and shows that the average and median offer size of these offerings are much larger than those of IPOs and SEOs.

Figure 2. Capital raising through registered debt offerings (in $ billions), 1996-2016



Source: DERA analysis

Next, we consider the cost of registered debt offerings. Because of the low level of interest rates, companies may be able to obtain debt financing at low cost. We find that the average and median gross spreads are notably lower for registered debt offerings. The gross spreads reported in Table 2 are similar to what prior economic studies have documented (Fang (2005)): issuers raising capital through registered bond issues pay commissions between 0.7% and 1.5% of the size of the offering.

III. Capital Markets for Exempt Offerings

A. Introduction

Having considered registered offerings, we now turn to the analysis of exempt issuance. Total primary unregistered issuance in the United States, which is the capital raised through all the different types of unregistered offerings discussed below, has increased from 2010 through 2016, as shown in Figure C.2. Most recently, it dropped from a peak of $1.87 trillion in 2015 to $1.68 trillion in 2016. During the period 2009-2016, total primary unregistered issuance has consistently outpaced total primary registered issuance. Amounts raised through exempt securities offerings of debt and equity for 2012 through 2016 combined exceeded amounts raised through registered offerings of debt and equity over the same time period by approximately 26%. In comparison, the same figure for 2009 through 2011 was 21.6%.

This market is governed by several exemptions from registration, including those under Sections 4(a)(2), 3(b) and 3(a)(11) of the Securities Act. For example, Section 3(b) is the exemptive authority for Rule 504 under Regulation D as well as Regulation A.[49] Other parts of the exempt market rely on "safe harbors": rules and regulations that set forth specific conditions that, if satisfied, ensure compliance with an exemption from registration. For example, issuers can use Rule 506(b) of Regulation D, which is a non-exclusive safe harbor under Section 4(a)(2), Regulation S for offerings outside of the United States, and Rule 144A, for the resale of restricted securities to qualified institutional buyers. Finally, Rule 506(c) of Regulation D is a stand-alone exemption for unregistered sales to accredited investors by means of general solicitation. Bauguess et al. (2015) provide a comparative analysis of the characteristics of these and other offering exemptions and safe harbors.

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[49] In 2015, Regulation A was amended to reflect the changes included in Title IV of the JOBS Act. Among the changes in Regulation A is an increase in the amount of capital that can be raised (from $5 million to $50 million) and preemption from state registration and review for certain offerings. *See* Rel. No. 33-9741, *Amendments to Regulation A* (Mar. 25, 2015) (Regulation A+ Adopting Release). Rule 504 was amended, effective January 20, 2017, to increase the amount of capital that can be raised (from $1 million to $5 million) and to add the disqualification of certain bad actors. Rule 505 has been repealed effective May 22, 2017. *See* Rel. No. 33-10238 *Exemptions to Facilitate Intrastate and Regional Securities Offerings* (Oct. 26, 2016) 81 FR 83494. We included the historical Rule 505 data in our analysis.

The importance of exempt capital markets as a source of financing in the economy is underscored by the fact that less than 0.02% of the estimated 28.8 million firms in the United States are currently exchange-listed firms.[50] Moreover, there has been a steady and substantial decrease in the number of reporting companies in the United States.[51] During this period, exempt offerings of securities have contributed substantially to capital formation in the U.S. economy, particularly for small and emerging companies that are often considered to be the engine for creating new jobs,[52] driving innovation, and accelerating economic growth. Hence, exempt capital markets provide an important financing alternative for companies that, for various reasons, forego financing in the registered capital markets.

Data for some of these exemptions are more readily available than for others. For example, because issuers relying on Section 4(a)(2) are not required to file any document with the Commission, offering information available in the commercial databases likely underestimates the amount of capital raised through this exemption. Similarly, the available data on Regulation D offerings could underestimate the true amount of capital raised through such offerings. While Regulation D requires the filing of a notice on Form D no later than 15 days after the first sale of securities, that filing is not a condition to the provision. Accordingly, it is

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[50] *See* SBA, Office of Advocacy, United States Small Business Profile (2016), *available at* https://www.sba.gov/sites/default/files/advocacy/United_States.pdf. *See also* Barry Ritholtz, *Where Have All the Public Companies Gone?*, BLOOMBERG VIEW (Jun. 24, 2015).

[51] The decline in the number of US-listed firms in 1996-2003 represents approximately 74% of the decline from 1996 to 2016. *See* Ernst & Young, May 2017, "Looking behind the declining number of public companies: An analysis of trends in US capital markets," https://www.sec.gov/spotlight/investor-advisory-committee-2012/ey-an-analysis-of-trends-in-the-us-capital-markets.pdf. *Also see* Doidge et al. (2017).

[52] During the period 1998-2008, U. S. Small Business Administration estimates show that small businesses contributed almost 50% of U.S. non-farm GDP and accounted for 55% of U.S. employment, including 66% of all net new jobs since the 1970s. *See* Robert Longley, *Top Ten Reasons to Love US Small Businesses* THOUGHTCO, *at* https://www.thoughtco.com/reasons-to-love-us-small-businesses-3319899 (Sept. 4, 2015) (citing Office of Advocacy, Small Business Administration). *See also* Small Business Administration, Small Business Quarterly Bulletins, *at* https://www.sba.gov/advocacy/small-business-quarterly-bulletins.

possible that some issuers do not file a Form D for offerings under Regulation D.[53] In addition, there is no requirement to file a Form D amendment reporting the total amount actually raised in the offering under Regulation D.[54] Data used in the primary issuance analysis is described in more detail in Appendix C.

B. General data on Regulation D and Rule 144A offerings

Figure 3 shows the amounts raised in Regulation D offerings, given the data limitations discussed above, and Rule 144A offerings. The amount of capital raised through Regulation D offerings is much larger than that raised in the Rule 144A market. When combined, the capital raised through Regulation D and Rule 144A offerings in a year is consistently larger than the total capital raised via registered equity and debt offerings. Most Regulation D offerings (over 66%) include equity securities; by contrast, in the Rule 144A market, the vast majority of issuers are financial institutions and over 99% of securities are debt securities.

Table 3 provides summary statistics on the number of Regulation D offerings and the average and median offering amount.[55] The number of Regulation D offerings is an order of magnitude larger than the number of registered debt and equity offerings. However, the average and median offer sizes of Regulation D offerings are much smaller than those of registered equity and debt offerings.

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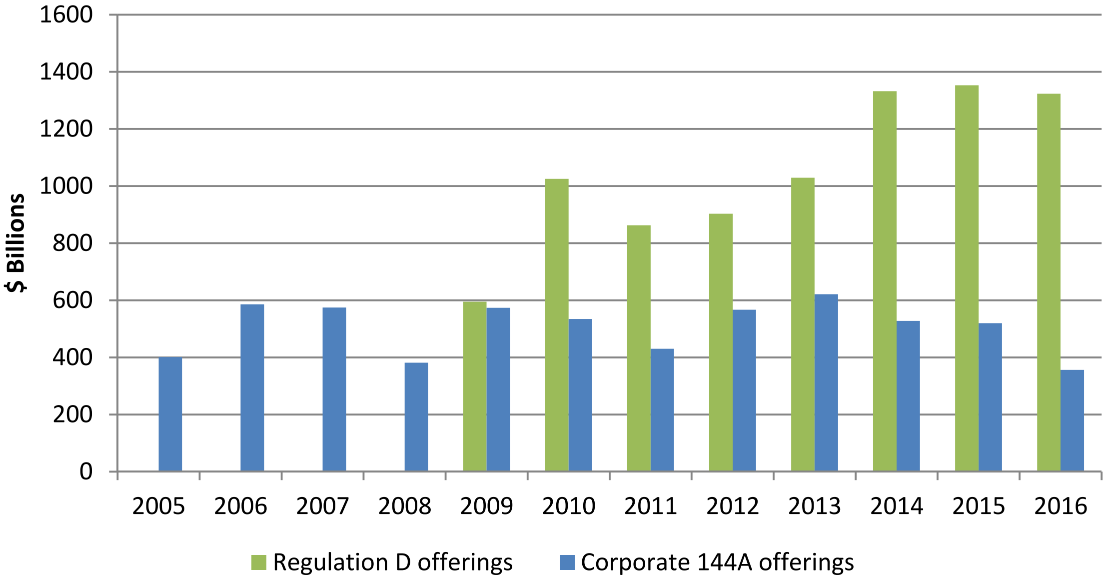
[53] Separate analysis by DERA staff of Form D filings by funds advised by registered investment advisers and broker-dealer members of the Financial Industry Regulatory Authority, Inc. (FINRA) suggests that Form D filings are not made for as much as 10% of unregistered offerings eligible to use the Rule 506(b) safe harbor under Regulation D.

[54] *See* the General Instructions to Form D. An update to Form D may be required to reflect a change in the information previously filed, except that certain less substantial changes enumerated in Rule 502 of Regulation D (e.g., an increase in the offering amount of less than 10%) do not trigger the requirement to update the filing. If the requirement to update is triggered, current information must be provided for the entire form.

[55] Due to data availability constraints, the analysis of Regulation D issuance covers 2009 through 2016

Figure 3. Capital raised through Regulation D and corporate Rule 144A offerings (in $ billions), 2005-2016



Source: DERA analysis

C. Rule 506(c) of Regulation D

Title II of the JOBS Act directed the Commission to engage in rulemaking to permit general solicitation in Rule 506 offerings, provided that sales are made only to accredited investors and the issuer takes reasonable steps to verify purchasers' accredited investor status. The Commission subsequently adopted Rule 506(c) of Regulation D, permitting the use of general solicitation and advertising subject to such conditions. From September 23, 2013, to December 31, 2016, a total of 5,374 issuers disclosed in their Forms D that they initiated 5,474 new Rule 506(c) offerings (Table 4). During that period, almost $70.6 billion was reported raised in initial Form D filings. An additional $37.1 billion was reported to be raised in amended form D filings, some of which were originally initiated as Rule 506(b) offerings. During the same period, there were 65,772 new Rule 506(b) offerings that reported to raise $2,186.2 billion in initial Form D filings, and an additional $1,935.8 billion was reported to be raised in amended form D filings. Though large in absolute terms, issuances claiming the new Rule 506(c) exemption have accounted for only 3% of the reported capital raised pursuant to Rule 506 since becoming effective in September 2013, through December 31, 2016.

While the underlying motivation for permitting general solicitation was to boost capital formation through increased accessibility of certain issuers to accredited investors, the vast majority of Regulation D issuers continue to raise capital through Rule 506(b) offerings. Some have noted that the novelty of the Rule 506(c) provisions after decades of non-permissibility of general solicitation in Regulation D offerings may be one reason why Rule 506(b) continues to dominate the Regulation D market. In particular, issuers with pre-existing sources of financing or intermediation channels, or both, may not yet have a need for the new flexibility. Other issuers may become more comfortable with market practices as they develop over time, including, among other things, certainty over what constitutes general solicitation.[56] There may also be concerns about the added burden or appropriate levels of verification of the accredited investor status of all purchasers.[57] For instance, Warren (2015) indicates that investor privacy concerns regarding the disclosure of confidential financial information may be behind issuer reluctance to rely on Rule 506(c) provisions. Markets may develop more efficient means for verifying investor status over time.

Regulatory uncertainty has also been identified as a possible explanation for the relatively low level of Rule 506(c) offerings. For example, certain pooled investment funds that need to comply with Commodity Futures Trading Commission (CFTC) regulations continued to be

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[56] *See*, e.g., Keith Higgins, Director of the Division of Corporation Finance, U.S. Securities and Exchange Commission, Remarks before the 2014 Angel Capital Association Conference (Mar. 28, 2014) *available at* http://www.sec.gov/News/Speech/Detail/Speech/1370541320533. *See also* comments of Jean Peters, Board member, Angel Capital Association, at the 33rd Securities & Exchange Commission Government-Business Forum on Small Business Capital Formation (Nov. 20, 2014).

[57] *See* comments of Jean Peters, Board member, Angel Capital Association, at the 33rd Securities & Exchange Commission Government-Business Forum on Small Business Capital Formation (Nov. 20, 2014).

subject to the CFTC's prohibition on advertising after September 23, 2013 (and at least until September 2014), and therefore could not use Rule 506(c).[58] Further, the Commission's proposed amendments to Regulation D and Form D at the time Rule 506(c) was adopted have elicited widely divergent views from commenters, with some commenters expressing the view that the "overhang" from the proposed (but never finalized nor withdrawn) rule has chilled use of the new exemption.[59]

Additional analysis in Table 4 shows that the average amount reported sold in an initial Rule 506(c) offering ($13 million) is much smaller than the average amount reported sold in a Rule 506(b) offering ($26 million). The lower amounts reported to be raised at the date of initial filing may be because issuers that anticipated difficulties raising capital in a timely manner chose the Rule 506(c) market so that they would have an ability to advertise or generally solicit their offering to a broader audience of potential investors. It is also possible that some sophisticated investors perceive the election of the Rule 506(c) exemption as a signal that issuers anticipate difficulties in raising sufficient capital and consequently consider it a less attractive offering, which could also dissuade issuers from using the new exemption for their financing needs.

Overall, it is not clear whether offerings under Rule 506(c) are indicative of new capital formation or a reallocation from other offering types. Consistent with the somewhat limited uptake of new Rule 506(c), we do not observe a notable migration of existing issuer capital raising activity from Rule 506(b) to Rule 506(c). In particular, only a small number of offerings

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[58] *See* Letter from Gary Barnett, Director, Division of Swap and Intermediary Oversight, CFTC to Regina Thoele, National Futures Association, available at http://www.cftc.gov/idc/groups/public/@lrlettergeneral/documents/letter/14-116.pdf.

[59] *See* Warren (2015). *See also* Keith Higgins, Director of the Division of Corporation Finance, U.S. Securities and Exchange Commission, Remarks before the 2014 Angel Capital Association Conference (Mar 28, 2014) available at https://www.sec.gov/news/speech/2014-spch032814kfh (noting that then-Chair White had stated publicly that issuers are not required to comply with the proposed rule, and that appropriate transition provisions would be considered for ongoing offerings if a final rule were adopted).

switched from relying on Rule 506(b) to Rule 506(c). From September 23, 2013 to December 31, 2014, approximately 398 continuing Regulation D offerings switched their exemption to Rule 506(c).[60] These "switched" offerings have reported capital raisings of $12 billion. There has been a similar movement in the number of "repeat" issuers (issuers that used to access the Regulation D market via Rule 506(b) offerings) that have switched their offering types from Rule 506(b) to subsequent Rule 506(c) offering: issuers that had a prior Regulation D offering initiated 447 new Rule 506(c) offerings. These issuers have reported capital raisings of $16.7 billion.

D. Investors in Regulation D Offerings

Regulation D allows both accredited and non-accredited investors to participate in private offerings, with an unlimited number of non-accredited investors in Rule 504 offerings, while former Rule 505[61] and Rule 506(b) offerings may include no more than 35 non-accredited investors. Only accredited investors can participate in Rule 506(c) offerings. On the basis of information collected from Form D filings, most participants in Regulation D offerings are accredited. For example, on average 9% of new offerings included non-accredited investors for the period 2009-2016 (Table 5). Offerings by financial issuers and real estate investment trusts (REITs) are more likely to have non-accredited investors (13% of offerings had at least one such investor during 2009-2016), while offerings by venture capital funds only rarely include non-accredited investors (only 1% of offerings have at least one such investor).

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[60] The transition guidance in the Rule 506(c) Adopting Release clarifies that only offerings initiated prior to September 23, 2013, can rely on the transition guidance to switch their exemption to Rule 506(c). *See* Rel. No. 33-9415, *Eliminating the Prohibition Against General Solicitation and General Advertising in Rule 506 and Rule 144A Offerings* (July 10, 2013).

[61] As noted above, the repeal of Rule 505 became effective May 22, 2017. *See* Rel. No. 33-10238, *Exemptions to Facilitate Intrastate and Regional Securities Offerings* (Oct. 26, 2016).

Aggregated Form D information also indicates that, on average, more than 260,000 investors participated in Regulation D offerings for the period 2009-2016, of which more than 103,000 participated in offerings by nonfinancial issuers, more than triple the number of investors that participated in offerings by hedge funds. However, the number of unique investors is likely less than 260,000. Because an investor can participate in more than one Regulation D offering, our aggregation likely overstates the actual number of unique investors, and we have no method of estimating the extent of overlap. The mean number of investors per offering (14) is substantially larger than the median (4), indicating the presence of a small number of offerings with a large number of investors. Much of this skew appears to be driven by financial offerings. For the period of 2009-2016, the median number of investors per offering varied between two and seven across all types of offerings. During the same period of time, the mean number of investors in nonfinancial offerings was nine, while the mean number of investors in financial, pooled investment funds (e.g., hedge funds, private equity funds, and venture capital funds) and REIT offerings varied from 15 to 25.

Offerings involving non-accredited investors are typically smaller than those that do not involve non-accredited investors. This is evident in Table 6 below which shows that while the presence of non-accredited investors is large in former Rule 505 offerings (40%), where the number of non-accredited investors is limited to 35 and offering limit is $5 million, the proportion is much higher for offerings under Rule 504 (58%) that have access to an unlimited number of non-accredited investors but historically had an offer limit of $1 million. Interestingly, a notably lower percentage of Rule 506(b) offerings (8%), including those that have an offer size of up to $5 million, report selling or intending to sell to a non-accredited investor. The big difference between Rules 506(b) and (c) and other rules under Regulation D is that the former have preemption from state registration and review.[62] Rule 506(b) provisions, unlike Rule 504 or former Rule 505 provisions, also require the non-accredited investors to be "sophisticated."[63] Thus, while issuers may prefer to raise capital under Rule 506(b) because of the preemption of state registration and review, non-accredited investors who are also not sophisticated are thus unable to participate in a Rule 506(b) offering.

E. Regulation D Offering Fees

When an intermediary is used in a Regulation D offering, there is notable variation in the fees across each class of issuer. We calculate the total fee for an offering as the sum of commissions and finder's fees, scaled by the offering amount. Information from Form D filings indicates that total fees are smallest for pooled investment funds and largest for nonfinancial issuers (Figure 4). Nonfinancial issuers paid on average about 6% in total fees for Regulation D offerings in 2009-2016. In comparison, a company going public pays an average gross spread of 7% to its IPO underwriters, while a reporting company raising equity through a follow-on (seasoned) equity offering pays an average gross spread of about 5.4%. Issuers raising capital through registered bond issues pay commissions between 0.9% and 1.5% of the size of the offering.

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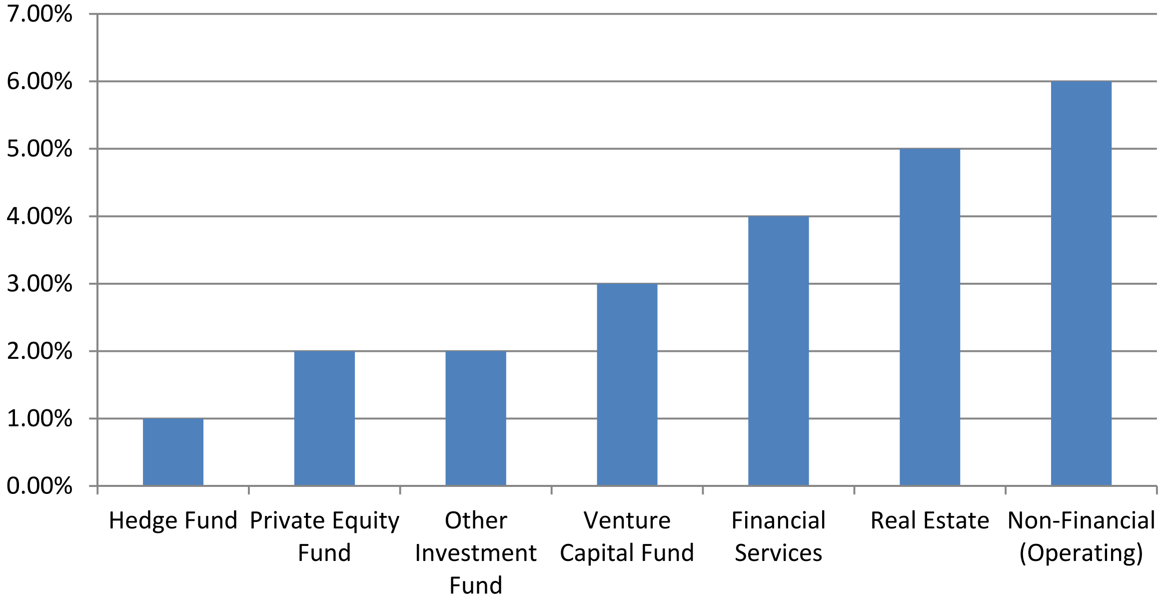
[62] States retain the authority to investigate and bring enforcement actions for fraud, impose state notice filing requirements, and collect state fees.

[63] Non-accredited investors in Rule 506(b) offerings must have sufficient knowledge and experience in financial and business matters to make them capable of evaluating the merits and risks of the prospective investment, or the issuer must reasonably believe immediately prior to making any sale that such purchaser comes within this description. *See* Rule 506(b)(2)(ii).

Figure 4. Total fees paid by type of Regulation D issuer: 2009-2016

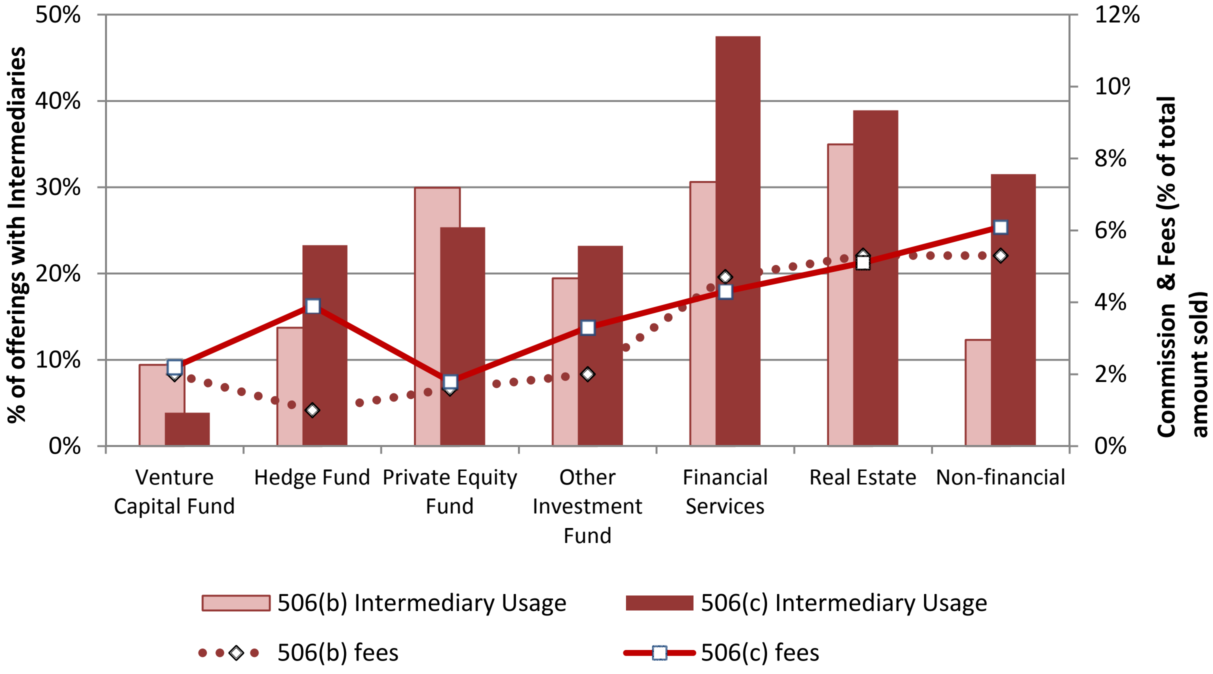


Source: DERA analysis

In contrast to operating issuers, hedge funds raising capital through Regulation D offerings and private equity funds paid about 1%. Brokers and finders are no more costly, on average, than the underwriters who charge fees for registered offerings, so fees do not provide an obvious reason for their relatively infrequent use in exempt offerings.

The availability of general solicitation under new Rule 506(c) may have changed the role of intermediaries in these offerings relative to their role in the traditional offerings under Regulation D. During the period between September 23, 2013, and December 31, 2016, intermediary usage in Rule 506(c) offerings was dramatically higher among operating and financial issuers, compared to similar Rule 506(b) issuers (Figure 5). Overall, Rule 506(c) offerings exhibited a higher level of intermediary usage (33% of new offerings) than Rule 506(b) offerings (17% of new offerings). The higher usage of intermediaries in Rule 506(c) offerings may relate to issuers, and especially non-fund issuers, seeking to rely on outside entities, including third-party online platforms, to verify accredited investor status, a requirement for using general solicitation.

Figure 5. Role of intermediaries in Rule 506(c) market: September 23, 2013 - December 31, 2016

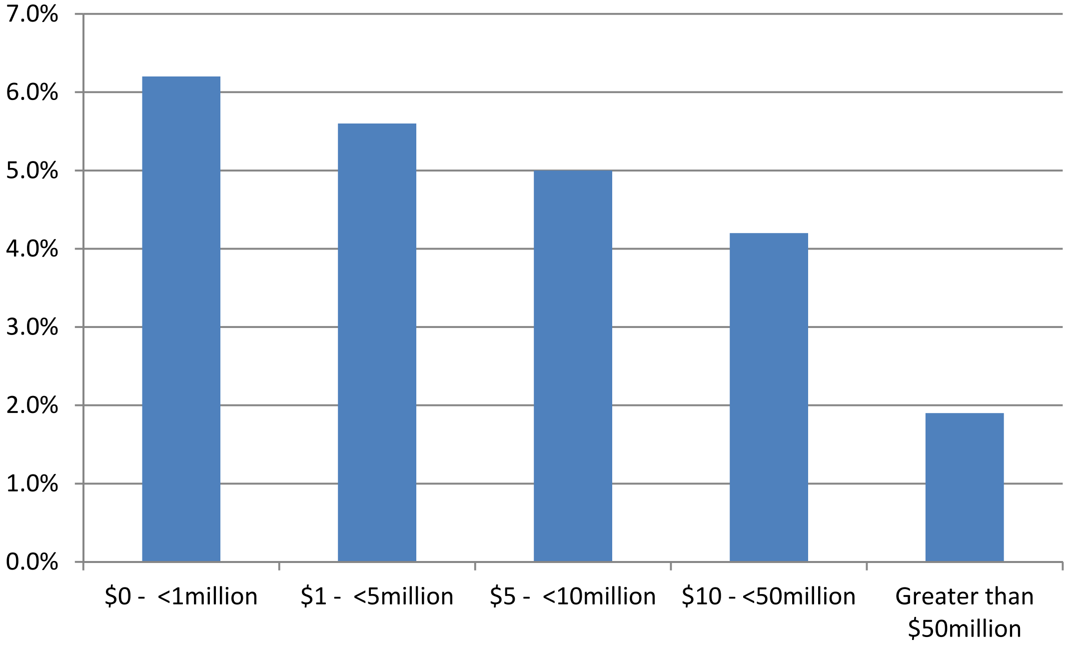


Source: DERA analysis

On average, Rule 506(c) offerings also pay higher fees than Rule 506(b) issuers. Figure 5 shows that operating issuers paid almost 6.1% in fees in 506(c) offerings, relative to 5.3% paid by such non-fund, nonfinancial Rule 506(b) offerings.

Figure 6 depicts the fees for different offering sizes, irrespective of issuer type or provision under Regulation D. Average total fees decrease with offering size (Figure 6). Unlike the gross spreads in registered offerings, the differences in commissions for Regulation D offerings of different sizes are large: the average commission paid by issuers engaging in offerings of up to $1 million (6.2% over the period 2009-2016) is more than three times higher than the average commission paid by issuers engaging in offerings of more than $50 million (1.9% over the period 2009-2016). These results are consistent with larger deals generating economies of scale for the involved intermediaries. Even so, the vast majority of the offerings are conducted without the use of a financial intermediary.

Figure 6. Total fees paid by size of Regulation D offering: 2009-2016



Source: DERA analysis

Overall, capital formation through private placement of securities has increased substantially since the onset of the financial crisis. Amounts raised through exempt securities offerings have outpaced the level of capital formation through registered securities offerings during recent years. In Parts A.III.B through A.III.E, we have provided insights into a large segment of the exempt securities market—offerings conducted in reliance on Regulation D. Next, we turn to another type of exempt offerings, namely, offerings under Regulation A.

F. Regulation A Activity Overview

Regulation A is an exemption from registration for small offerings under Section 3(b)(2) of the Securities Act. Prior to June 19, 2015, it enabled issuers to raise up to $5 million in a 12-month period (subsequently, up to $50 million). It is available to issuers organized, and with a principal place of business, in the United States or Canada. Historically, the Regulation A exemption was not available to Securities Exchange Act of 1934 (Exchange Act) reporting companies, investment companies (including business development companies), development stage companies that have no specific business plan or purpose or have indicated that their business plan is to engage in a merger or acquisition with an unidentified company or companies, issuers of fractional undivided interests in oil or gas rights or a similar interest in other mineral rights. In addition to these existing categories of ineligible issuers, the newly amended Regulation A also excludes issuers that have not filed certain ongoing reports required by Regulation A, issuers subject to certain Section 12(j) orders by the Commission, and issuers subject to "bad actor" disqualification under Rule 262.

Title IV of the JOBS Act added Section 3(b)(2) to the Securities Act, directing the Commission to adopt rules exempting from registration public offerings of up to $50 million annually. On December 18, 2013, the Commission proposed rules to implement Title IV of the JOBS Act by modernizing and expanding Regulation A and, on March 25, 2015, the Commission adopted final rules.[64] The final rules expand Regulation A into two tiers: Tier 1, for securities offerings of up to $20 million (that tracks more closely "old" Regulation A); and Tier 2, for offerings of up to $50 million. Under the final rules, Tier 2 issuers are required to include audited financial statements in their offering documents and to file annual, semiannual, and current reports with the Commission. With the exception of securities listed on a national securities exchange, upon qualification, purchasers in Tier 2 offerings either must be accredited investors or are subject to specified limitations on their investment. The amendments to Regulation A took effect on June 19, 2015, and may have resulted in changes in the type of offerings and issuers in this market in potentially notable ways.

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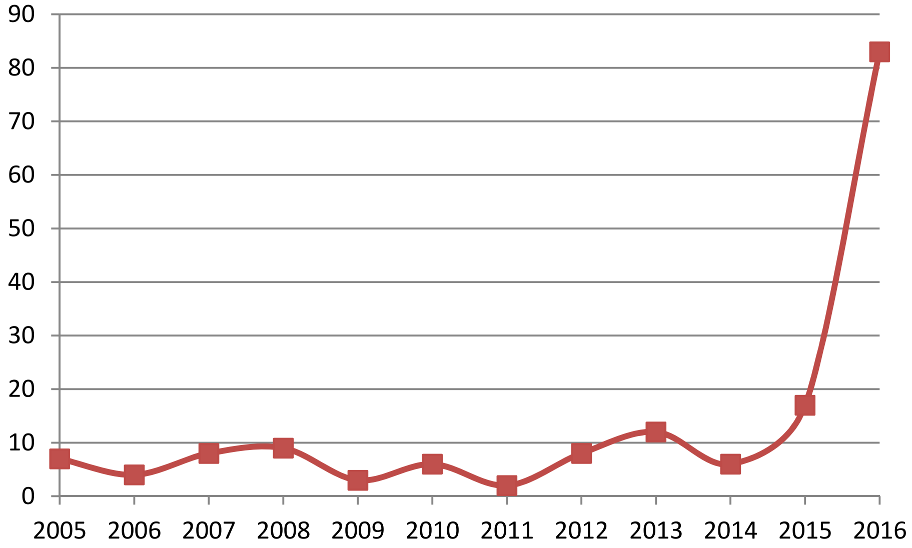
[64] *See* Regulation A+ Adopting Release.

We consider Regulation A offerings qualified by the Commission during 2005-2016.[65] A little under half of offerings were identified as being by issuers in the financial sector. The most common jurisdiction of incorporation was Delaware. Figures 7 and 8 report the number of qualified offerings and amounts sought in qualified offerings between 2005 and 2016.

Figure 7. Number of qualified Regulation A offerings, 2005-2016



Source: DERA analysis

In a typical year during 2005-2016, there were about 14 qualified offerings seeking to raise approximately $163.3 million. We note that there were substantially more issuers seeking to raise capital under Regulation A during June 19, 2015– December 31, 2016 (97 qualified offerings seeking to raise up to approximately $1.8 billion in the aggregate). We do not have complete information about amounts raised during that time. We estimate, on the basis of issuer

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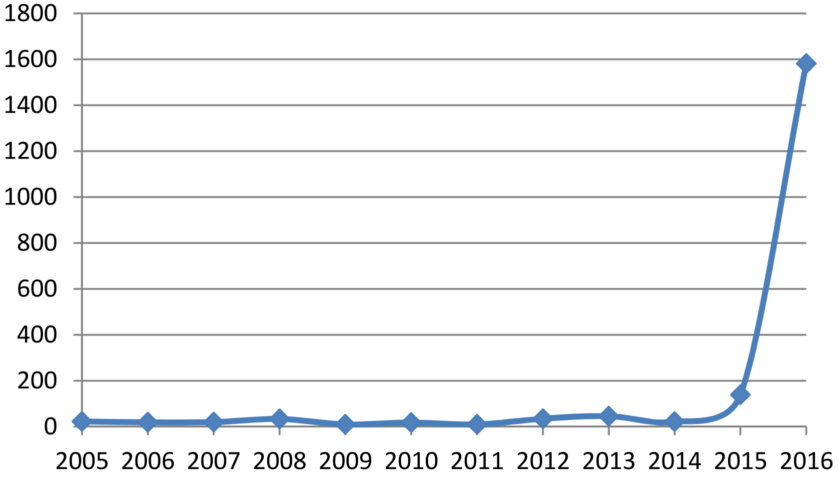
[65] Where relevant and where sufficient information was available, we focused on unique offerings and exclude post-qualification amendments or new filings that are substantially similar to prior filings by the same issuer. We sought to maintain accuracy, but some measurement error is inevitable. For some offerings, offer amounts were not available in offering circulars. Offerings with missing information on amounts sought were excluded from the totals.

reports of amounts raised filed during 2005-2016 that are available to us, that 56 issuers reported positive proceeds in Regulation A offerings, totaling approximately $314.6 million.[66] The total includes 27 issuers that reported in 2015-2016 an aggregate of approximately $238.6 million in proceeds raised in completed and ongoing offerings qualified under amended Regulation A.

Figure 8. Aggregate amounts sought in qualified Regulation A offerings, 2005-2016[67]



Source: DERA analysis

The evolution of Regulation A offering activity during the period under consideration, 2005-2016, was affected by several relevant market and institutional considerations. First, the Commission amended the Regulation A exemption in 2015 as part of implementing the mandate

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[66] Some issuers filed reports of sales with zero proceeds. Additionally, incomplete information is available to us regarding the outcomes of Regulation A offerings during the examined period. Amounts raised are based on the reports of sales filed during the examined period and thus reflect a lag: they do not include amounts raised during the examined period that are reported at a later date, amounts raised in offerings in progress (unless the issuer has opted to report them during the examined period), or amounts raised and reported after the end of the examined period. For some offerings in the pre-amendment period, final reports of sales on Form 2-A were either not available or not accessible electronically from EDGAR or ThomsonOne. Thus, we cannot determine with certainty whether all of the offerings that qualified during the examined period have commenced or if any have been abandoned or terminated by issuers.

[67] These amounts are not inflation-adjusted. Since larger aggregate offering amounts were observed at the end of the examined period, expressing offering amounts in 2005 dollars had the effect of accentuating the differences between pre-amendment and post-amendment annual totals.

of Title IV of the JOBS Act. Second, compared to the size of the registered offerings and private placement markets, Regulation A experienced relatively limited use during the examined period, particularly prior to the effectiveness of the 2015 amendments. When the number of observations is small, statistical analysis lacks power and may be easily skewed by a few observations. Thus, any inference regarding potential trends or the set of issuers seeking to participate in this market must be approached with considerable caution. Third, to the extent that the Regulation A market serves as a smaller-scale alternative to a traditional IPO or SEO or as a method of financing merger and acquisition transactions, growth outlook—and, in turn, the extent of investor interest in a potential offering—at the economy and industry level can affect Regulation A activity. We discuss these considerations in greater detail below.

The end of the examined period includes the months immediately following the effectiveness of Regulation A amendments. Although the period after the effectiveness of the amendments was relatively short, it was characterized by increased filing activity, with filers taking advantage of the expanded Regulation A provisions and seeking qualification of larger maximum offering amounts than under pre-amendment Regulation A. While it is too early to assess the extent to which Regulation A amendments will affect the amount of capital formation over the long run, based on the early indications available so far, aggregate filing counts and aggregate offer amounts and deal sizes have likely increased relative to the pre-amendment period.

Furthermore, the 2015 Regulation A amendments contained certain provisions that may have ramifications for the development of a potential secondary market in Regulation A securities. Specifically, the creation of an ongoing reporting regime for issuers in Tier 2 offerings may contribute to a reduction in information asymmetries between issuers and investors and enable issuers to meet the requirements for having their securities quoted on one of the higher over-the-counter (OTC) market tiers, potentially resulting in improved liquidity for Regulation A investors. However, at this time, for the majority of issuers secondary trading in Regulation A securities is either at a nascent stage or nonexistent.

Prior to the adoption of Regulation A amendments, analysis indicated that among the factors that could potentially be related to limited use of Regulation A were compliance with state securities review and qualification, a comparatively low $5 million offering limit, the timing and cost associated with filing an offering statement with the Commission for qualification, and the availability of other exemptions under the federal securities laws.[68]

While Regulation A activity has exhibited a notable increase after the effectiveness of the Regulation A amendments, absolute levels of filing activity have remained low compared to other unregistered offerings such as Regulation D and Rule 144A, potentially consistent with issuers, service providers, and investors adjusting and learning about the new provisions. To the extent that the Regulation A amendments require an initial period of adjustment and/or confront market participants with a learning curve, the Regulation A offering activity may not be representative of the typical level of Regulation A offering activity expected after the market has gained experience with amended Regulation A.

At the same time, it is possible that future Regulation A offering activity may remain modest. Issuers may continue to prefer Rule 506(b) offerings and private placements in reliance on Section 4(a)(2) because of their lower initial and ongoing compliance related cost and the absence of an offering limit. Issuers that elect to undertake an initial public offering may continue to favor the traditional IPO route and become Exchange Act reporting companies.

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[68] *See* GAO, *Factors that May Affect Trends in Regulation A Offerings*, GAO-12-839 (July 2012), *available at* http://www.gao.gov/assets/600/592113.pdf (GAO Report).

Additionally, a lack of secondary market liquidity may discourage investors from participating in Regulation A offerings at valuations that the issuer finds attractive.

Furthermore, investors may hesitate to invest in issuers about which the market has less information (known as "information asymmetry") because of concerns about adverse selection (lower quality issuers choosing to raise financing). In many cases, a venture capital fund or a major underwriter, which may provide implicit certification of the prospects of a startup or small issuer, is not involved. Most Regulation A issuers are small companies without analyst coverage or notable institutional ownership, and both tiers of offerings subject issuers to disclosure requirements that are less extensive than those imposed on Exchange Act reporting companies. While institutions may be in a better position to analyze information about opaque issuers and overcome adverse selection, less sophisticated investors may have greater difficulty in evaluating the prospects of an issuer on the basis of offering materials alone. In addition, while venture capital and angel investors may be able to negotiate downside protection options for their investments in high-risk and high-information asymmetry companies, less sophisticated investors may have less bargaining power in negotiating offering terms. Having less information about the issuer may discourage such investors from investing or may lead investors only to invest in offerings at valuations below those that the issuer would find attractive. Finally, we note that there is not enough evidence at this time to determine whether the increase in capital formation following amendments to Regulation A has served as a complement to or a substitute for capital raising via other methods.

Overall, early signs indicate that amended Regulation A may offer a potentially viable public offering on-ramp for smaller issuers as an alternative to a traditional registered IPO and offer either an alternative or a complement to other securities offering methods that are exempt from Securities Act registration. Preliminary evidence suggests that there has been an increase in Regulation A offering activity in the initial period since effectiveness of the Regulation A amendments; different types of issuers have initiated offerings; and issuers participating in the offerings have generally sought to utilize the new provisions afforded by the 2015 amendments.

Like other small-scale analyses, the findings of this analysis of the Regulation A market are qualified by the sample size and the relatively short observation period, thus, it is unclear to what extent it can be extrapolated to future years or periods with different aggregate conditions. The types of issuers that use this offering method in the future may differ from early adopters, and medium- and long-term outcomes of Regulation A issuers remain an area for future analysis. Further, questions remain regarding future offering outcomes and trends in intermediary involvement and secondary market liquidity as the Regulation A market continues to develop.

G. Regulation Crowdfunding Activity Overview

Title III of the JOBS Act (Title III) amended Section 4 of the Securities Act and created a new exemption from registration for Internet-based securities offerings of up to $1 million[69] over a 12-month period. Title III was intended to help small and startup businesses conduct low-dollar capital raising on the Internet. It can be thought of as an Internet-based method` of raising seed financing from a broad, mostly retail investor base. Title III included a number of investor protection provisions, including investment limitations, issuer disclosure requirements, and a requirement to use regulated intermediaries. The SEC proposed securities-based crowdfunding rules on October 23, 2013, and adopted the final “Regulation Crowdfunding” rules on October

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[69] On March 31, 2017, the Commission adopted amendments to increase the amount that issuers can raise through crowdfunding to adjust for inflation. The maximum aggregate offering amount increased to $1,070,000, and the new thresholds became effective on April 12, 2017. *See* JOBS Act Technical Amendments Release.

30, 2015, to implement the requirements of Title III.[70] Issuers were able to use the new exemption beginning May 16, 2016, when Regulation Crowdfunding became effective.[71]

While securities-based crowdfunding under Regulation Crowdfunding shares certain similarities with non-securities-based (lending-based, reward-based, donation-based, and royalty-based) crowdfunding, such as the ability of the public to participate and the use of an Internet-based platform to solicit backers, there are important distinctions. Non-securities-based crowdfunding campaigns do not involve a profit or revenue-sharing model and are generally not subject to regulation under federal securities laws. Although any crowdfunding backer may have nonpecuniary reasons for participating, backers in non-securities based crowdfunding campaigns are more likely to be guided by such motives. Overall, the differences in the legal framework, characteristics of fundraisers, and objectives of funders limit extrapolation from non-securities based crowdfunding to Title III crowdfunding.

Regulation Crowdfunding established requirements for issuers and intermediaries seeking to participate in an Internet-based crowdfunding offering. The key provisions are summarized below:[72]

- A given issuer is able to raise up to $1,070,000 across all crowdfunding offerings in a 12-month period. An issuer must raise at least the target amount to receive funds. Crowdfunding securities are generally subject to resale limitations for one year.

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[70] *See* Rel. No. 33-9470, *Crowdfunding* (Oct. 23, 2013) 78 FR 66427 (Crowdfunding Proposing Release); Rel. No. 33-9974, *Crowdfunding* (Oct. 30, 2015) 80 FR 71387 (Crowdfunding Adopting Release).

[71] Provisions related to funding portal registration became effective on January 29, 2016, to give funding portals additional time to undergo the SEC registration and FINRA membership process.

[72] *See* Crowdfunding Adopting Release for details. In the JOBS Act Technical Amendments Release, the Commission revised the investment limits and other dollar amount thresholds in Regulation Crowdfunding to adjust for inflation. The inflated-adjusted amounts are reflected below.

- The rules impose limits on the amount that an investor can invest in all Title III crowdfunding offerings over a 12-month period. Investors with both an annual income and net worth of at least $107,000 can invest up to 10% of the lesser of annual income or net worth, but an investor's total investment across all Title III offerings may not exceed $107,000 in a 12-month period. Other investors can invest the greater of either $2,200 or 5% of the lesser of their annual income or net worth.
- Crowdfunding issuers are subject to disclosure requirements at the time of the offering (on Form C), during the offering's progress and on completion of the offering (on Form C-U) and annually in the form of annual reporting requirements (on Form C-AR). Additionally, in offerings of over $107,000 in a 12-month period, financial statements must be reviewed by an independent accountant, and in offerings of over $535,000 in a 12-month period (except the issuer's first crowdfunding offering), financial statements must be audited.
- Crowdfunding securities must be offered through an SEC-registered intermediary, either a broker-dealer or a funding portal, a new intermediary type established in Regulation Crowdfunding. These intermediaries must take measures to reduce the risk of fraud, make required disclosures about issuers available to the public, provide communication channels to permit discussion of offerings on the platform, disclose the compensation received by an intermediary, provide educational materials to investors, and comply with additional requirements related to investor commitments, notices to investors, and

maintenance and transmission of funds. Registered funding portals that participate in crowdfunding offerings may engage in a narrower set of activities than broker-dealers.[73]

Given the offering limits, crowdfunding is primarily used by relatively small issuers, thus many of the economic considerations applicable to small and early-stage issuers apply to crowdfunding as well.[74] The availability of solicitation over the Internet and sales to investors nationwide, irrespective of the location of the issuer (as long as the issuer is a U.S. issuer) distinguish Regulation Crowdfunding from intrastate securities-based crowdfunding regulated under state law that historically has relied on Securities Act Rules 147 or 504.[75] The statistics reported in Table 7 are based on the analysis of data as reported in EDGAR filings of Forms C, C-U, and CFPORTAL through December 31, 2016, except as specified otherwise.[76] For offerings that have been amended, the information is generally based on the latest amendment associated with that central index key (CIK) and file number as of the report date, except as specified.

Between May 16, 2016, and December 31, 2016, excluding 24 withdrawn[77] offerings and potential duplicate filings,[78] there were 163 unique offerings by 156 issuers (including 7 issuers

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[73] Among other things, a funding portal cannot offer investment advice or recommendations; solicit purchases, sales or offers to buy the securities offered or displayed on its platform; compensate employees, agents or other persons for solicitation or based on the sale of securities on its platform; and hold, manage, possess, or otherwise handle investor funds or securities.

[74] *See* Crowdfunding Adopting Release.

[75] *See* Crowdfunding Adopting Release. To facilitate intrastate securities-based crowdfunding, the Commission recently amended Rule 147 and Rule 504 and adopted a new intrastate offering exemption as Rule 147A. *See* Rel. No. 33-10238, *Exemptions to Facilitate Intrastate and Regional Securities Offerings* (Oct. 26, 2016). Amendments to Rule 504 took effect on January 20, 2017. The amended Rule 147 and the new Rule 147A took effect on April 20, 2017.

[76] Data comes from the XML portion of Forms C and C-U and amendments to them. When we refer to offerings, we refer to initiated offerings that have not been withdrawn, unless specified otherwise. We analyze withdrawn offerings separately. When discussing completed offerings, we refer to offerings that have reported proceeds of at least the amount raised on Form C-U. Unless specified otherwise, offerings with Forms C-U filed without proceeds information reported are excluded from the analysis.

[77] Withdrawn offerings include unique offerings for which a Form C-W was filed and a new Form C or amendment was not subsequently filed and offerings that used an intermediary that filed a Form CFPORTAL-W to withdraw its

[Footnote continued on next page]

that filed for more than one crowdfunding offering).[79] Of those, 28 offerings reported meeting their target amount on Form C-U as of December 31, 2016.[80] Statistics are presented at the offering level.

The median (average) offering between May 16, 2016, and December 31, 2016, targeted approximately $53,000 ($110,000). For almost all of these offerings, oversubscriptions up to a higher maximum were accepted (the median issuer set the maximum close to the $1 million limit in the final rules). Of the offerings that reported having raised at least the target amount, the median (average) amount reported raised was notably larger, at approximately $171,000 ($290,000).[81]

Amounts reported raised are based on filings of Form C-U and generally pertain to completed and not ongoing offerings. Under the final rules, interim progress updates may be provided by the intermediary and are not required to be filed on EDGAR, but issuers must file Form C-U within 5 business days of reaching the target amount for offerings that do not accept amounts in excess of the target amount known as "oversubscriptions" and within 5 business days

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funding portal registration, even if the filings themselves had not been withdrawn. During this time period, 24 offerings were classified as withdrawn. The remaining sample may contain additional withdrawn or abandoned offerings that have not been identified using these criteria (e.g., offerings that have reached the deadline date but have not been associated with filing activity or updates) and additional offerings may be classified as withdrawn at a future date (e.g., if the issuer withdraws an offering or if the portal through which it is offered withdraws its registration). Overall, since amounts sought may not be successfully raised, statistics on the amounts sought should be interpreted with caution. The actual *ex post* amount of capital formation in this market may be considerably lower than the amounts sought in offerings that had been initiated.

[78] Cases of multiple filings by the same filer on Form C with substantially similar offering information made within a short span of time are consolidated into a single offering.

[79] *See* Ivanov and Knyazeva (2017).

[80] In addition, there were four Forms C-U filed during January 1, 2017 - January 15, 2017, for offerings with deadline dates in 2016; for one of two offerings for which Forms C-U were filed before January 1, 2017, without proceeds information, proceeds information was obtained on the funding portal page. As of January 15, 2017, approximately $10 million in proceeds was reported raised for 33 offerings by issuers filing Forms C-U. No offerings have been withdrawn on Form C-W between January 1, 2017, and January 15, 2017.

[81] Unless specified otherwise, amounts raised are based on data through December 31, 2016. If data from note 80 above is added, the median (average) raise becomes approximately $171,000 ($303,000), which illustrates the caveat that estimates obtained from a small sample can be highly sensitive to the addition of new data.

of reaching the offering's deadline date for offerings that accept oversubscriptions.[82] The offering characteristics in Table 8 show that a typical offering was due to close within 4-5 months of initiation.[83] With very few exceptions, issuers permitted oversubscriptions—investments above the target amount sought. Issuers took advantage of the flexibility afforded by Internet solicitation to raise as much capital as possible in a crowdfunding offering.

As can be seen from Table 8 and Figure 9, the most popular security issued was common or preferred equity, accounting for 36% of offerings. Debt accounted for 20%, and there were various other security types, such as units, convertibles, "simple agreements for future equity,"[84] and others (including revenue sharing and membership / limited liability company (LLC) interests).

Overall, initial evidence on the Title III crowdfunding market activity suggests that some small, pre-revenue growth firms are beginning to use crowdfunding as a securities offering method. However, the small sample limits the inference that can be drawn from statistics on issuer and offering characteristics, fees, and measures of offering activity. More time is needed to assess this market as it develops.

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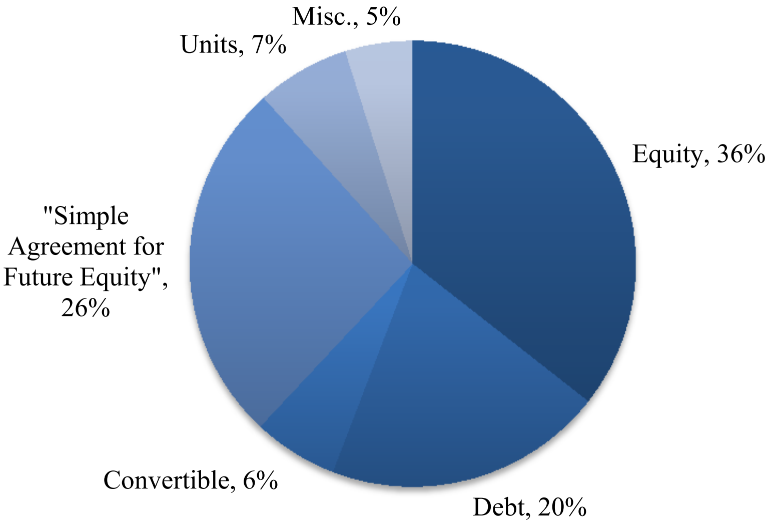
[82] *See also* Crowdfunding Adopting Release, at 71417.

[83] Offering information is based on the most recent filing for each offering, except as specified otherwise. Offering duration (the number of months between the filing date and the deadline date) is based on the first filing.

[84] "Simple agreements for future equity," used in 26% of the offerings so far, were designed by a Silicon Valley startup accelerator for early-stage entrepreneurial ventures to provide their holders with option-like payoffs from a potential conversion into equity, contingent on a subsequent valuation event (such as a follow-on financing round or offering at a specified valuation) but no voting, dividend or coupon rights. Issuers may offer voting rights to larger investors. The conversion terms are based on whether the subsequent valuation event was at a higher than specified valuation. *See* Green, Joseph, and John Coyle, 2016, Crowdfunding and the not-so-safe SAFE, 102 *Virginia Law Review Online* 168, http://ssrn.com/abstract_id=2830213. *But see* Wroldsen, Jack, 2017, Crowdfunding investment contracts, 11 *Virginia Law & Business Review* (forthcoming), http://ssrn.com/abstract_id=2844771.

Figure 9. Distribution of crowdfunding security types



Source: DERA analysis

IV. The ABS Market

Asset-backed securitization (ABS) plays an important role in the creation of credit by increasing the amount of capital available for the origination of loans and other receivables through the transfer of those assets in exchange for new capital to other market participants.[85] Benefits of the securitization process may include reduced cost of credit and expanded access to credit for borrowers, ability to match risk profiles of securities to investors' specific demands, and increased secondary market liquidity for loans and other receivables. In addition, the ABS market, although not a primary issue market, is nevertheless an important one because it supports a large volume of primary offerings issuance of underlying consumer and business loans and, thus, plays an important indirect role in capital raising.[86]

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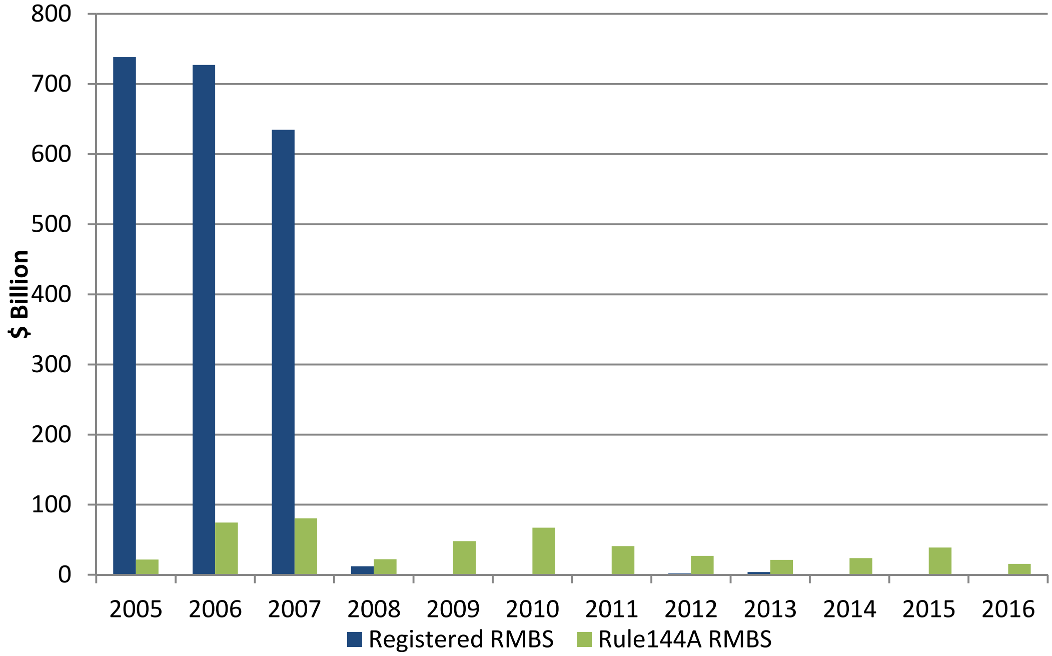
[85] *See* Rel. No. 34-73407, *Credit Risk Retention* (Oct. 22, 2014), 79 FR 77602 (Credit Risk Retention Adopting Release).

[86] We make a distinction here between the primary market for the ABS as *securities* and the primary market for the underlying *assets* (loans, receivables, etc.).

Figures 10 and 11 show the dollar volume of both registered and Rule 144A ABS offerings for different types of underlying loans: Figure 10 for Residential Mortgage-Backed Securities (RMBS) and Figure 11 for ABS backed by all other types of collateral.

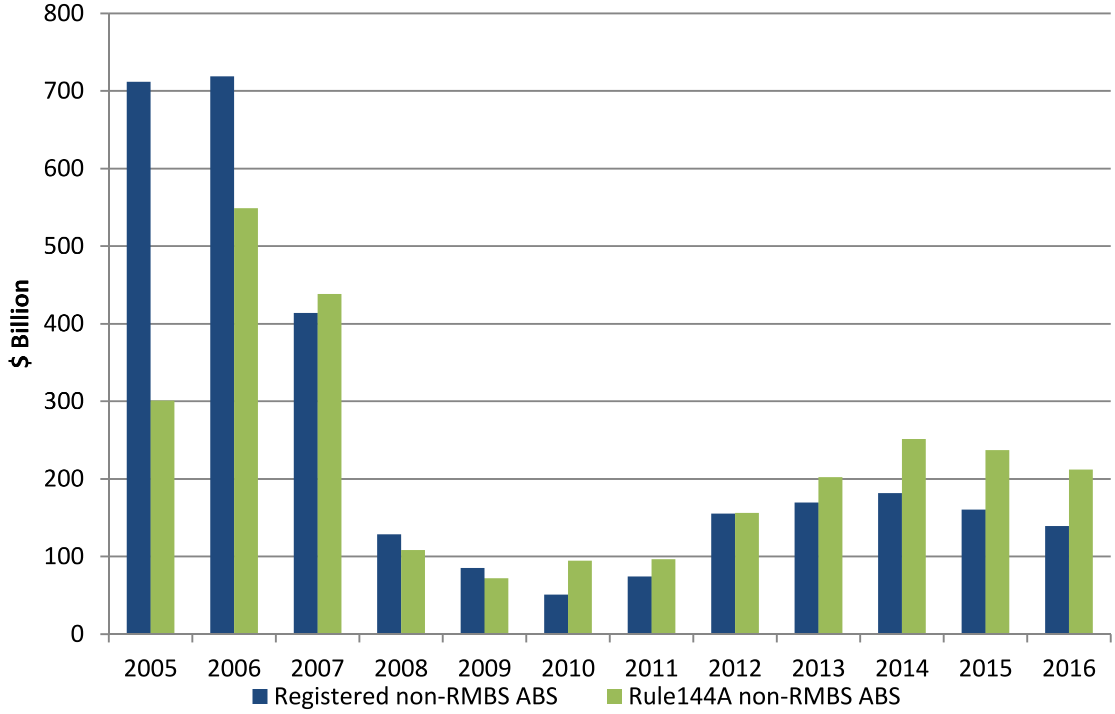
Figure 10. Registered and Rule 144A RMBS offerings (in $ billions), 2005-2016



Source: DERA analysis

The dollar volume of both types of offerings has decreased dramatically following the financial crisis. However, the issuance of registered RMBS almost stopped after 2008, whereas the issuance of registered ABS backed by other types of loans continued. We note that the market for private-label RMBS is distinct from other ABS markets because of the presence of Government Sponsored Enterprises (GSE), and its dynamics are more likely linked to the dynamics of the underlying housing market rather than to any effects stemming from changes in the securities market.[87]

Figure 11. Registered and Rule 144A non-RMBS ABS offerings (in $ billions), 2005-2016



Source: DERA analysis

For non-RMBS, we observe that the overall volume of ABS issuance has notably recovered since the trough of 2010. We also observe that the volume of private non-RMBS ABS offerings was slightly larger than the volume of registered ones following the financial crisis, a reversal from the pre-crisis period. Table 9 presents the number of ABS offerings, the average and median size of offerings, and the gross fees associated with offerings between 0.2% and 0.4%. There is no discernible trend in the fees over the period under examination.

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[87] *See,* e.g., Rel. No. 33-9638, *Asset-Backed Securities Disclosure and Registration* (Sept. 4, 2014) 79 FR at 57192 (Regulation AB2 Adopting Release). ("In the RMBS market, private-label RMBS issuers encounter competitive pressure from government-sponsored enterprises, whose mortgage-backed securities are guaranteed and exempt from registration and reporting requirements. As private-label issuance has declined, issuance of agency RMBS has increased.").

We note that recent rules specific to the ABS market went into effect at the end of or after the time period considered in the Report,[88] and some rules (such as credit risk retention) affected both registered and private markets. Regulation AB2, which fully applies only to some types of registered ABS offerings, went into effect in stages, in November 2015 and in November 2016;[89] the Credit Risk Retention rule went into effect in December 2016 for most asset classes and applies to both registered and unregistered ABS.[90] Thus, it is challenging to causally attribute the above trends to regulatory impacts. Further, while such trends may be generally consistent with regulatory impacts, they are also consistent with other explanations, such as a shift in investor risk tolerance and beliefs about the risks and returns of various ABS offerings following the financial crisis.

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[88] As we noted in the Methodological Considerations section, it is possible that some market participants anticipated and responded to some of these reforms ahead of the compliance or effective dates.

[89] Regulation AB2 shelf eligibility requirements other than asset-level disclosure and some other requirements went into effect in November 2015. The asset-level disclosure requirements went into effect in November 2016 for some types of ABS. Proposals to apply asset-level disclosure requirements to other types of ABS remain outstanding. *See* Regulation AB2 Adopting Release, 79 FR at 57184.

[90] *See* Credit Risk Retention Adopting Release, 79 FR at 77602.

V. Tables on Primary Issuance

Table 1. Number of offerings, offer size, and gross spreads for IPOs and SEOs, 2005-2016

Year	Number of offerings		Average offer size		Median offer size		Average gross spread		Median gross spread	
	SEOs	IPOs	SEOs	IPOs	SEOs	IPOs	SEOs	IPOs	SEOs	IPOs
2005	477	236	$192	$159	$100	$105	4.3%	6.7%	4.7%	7.0%
2006	486	246	$196	$188	$108	$104	4.2%	6.5%	4.6%	7.0%
2007	439	298	$206	$210	$117	$114	4.3%	6.6%	4.5%	7.0%
2008	280	53	$504	$195	$136	$126	4.1%	6.7%	4.2%	7.0%
2009	858	69	$243	$311	$65	$139	4.8%	6.3%	4.8%	6.8%
2010	861	200	$201	$203	$53	$90	4.8%	6.7%	5.0%	7.0%
2011	641	201	$197	$187	$69	$81	4.5%	6.3%	4.6%	7.0%
2012	738	206	$231	$217	$75	$77	4.5%	6.4%	4.5%	7.0%
2013	920	283	$196	$202	$90	$99	4.5%	6.5%	4.5%	7.0%
2014	811	347	$195	$257	$101	$90	4.6%	6.5%	4.8%	7.0%
2015	767	218	$223	$164	$98	$80	4.6%	6.5%	5.0%	7.0%
2016	702	119	$155	$90	$207	$80	4.3%	6.5%	4.5%	7.0%

Source: DERA analysis

Table 2. Number of offerings, offer size, and gross spreads for public debt offerings, 2005-2016

Year	Number of offerings	Average offer size	Median offer size	Mean gross spread	Median gross spread
2005	1,843	$406	$250	1.2%	1.0%
2006	1,739	$557	$350	1.0%	0.7%
2007	1,489	$662	$425	1.3%	1.0%
2008	1,189	$740	$400	1.5%	1.2%
2009	1,405	$734	$500	1.3%	0.8%
2010	1,827	$448	$250	1.7%	1.5%
2011	1,537	$528	$350	1.7%	1.3%
2012	1,481	$661	$500	1.0%	0.7%
2013	1,514	$698	$500	0.8%	0.7%
2014	1,604	$695	$500	1.3%	0.8%
2015	1,565	$775	$500	1.1%	0.7%
2016	1,636	$810	$500	0.8%	0.7%

Source: DERA analysis

Table 3. Capital raised through Regulation D and Regulation D/A (amended) offerings*

Year	Regulation D filings (number)	Regulation D/A filings (number)	Mean amount sold ($ millions)	Median amount sold* ($ millions)
2009	13,764	7,077	36	1.5
2010	17,581	11,864	26	1.4
2011	18,174	12,536	28	1.5
2012	18,187	13,284	27	1.5
2013	19,846	14,533	24	1.5
2014	22,004	15,254	24	1.5
2015	22,854	15,651	25	1.5
2016	22,992	16,490	25	1.5

Source: DERA analysis

*Mean and median amount sold based on initial (new) Form D filings only. Total amount sold includes additional amounts raised and reported in amended filings, recorded at the time of the amendment.

Table 4. Capital raised through Rule 506(c) and Rule 506(b) offerings: September 23, 2013 - December 31, 2016

Rule	Form D Filings	Number of Amendment Filings	Total amount sold* ($ billions)	Mean amount sold ($ millions)	Median amount sold ($ millions)	Median offer size ($ millions)
506(c)	5,474	874	$108	$13	$0.7	$2.4
506(b)	65,772	33,430	$4,122	$26	$1.6	$2.2
All 506	71,146	34,304	$4,230	$25	$1.5	$2.3
Regulation D**	73,556	50,491	$4,232	$24	$1.4	$2.0

Source: DERA analysis

* Total amount sold includes incremental amounts reported to be raised in amended filings (Form D/As). Mean and median amounts sold based on initial (new) Form D filings only. Median offer size is based on offerings that report their amount of offering.
** Includes all four rules: Rules 504, 505, 506(b) and 506(c).

Table 5. Investors participating in Regulation D offerings: 2009-2016

	Total Number of Investors	Mean Investors per Offering	Median Investors per Offering	Fraction of offerings with at least one non-accredited investor
Hedge Funds	32,684	17	2	7%
Private Equity Funds	22,572	18	3	4%
Venture Capital Funds	7,428	15	4	1%
Other Investment Funds	31,524	24	6	5%
Financial Services	12,220	15	4	13%
Real Estate	53,943	25	7	13%
Nonfinancial Issuers	103,194	9	4	10%
All offerings	263,621	14	4	9%

Source: DERA analysis

Table 6. Proportion of Regulation D offerings that sold or intend to sell to non-accredited investors[91]

	Rule 504	Rule 505	Rule 506(b) Offerings <=$5 million	All 506(b) offerings
2009	53%	39%	10%	10%
2010	54%	41%	9%	8%
2011	57%	43%	9%	8%
2012	58%	44%	10%	8%
2013	61%	41%	9%	8%
2014	60%	36%	8%	7%
2015	61%	43%	7%	6%
2016	65%	41%	7%	6%
2009-2016	58%	40%	8%	7%

Source: DERA analysis

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[91] Rule 506(c) offerings can sell only to accredited investors.

Table 7. Market size statistics (at the offering level) for crowdfunding offerings, 2016

	Aggregate ($ million)[92]	Median ($ 000s)	Mean ($ 000s)	Observations
Target amount	18.0	53	110	163
Maximum amount[93]	101.1	999	647.5	163
Amount raised	8.1	171	290	28[94]

Source: DERA analysis

Table 8. Offering characteristics for crowdfunding offerings, 2016

	Mean	Median	Observations
Offering duration, in months	4.5	4.0	163
%: Oversubscriptions accepted	98%		163
Number of jurisdictions of solicitation	50.6	51.0	163
%: Security type 'equity'	36%		163
%: Security type 'debt'	20%		163
%: Security type 'other'	44%		163

Source: DERA analysis

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[92] For issuers with multiple crowdfunding offerings, if the cumulative target or maximum offer amount is greater than $1 million, we cap it at $1 million for purposes of computing aggregate amounts offered. For example, if an issuer seeks up to $1 million in the first offering, raises $200,000, and seeks up to $800,000 in the second offering, we record the cumulative maximum amount sought by the issuer as $1 million.

[93] Maximum amount is defined as the maximum amount as specified in Form C if the offering accepts oversubscriptions (investments above the target amount) and is defined as the target amount if the offering does not accept oversubscriptions.

[94] Excludes reports without information on the proceeds (for example, reports noting "end of offering" without indicating a dollar amount of proceeds).

Table 9. Number of offerings, offer size, and gross spreads for registered and private ABS offerings, 2005-2016

	Number of offerings		Average ($ mil)		Median ($ mil)		Gross Fee	
Year	Reg'd	Rule 144A	Reg'd	Rule 144A	Reg'd	Rule 144A	Reg'd	Rule 144A
2005	1,594	907	$910	$356	$734	$206	0.2%	0.3%
2006	1,508	1,550	$959	$402	$796	$226	0.2%	0.3%
2007	1,088	1,102	$964	$471	$700	$300	0.2%	0.2%
2008	163	240	$863	$545	$710	$190	0.2%	0.3%
2009	80	264	$1,068	$454	$946	$250	0.3%	0.4%
2010	65	395	$785	$410	$772	$210	0.3%	0.4%
2011	86	280	$871	$491	$877	$303	0.3%	0.4%
2012	157	449	$1,001	$408	$1,026	$358	0.3%	0.4%
2013	180	540	$964	$414	$995	$388	0.3%	0.3%
2014	188	628	$966	$439	$1,000	$412	0.3%	0.3%
2015	178	635	$901	$434	$951	$408	0.3%	0.2%
2016	151	547	$924	$416	$894	$400	0.3%	0.3%

Source: DERA analysis

Part B. Market Liquidity

I. Introduction

As discussed above, primary issuance enables issuers to raise capital and impacts the types of securities available for capital allocation by businesses, investors, and consumers. Primary issuance characteristics can contribute to a reduction in secondary market liquidity if there is a high degree of concentration of risky issuers in certain issuance types or when primary issuance becomes fragmented. At the same time, the liquidity of issues in secondary markets determines whether investors are able to exit positions of different sizes quickly and without price impact, which may influence investor demand for securities in primary markets. As we noted earlier, the ability of market participants to exit their investments when secondary market liquidity is strong may facilitate primary issuance and increase the probability of placement success.

Therefore, secondary liquidity is an important characteristic that influences capital markets. In this section we turn to the evolution of market liquidity. In addition to analyzing liquidity in Treasuries and corporate bonds, we consider developments in single-name CDS and funds to test whether spillovers and liquidity diffusion across markets may contribute to observed trends in Treasuries and corporates. The sections below discuss a variety of liquidity metrics in those markets.

From the outset, we note that the analysis below considers the time series and cross-sectional evolution of various liquidity metrics, and does not seek to estimate the optimal amount of liquidity under various market structures or stress scenarios. Similarly, we recognize that liquidity is only one attribute of a market, albeit an important one. We do not seek to establish how liquidity should or should not be weighed against other market attributes, such as informational efficiency or market stability.[95]

II. Empirical Measures of Market Liquidity

Broadly, liquidity refers to the ability to execute transactions of a required size in a short period of time with little price impact.[96] A vast academic literature on market microstructure formulates different measures reflecting various dimensions of liquidity.[97] Existing measures of liquidity can be grouped roughly into three categories: trading activity measures (e.g., trading volume, turnover, average trade size), transaction cost measures (e.g., bid-ask spread, price impact), and measures of liquidity supply (e.g., dealer inventory, order book depth). Because liquidity is priced, i.e., the ability to sell an asset quickly has value in and of itself,[98] some of these measures reflect not only direct execution costs, but also the premium paid for more liquid assets. Some measures can be observed only at specific frequencies (e.g., daily), but many of these measures can be estimated with both daily and intraday data.

Trading Activity

Trading activity metrics generally reflect the overall amount of trading in a particular bond or market, and greater activity may reflect an increased ability of a participant to buy or sell

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[95] For instance, there may be a tradeoff between informational efficiency and liquidity. When markets are opaque, market participants may be less willing to transact, dampening liquidity. At the same time, when market participants are highly informed about the value of an asset, prices accurately reflect existing information and little trading may occur. For example, Grossman and Stiglitz (1980) showed that informational efficiency reduces incentives of economic agents to expend resources to acquire information. Their seminal result is that, because information is costly, prices cannot perfectly reflect available information—if they did, those who spent resources to obtain it would receive no compensation. Therefore, they conclude that there is an equilibrium amount of "disequilibrium."

[96] *See,* e.g., Sarr and Lybek (2002) and Bank for International Settlements (2014).

[97] These dimensions of liquidity are: (i) tightness, which refers to low transaction costs; (ii) immediacy, which refers to the speed with which orders can be executed; (iii) depth and breadth, which refer to the existence of abundant buy and sell orders at various price levels; and (iv) resiliency, that refers to the market's ability to quickly correct order imbalances and move prices back to fundamental values if prices are disturbed. *See* Sarr and Lybek (2002).

[98] *See*, e.g., Amihud et al. (2013) for a collection of academic articles that present theory and empirical evidence on the effect of liquidity on asset prices and how liquidity risk affects prices.

a bond. Trading volume and turnover directly measure trading activity in the market. If markets are liquid, then market participants should be able to exchange large volumes of traded assets either in absolute terms (trading volume) or in relation to the outstanding amounts of the assets (turnover). We note that both of these metrics are influenced by the changing trading needs of investors (e.g., trading volume might be elevated during times of high volatility), and by the changing supply of an asset (e.g., turnover does not take into account the share of a security's supply held by long-term investors and not available for trading, which might change over time). Therefore, it may be difficult to disentangle liquidity supply and liquidity demand explanations of the evolution in trading volume and turnover.

Average transaction size is sometimes used as a measure of liquidity—larger average trade size reflects participants' ability and willingness to trade large quantities of assets with small price impact. However, with the advent of electronic markets, investors may be able to more efficiently split larger transactions into smaller amounts and rely on algorithms to optimize execution or to obscure their trading strategies. Thus, a transaction size metric might exhibit a secular downward trend because of structural changes in the market rather than any other effects.

Transaction Costs

Transaction costs and price impact of trades capture the price dimension of liquidity, with lower transaction costs and lower price impact generally suggesting improvements in this liquidity dimension. We note that empirical measures of transaction costs reflect trade execution costs and do not reflect untraded bonds. Therefore, it is important to interpret the transaction cost evidence in conjunction with the trading activity metrics above.

A quoted bid-ask spread is a common transaction cost measure. It is calculated as the difference between buy and sell quoted prices and serves as a proxy for the direct cost of a round-trip trade. A quoted bid-ask spread measures the tightness dimension of liquidity and the direct transaction costs of executing a trade. However, a quoted bid-ask spread does not take into account the quantity dimension of the order book. The quantities available at the bid or the ask price might be limited, despite a narrow quoted bid-ask spread and, thus, execution of large trades at these prices might not be possible. A closely related metric is the effective spread, which is a better proxy for true transaction costs. It is twice the difference between the execution price and the average of the bid and the ask price. In the absence of quote data, Roll (1984) suggests an estimator of the effective spread on the basis of the serial covariance of the change in price and shows that, under certain assumptions, this measure approximates transaction costs well.

Other transaction cost measures are related to price impact, motivated by Kyle (1985), and are based on the estimated price changes per given net order flow. Price impact measures assess the change in a security's price when a liquidity taker uses up some of the supplied liquidity. Lower price impact indicates better market resiliency and an ability to execute trades without adverse impact on prices. However, price impact does not measure direct transaction costs or market depth.

Liquidity Supply

Liquidity supply in fixed income markets can be represented by the total amount of bonds held by dealers in inventory. This is an *ex post* measure of whether dealers have been willing to take on inventory risk. It may be interpreted as an imperfect proxy of potential future ability of dealers to supply liquidity, but does not necessarily measure dealers' willingness to provide liquidity. This measure also does not take into account the possibility that market participants other than dealers might substitute for dealers as liquidity providers. A reduction in the dealer inventory levels may be offset by an increase in the inventory held by non-dealer liquidity providers.

Similarly, visible quoted depth represents the amount of securities available for sale/purchase at the best bid/offer. Quoted depth measures the supply of liquidity by market participants as the volume that can be transacted at the quoted levels. Another measure of market depth, order book depth, is the amount of securities available for sale/purchase within a certain price range. We note, however, that neither measure of depth considers the cost dimension of liquidity, because they both focus on the quantity offered for purchase or sale conditional on price.

Composite Measures

Finally, some studies suggest composite measures that would present a single number to summarize multiple facets of liquidity.[99] These composite measures typically rely on weighted averages or principal component analysis of several liquidity measures that quantify different dimensions of liquidity. However, such index measures may be difficult to interpret, and there is little consensus in academic and practitioner research on the use of aggregate liquidity metrics.

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[99] *See,* e.g., Korajczyk and Sadka (2008) and Adrian et al. (2015) that use methods based on the principal component analysis for the U.S. equity markets and for the U.S. Treasury markets, respectively, Autorité des Marchés Financiers (2015) that uses weighted averages to measure liquidity of French bond market, and Financial Conduct Authority (2016) that uses a combination of both approaches to measure liquidity of the UK bond market.

III. Treasuries

A. Introduction

U.S. Treasury securities are fixed income securities issued by the U.S. government, priced by most market participants as nearly default free.[100] These securities play a unique role in financial markets because of their aggregate market size, level of trading activity, and backing by the U.S. Government. They serve as a critical element in the financing of the U.S. Government and the execution of U.S. monetary policy. U.S. Treasuries are used as a high-quality investment, a store of value, and as a primary tool for interest rate risk management by not only investors, but also nation states. In addition, their yield is often used as the benchmark yield for pricing many other fixed income instruments.[101]

The U.S. Treasury market is the largest government securities market in the world. As of September 30, 2016, there are $19.6 trillion of Treasuries securities outstanding, with $14.2 trillion held by the public. Of publicly held debt, $13.6 trillion is tradable in financial markets.[102] Treasury securities make up approximately 33% of the entire U.S. fixed income market, which also includes municipal, mortgage-related, corporate, federal agency, money market, and asset-backed securities.[103]

The U.S. Treasury market is also one of the most liquid and lowest transaction cost fixed income markets in the world.[104] Treasury securities can be viewed as close cash substitutes because market participants can generally rely on the ability to convert Treasuries into cash

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[100] Krishnamurthy and Vissing-Jorgensen (2012) even argue that the Treasury interest rates are lower that the "true" riskless interest rates because of the liquidity and convenience of Treasury securities.

[101] *See* Fleming (2000) and Joint Economic Committee (2001).

[102] *See* Monthly Statement of the Public Debt of the United States, September 30, 2016, U.S. Treasury at https://www.treasurydirect.gov/govt/reports/pd/mspd/mspd.htm.

[103] *See* SIFMA statistics at http://www.sifma.org/research/statistics.aspx.

[104] *See,* e.g., Bank for International Settlements (2016).

rapidly and at low cost. Currently, trading in the U.S. Treasury market is more active than in all other U.S. fixed income markets combined. The average daily trading volume in the U.S. Treasury market in September 2016 was $499 billion and made up 64.6% of the entire U.S. bond markets trading volume.[105]

Because of its importance in setting benchmarks for financial markets, its scale, and its trading activity, the liquidity of the secondary U.S. Treasury market is an important consideration for both market participants and regulators.[106] In this section, we consider changes in U.S. Treasury market liquidity and whether any observed changes are consistent with the hypothesis that Dodd Frank, Volcker, and Basel III reforms, among other factors, had adverse effects on liquidity in this market. From the outset, we note that the Treasury market has evolved since the financial crisis of 2007–2009 in ways that may have influenced liquidity conditions. We summarize these changes below and discuss how they and other potential drivers may be changing liquidity conditions.

First, regulators introduced, adopted, and made effective several new regulations that affected market participants—and, in particular, dealers. During and after the crisis, most major dealers became banks or bank holding companies and, thus, became subject to new enhanced capital and liquidity requirements and other applicable banking regulations. In particular, the new leverage ratio requirements of the Basel III framework were intended to constrain excess leverage and may have increased the costs of market making in U.S. Treasuries.[107] Parts of the Dodd-Frank Act—in particular, the Volcker Rule—also directly affected dealers' trading

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[105] *See* SIFMA statistics at http://www.sifma.org/research/statistics.aspx.

[106] The Treasury, the SEC, the Office of the Comptroller of the Currency (OCC), the Federal Reserve Board (FRB), and the Federal Deposit Insurance Corporation (FDIC), regulate different aspects of the cash Treasury market and many of its participants, while the CFTC regulates the futures markets, including the Treasury futures markets, and many of its participants. *See* Joint Staff Report (2015).

[107] *See,* e.g., Bank for International Settlements (2014).

activities in fixed income markets. Some market participants believe that these regulations have substantially changed dealers' business models and practices, affecting dealers' balance sheets and profitability and their ability to provide liquidity to fixed income markets.[108] For instance, some have argued that Basel III minimum capital requirement and its lack of risk-weighting may potentially make capital intensive, low risk, low-margin and high-volume business, such as market-making in highly rated sovereign bonds and repo, less profitable and may, therefore, reduce its volume. For a more detailed regulatory reform timeline that covers other post-crisis regulations, see Appendix A.

Second, the U.S. Treasury market structure has undergone substantial structural changes over the last decade. Most interdealer trading and a substantial share of institutional trading in Treasuries has migrated from voice networks to electronic marketplaces. According to Greenwich Associates (2015), 84% of institutional investors traded Government bonds electronically in 2015 compared to 61% in 2005. The growth of electronic trading has increased the speed of trading while reducing its cost.

Third, the U.S. Treasury market recently experienced two major events that affected market liquidity: the 2013 Taper Tantrum, when remarks by then-Federal Reserve Chairman Ben Bernanke triggered a substantial selloff and a yield increase of over 100 basis points within a 10-week period,[109] and the October 15, 2014 event, when yields abruptly decreased and reverted within a span of 15 minutes without any clear catalyst. In response to the second event, staff from a group of regulators produced a joint report (Joint Staff Report (2015)) and hosted two conferences on Treasury market structure and liquidity in 2015 and 2016.

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[108] *See* Bank for International Settlements (2014) and Bank for International Settlements (2016).

[109] *See,* e.g., Silvia and Moehring. *Case Study of the Taper Tantrum and Term Premiums*, Wells Fargo Securities (Aug. 4, 2015).

We recognize that several recent regulatory initiatives aim to change some aspects of the Treasury market structure. For instance, the implementation of post-trade reporting of Treasury transactions for FINRA members and the corresponding expansion of TRACE reporting,[110] the Federal Reserve's transaction initiatives for banks announced in 2016,[111] and other related reforms aimed at improving market monitoring and oversight by regulatory agencies may impact market participants' behavior, market structure, participation, and liquidity metrics going forward.

In the following sections, we review possible determinants of the changes in Treasury market liquidity and challenges in causal identification of the effect of individual factors, applicable empirical liquidity measures, and recent evidence on the evolution of secondary market liquidity in Treasuries.

B. Determinants of Liquidity Changes

Multiple factors potentially affect market liquidity, and in this section we consider a number of such factors. However, as discussed in the Broad Economic Considerations section of the Report above,[112] our analysis of Treasury market liquidity faces challenges in establishing causality for any single driving factor that might affect Treasury market liquidity. Among other complications, we note that the precise timeline of various regulatory changes and market responses to each regulatory reform is ambiguous because of multiple other events and market-wide structural changes occurring over the same period of time. We also note that various

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[110] Rel. No. 34-79116, *Self-Regulatory Organizations; Financial Industry Regulatory Authority, Inc.; Notice of Filing of Amendment No. 1 and Order Granting Accelerated Approval of a Proposed Rule Change, as Modified by Amendment No. 1, Relating to the Reporting of Transactions in U.S. Treasury Securities to TRACE* (Oct. 18, 2016) 81 FR 73167 (Oct. 24, 2016).

[111] *See* Press Release, Board of Governors of the Federal Reserve System, *Federal Reserve Board announces plans to enter negotiations with FINRA to potentially act as collection agent of U.S. Treasury securities secondary market transactions data* (Oct. 21, 2016), available at https://www.federalreserve.gov/newsevents/press/other/20161021a.htm.

[112] *See* Introduction to the report.

liquidity drivers may offset one another and dampen observed trends, which may lead us to observe that Treasury liquidity has not changed in response to regulatory changes in aggregate, whereas each change might have, in fact, differentially affected liquidity, with individual impacts in opposite directions. Such considerations further complicate causal identification.

One of the most commonly cited factors behind changes in secondary market liquidity is the introduction of new regulations, in particular, the Dodd-Frank Act (especially, the Volcker Rule) and the Basel III framework post-crisis. These regulations were aimed at promoting financial stability.[113] However, some commenters have argued that those regulations imposed higher costs of carrying inventory and restrictions on proprietary trading activities of banks, which may have reduced dealer provision of liquidity. Crucially, we note that U.S. Treasuries are exempt from the Volcker Rule's prohibitions on proprietary trading. Therefore, the changes in Treasury market liquidity reported below are unlikely to be directly attributable to the Volcker Rule, though the Volcker Rule may indirectly affect them as a result of spillover effects from other markets.[114]

In addition to the regulatory reforms of interest, the Treasury and other fixed income markets underwent a number of structural changes in recent years. The growth of electronic trading, an increasing share of proprietary trading firms in the Treasuries market, and the growth of bond ownership by large asset managers are all likely to have impacted Treasury liquidity.

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[113] *See* Preamble, Dodd–Frank Wall Street Reform and Consumer Protection Act, Pub.L. 111–203, H.R. 4173.

[114] For example, one of the related markets is the market for derivatives on Treasuries. The Volcker Rule does not provide an exemption for trading in derivatives on Treasury securities similar to the exemption for Treasuries (although other exemptions, e.g., the risk-mitigating hedging exemption, may be available for such trading). *See* Rel. No. BHCA-1, *Prohibitions and Restrictions on Proprietary Trading and Certain Interests In, and Relationships with, Hedge Funds and Private Equity Funds* (Dec. 10, 2013) 79 FR at 5639 (Volcker Rule Adopting Release). The lack of exemption for derivatives on U.S. Government obligations could affect liquidity in the underlying Treasury market in either direction.

For instance, the bond ownership share by mutual funds has risen notably post-crisis.[115] Traditionally, mutual funds have been liquidity seekers, and their increased ownership of bonds together with higher magnitude and volatility of fund flows[116] may create higher and more volatile liquidity demand because of higher redemption risk. At the same time, increases in trading activity by proprietary trading firms might make them *de facto* liquidity providers.[117]

Moreover, the financial crisis may have led to changes in dealer risk appetites, return expectations, and risk management practices, resulting in changes in observed liquidity conditions. A general decline in risk taking and changes in risk management practices combined may have contributed to reductions in dealer leverage independent of regulatory compliance effects. Adrian et al. (2017a) document dealer deleveraging and a reduction in balance sheets occurring during and in the immediate aftermath of the 2007-2008 financial crisis, before many of the regulations at issue were announced, proposed, or adopted.

Three additional factors, including diffusion of liquidity to other markets, liquidity jumps, and liquidity bifurcation (diverging liquidity conditions in the same market for different subgroups of bonds), may further obstruct inference about causal effects of particular drivers of liquidity. These three factors, to date, have not been widely studied in the academic literature because of data limitations and difficulty in finding clear evidence to permit accurate causal attribution of changes in liquidity to changes in these factors.

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[115] *See* Figure 4.5 in Joint Staff Report (2015), which shows that the share of Treasury securities held by mutual funds has increased in recent years, from under 4 percent in the years preceding the financial crisis to 6.7 percent at the end of March 2015.

[116] *See* Figure 4.6 in Joint Staff Report (2015), which shows that the magnitude and the volatility of Government bond fund flows has increased since 2008.

[117] *See* Joint Staff Report (2015). The Report notes, however, that proprietary trading firms often act as short-term liquidity providers and do not carry substantial inventory to respond to liquidity demands from other market participants.

First, in addition to the cash Treasury market, market participants have access to an active Treasury futures market.[118] Thus, changes in Treasury market liquidity may reflect a diffusion of liquidity between the cash Treasury market and the Treasury futures market. For a complete picture of the liquidity conditions available to Treasury market investors, we need to consider the co-liquidity of the Treasury market with its derivatives market; and so we review available evidence in the following sections. We also recognize that liquidity in corporate bond and single-name CDS markets may interact with activity in Treasuries.[119] Hence, for a cohesive understanding of changes in market liquidity conditions, it is important to consider liquidity in Treasuries in conjunction with liquidity in corporate bond and single-name CDS markets.

Second, Adrian et al. (2015) introduce the concept of "liquidity risk" that describes the elevated probability of sudden spikes in illiquidity rather than changes in the overall liquidity level (similar to elevated "volatility of liquidity"). They argue that the recent increase in incidence of "flash" events in various financial markets can be described by a model of liquidity that has a slow-moving continuous level component and a jump component. However, jumps in liquidity have not been rigorously studied. If such liquidity risk is indeed present in the Treasury market, there are no main studies of its causes or drivers. If, as these researchers posit, changes in liquidity include a jump component, a factor may affect liquidity by changing the intensity and the size of the jump component without affecting the slow moving component of liquidity. For econometricians, estimating and making statistical inferences about models with jumps is generally more difficult and requires a longer time series of data. This, in turn, makes statistical inferences that rely on such models to identify changes in the level of liquidity difficult to make.

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[118] *See* Joint Staff Report (2015), Tables 3.3 and 3.4.

[119] We explore changes in corporate bond and CDS markets liquidity later in Sections IV and V of Part B of this report.

Third, liquidity conditions in different sectors of the same market may evolve in opposite directions ("liquidity bifurcation"). For example, a highly liquid electronic market for the most recently issued Treasuries of a particular maturity ("on-the-run" Treasuries) may attract participants seeking liquidity and low transaction costs who might otherwise seek to trade in the largely voice-based markets for Treasuries issued before the most recent issue ("off-the-run" Treasuries) and Treasury Inflation Protected Securities (TIPS), reducing liquidity in these markets. Therefore, looking at a single market-wide measure of liquidity might obscure more complicated substitution between market segments.

In light of the above, it is difficult to disentangle multiple concurrent and correlated drivers of liquidity, limiting our ability to draw causal inference with respect to any individual determinant of liquidity. While we are unable to identify causal impacts, the analysis below sheds light on the evolution of transaction activity and liquidity in Treasuries and evaluates alternative explanations of observed changes.

C. Empirical Measures

Many of the measures of liquidity discussed in the introduction to Part B of this Report were originally proposed for use in particular markets, most commonly the equity market, and tested in those markets. Because of differences in market structure and data constraints, many traditional measures of liquidity are not readily applicable to the U.S. Treasury market. At the same time, unique features of the U.S. Treasury market give rise to several Treasury-specific liquidity measures that do not translate well to other markets. In this section, we review measures that are applicable to the U.S. Treasury market and that have been used in the literature to study its liquidity conditions, notably measures of funding liquidity (e.g., measures reflecting the ability to execute arbitrage opportunities, such as yield curve fitting error, on-the-run/off-the-run spread, or the yield spread between bonds issued by the Resolution Funding Corporation and those issued by the U.S. Treasury (RefCorp spread)).

Funding Liquidity

Several liquidity measures are based on the ability to execute arbitrage opportunities and on the availability of funds to take advantage of such opportunities (here, referred to as "funding liquidity"). The U.S. Treasury market is unique in that it includes multiple securities with similar or identical cash flows and credit risk—the credit risk of the U.S. Government. The existence of multiple securities with similar cash flows allows participants to build arbitrage portfolios to take advantage of mispricing between two or more sets of securities. Often, however, such portfolios are characterized by different liquidity and the execution of arbitrage trades might require additional funding: divergence in prices of such portfolios can occur when there are limits to arbitrage, such as when arbitrageurs are capital constrained (have low *funding* liquidity). The price difference between arbitrage portfolios can be interpreted as a proxy for a *market* liquidity measure because good funding liquidity allows traders to provide market liquidity and vice versa; good market liquidity eases funding constraints of traders.[120]

The first such measure, the yield curve fitting errors (Hu et al. (2013)), is the sum of squared residuals of observed Treasury yields from a fitted term structure model. These errors are evidence of unexploited profits and reflect liquidity constraints faced by arbitrage capital that, in the absence of funding constraints, should be able to eliminate deviations between observed Treasury yields and their expected yields, based on fundamentals, which are assumed to lie on the fitted term structure.

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[120] *See* Brunnermeier and Pedersen (2009) for detailed arguments connecting funding liquidity and market liquidity.

The second arbitrage motivated measure, the on-the-run/off-the-run spread, is the difference between yields on an on-the-run Treasury and a synthetic off-the-run Treasury that is constructed from the off-the-run yield curve. This construction relies on the fact that a 5-year bond 3 years after its issuance becomes a 2-year bond that is similar to a newly issued 2-year bond up to a difference in coupon rates. Because both bonds have the same credit risk and cash flows, but their liquidity characteristics may be notably different, the yield differential between them is primarily attributed to the liquidity premium on the Treasury market.

The third measure, the RefCorp spread, should reflect only differences in liquidity because both sets of bonds have the same credit risk.[121] All three arbitrage-based measures of liquidity share the same limitations: they are indirect measures of *market* liquidity, and they do not directly assess the size, cost, or immediacy dimensions of liquidity. Those three measures capture *funding* liquidity, which might be affected by factors other than those that are relevant to market liquidity.

D. Recent Evidence

In this section, we assess the empirical evidence on the current state of Treasury market liquidity. First, we consider studies that examine the time series evolution of liquidity measures from a period before the crisis to a period after several regulatory reforms took place. The measures include bid-ask spreads, depth, price impact, trade size, yield curve fitting errors, RefCorp spread, on-the-run premia, return autocovariances, and turnover. Second, we discuss several studies that analyze Treasury liquidity during recent periods of market stress to better

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[121] The Resolution Funding Corporation (RefCorp) is a government agency created by the Financial Institutions Reform, Recovery, and Enforcement Act of 1989. RefCorp bonds' principal is fully collateralized by U.S. Treasury bonds and full payment of coupons is guaranteed by the U.S. Treasury.

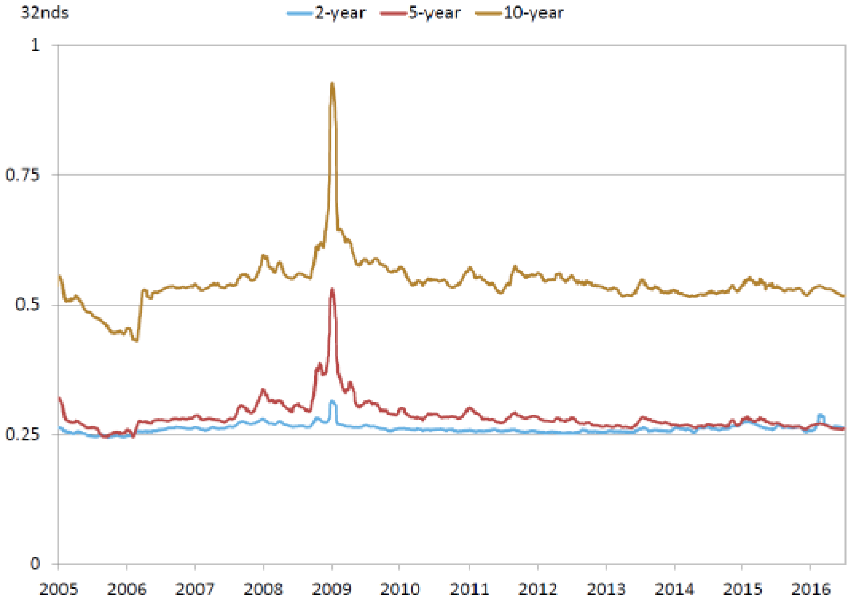
understand the Treasury market's resilience. Finally, we address the implications of liquidity in the interest-rate derivatives market for our findings about Treasury market liquidity.

In a comprehensive study of fixed income liquidity, Adrian et al. (2017a) analyze a number of intraday and daily measures of U.S. Treasury market liquidity. The authors examine the three most actively traded Treasury securities—on-the-run 2-, 5- and 10- year notes—and construct the following market liquidity measures: (1) bid-ask spread, (2) order book depth, (3) price impact, (4) trade size, (5) yield curve fitting error, and (6) RefCorp spread. Measures (1) through (4) rely on intraday data, while (5) and (6) are constructed using daily data. As detailed below, most of these measures indicate that Treasury liquidity is within historical norms, and that post-crisis regulatory changes do not appear to have had a notable impact.

Treasury bid-ask spreads, calculated as the difference between highest bid and the lowest ask, are presented in Figure 12. The Figure shows that bid-ask spreads were substantially higher during the crisis, suggesting that the cost dimension of liquidity was higher and liquidity lower during that period of market stress. However, bid-ask spreads have been low and stable since then, consistent with the view that this dimension of Treasury market liquidity is now back to pre-crisis levels. As discussed above, we recognize that bid-ask spreads do not fully reflect the supply of liquidity. Therefore, we turn to the evidence on other facets of liquidity.

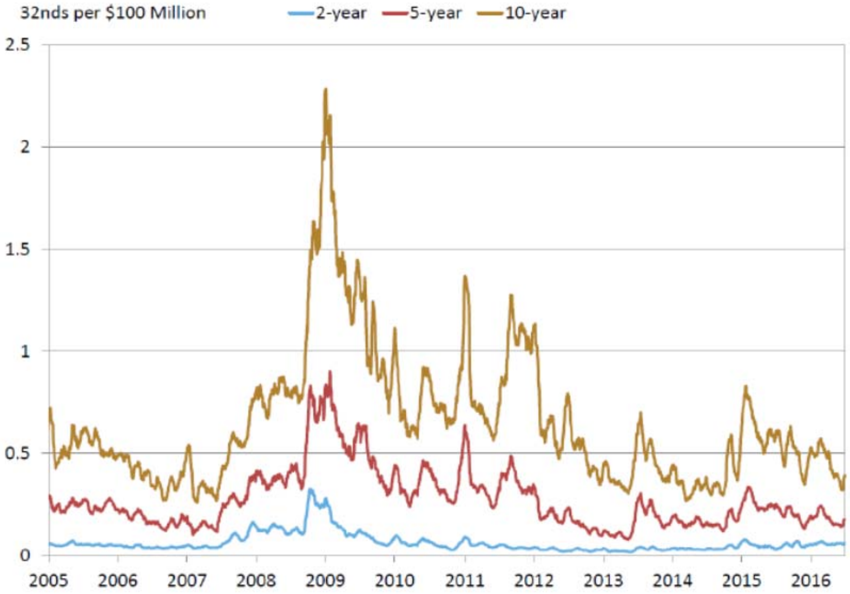
We present the time series of Treasury price impact, order book depth, and trade size in Figures 13 through 15. Price impact is motivated by Kyle (1985) and is calculated as the estimated price change per $100 million net order flow. Order book depth is the quantity of securities that is explicitly bid for or offered for sale at the best five bid and offer prices in the BrokerTec limit order book. Lower impact, more depth, and larger trade sizes are indicative of higher liquidity.

Figure 12. Treasury bid-ask spreads



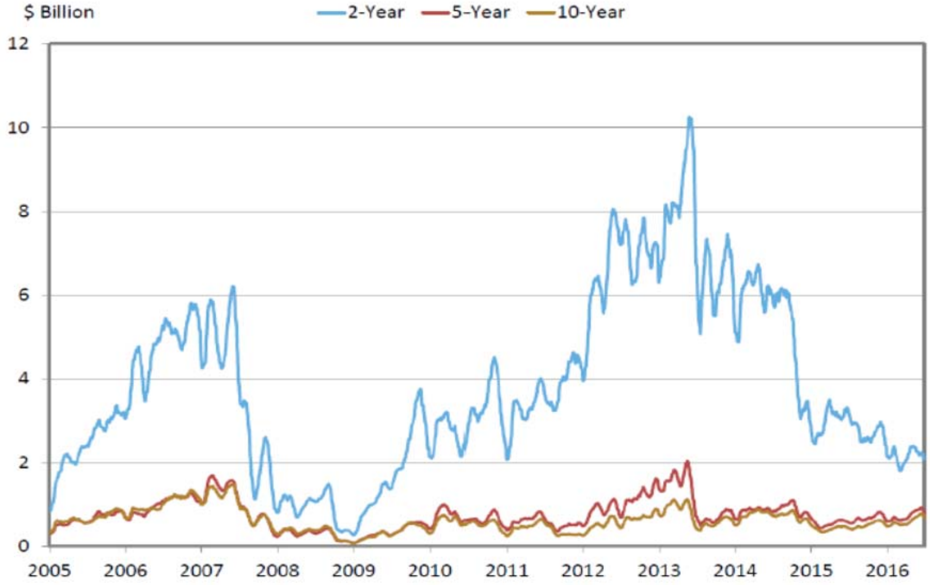
The chart plots the 21-day moving averages of average daily bid-ask spreads for on-the-run notes in the interdealer market. Price is per $100 par. Spreads are measured in 32nds of a point where a point equals one percent of par. Data is from BrokerTec. Source: Adrian et al. (2017a).

Figure 13. Treasury price impact



The chart plots the 4-week moving average of slope coefficients from weekly regressions of 5-minute price changes (calculated using bid-ask midpoints) on 5-minute net order flow for on-the-run notes. Price is per $100 par. Price impact is reported in 32nds of a point per $100 million of net order flow. Data is from BrokerTec. Source: Adrian et al. (2017a).

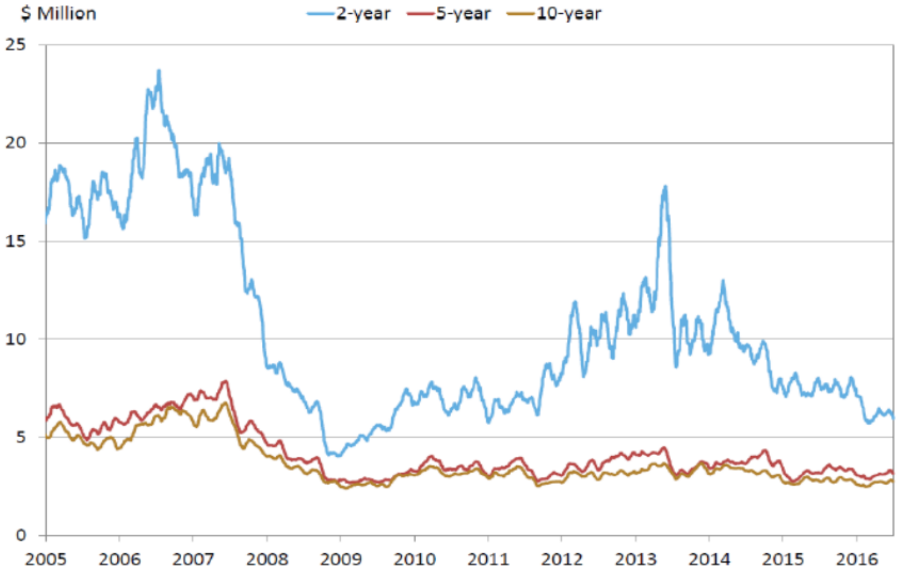
Figure 14. Treasury order book depth



The chart plots the 21-day moving averages of average daily order book depth for on-the-run notes. Order book depth is summed across the top five levels of both sides of the order book and is reported in billions of dollars. Data is from BrokerTec. Source: Adrian et al. (2017a).

Figures 13 through 15 show that these liquidity measures follow a similar pattern: liquidity dramatically deteriorated during the crisis, rebounded in the post-crisis period, and deteriorated again around other periods of market stress (May 2013 and October 2014). While price impact is now at a pre-crisis level, the current level of order book depth and average trade size paint a less clear picture. Both measures increased through 2013 but then began to decrease and are now at a relatively low level compared to the pre-crisis period. However, it is difficult to interpret this decline as evidence of a reduction in liquidity for several reasons. First, as discussed above, both measures are only partial indicators of liquidity. Second, depth estimated from the order book might be substantially lower or higher than true depth. For example, market participants may be willing to trade larger quantities than they quote, if market participants submit the same quote to different outlets with the intent to execute at one outlet and cancel the remaining quotes. Finally, declining trade sizes might simply reflect the increased presence of high-frequency trading in the Treasury interdealer market and their preference for smaller trade sizes as documented in the Joint Staff Report (2015).

Figure 15. Treasury trade size



The chart plots the 21-day moving averages of average daily trade size in the interdealer market in millions of dollars for on-the-run notes. Data is from BrokerTec. Source: Adrian et al. (2017a).

The two funding liquidity measures analyzed in Adrian et al. (2017a), namely yield curve fitting errors and RefCorp spreads, show no notable deterioration in liquidity over time. As discussed above, yield curve fitting errors (Hu et al. (2013)) reflect unexploited profits that may result from liquidity constraints in other markets, and the yield spread between bonds issued by the Resolution Funding Corporation and those issued by the U.S. Treasury (Longstaff (2004)) should reflect only differences in liquidity. Both measures substantially increased during the crisis, but fitting errors revert to levels similar to the pre-crisis period. RefCorp spreads, though lower than during the crisis, remain slightly elevated. This appears to be inconsistent with the adverse effects of regulatory reforms, such as the Volcker Rule or Basel III, on Treasury liquidity. Similar to the above caveat, we recognize that these measures reflect only one dimension of liquidity.

Trebbi and Xiao (2015) present a more systematic analysis of the effect of these reforms. The authors examine a sample of 1,124 Treasury bills, notes, and bonds traded between April 1, 2005, and December 31, 2014. Using a statistical method that allows them to identify structural breaks in market liquidity without knowing the exact timing of such breaks, they look for structural breaks in four Treasury market liquidity measures: (1) yield curve fitting errors, (2) on-the-run premia, (3) return autocovariances, and (4) turnover.[122] Trebbi and Xiao (2015) document that fitting errors, on-the-run premia, and return autocovariances show deterioration during the crisis, but then normalize, consistent with the evidence in Adrian et al. (2017a). They also find that turnover and return autocovariances show a small break in late 2011, close to the release of the first proposed Volcker Rule in November 2011, but the break is to a higher liquidity level. Only turnover appears to break to a lower liquidity level in 2008 (see Figure 16), but this may be an artifact of quantitative easing, which resulted in increased Treasury issuance and large Treasury holdings by the Federal Reserve in the aftermath of the crisis. Trebbi and Xiao (2015) conclude that post-crisis regulatory changes do not seem to have resulted in a statistically or economically significant deterioration in Treasury market liquidity.

Finally, Adrian et al. (2015) construct a Treasury illiquidity index as the first principal component of the inverse of market depth, quoted bid-ask spread, and returns autocovariance (Roll (1984)). That is, the index captures a single factor that is responsible for most of the common variation in the three liquidity measures and therefore reflects both transaction costs and market depth in a composite measure of liquidity. As shown in Figure 17, the illiquidity index spikes substantially around the 2007-2008 financial crisis and then a few more times, though to a lesser extent, through the end of 2011. After that, the only notable increase in the

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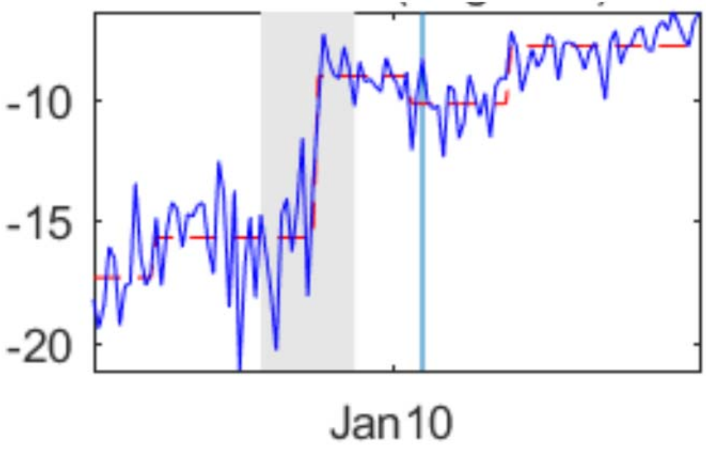
[122] *See* Part B.III.C above for the description of various liquidity measures unique to the Treasury market.

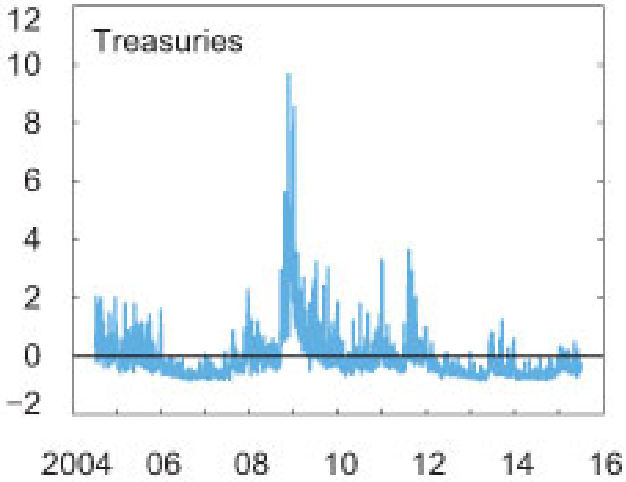
index occurs around the Taper Tantrum of 2013. For other post-2011 periods, the index remains at or below pre-crisis levels.

Figure 16. Treasury (negative) turnover



The chart plots the time series of negative turnover (blue line), defined as minus one times annualized monthly trading volume divided by amount outstanding, and its estimated mean (red line). The solid vertical line indicates the passage of the Dodd-Frank Act (July, 2010). The sample period is from April 2005 to December 2014. The data frequency is monthly. The grey area indicates recession. Source: Trebbi and Xiao (2015).

Figure 17. Treasury illiquidity index



The chart plots a Treasury illiquidity index that is calculated as the first principal component of daily (inverse) market depth, the quoted bid-ask spread, and Roll's effective bid-ask spread for the on-the-run 10-year note. Roll's measure uses 1-minute intraday returns to compute daily autocovariance; the daily depth averages intraday 1-minute order book depth at the innermost three tier. Data is from Bloomberg, BrokerTec, and the FRB. Source: Adrian, et al. (2015).

To gain additional insight into market resilience after the crisis, several studies focus on Treasury liquidity during periods of market stress. Some market participants have argued that regulation-induced dealer balance sheet constraints may have amplified the rise in yields and volatility,[123] so several studies addressed this issue in two stress contexts. First, Adrian et al. (2013) and Adrian et al. (2017a) study Treasury market liquidity during the "Taper Tantrum" of 2013. These studies show that less constrained dealers reduced their net positions during the stress period to a greater extent than more constrained dealers. The papers conclude that dealers' unwillingness to engage in market making may have been driven by increased uncertainty and repricing of duration risk, but not by balance sheet constraints.

A second incidence of Treasury market stress was the Flash Event of October 15, 2014, when yields rapidly fell and then rose within a short time interval. This event was extensively analyzed in the Joint Staff Report (2015). While the report does not identify the exact cause of the event, it establishes no direct link between the event and post-crisis regulatory changes. Importantly, it indicates some important structural changes in the Treasury market that may have an impact on liquidity. The report documents that the composition of participants in the Treasury market has changed substantially, with many market participants using electronic trading strategies and execution systems. As Table 10 indicates, principal trading firms (PTFs), which are principal investors that employ automated trading strategies, now account for more than half of the trading volume in the electronically brokered Treasury market. Furthermore, their trading activity is highly concentrated: the ten most active PTFs account for 93% of PTF trading volume, while the ten most active dealers account for only 77% of dealer trading volume. The report concludes that the growth of automated trading in the Treasury market introduces new challenges around operational risk, oversight and risk management, and market liquidity.

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[123] *See* Matt Cameron & Lukas Baker, *The great unwind: Buy-side fears impact of market-making constraints*, RISK (July 30, 2013).

Table 10. Treasury market participants

	Bank/ Dealer	Principal Trading Firm
Number of Participants	45	40
Volume	35%	56%
Top 10 Volume Share	77%	93%
Top 10 HHI	0.11	0.23

The table presents market participant composition statistics for the 10-year, on-the-run Treasury during April 2 through April 17, 2014. HHI is Herfindahl-Hirschman Index. Data is from BrokerTec. Source: Joint Staff Report (2015), Tables 3.3 and 3.7.

It is important to note that the assessment of Treasury market liquidity in this section focuses on the Treasury cash market. However, an investor looking to gain exposure to U.S. interest rates can do so in the derivatives market as well through synthetic positions in futures, options, or swaps. To the extent that liquidity in the cash and derivative markets is additive, our focus on liquidity measures from the cash market may underestimate overall Treasury liquidity. For instance, the price impact measures discussed above consider price change in relation to net order flow from the cash market only. According to the Joint Staff Report (2015), during April 2 through April 17, 2014, average daily volume was \$53 (\$44) billion in the cash market compared to \$132 (\$248) billion in the futures market for Treasuries maturing in 5 (10) years. Because trading activity in the cash Treasury market is only a small fraction of total trading activity in Treasury-related interest rate markets, the true price impact of the aggregate order flow to all Treasury-related markets may be smaller than reported above, because some of that order flow might be absorbed by the derivatives market and, thus, might not be visible to observers and might not be accounted for in the cash market price impact calculations. Therefore, the estimated price impact might overstate the true price impact of the overall order flow on all related markets.

On the other hand, other dimensions of liquidity may not be additive across the cash and derivative markets. Dobrev and Schaumburg (2015) analyze quotes by high-frequency traders in the Treasury cash and futures markets and document that trades in the futures market are instantaneously followed by decreased depth in the cash market. This is consistent with contemporaneous quotes in each market reflecting more than the total quantity these traders intend to trade and suggests that Treasury depth may not be additive across the cash and derivative markets. Finally, as we noted earlier,[124] differential impact of some regulations on the Treasury cash market and the Treasury derivatives market might change relative liquidity conditions of the two markets over time.

E. Summary

Overall, we find no consistent empirical evidence that Treasury market liquidity deteriorated as a result of post-crisis regulatory changes. The studies assessed in this section analyze a wide range of liquidity measures that quantify different dimensions of liquidity and use a variety of empirical methods to examine changes in these measures. None of these studies provide empirical support for a causal link between various regulations, and in particular, the Volcker Rule, and changing Treasury market liquidity conditions.

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[124] *See* footnote 114 above.

IV. Corporate Bonds

A. Introduction

As analyzed in Part A, the U.S. corporate bond market is one of the world's largest sources of capital for companies. In addition, the corporate bond market provides valuable investment opportunities for market participants. Similar to Treasuries, corporate bonds are sensitive to interest rate fluctuations and provide investors with opportunities to gain exposure to interest rate risk. Further, corporate bonds enable market participants to gain exposure to the credit risk of individual issuers. In this Part we explore the liquidity of corporate bonds in the time series and in the cross section. We consider existing research as well as generate new estimates for a number of measures that reflect various aspects of liquidity. As discussed below, we find mixed evidence on the direction and magnitude of time series changes in corporate bond liquidity. While some metrics point to an improvement in liquidity conditions, others show no economically significant changes, yet others suggest liquidity may have declined. Cross-sectional analysis further indicates that the evolution of liquidity has not been uniform across various groups of issuers and bonds. Lastly, we show that some of the observed changes in corporate bond liquidity appear to have occurred in the crisis and post-crisis periods, prior to regulatory action.

Importantly, while some measures allow us to delineate liquidity supply from liquidity demand, other measures may reflect both, obscuring inference. As discussed in prior sections, we continue to recognize challenges to causal inference, including the prolonged regulatory timeline, market anticipation of regulatory changes, and a lack of cleanly identified and comparable control and treatment groups. As a result of these factors, we are unable to rely on common econometric techniques for testing causal impacts, and as discussed below, existing research lacks consensus concerning the direction of and fundamental drivers behind the observed liquidity changes.

Below we critically examine existing research on various aspects of corporate bond market liquidity over time and perform data analysis using commercially available and regulatory data. We first consider existing results (Part B.IV.B.1 and B.IV.B.2) and present our own analysis of various metrics (Part B.IV.C) of corporate bond liquidity, identifying those dimensions of liquidity that may have improved and those that may have deteriorated over time. Next, we discuss several alternative explanations for observed changes in liquidity metrics. As we noted above, the passage of Dodd-Frank reforms, including the Volcker Rule, and Basel III may have contributed to changes in corporate bond liquidity. However, it is also possible that rules requiring post-trade transparency have impacted bond liquidity, and that the financial crisis resulted in changes in risk preferences among dealers and customers. We review existing research on these potential alternative effects (Part B.IV.B.3). We also decompose the evolution in liquidity metrics into several time periods, including TRACE phase-in, pre-crisis, crisis, post-crisis, regulatory and post-regulatory time periods (defined in detail and presented in Part B.IV.C.). We report and discuss the timing of observed changes in liquidity measures throughout the analysis.

Further, we consider the role of dealers and market structure in the provision of liquidity by various groups of participants. Corporate bond markets have traditionally been structured as OTC markets where dealers own or acquire the bonds to facilitate transactions with customers or other dealers. In this "principal" market, customers compensate dealers for supplying liquidity through the bid-ask spread or the "markup" as measured by the difference between a dealer's purchase and sale price. This is in sharp contrast to an "agency" market where transactions are brokered between two customers, and the intermediary charges commission for its service as an agent.

This principal market structure requires dealers to acquire positions to facilitate transactions, and trading of bonds primarily occurs via bilateral transactions between a dealer and a customer or between two dealers. Dealers with adequate capital will often hold inventories of bonds to more readily facilitate customer buying and selling activity. Furthermore, without a central exchange, the corporate bond market is highly fragmented and pre-trade pricing information is not broadly disseminated.

Parts B.IV.B.1 and B.IV.B.2 explore existing research on the role of dealer provision of liquidity before and after regulatory reforms and in times of market stress. We also discuss whether macroeconomic factors, such as the low interest rate environment, may influence dealer behavior by affecting the profitability of traditional dealer business models. Moreover, to the extent that electronic trading may impact the role of dealers and nondealers in the provision of liquidity, market structure may influence observed changes in liquidity metrics. Part B.IV.B.3 explores existing research on the role of electronic trading, and Part B.IV.C.3 analyzes unique regulatory data on corporate bond activity on an ATS. Finally, we recognize that single-name CDS are an alternative credit market, and funds may serve as another tool for investors to gain exposure to corporates. We further explore these markets in Sections B.V and B.VI.

B. Existing Research

A large body of finance research is devoted to recent changes in corporate bond market liquidity. In this section, we consider existing research on overall trends in corporate bond liquidity as well as potential drivers behind observed changes in dealer and non-dealer provision of liquidity in recent years. The discussion below is organized as follows.

First, we assess existing research on various liquidity metrics and observe mixed results for different measures of liquidity, including some evidence that certain aspects of liquidity have remained stable or actually improved following regulatory reforms (e.g., transaction costs, turnover in less active bonds, daily trades of blocks in active bonds). Second, we distinguish between liquidity provision in normal times and in times of market stress, and we analyze the evidence on the role of dealers during these periods. Our specific focus is on whether dealers provide sufficient liquidity in times of market stress when demand for liquidity increases, or whether they become less willing to commit capital and engage in principal trading on stressful days. Finally, we turn to the evidence on potential drivers of changes in liquidity. Sections II.B.3a through II.B.3c explore and critically assess research on the impacts of regulations (Dodd-Frank, Volcker and Basel III), post-trade transparency, and electronic trading on various aspects of corporate bond liquidity.[125]

1. *Dimensions of Liquidity*

In this section, we consider existing research on the evolution of different dimensions of corporate bond liquidity. As analyzed in Part A, debt issuance remains a vital source of capital for businesses, and primary issuance in the U.S. corporate bond market has grown tremendously since the early 2000s. Public debt issuance in the United States grew from about $0.8 trillion in 2005 to about $1.3 trillion in 2016 (Figure 2). Against this backdrop of increasing primary issuance, we turn to the analysis of changes in secondary market corporate bond liquidity.

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[125] While the analysis of existing research on corporate bond liquidity draws primarily from academic papers, our observations are largely consistent with existing regulatory and other related studies, including Mizrach (2015), Fender and Lewrick (2015), Adrian et al. (2017a), Bech et al. (2016), BIS (2014, 2015, 2016), IOSCO (2016), BlackRock (2014, 2016), PWC (2015), and CFA Institute (2016).

As noted in the introduction to Part B, liquidity broadly refers to the ability to execute transactions of a required size in a short period of time with little price impact. Existing research has developed a large number of liquidity measures that reflect different dimensions of liquidity. In this subsection, we consider the evidence on three broad groups of measures: trading activity (e.g., trading volume, turnover), transaction costs (e.g., Roll (1984), Schultz (2001), and Edwards, Harris, and Piwowar (2007) price impact measures),[126] and measures of liquidity supply (e.g., dealer inventory, trade sizes). We also recognize that the evolution of liquidity has not impacted all bonds uniformly, and we explore both aggregate liquidity trends and cross-sectional heterogeneity in liquidity metrics.

a). Trading Activity

As discussed in Part B.II, trading activity metrics generally reflect the overall amount of trading in a particular bond or market. For example, greater volume or turnover point to more activity, and an increase in the number of block trades would suggest that market participants are able and willing to transact at larger trade sizes (blocks).

Trends in different measures of trading activity in corporate bonds are mixed. Trading volume increased from about $5 trillion to about $8.3 trillion between 2003 and 2014, while the turnover ratio dropped only slightly from 1.2 in 2003 to 1.1 in 2014 (IOSCO, 2016). Importantly, changes in trading activity have not been universal across subsets of the bond

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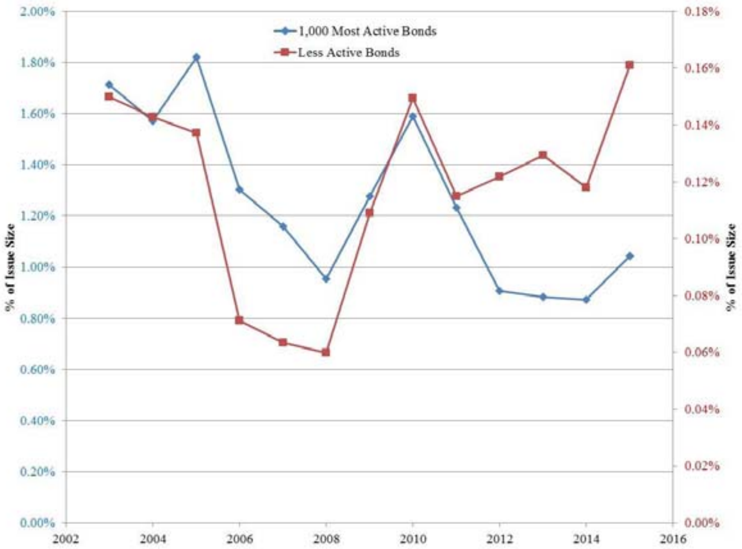
[126] Schultz (2001) estimates transaction costs by regressing the difference between the trade price and the reference price (contemporaneous bid quote) on a trade side dummy (variable that takes a value of one for buys and zero for sells); the average round-trip transaction cost is the regression coefficient on the trade side dummy. Edwards, Harris, and Piwowar (2007) present transaction cost estimation methodologies that are appropriate for corporate bond transaction data and the secondary trading market structure discussed in Part B.IV.A. Using data that identifies dealer-dealer trades and dealer-customer trades, the authors propose a measure of transactions costs (referred to as "EHP measure") equal to the difference between an average adjusted customer buy price and an average adjusted customer sell price or twice the difference between a customer price and a dealer price. The EHP measure can be interpreted as imputed effective round-trip costs. As discussed in Part B.II, the Roll (1984) measure relies on estimating serial covariances of price changes.

market. Mizrach (2015) analyzes trading activity measures separately for the 1000 most actively traded bonds and for less actively traded bonds. As shown in Figure 18 below, the paper finds that the median turnover of the 1000 most active bonds declined from approximately 1.8% in 2005 to approximately 1% in 2015, while the turnover of the less active bonds remained at approximately 0.16%.

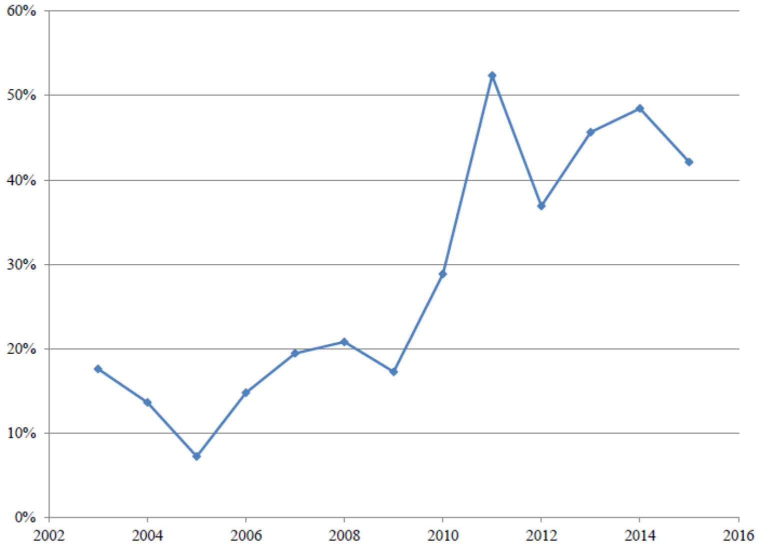
Figure 18. Median daily turnover (% of Issue)



This figure plots the median daily turnover ratio in the most active 1,000 issues for each year (left scale) and the turnover in the less active bonds (right scale.) Source: Mizrach (2015)

Moreover, the most active bonds are increasingly likely to include recently issued bonds as shown in Figure 19 below. From 2003 to 2007, bonds issued in the last 90 days comprised less than 20% of the 1000 most active bonds. Since 2011, such newly issued bonds represent about 45% of the most active bonds, which may be consistent with the rise in new issues in recent years.

Figure 19. Percentage of most actively traded bonds issued in the last 90 days



This figure plots the average annual percentage of bonds among the most active 1,000 that were issued within the last 90 days on a rolling basis. Source: Mizrach (2015)

Mizrach (2015) decomposes the number of block trades for the 1000 most active bonds by block size, as shown in Figure 20 below. The results appear to be mixed. On the one hand, the number of trades in blocks of $5 million to $10 million per day has declined by slightly more than 100 between 2003 and 2015. On the other hand, the number of trades for blocks of $10 million or larger per day has actually increased slightly during the same period for the two larger size groups.

At the same time, Mizrach (2015) finds that trade size for the 1000 most active issues decreased by approximately 35% between 2007 and 2013, and the proportion of total volume traded in large blocks (defined as blocks of $5 million or more) has decreased by almost 15%. In a similar vein, Bessembinder et al. (2016) define blocks using a $10 million trade size threshold and finds that block trade volume relative to aggregate volume declined from 27% in pre-crisis period to 22% in the regulatory period, while the corresponding average trade size decreased from $3.2 million to $1.8 million.

Figure 20. Number of block trades per day in active bonds

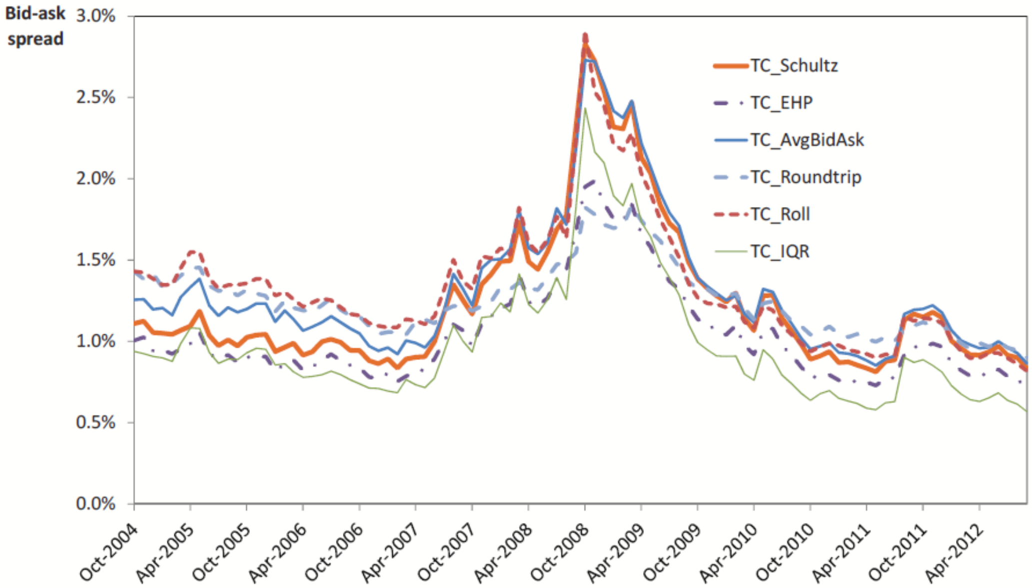
This figure plots the number of trades between \$5 and \$10mln, between \$10 and \$25mln \$25mln, and over \$25mln in size in the most actively traded bonds in those size groups. Source: Mizrach (2015)

b). Transaction Costs

Transaction costs reflect the price dimension of liquidity, and lower transaction costs would generally point to an improvement in that liquidity dimension, as discussed in Part B.II. Estimating corporate bond transaction costs requires a different estimation methodology from estimating transaction costs for equities because of important differences in data and market structure. Corporate bonds primarily trade in dealer-dominated, OTC market with limited price transparency. Unlike equities data, quotation data for corporate bonds are not publicly available. As a result, it is difficult to estimate transaction costs using quoted spread or quotation data. In addition, many corporate bonds are traded infrequently making transaction data scarce.

Evidence on transaction costs and price impact tends to show that these measures have improved over time, with the exception of the financial crisis period, during which costs were substantially higher compared to other periods. Schestag et al. (2016) calculate high frequency transaction costs measures, including Roll (1984), Schultz (2001), and Edwards, Harris, and Piwowar (2007) measures (Roll, Schultz, and EHP respectively) between 2004 and 2012, without breaking down the sample into sub-periods. As shown in Figure 21, transaction costs increased markedly during the financial crisis, but have since reverted back to below pre-crisis levels.

Figure 21. Transaction costs (TC)



This figure plots the time series of monthly high-frequency transaction cost measures calculated from intraday enhanced TRACE: Schultz (2001) and Edwards, Harris, and Piwowar (2007) measures use regressions to estimate costs from the difference between trade price and reference prices; relative difference between average customer buy and average customer sell (average bid-ask); round-trip transaction cost (Feldhütter (2012)); negative autocovariance of returns from trade prices (Roll (1984)); interquartile range of trade prices (e.g., Pu (2009)). Source: Schestag et al. (2016).

When considering transaction costs in the corporate bond market, dealer dominance and low pre-trade transparency make it important to distinguish between costs on dealer-to-customer trades and dealer-to-dealer trades. Transaction costs on dealer-to-customer principal trades directly reflect customer trade execution costs. Bessembinder et al. (2016) estimate transaction costs for different times, and defines five distinct sub-periods: (1) the TRACE phase-in period (1/2003-12/2005), (2) the pre-crisis period (1/2006-6/2007), (3) the crisis period (7/2007-4/2009), (4) the post-crisis period (5/2009-6/2012), and (5) the "regulatory" period (7/2012-5/2014), a period of heightened post-crisis regulatory activity starting in July 2012 when the Volcker Rule was originally scheduled to be effective. The paper reports that the average transaction cost in customer-to-dealer principal trades has evolved from 61 bps in the TRACE phase-in period to 52 bps in the pre-crisis period, 72 bps in the crisis period, 62 bps in the post-crisis period, and 42 bps in the regulatory period. Bessembinder et al. (2016) results suggest that liquidity may be higher along the cost dimension, reflecting lower transaction costs for customers buying from or selling to dealers, during the regulatory period compared with other sample periods.

In addition, transaction costs vary based on credit quality, trade size, and issue size. Although Bessembinder et al. (2016) estimate the transaction costs of investment grade bonds of 40 bps were lower than that of high-yield bonds of 46 bps in the regulatory period, this relationship was not stable in their sample. For example, during the crisis period, the transaction cost of investment grade bonds was higher than that of the high yield bonds (78 bps versus 52 bps). To the extent that transaction costs reflect a dimension of liquidity, this suggests that investment grade bonds were more liquid than high yield bonds during the regulatory period, while the opposite was the case during the financial crisis.

Existing literature also documents an inverse relationship between transaction costs and trade size across time (Bessembinder et al. (2016)). For example, small trades ($100,000 or lower) had estimated average transaction costs of 61 bps to 96 bps in different periods. At the same time, blocks of $5 million or larger traded at a cost of 17 bps to 32 bps during the sample period. The inverse relationship between transaction costs and trade size continued to hold across all 5 sub-periods in their sample. This result is consistent with retail trades involving higher transaction costs.

c). Liquidity Supply

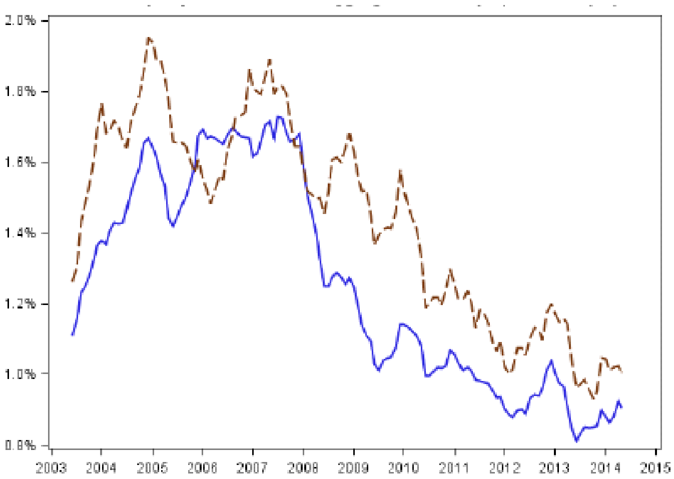
When transaction costs are estimated for completed trades, they do not reflect difficulty in arranging trades or the incidence of trades that may be demanded, but not completed. We now consider existing research on the evolution of measures related to dealer balance sheets and inventory, which may reflect dealers' role as liquidity providers and their managing of inventory.

Bessembinder et al. (2016) show that dealers have shrunk their intraday capital commitment, measured as the absolute difference between their daily accumulated buy volume and sell volume. Specifically, they find that this measure declined from 2.29% relative to aggregate volume in the pre-crisis period to 1.74% in the crisis period, and to 0.97% in the regulatory period. Thus, dealers' average intraday capital commitment dropped by 68% from the pre-crisis period to the regulatory period. Figure 22 shows a decline in intraday capital commitment for investment grade and high yield portfolios. We note that the decline in intraday capital commitment appears to have started in approximately mid-2008 and preceded the passage of post-crisis regulations. These results may be consistent with a reduction in dealers' willingness to carry inventories post-crisis, or could reflect an increased ability of dealers to dispose of their bond inventories.

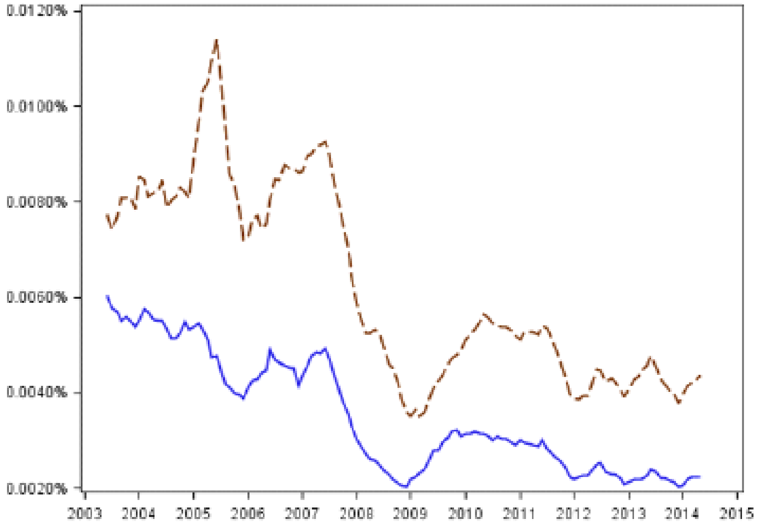
In addition, the paper examines dealer capital commitment to facilitate block trading in various time periods. The paper defines block trades as transactions of at least $10 million, and constructs a block-trade offset measure, defined as the percentage of the block quantity reversed by the end of the day. The paper finds that this measure increased from 39.8% in the pre-crisis period to 47.7% in the crisis period, and to 59.9% in the regulatory period. Thus, dealers' block-trade offset rose by 51% from the pre-crisis period to the regulatory period, which may be consistent with a reduction of dealer risk taking, regulatory impacts, or an enhanced ability of dealers to offset block trades.

Figure 22. Intraday capital commitment

Panel A. Intraday capital commitment / Aggregate volume (Top 75% Sample)



Panel B. Intraday capital commitment / Total outstanding (Top 75% Sample)



This figure plots the 6-month moving average intraday capital commitment for investment grade (solid blue) and high yield (dashed brown) portfolios. Source: Bessembinder et al. (2016).

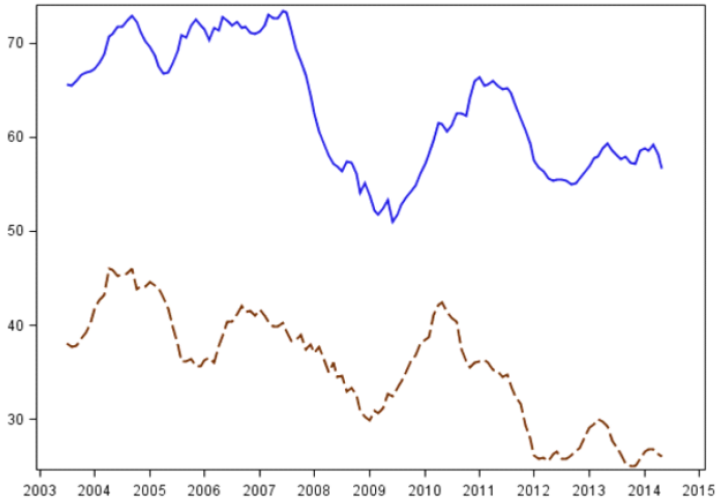
Goldstein and Hotchkiss (2017) focus on the effect of expected illiquidity of a traded bond for dealer decision to take on inventory. They find that dealers take on less inventory risk when expected liquidity of a bond is lower, i.e., dealers are less likely to absorb a trade into inventory and are more likely to offset the transaction on the same day when a bond is less liquid. The paper also finds that the effect of expected bond illiquidity on spreads and on the likelihood of dealers offsetting the trade on the same day is particularly severe for the least actively traded bonds and for bonds with low credit quality. For instance, the paper documents that dealers offset approximately 75% of trades in the lowest rated, least actively traded bonds. At the same time, they estimate the figure at only 55% for the highest credit quality, most actively traded bonds. If dealers are less likely to absorb inactively traded bonds with low credit quality into inventory, such bonds can have lower roundtrip costs than higher quality actively traded bonds. This offers a potential explanation for the decline in transaction costs accompanied by decreases in dealer capital commitment. Namely, dealers may be less likely to engage in market making when bonds are less liquid, and lower transaction costs in observed trades may be a reflection of dealers choosing not to take certain groups of bonds into inventory.

2. Liquidity Provision in Times of Stress

The evidence on the evolution in aggregate liquidity metrics and cross-sectional heterogeneity in such metrics presented so far suggests that some trading activity and transaction cost measures either have not deteriorated or have actually improved in recent years. At the same time, dealer willingness to provide liquidity may have decreased in recent years, as reflected in reduced dealer capital commitment. The above results do not distinguish, however, between dealer provision of liquidity in normal times and in times of market stress, when liquidity is needed most. We now consider evidence on dealer provision of liquidity in times of market stress.

Bessembinder et al. (2016) define times of market stress as days when customer-dealer trading volume exceeds the 6-month average of daily trading volume for that bond by more than two standard deviations. The authors focus on the activity of the single most active dealer, a choice that reflects an understanding that institutional customers may delegate execution of a large order to a single dealer. They find that the fraction of agency trading on stressful days is slightly higher in the regulatory period than in the benchmark period and that the proportion of stressful day activity completed on a principal basis but reversed before the end of the day (i.e. not absorbed into the dealers' overnight inventory) increased. However, dealers' willingness to commit capital on stressful days, measured by the proportion of stressful day activity that is absorbed into the dealers' overnight inventory, remains at crisis period levels during the regulatory period. Figure 23 shows the evolution in stressful day activity where the dealer commits overnight capital.

Figure 23. Dealer overnight capital commitment on stressful days



This figure shows the fraction of trading activity where the dealer commits overnight capital on days of market stress for investment grade (solid blue) and high yield (dashed brown) portfolios. Source: Bessembinder et al. (2016).

Di Maggio et al. (2017) study the role of dealer networks and trading relationships in times of stress, using high volatility and financial crisis periods to proxy for stress periods. The paper finds that the role of stronger relationships and dealer centrality is particularly acute in times of stress. During stress periods, dealers provide less liquidity to clients and peripheral dealers. During the peak of the crisis, core dealers charged higher spreads to peripheral dealers and clients but lower spreads to dealers with whom they had strong ties. Further, during the Lehman collapse, dealers cut back their inventory more for bonds that clients were selling more aggressively. The paper concluded that dealers' inability or unwillingness to provide liquidity partly contributes to market illiquidity during times of stress. We note that because of a lack of data on dealer inventories, the paper constructs dealer inventories from transaction data, which requires fairly strong assumptions on beginning-of-period positions (see more in Part B.IV.B.3). As a result, we recognize that these empirical estimates could be sensitive to such assumptions.

In contrast, Choi and Shachar (2016) directly observe dealers' corporate bond positions and find that dealers' inventory increased sharply following the collapse of Lehman Brothers. They argue, therefore, that dealers supplied liquidity during the crisis, and that price declines during the crisis were concentrated in bonds with available CDS contracts and active basis trading. They argue that the unwinding of CDS-bond basis trading by hedge funds and other highly levered traders may have been the main culprit. However, we also recognize that the result is consistent with dealers being unable to unwind their positions. Further, the paper does not test whether dealers were providing liquidity primarily to customers or to other dealers (or both), and the authors did not consider the transaction costs and fees dealers may have charged for the provision of liquidity in stress times.

Goldstein and Hotchkiss (2017) find that dealers are more likely to act like brokers and are less likely to engage in market making when illiquidity increases. This result is especially important in explaining changes in dealer activity in times of stress when overall market illiquidity rises. The paper shows that dealers were less likely to take on inventory risk and were statistically and economically significantly more likely to offset trades on the same day during the financial crisis (second quarter of 2007 through second quarter of 2009). Further, this behavior persists across credit quality categories: in times of severe market stress when dealers are less willing to commit capital, even higher rated bonds may be traded conditional on dealers' ability to offset the trade. The paper also finds that dealers continue to be somewhat more likely to engage in offsets post-crisis period relative to the pre-crisis period.

Further research into the role of dealers during stressed times is warranted. Preliminary evidence, however, indicates that dealers may not always lean against the wind in times of severe market stress. We continue to recognize that potential reductions in dealer provision of liquidity may not adversely impact market liquidity if changes in market structure enable customers to seek liquidity from other customers.

Now that we have considered existing research on the evolution of liquidity over time in normal times and in times of stress, we turn to the research on potential drivers to changes in liquidity. In the subsections that follow, we explore and critically assess research on the relationship between regulations, post-trade transparency, emergence of and liquidity in the single-name CDS market, electronic trading, and market structure on various aspects of corporate bond liquidity.

3. Drivers of Changes in Liquidity

a). Dodd-Frank, Volcker Rule, and Basel III

An emerging body of academic literature addresses various effects of regulatory reforms at issue on corporate bond liquidity and delivers mixed results. In this section, we consider this evidence and explore how various aspects of empirical design may impact each study's conclusions.

First, one of two papers highlighted in the Treasury (2017) report[127] is Bao et al. (2016). The paper uses TRACE data to study transactions in downgraded bonds relying on a differences-in-differences econometric test to produce three main results. First, the price impact for bonds newly downgraded from BBB to BB relative to other BB bonds increased after the implementation of the Volcker Rule, but is comparable to price impact measured during the financial crisis. Second, non-bank affiliated dealers take an increasingly higher proportion of dealer-customer trades relative to affiliated dealers, and bank affiliated dealers have increased the proportion of agency trades in their total volume (defined as offsetting a customer trade by another trade within one minute, following Harris (2015) and Bessembinder et al. (2016)). Third, to understand whether Basel III implementation and Comprehensive Capital Analysis and Review (CCAR) tests confounded their results, the authors identify subgroups of Volcker affected dealers that were constrained by CCAR and those that were not. They find that capital commitment has decreased for affected dealers that have neither failed nor conditionally passed CCAR tests.

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[127] *See* U.S. Department of the Treasury, June 2017, "A Financial System that Creates Economic Opportunities: Banks and Credit Unions."

Bao et al. (2016) measure capital commitment differently from Bessembinder et al. (2016), which may impact their results. As a general matter, optimal inventory levels for different dealers are not observable, and starting inventory levels are presumed to reflect dealer's optimal inventory. Capital commitment is, then, measured as the accumulated buys net of accumulated sells relative to that starting inventory level (weighted over time). Bao et al. (2016) construct the measure over the course of a month, whereas Bessembinder et al. (2016) rely on a daily measure. This difference reflects varying assumptions about optimal inventory levels. Where the daily measure assumes that dealers begin each day with optimal levels of bond inventory, the monthly measure allows for inventory to continue to move away from optimal levels over multiple days and weeks. While the effect of this measurement difference on the paper's conclusions is unclear, we recognize that assumptions regarding optimal inventory levels may impact estimates of dealer capital commitments.

We also note that Bao et al. (2016) use the effective date of the Volcker Rule as the cut-off date to conduct their sub-period analyses. To the extent that markets anticipated the implementation of the Volcker Rule, this approach may mean that their estimates of impacts from the Volcker Rule are conservative and bias them against finding a significant result. At the same time, however, affected dealers that did not adjust to the reforms in the nearly 4 years prior to the effective date may be those with the highest costs of compliance and those that have under-reacted in the post-crisis and post-Dodd-Frank period, exhibiting the biggest reductions in capital commitments. Therefore, measuring their actions could lead the authors to overestimate the impact of the Volcker Rule.

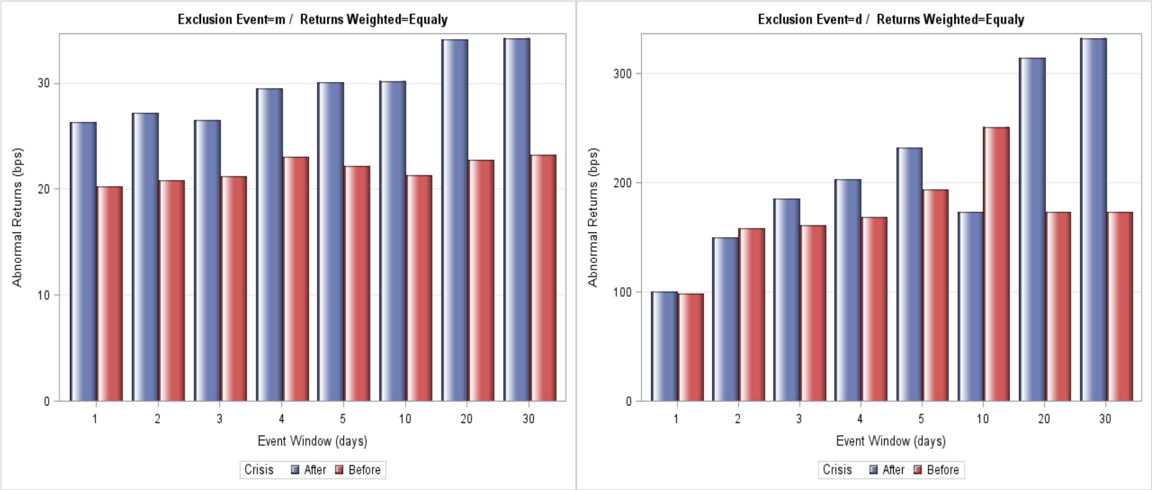
To attribute the reduction of dealer capital commitment to the effects of individual regulations, Bao et al. (2016) compare changes in market making for dealers affected by the

Volcker Rule, Basel III, and CCAR. They find that Volcker-affected dealers (including those not constrained by Basel III and CCAR) reduced market making during times of stress, while non-Volcker-affected dealers increased their liquidity provision during stress times. Bao et al. (2016) interpret these results to suggest that the Volcker Rule resulted in a net reduction in dealer provision of liquidity in times of stress. Since the liquidity provision declined both for Volcker-affected dealers constrained by Basel III and CCAR and those that were not, the paper concludes that the results are not consistent with the impacts of Basel III or CCAR.

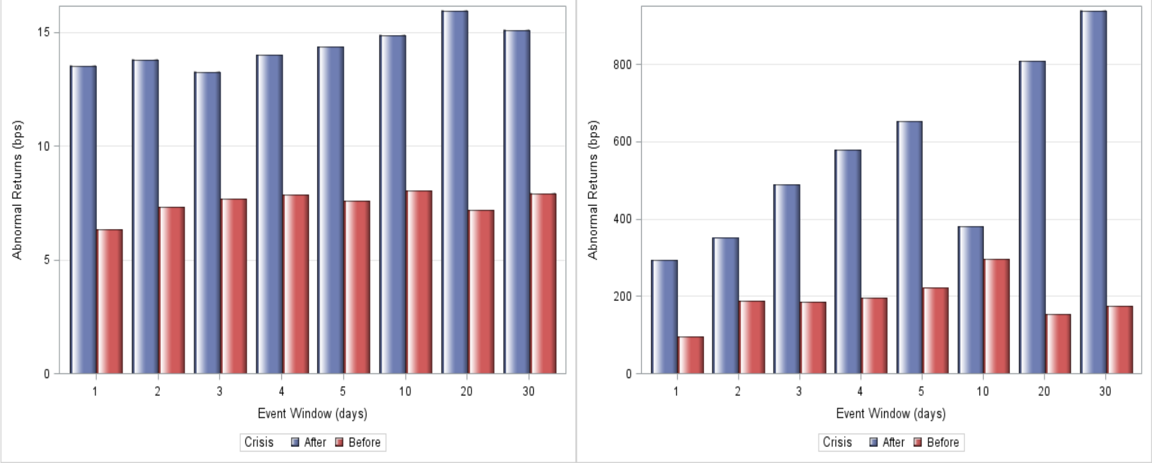
We note that the validity of such inference depends on whether the identifying assumptions behind difference-in-difference estimation are satisfied. Specifically, the two dealer groups must be following "parallel trends" in their market making activity prior to the shock. The Volcker Rule primarily affected bank-affiliated dealers, which carried large inventories during the crisis. As shown in our analysis of Financial and Operational Combined Uniform Single (FOCUS) data below, bank-affiliated dealers experienced large negative shocks to the profitability of their debt trading and reduced their inventory in the aftermath of the crisis and prior to the enactment of the Dodd-Frank Act and implementation of the Volcker Rule. At the same time, dealers that were not bank affiliates and not affected by the Volcker Rule carried smaller inventories during the crisis and did not experience precipitous declines in the profitability of trading during the crisis, suggesting a different trend in liquidity provision by these dealers. To the extent that the profitability of trading is an important determinant of dealer choice to engage in trading, this points to an alternative explanation: Volcker-affected dealers may have reassessed the risk-return tradeoff of providing liquidity in times of stress following the crisis and pulled back on liquidity provision during stressed days. To the extent that the parallel trends assumption for the two dealer groups may be violated, the validity of this empirical methodology and resulting inference about causal impacts of the Volcker Rule and other regulations would be affected.

Second, Dick-Nielsen and Rossi (2016) use a different empirical setting to examine the cost of immediacy for different bonds. The paper's empirical design relies on the Barclay Capital Investment Grade Corporate Bond Index exclusion event as a quasi-natural experiment. When bonds are excluded from the Barclay Capital (formerly Lehman) Investment Grade corporate bond index, index tracking funds sell bonds to dealers and seek to execute these transactions quickly to minimize tracking error. Importantly, such bond trades are motivated by index exclusion rules and not information about bond fundamentals, meaning dealer bids are likely to reflect the price of immediacy and are less likely to be influenced by adverse selection costs of trading with more informed sellers. The paper introduces two main measures. First, the authors calculate the intertemporal bid-ask spreads, which are essentially the raw returns between the average dealer-purchase price and the average dealer-selling price on each day following the exclusion date. Second, they estimate abnormal dealer returns for the excluded bonds by subtracting the returns of a matched benchmark portfolio from the intertemporal bid-ask spreads. They find that the cost of immediacy has doubled for investment grade bonds, and more than tripled for high yield bonds between the pre-crisis (June 2002 – June 2007) and the post-crisis periods (January 2010 – December 2013; see detail in Figure 24 below.) They also find dealer inventories declined in the post-crisis period, and not during the crisis period itself, despite the intuition that dealers should have been more constrained in terms of their risk-bearing capacity during the crisis period. The authors conclude that lower capital commitment by dealers in the post-crisis period may be driven by regulatory reforms. However, we note that it is also consistent with post-crisis changes in dealer risk aversion and the low interest rate environment during this period changing the profitability of traditional dealer business models.

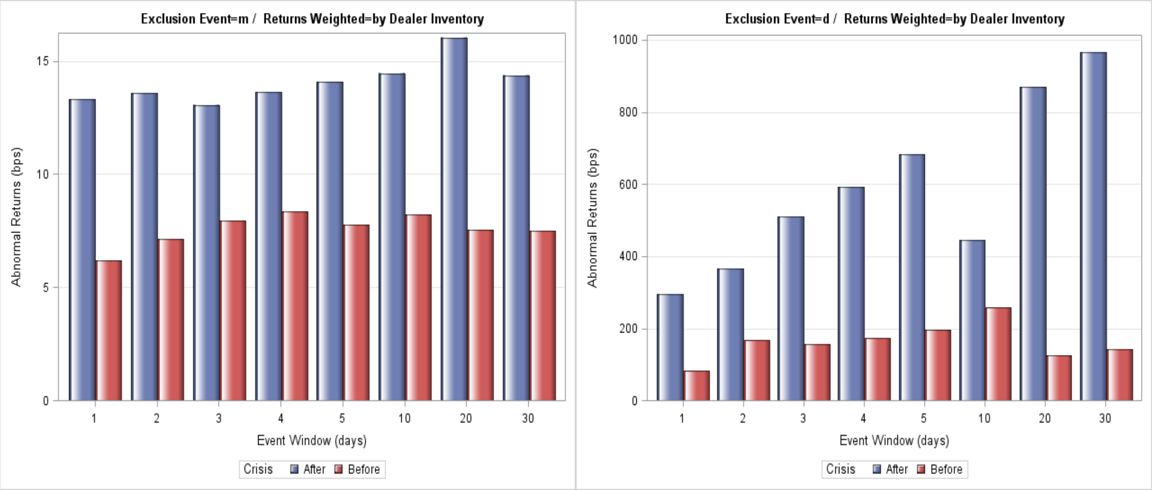
Figure 24. Cost of immediacy before and after the credit crisis (dealer level)



(a) Maturity (EW) (b) Downgrade (EW)



(c) Maturity (VW1) (d) Downgrade (VW1)



(e) Maturity (VW2) (f) Downgrade (VW1)

Source: Dick-Nielsen and Rossi (2016)

Third, Anderson and Stulz (2017) consider the evolution of liquidity metrics in normal times and in times of market stress during pre-crisis (2004-2006) and post-crisis (2010-2012; and 2013-2014) periods. The paper finds that price-based liquidity metrics for small and large trades in 2013 through 2014 are generally better when compared against the pre-crisis 2004-2006 levels. However, they document a reduction in turnover post-crisis, which may point to a decreased ability of market participants to execute trades. The paper further uses three different groups of stress events, including large swings in the Chicago Board Options Exchange Volatility Index (VIX),[128] large increases in bond yields, and downgrades of investment grade bonds to high yield. They do not find statistically or economically significant deterioration in price impact around idiosyncratic stress events after the crisis compared to the pre-crisis period.

The empirical approach in Anderson and Stulz (2017) differs from that in Bao et al. (2016) along several dimensions, which likely impacts the paper's conclusions. Unlike the Bao et al. (2016) paper, which compared bonds newly downgraded to high yield with non-

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[128] The VIX is derived from the prices of options written on the S&P 500 index and represents a proxy for perceived financial market volatility.

downgraded high yield bonds, Anderson and Stulz (2017) compare downgraded bonds likely to trigger forced sales against other downgraded bonds unlikely to trigger such sales. Second, they control for potential differences in the information content of downgrades across economic cycles (e.g., pre-crisis compared to post-crisis), which may have confounded results in Bao et al. (2016). Finally, their pre-crisis period excludes the peak of the credit boom in 2007 and limits the subsample to 2004 through 2006, whereas Bao et al. (2016) define the pre-crisis period as January 1, 2006, through June 30, 2007. Anderson and Stulz (2017) find that the results in Bao et al. (2016) are sensitive to the choice of the pre-crisis period and that downgrades in the Bao et al. (2016) pre-crisis period do not appear to impact liquidity metrics, casting doubt on the robustness of that empirical design.

In addition to bond downgrades, Anderson and Stulz (2017) use VIX and bond yield shocks as proxies for stress events. We note that such shocks, particularly within-sample VIX shocks, do not distinguish between shocks to liquidity supply and liquidity demand. Further, VIX shocks may not be indicative of dealer stress, particularly pre-crisis. This may lead the authors to overestimate liquidity provision in times of stress during the pre-crisis period, consistent with the paper's finding of more adverse price impact of VIX shocks in the post-crisis period.

Fourth, Adrian et al. (2017b) examine dealer liquidity provision using a methodology similar to Bao et al. (2016) and Bessembinder et al. (2016). Because Adrian et al. (2017b) do not focus on liquidity in stress scenarios, they are able to analyze a substantially larger sample (approximately 12,800 issues) compared with Bao et al. (2016)'s sample (687 issues by 218 firms, including 45 firms in the "post-Dodd Frank" period and 55 firms in the "post-Volcker" period). The paper introduces three main sets of results. First, they find that bonds traded by highly levered institutions and bank holding companies with small loan portfolio and higher trading revenues are less liquid. Second, more levered dealers and dealers with higher trading revenues have decreased transaction volume after the financial crisis. Third, such institutions have lower customer volume relative to dealer volume in the 2014-2016 "rule implementation" period. The paper interprets these results to suggest that more stringent leverage requirements and post-crisis regulatory reforms more generally may have reduced some dealers' ability to provide liquidity.

One interpretation of this evidence is that institutions most impacted by post-crisis regulations are less able to intermediate customer trades.[129] However, three caveats are relevant for the interpretation of the results in Adrian et al. (2017b). First, we note that the paper splits the period after December 2009 into 2 sub-periods: the "Rule writing" and "Rule implementation" period. Unlike Bessembinder et al. (2016), and Bao et al. (2016), the paper does not have a "post-crisis" period per se. Given the regulatory timeline issues discussed above, it is difficult to disentangle regulation-driven changes in dealer behavior from post-crisis changes (due to, for instance, post-crisis and pre-regulation increase in risk aversion and updating of beliefs about the risks and returns of holding large inventories and traditional market making, evolving market structure, and a low interest rate environment). Second, the paper interprets changes to customer–dealer trading volume as evidence of dealer ability to intermediate trades. To the extent that dealers identified in the paper as more likely to be constrained have also suffered large losses on trading positions during the crisis, this evidence is also consistent with a decreased willingness of dealers to intermediate customer trades as a result of crisis-related changes to profitability of trading or risk aversion. Third, the paper focuses on

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[129] *See* U.S. Department of the Treasury, June 2017, "A Financial System that Creates Economic Opportunities: Banks and Credit Unions."

the activity of BHC affiliated dealers. To the extent that non-BHC affiliated dealers may have increased their activity, as suggested by Bao et al. (2016), the results in Adrian et al. (2017b) do not speak to the aggregate effect of regulatory changes on bond market liquidity.

Fifth, Choi and Huh (2017) argue that the calculation of the bid-ask spread assumes that dealers provide liquidity to customers, which may underestimate actual transaction costs if liquidity is provided by customers. They find that a substantial amount of liquidity provision has moved from dealers to customers in the post-regulation period. Omitting trades in which customers provide liquidity and focusing only on trades in which customers demand liquidity, the authors estimate that spreads in recent years are higher compared to those in the pre-crisis period. In contrast, Bessembinder et al. (2016) focuses on dealer-to-customer principal trades and finds the average transaction cost, particularly for small trades (less than $100,000) and large trades (over $1,000,000), is lowest in the pre-crisis and regulation periods. The difference between these two results may stem from different proxies for transaction costs and the measurement of principal trading activity.

As noted above, Bessembinder et al. (2016) find that overall transaction costs have declined over time, with a notable exception of the crisis period. This finding is consistent with Schestag et al. (2016) that examines a number of daily and intraday liquidity measures and finds that post-regulation transaction costs of bonds were at or below the pre-crisis level. They also find that intraday transaction cost measures are highly correlated. We note, however, that Schestag et al. (2016) uses daily bid-ask quotes from the Bloomberg Generic Composite Rate (BGN) and Composite Bloomberg Bond Trader (CBBT). The quotes from BGN are indicative rather than binding, and some of these quotes are stale. The paper acknowledges the shortcoming of BGN and suggests the use of executable quotes from CBBT, especially for the transaction costs of institutional investors; however, the extent to which data sources may drive the paper's empirical findings is unclear.

Importantly, we note that existing studies on the impact of regulatory reforms on corporate bond liquidity impose time cutoffs identifying the "regulatory" period. However, as discussed above, regulatory reforms of interest were proposed, adopted, and have become effective over a prolonged period of time. For instance, the statutory Volcker Rule was first enacted on July 21, 2010, but final rules implementing the statutory Volcker Rule did not become effective until April 1, 2014, and compliance with the Rule's proprietary trading restrictions was not required until July 21, 2015. The results of such analyses are, therefore, likely to be sensitive to the choice of the regulatory time period and may bias their results.

To address this timing concern, and in contrast to the above studies of regulatory impacts, Trebbi and Xiao (2016) apply macroeconomic breakpoint methodologies (Bai and Perron, 1998, 2003; Stock and Watson, 2011; Chen et al. 2014) to let the data determine the timing of structural breaks for a large set of liquidity measures from April 2005 to December 2014. The paper's conclusions are consistent with Bessembinder et al. (2016) and Schestag et al. (2016). Specifically, the paper finds that transaction costs are not significantly worse in recent years compared to the pre-crisis period.

One weakness of the breakpoint analysis of Trebbi and Xiao (2016) is that other contemporaneous policy measures, such as quantitative easing and bank bailouts, could have mitigated the impacts of the Volcker Rule, which may bias against finding deterioration in liquidity. The paper's latent factor techniques require heuristic choices of certain parameters, and there are cases where these choices imply there are zero breaks in latent liquidity throughout the period of interest. Crucially, to cleanly identify the Volcker Rule effects, the authors need to distinguish between bonds that were affected by the Volcker Rule and those that were not. Trebbi and Xiao (2016) assume that if a bond has at least one underwriter that is not subject to the Volcker Rule, the bond should be immune from liquidity effects, whereas bonds issued entirely by underwriters covered by the rule should experience Volcker-specific liquidity disruptions. If largely the same dealers make markets in affected and unaffected bonds, there may be spillovers from reduced liquidity in Volcker-affected bonds to Volcker unaffected bonds. This could impact the "control" group and bias the authors against finding statistically significant differences between two groups. The lack of significant liquidity disruptions in these results may simply reflect a lack of clear delineation between Volcker vs. non-Volcker affected bonds in this historical setting.

b). Electronic Trading

As discussed above, dealer supply of liquidity may have declined post-crisis, as bank affiliated dealers reduced their capital commitment and shifted their business model from principal trading to agency trading post-crisis. However, prior sections presented mixed evidence concerning whether dealers actually provide liquidity in times of market stress and showed that many corporate bond liquidity measures have not deteriorated in the post-regulation period. This may point to an increasing role of alternative liquidity providers, such as non-bank dealers and institutional investors, and the emergence of electronic trading venues. We now turn to existing research on electronic trading in corporate bonds.

Traditionally, corporate bonds traded via "voice" intermediation, though the fraction of buy-side participants trading corporate bonds on electronic venues may have increased in recent years.[130] Furthermore, the empirical results we present above indicate that corporate bond trading may be evolving toward a market structure where dealers increasingly engage in more agency or riskless principal based trading and carry less inventory. To the extent that electronic trading could facilitate agency or riskless principal based trading, it is important to understand various aspects of electronic trading for corporate bonds and how electronic trading is different from voice intermediated trading. For instance, one difference between voice intermediated and electronic trading is the broader (vs. bilateral) availability of or greater ease of access to pre-trade information (e.g., quoted price and quoted size).

Existing research on electronic trading venues is constrained by data availability. Most recently, Mizrach (2015) relies on survey data from Greenwich Associates (2015) to show that electronic platforms play an important role in facilitating trading of corporate bonds. The paper estimates that such electronic platforms were used for 80% of investment grade bonds and 43% of high yield bonds in 2014. Mizrach (2015) explains that, while most of these electronic platforms involve activities to facilitate trades, such as seeking or posting quotes, they do not provide direct electronic trading venues to corporate bond investors. Therefore, the paper suggests that fully automated electronic trading represents only 16% of volume weighted market share for investment grade bonds and 4% for high yield bonds. At the same time, when interpreting results that compare the performance of electronic trading venues to other trading methods, it is important to note that electronic trading venues may employ market mechanisms that are very different from traditional execution methods.

Using electronic auction data from MarketAxess, Hendershott and Madhavan (2015) compare transaction costs of electronic and voice trades for 4.6 million customer-to-dealer

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[130] *See,* e.g., Greenwich Associates (2015).

corporate bond trades between January 2010 and April 2011. In these auctions, investors query multiple dealers electronically, and dealers may respond with their bids in 5-20 minutes. At the end of each auction, investors either select the best quote to trade or choose not to trade at all.[131]

The paper finds that electronic trading is concentrated in bonds we expect ex ante to be more liquid, but reduces transaction costs after accounting for endogenous venue selection, among other things. For instance, for the smallest trade size up to $100K,[132] the average transaction cost is 22 bps for electronic trades and 87 bps for voice trades for investment grade bonds. For high yield bonds, the average transaction cost is 36 bps for electronic trades and 122 bps for voice trades. Thus, investors transacting in amounts up to $100K, on average, can reduce transaction costs by more than 70% by trading electronically. The magnitude of the reduction in transaction costs from electronic trading is inversely related to trade size, and large institutional investors on average save slightly over 20% of the transaction costs using electronic trades. We note that even though small trade sizes save proportionally more transaction costs using electronic trades, they still incur higher absolute transaction costs when compared with the larger trade sizes. Thus, the inverse relationship between transaction cost and trade size is robust to different market structures and trading technologies. An important limitation of the analysis recognized by the authors is the lack of observability of phone searches not resulting in trades, which limits the authors' ability to analyze unfilled orders under various mechanisms.

Harris (2015) uses data for the period of December 15, 2014, to March 31,2015, and finds that retail investors incur notably higher transaction costs than institutional investors: the

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[131] Bech et al. (2016) note that this kind of request-for-quote (RFQ) platform represents more than 95% of all electronic dealer-to-customer trades on multi-dealer platforms.

[132] Small trade sizes are commonly assumed to be retail trades, as few retail trades have sizes over $100K. However, we recognize that institutions may engage in smaller trades for index rebalancing, to optimize transaction costs or quality of execution.

paper estimates average transaction costs of 85 bps for retail, versus 52 bps for institutional trades. The paper also explores the incidence of trade-throughs (trades executed at a price above the best standing ask or at a price below the best standing bid), and riskless principal trades (RPTs), in which dealers offset a customer trade with an interdealer trade and carry no inventory risk (defined as pairs of sequentially adjacent trades of the same size for which one trade is a customer trade). Harris (2015) documents that the trade-through rate is 43%, the RPT rate is 42%, and 41% of the trade-throughs are RPTs during the sample period (April 2014 through March 2015). The paper suggests that the prevalence of electronic bond trading may primarily benefit dealers and does not necessarily result in low trade-throughs for customers. It is important to note that most of these electronic trading platforms are used by dealers to facilitate trading, but not used as venues where customers can transact with each other directly. Overall, the paper concludes that electronic markets are an important liquidity source even in illiquid instruments, though the benefits are higher for more liquid bonds. The paper further suggests that the development of electronic crossing systems to directly match customers may serve as a path to centralized and continuous trading.

One potential limitation of the analysis in Harris (2015) is that some of the quotes from Interactive Brokers (IB) are indicative quotes, which dealers might not honor. Harris (2015) recognizes this and notes that during the week ending September 10, 2015, IB obtained complete fills for 83% of its customers' orders without cancellations. While this evidence is anecdotal, it may suggest that the quoted and indicated prices that IB records are largely actionable and the above estimates are meaningful. The paper concludes by proposing a pre-trade transparency initiative enabling the collection and dissemination of the National Best Bid and Offer (NBBO) facility for the bond market and an eventual transition to a fully automated, electronic trading market for U.S. corporate bonds.

Finally, Li and Li (2016) theoretically model principal and agency trading. In their model, agency trading by dealers is more likely to emerge in markets with high transparency, turnover, and costs of inventory. Dealer principal trading is more likely in opaque, decentralized, and illiquid markets. To the extent that the emerging electronic trading enhances transparency in bond markets, it is conducive to the shift from principal to agency trading by dealers. They also show that agency trading increases with intermediary holding cost and empirically document that shocks to broker-dealer leverage and dealer funding cost proxies increase the fraction of agency trading for high yield bonds. To the extent that the Volcker Rule may have increased inventory costs for bank-affiliated dealers, the paper's evidence would predict a corresponding shift to agency trading.

In sum, the growth in agency trading by dealers may be consistent with both the potential impacts of the Volcker Rule and the effects from the emergence of electronic trading.

c). Post-Trade Transparency

In addition to regulatory impacts, market structure changes, evolving dealer risk preferences, and liquidity demand shifts, it is possible that post-trade transparency may also have impacted bond liquidity and market quality. The effect of post-trade transparency on financial markets is an ongoing issue widely examined by researchers (Acharya et al. 2009; French et al., 2010). The initiation of TRACE reporting for publicly traded bonds in 2003 and 2004 and 144A bonds in 2014 may have contributed to observed liquidity changes. As a result, we need to consider how post-trade transparency may have impacted bond liquidity, and whether observed changes in liquidity measures are consistent with the effects of post-trade transparency.

As we discuss in more detail below, existing research suggests that post-trade transparency generally reduces price dispersion for all bonds by mitigating information asymmetries among traders. However, the effects of post-trade transparency on transaction costs and trading activity are not universal. For most investment grade bonds, post-trade transparency clearly reduces transaction costs; but for thinly traded investment grade bonds and for high yield bonds, post-trade transparency reduces trading activity with little effect on transaction costs (e.g., Asquith et al. (2014)).

Early studies of post-trade transparency generally concluded that TRACE reporting led to better market liquidity for corporate bonds (Bessembinder et al., 2006; Edwards et al., 2007; Goldstein et al., 2007). Bessembinder et al. (2006) use the dataset of the National Association of Insurance Commissions (NAIC) to examine the effect of post-trade transparency of 439 bonds phased in on July 1, 2002. They estimate a reduction in the imputed transaction cost of these transparent bonds of about 5 to 10 bps as well as a decline in the concentration ratio of the largest dealers.

Edwards et al. (2007) use TRACE data for all trades from January 2003 to January 2005 to examine the effect of post-trade transparency on a large set of bonds, phased in sequentially on March 1, 2003, April 14, 2003, and October 1, 2004. They find that post-trade transparency reduces the imputed transaction costs across all different trade sizes. Similarly, Goldstein et al. (2007) uses the TRACE dataset for all trades from July 8, 2002, to February 27, 2004 to examine the effect of post-trade transparency on 120 BBB-rated bonds (90 actively traded and 30 thinly traded), phased in on April 14, 2003. They find that post-trade transparency reduces the transaction cost of the actively traded bonds but has no statistically significant effect on thinly traded bonds.

Bessembinder et al. (2016) revisit this issue, using both the 2003-2004 initiation of transaction reporting for public bonds, phased in sequentially on March 1, 2003, April 14, 2003, and October 1, 2004, as well as the 2014 initiation for 144A bonds. They perform a differences-in-differences estimation and find that TRACE reporting for publicly traded bonds resulted in statistically significant increases in trading activity, mixed effects on intraday capital commitment, and no effect on market quality. Similar estimates around the 2014 transaction reporting change for 144A bonds in Bessembinder et al. (2016) show a lack of significance of TRACE reporting for all metrics except for a slight increase in trading activity. They also find lower declines in dealer capital commitment for TRACE-eligible bonds during the financial crisis.

In a different context, Han et al. (2016) study the impact of public registration of 144A bonds. They find that increased transparency improves bid-ask spreads, particularly of bonds with higher ex ante information asymmetry. They also find that dealers reduce their net positions in 144A bonds after public registration of the bonds. This result is consistent with the observation in Li and Li (2016) that increased transparency is conducive to agency trading. Overall, the evidence suggests that post-trade transparency via TRACE reporting may improve market liquidity, or at least not hurt it.

Asquith et al. (2014) use the historical TRACE dataset for the period of July 1, 2002 to December 31, 2006, to examine the effect of post-trade transparency of a large set of bonds, phased in sequentially on March 1, 2003, April 14, 2003, October 1, 2004, and February 7, 2005. Thus, unlike all previous studies, which focused on some selected TRACE phased-in period(s), Asquith et al. (2014) include all four major phase-in periods for public bonds, including 2,800 high yield bonds, to examine the effect of post-trade transparency on trading activity and price dispersion. As such, they argue that the earlier studies on the post-trade transparency (Bessembinder et al., 2006; Edwards et al., 2007; Goldstein et al., 2007) are essentially incomplete as they only apply to the specific subset of bonds affected in one or several phases of TRACE implementation, but not all bonds. The paper finds that post-trade transparency leads to an overall reduction in both trading activity, especially for the high yield bonds phased in last, indicating a deterioration in this dimension of liquidity. However, the paper also found that post-trade transparency reduced price dispersion for bonds in the high yield sample.

Given their findings, Asquith et al. (2014) argue that transparency reduces information asymmetry for previously opaque high yield bonds as reflected in smaller price dispersion, which, in turn, lowers the spreads (or transaction costs) the dealers can charge. In response, dealers reduce their inventory positions, essential for market making in illiquid high yield bonds. This results in a decrease in the trading activity in high yield bonds. In light of this, the paper argues that the expansion of post-trade transparency into other similarly thinly traded over-the-counter securities, such as asset-backed securities, may adversely affect trading activity. To the extent that trading activity metrics reflect the ability and willingness of market participants to execute buy and sell trades, this may indicate a reduction in this dimension of liquidity.

C. Data Analysis and Results

Below we explore changes in corporate bond liquidity over time, and consider whether the observed effects may be consistent with regulatory changes, as well as other factors. We first examine changes in corporate bond trading activity and transaction costs over time. We then explore changes in the trading behavior of certain market participants, with a particular emphasis on changes in dealers' trading activity over time. Finally, we discuss recent evidence about electronic trading and dealer quotations on ATS.

We recognize that data limitations constrain the scope of our empirical analysis of corporate bond liquidity. Because this analysis primarily relies on executed transaction data, it does not capture all dimensions of liquidity. For example, we are unable to examine changes in dropped (unexecuted) orders, order splitting, and difficulty in executing large block orders on liquidity, because order data for corporate bonds are generally not available for research. Conditional on data availability, this remains an open area for future research.

In estimating the transaction costs of corporate bonds, we follow the transaction cost estimation methods presented in Edwards, Harris, and Piwowar (2007): the EHP measure. Furthermore, to understand how corporate bond transaction costs have changed over time, we divide our sample spanning January 2003 – September 2016 into six subsamples, using partitions by Bessembinder et al. (2016), which reflect regulatory action and shifts in corporate bond market structure.

Our empirical results on trading activity and transaction costs are not consistent with the hypothesis that regulations reduced corporate bond market liquidity, consistent with prior studies. For example, we find that more corporate bonds traded in the "Regulatory" sub-period and in the "Post-regulatory" sub-period than in any other period in our sample. However, corporate bond trading activity in the "Regulatory" and the "Post-regulatory" sub-periods is more concentrated in liquid bonds with larger issue sizes. Further, we decompose trading activity and transaction costs by trade size. After July 2012, in general, we do not observe an increase in corporate bond transaction costs for larger trade size, but for some subgroup of corporate bonds, such as larger bonds (issue size greater than $500 million), certain investment grade bonds, younger bonds (less than 2 years since issuance), and longer maturity bonds (original maturity longer than 20 years), the estimated transaction costs of large trades are slightly higher than those estimated pre-crisis. In addition, we observe a decrease in transaction costs for smaller trade sizes after the post-crisis period. Our transaction cost analysis shows that the average transaction costs for smaller trade sizes after July 2012 are lower than those prior to the crisis.

Our analysis of dealer activity points to an evolving role of dealers in corporate bond markets, and some of the results are consistent with a reduction in dealer provision of liquidity during the post-regulatory period. However, our results are also consistent with greater ease in offloading inventory, changing economics of traditional dealer business models, post-crisis evolution in dealer risk taking and evolving macroeconomic conditions. Finally, we document large cross-sectional heterogeneity in ATS activity for different types of bond issues, and find that electronification may be associated with lower trade sizes.

The rest of Part B.IV.C is organized as follows: Part B.IV.C.1 provides an overview of corporate bond sample data and discusses corporate bond trading activity across sub-periods and also by cross-sectional bond characteristics; Part B.IV.C.2 provides empirical results on average transaction costs across sub-periods; Part B.IV.C.3 provides evidence on changes in dealer activity; Part B.IV.C.4 provides evidence on current activity in electronic venues.

1. Trading Activity

In this section, we describe our data, sample construction, and report summary statistics on corporate bond trading activity across sub-periods and by cross-sectional bond characteristics.

a). Data and Sample

Our sample period spans from January 2003[133] to September 2016.[134] For corporate bond transaction data, we use a regulatory version of TRACE that includes a broker-dealer identifier (i.e., market participant ID (MPID)), unmasked trade sizes, an indicator that identifies whether a trade is buy or sell, a trade identifier that classifies whether a trade is an interdealer or a customer trade, a broker-dealer capacity indicator that reports whether a trade is a principal trade or an agency trade for a reporting broker-dealer, and a credit quality code for investment grade and high yield bonds. That version of TRACE includes corporate bond trades disseminated via TRACE to the public as well as trades reported to FINRA but not disseminated to the public. These data also include issuer and issue information for TRACE-eligible bond issues updated daily. We merge these transaction data with bond characteristics provided by the Mergent Fixed Income Securities Database (FISD). The FISD database includes issue date, issue size, maturity date, and various bond features (e.g., convertible, putable, redeemable, pay-in-kind, variable rate, sinking fund).

We construct our corporate bond transaction data sample as follows. First, we exclude all primary market trades (i.e., "P1" trades in TRACE) from our analysis to isolate secondary market trades. Second, we drop all trades for Rule 144A issues because Rule 144A bonds are mostly traded by large institutions and the disclosure requirements for those bonds are lower. Third, we eliminate bonds that are not covered in the FISD. Appendix D.1 discusses sample filters and the potential effects of filtered observations on our liquidity study, Table D.1 reports

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[133] TRACE reporting commenced on July 1, 2002. We exclude data from July to December 2002 because of potential reporting inaccuracies as market participants familiarize themselves with the TRACE system.

[134] The end date of our sample is September 19, 2016.

data filters and sample composition by sub-period, and Table D.2, Panels A and B show the effects from the FISD database coverage changes on trading activity for filtered observations.

As mentioned above, we are interested in whether and how corporate bond activity and transaction costs have changed over time, and whether observed changes are associated with regulatory actions. To study corporate bond activity and transaction costs over time, we consider six sub-periods and compare metrics across those sub-periods. In defining appropriate sub-periods, we consider two important factors that could have affected corporate bond market liquidity, mainly, changes in corporate bond market structure and regulations. The designation of sub-periods in Bessembinder et al. (2016) reflects changes in both corporate bond market structure (e.g., post-trade transparency) and regulations, and we follow their period definitions closely. As discussed in Part B.IV.B.3 above, existing research shows that post-trade transparency (i.e., TRACE reporting) is associated with the decrease in corporate bond transaction costs. The dissemination of corporate bond transaction prices via TRACE was phased in for publicly traded bonds by the end of 2005. We designate January 2003 through December 2005 as the "TRACE Phase-in" sub-period. We define January 2006 through June 2007 as the "Pre-crisis" sub-period. We designate July 2007 through April 2009 as the "Crisis" sub-period and May 2009 through June 2012 as the "Post-crisis" sub-period. Lastly, we divide the rest of our sample into two additional sub-periods. We designate July 2012 through May 2014 as the "Regulatory" sub-period[135] and June 2014 through September 2016 as the "Post-regulatory" sub-period.

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[135] Our sample period cutoffs are aligned with Bessembinder et al. (2016) and are consistent with Bao et al. (2016), which uses the following cutoffs: pre-crisis 1/2006 – 6/2007; crisis 7/2007-4/2009, post-crisis 5/2009-7/2010, post Dodd-Frank 7/2010-3/2014, post-Volcker 4/2014-3/2016. We recognize that Dick-Nielsen and Rossi (2016) use a shorter post-crisis period of 2010 through 2013. Further, Anderson and Stulz (2017) use 2004-2006 as the pre-crisis period and 2010-2014 as the post-crisis period because of the constraints in the availability of Enhanced TRACE. [Footnote continued on next page]

As discussed in Broad Economic Considerations, it is often difficult to anticipate when regulatory activities should impact liquidity even with a clear regulatory timeline, and market participants may anticipate and change their behavior prior to the implementation of regulations. The Volcker Rule was originally set to take effect on July 21, 2012, with a 2-year phase-in period, and the FRB approved Basel III on July 2, 2013. Both dates fall in the "Regulatory" sub-period, but these regulatory changes may have been anticipated by market participants in the "Post-crisis" sub-period.[136] Furthermore, we note that during the "Post-regulatory" sub-period, FINRA commenced the dissemination of Rule 144A bond trades to the public via TRACE in June 2014. We exclude Rule 144A bond trades from our main transaction costs analysis. However, we recognize that our cost estimates in the "Post-regulatory" sub-period may be contaminated by potential spillovers from the improved post-transparency in Rule 144A bonds.

We provide an overview of our bond issuers and issues in our sample. Table 11[137] reports the distribution for the number of TRACE-eligible bond issues (i.e., CUSIPs) per issuer (i.e., firms) for each sub-period. The median issuer in our sample had two bond issues outstanding for any sub-period. The average number of bond issues per issuer was over 8 in all sub-periods, and it was the highest at around thirteen bond issues during the "Post-crisis" sub-period. The distribution for the number of TRACE-eligible bond issues per issuer was highly skewed. In any sub-period, firms in the 90th percentile of the distribution had more than 9 bond

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Given the availability of regulatory TRACE data through 2016 we use a full time series through 2016. Anderson and Stulz (2017) also argue that the inclusion of the credit boom during the first 6 months of 2007 may bias one to find a deterioration in liquidity post-crisis. Therefore, the selection of 1/2006 through 7/2007 as a "pre-crisis" sub-period is likely a conservative choice and may bias us to find reductions in liquidity post-crisis.

[136] As presented in Appendix A, BCBS finalized Basel III capital framework in December 2010, which falls in the "Post-crisis" sub-period.

[137] For Table 11, we drop three days in our sample, July 3, 2014, August 29, 2014, and November 26, 2014, due to error in data feed that includes TRACE-eligible bond issues.

issues outstanding and firms in the 99th percentile had over 100 TRACE-eligible bonds outstanding.

b). Full Sample Trading Activity

In this section,[138] we examine various trading activity measures and study how they have changed over time. In examining trading activity, we consider the following measures: the number of bond issues traded, trade counts, and par volume. We find that a notably larger portion of TRACE-eligible bonds trades over more days during the "Regulatory" and the "Post-regulatory" sub-periods compared to any earlier sub-periods. These findings are not consistent with the hypothesis that regulations reduced corporate bond market liquidity.

Each sub-period in our sample is of a different length, so we normalize measures of trading activity by taking the average over multiple trading days. Specifically, we first construct daily trading activity measures and then compute the averages over each sub-period. Table 12[139] reports the sub-period averages of the following daily statistics: the number of issuers with TRACE-eligible corporate bonds, the number of TRACE-eligible bond issues, the number of trades, and par volume for each sub-period. From Column (1) in Table 12, we note that the average daily number of issuers with TRACE-eligible corporate bonds decreased during the "Regulatory" and the "Post-regulatory" sub-periods. During the "Post-crisis" sub-period, there were 4,837 issuers with TRACE-eligible bonds, whereas there are only 3,306 and 3,185 issuers with TRACE-eligible bonds outstanding during the "Regulatory" and the "Post-regulatory" sub-periods, respectively. We observe similar changes over time for the average daily number of TRACE-eligible bond issues reported Column (3) of Table 12.

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[138] For all figures and tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

[139] For Table 12, we drop 3 days in our sample, July 3, 2014, August 29, 2014, and November 26, 2014, because of errors in the data feed that includes TRACE-eligible bond issues.

Given the growth in public debt placements shown in Part A, this may be consistent with increases in redemptions. It is also consistent with changes in the sample composition due to changes in the FISD database coverage. However, as shown in Tables D.1 and D.2, TRACE-eligible bonds with no coverage in the FISD database have notably larger average daily trade counts and par volumes during the "Post-crisis," the "Regulatory," and the "Post-regulatory" sub-periods than in earlier sub-periods. As a result, the exclusion of TRACE-eligible bonds with no coverage in the FISD database is less likely to bias our results towards finding better liquidity in the corporate bond market for the later sub-periods.[140]

Column (4) of Table 12 reports the average daily percentage of TRACE-eligible bond issues with at least one trade on a given day. The average daily portion of TRACE-eligible bonds traded is the highest during the "Regulatory" sub-period and the second lowest at 10.5% for the "Post-crisis" sub-period. However, we note that the average daily number of trades (approximately 38,300 trades per day) during the "Post-crisis" sub-period is higher than in any other sub-periods. This is consistent with trading activity being concentrated in fewer corporate bonds during the "Post-crisis" sub-period. Lastly, by comparing Columns (2) and (4) for every sub-period, we note that the average daily portion of firms with at least one trade on a given day in any of their bonds is substantially larger than the average daily portion of bond issues with trades. This difference primarily reflects firms that have multiple bond issues outstanding but few bonds traded.

Table 13[141] Panels A and B present summary statistics on trading activity across the six sub-periods. Panel A of Table 13 reports the distribution for the portion of business days (in

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[140] For an extended discussion of sample filters and sample composition, see Appendix D.

[141] For Table 13, we drop 3 days in our sample, July 3, 2014, August 29, 2014, and November 26, 2014 because of errors in the data feed that includes TRACE-eligible bond issues.

percentage) with at least one trade per TRACE-eligible bond issue during each sub-period. During the "Pre-crisis," the "Crisis," and the "Post-crisis" sub-periods, we observe that at least one-half of TRACE-eligible bonds do not trade (i.e., the median is 0%). Although one-half of bonds do not trade, approximately 5% of bonds trade on at least 78% of total business days during the "Post-crisis" sub-period. As mentioned above, this indicates that trading is concentrated in a small number of liquid corporate bonds during the "Post-crisis" sub-period. Furthermore, we note that a substantially larger portion of TRACE-eligible bonds trades on more days during the "Regulatory" and the "Post-regulatory" sub-period compared to any earlier sub-periods, which is not consistent with the hypothesis that regulations reduced corporate bond market liquidity. At least 25% of TRACE-eligible bonds have at least one trade on over 20% of total business days during the "Regulatory" sub-period and the "Post-regulatory" sub-period whereas approximately 25% of TRACE-eligible bonds have at least one trade on less than 10% of total business days during the "Pre-crisis," the "Crisis," and the "Post-crisis" sub-period.

Panel B of Table 13 presents the distribution for the portion of TRACE-eligible bond issues grouped by the number of trades per day for each sub-period. The average portion of TRACE-eligible bonds that do not trade on a given day ranges from approximately 79% to 91% across sub-periods. On average, the portion of bonds that do not trade is lower during the "Regulatory" and the "Post-regulatory" sub-period and higher during the "Crisis" and the "Post-crisis" sub-periods. Furthermore, during the "Regulatory" and the "Post-regulatory" sub-period, we estimate that a substantially larger portion of bonds trade at least once on a given day compared to other sub-periods.

c). Trading Activity and Cross-Sectional Bond Characteristics

In this section,[142] we examine how trading activity is related to cross-sectional bond characteristics, as well as how it has changed over time. Specifically, we consider issue size (measured in par value), credit quality, age (time since issuance), original maturity, and instrument complexity in our analysis. We find that throughout sub-periods, trading activity has been increasingly concentrated in bonds with issue size greater than $500 million. We also find that trading activity is concentrated in more recently issued bonds and bonds with maturity between 5 and 20 years across all sub-periods. Lastly, our analysis shows that trading activity is more concentrated in bonds with less complexity features during the "Regulatory" and the "Post-regulatory" sub-periods compared to any earlier sub-periods.

As above, we report average daily trading activity statistics to reduce the influence of differences in sub-period length. Table 14 Panels A through E report the number of TRACE-eligible bond issues and the portion of TRACE-eligible bonds with trades across sub-periods by bond characteristic. Figures 25 Panels A through E show the distribution (in percentage) of bond issues, trades, and par volume grouped by bonds with similar characteristics across sub-periods. From Panel A of Table 14, the fraction of TRACE-eligible bonds with trades is substantially larger for corporate bonds with larger issue size (greater than $100 million) during the "Regulatory" and the "Post-regulatory" sub-periods compared to the sub-periods prior to the financial crisis. We also note that the portion of TRACE-eligible bonds with trades for small bonds (issue size smaller than $100 million) is slightly smaller during the "Regulatory" and the "Post-regulatory" sub-periods than earlier sub-periods prior to the "Crisis" sub-period.

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[142] For all figures and tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

From Figure 25 Panel A, we observe that trade counts and par volume are highly concentrated in bonds with issue size greater than $500 million. For example, for the "Regulatory" sub-period, bonds with issue size greater than $500 million are approximately 42% of average daily traded bonds, 58% of average daily trades, and 74% of par volume, whereas bonds with issue size less than $100 million are 17% of average daily traded bonds, 9% of average daily trades, and 1% of average daily par volume. Furthermore, we note that the portion of average daily trades and par volume for bonds with issue size greater than $500 million has been increasing since the "Pre-crisis" sub-period. The average daily portions of traded bonds, trades, and par volume during the "TRACE Phase-in" and the "Pre-crisis" sub-periods are approximately 25%, 45%, and 58%, respectively, while the average daily portions of traded bonds, trades, and par volume during the "Post-regulatory" sub-period are approximately 48%, 63%, and 77%, respectively. This indicates that trading activity has been increasingly more concentrated in bonds with large issue size throughout sub-periods, consistent with liquidity clustering in a subset of traded bonds.

Panel B of Table 14 reports the number of TRACE-eligible bond issues and the portion of TRACE-eligible bonds with trades grouped by similar credit quality across sub-periods. Figure 25 Panel B shows the distribution of traded bonds, trades, and par volume grouped into four categories of credit quality. For our trading activity analysis on credit quality, we subdivide investment grade and high yield bond samples into two groups, bonds with a par volume weighted average price below $95 (out of $100 par) and bonds with a weighted average price above $95 on a given day. We consider bonds that trade below $95 to represent the segment of the corporate bond market with deteriorating credit quality. We recognize that this interpretation assumes that such bond groups are homogenous and are otherwise similar along other dimensions relevant to bond pricing, such as interest rate risk. From Panel B of Table 14, we observe that the portion of TRACE-eligible bonds with trades is substantially smaller for both investment grade and high yield bonds with deteriorating credit quality (price below $95) than investment grade and high yield bonds with a price above $95 in any sub-period. Across sub-periods, at most, 7% and 11% of investment grade and high yield bonds with a price below $95, respectively, are traded whereas at least 17% and 16% of investment grade and high yield bonds with a price above $95, respectively, are traded. Furthermore, although investment grade bonds with a price below $95 account for over 50% of all investment grade TRACE-eligible corporate bonds, only 1.9% of investment grade bonds with a price below $95 have trades during the "Post-crisis" sub-period. We also note that a substantially larger portion of investment grade bonds with a price above $95 are traded than any earlier sub-periods.

Figure 25 Panel B shows that at least 64% of average daily trading activity is attributed to investment grade bonds. Furthermore, the average daily proportion of traded bonds, trades, and par volume for corporate bonds with deteriorating credit quality accounts for less than 20% across all sub-periods with the exception of the "Crisis" period. We observe that the average daily portions of traded bonds, trades, and par volume for bonds with deteriorating credit quality are higher during the "Crisis" period and are approximately 49%, 43%, and 47%, respectively.

Panels C and D of Table 14 report the number of TRACE-eligible bond issues and the portion of TRACE-eligible bonds with trades grouped by similar bond age and original maturity, respectively, across sub-periods. Figure 25 Panel C and Panel D show the average daily distribution of bond issues, trades, and par volume grouped by bond age (time since issuance) and original maturity, respectively. In Panel C of Table 14, we observe that a larger portion of older bonds (bonds issued over 2 years ago) is traded during the "Regulatory" and the "Post-regulatory" sub-period than any earlier sub-periods. With the exception of the "Crisis" and "Post-crisis" sub-period, at least 12% of younger bonds with age less than 2 year have trades. In Figure 25 Panel C, we note that younger bonds (less than 2 years since issuance) account for approximately 50% of average daily par volume across all sub-periods and older bonds (greater than 5 years since issuance) account for less than 20% of average daily par volume across all sub-periods.

In Panel D of Table 14, we note that a larger portion of longer original maturity bonds (original maturity longer than 5 years) are traded than short maturity bonds (original maturity less than 5 years) in any sub-period. At least 12% of longer original maturity bonds (original maturity longer than 5 years) have trades across any sub-periods. The portion of longer original maturity bonds (original maturity longer than 5 years) with trades is larger (at least 21%) during the "Regulatory" and the "Post-regulatory" sub-period than any earlier sub-periods. From Figure 25 Panel D, we observe that bonds with maturity between 5 years and 20 years account for approximately 70% of trades and par volume across all sub-periods. Bonds with maturity of less than 2 years do not trade actively. These results indicate that trading activity is concentrated in more recently issued, younger bonds and bonds with maturity between 5 and 20 years.

Using bond features included in the FISD, we construct an instrument complexity variable by aggregating the number of the following bond features: variable rate, nonstandard interest payment frequencies, pay-in-kind, redeemable, convertible, unconventional day count basis for accrued interests, and sinking fund.[143] From Table 14 Panel E, in any sub-period, a substantially larger portion of corporate bonds with less complexity features (zero or one

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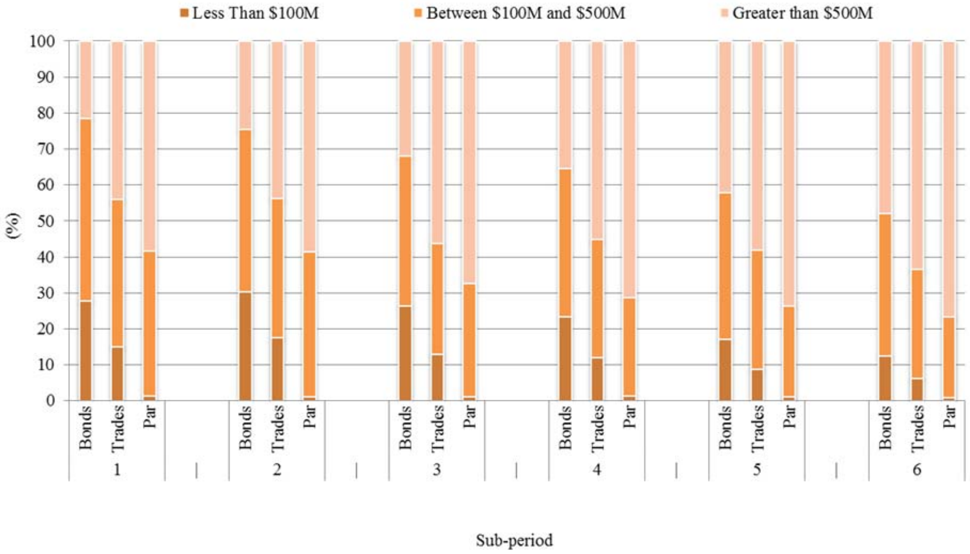
[143] Edwards, Harris, and Piwowar (2007) consider a similar list of instrument complexity features: callable, putable, coupon types (fixed, floating, or variable), sinking fund, non-standard interest payment frequency, and nonstandard interest accrual basis.

complexity feature) are traded than corporate bonds with more complexity features (two or more complexity features). We note that the portion of TRACE-eligible bonds with less complexity features (zero or one complexity feature) is substantially larger than corporate bonds with more complexity features (two or more complexity features) in the recent sub-periods, the “Regulatory” and the “Post-regulatory” sub-period.

Figure 25 Panel E reports the distribution of traded bonds, trades, and par volume across the number of complexity features. From Figure 25 Panel E, across all sub-periods, we observe that less than 20% of average daily traded bonds and trades have two or more complexity features. Furthermore, we note that during the “Regulatory” and the “Post-regulatory” sub-period, bonds with either zero or one complexity feature account for over 92% of average daily corporate bond trades and par volume showing that trading activity is more concentrated in bonds with fewer complexity features in recent years.

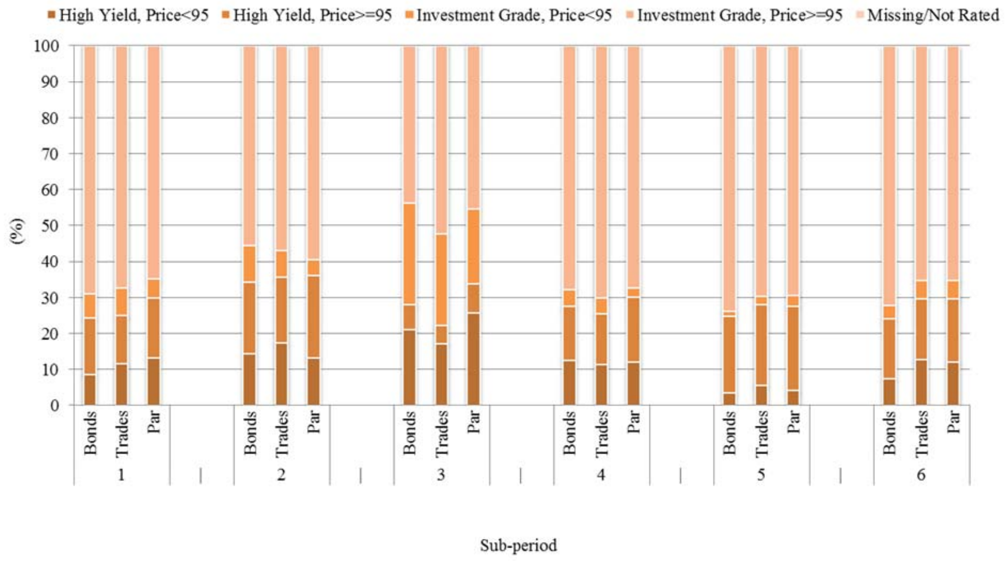
Figure 25. Cross-sectional bond characteristics: Bond issues, trades, and par volume

Panel A. Issue size distribution



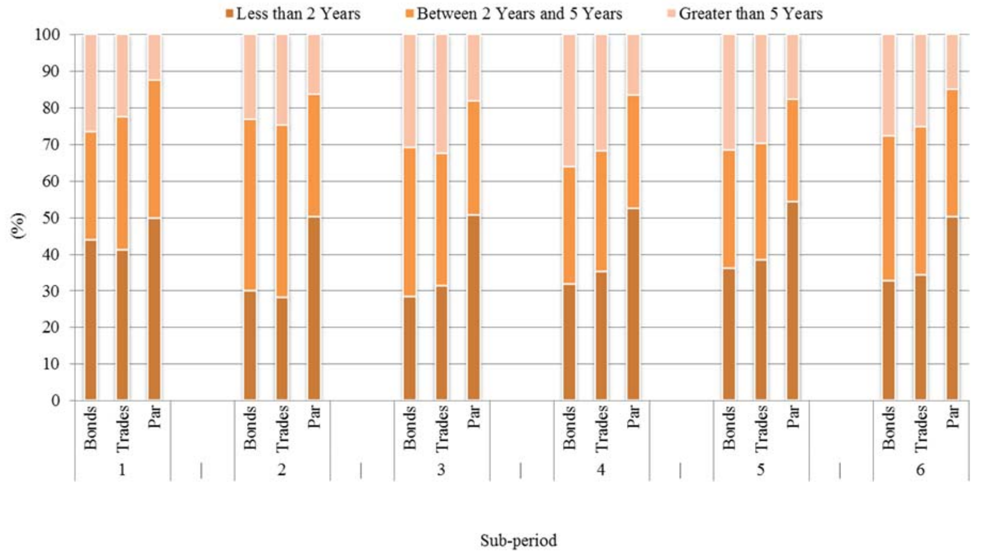
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel B. Credit quality distribution



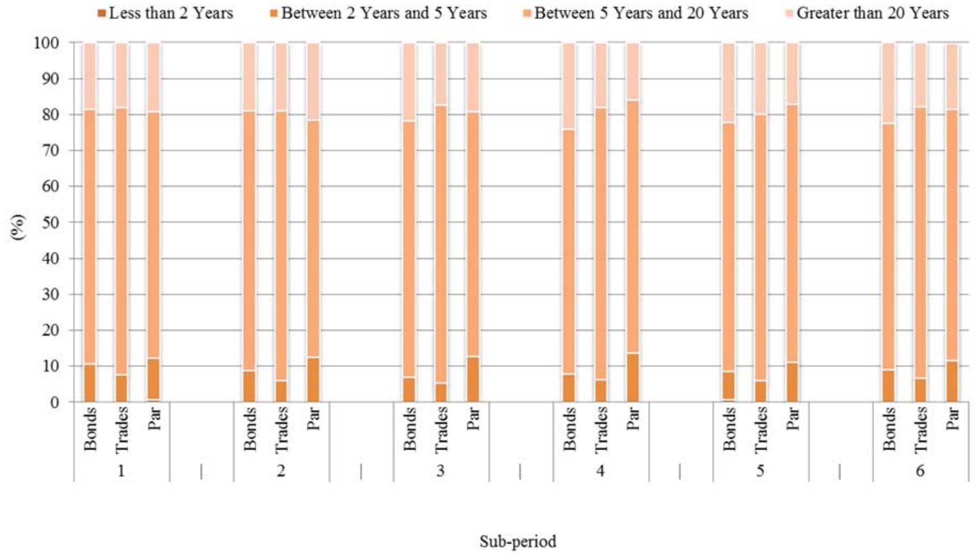
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel C. Age distribution



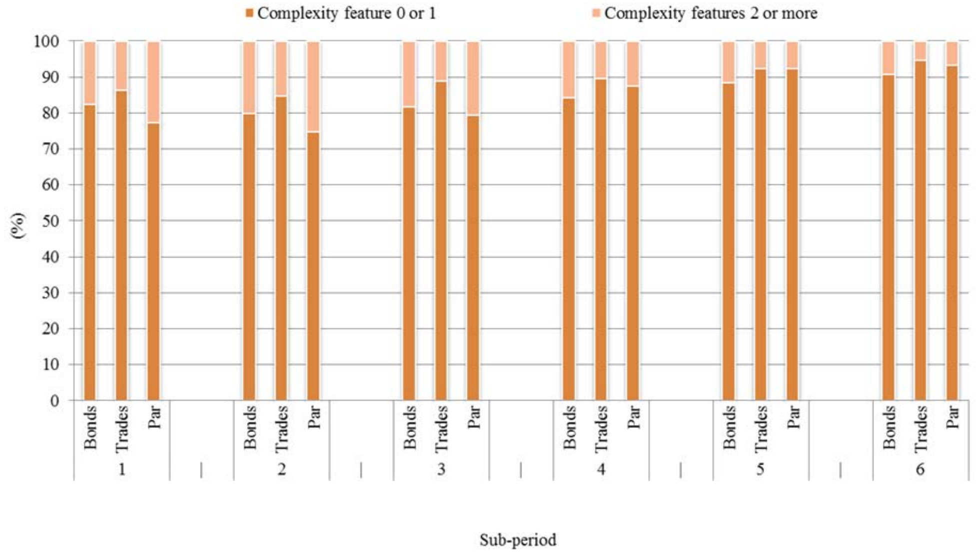
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel D. Maturity distribution



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel E. Complexity distribution



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”
Source: DERA analysis

2. Transaction Costs

In this section,[144] we discuss our empirical results on average transaction costs for corporate bonds across sub-periods and also by cross-sectional bond characteristics. Following Edwards, Harris, and Piwowar (2007), we control for corporate bond market return, duration risk, and credit risk, which influence bond pricing, in estimating average transaction costs for customer trades.

a). Full Sample Results

Our transaction cost analysis shows that there is a decrease in transaction costs for smaller trade size after the "Post-crisis" sub-period. We observe that the average transaction costs for smaller trade size during the "Regulatory" and the "Post-regulatory" sub-period are lower than those for smaller trade size during the "Pre-crisis" sub-period. Furthermore, we do not observe an increase in corporate bond transaction costs for larger trade size during the "Regulatory" and the "Post-regulatory" sub-period period. Rather, the average transaction costs for larger trade size during the "Regulatory" and the "Post-regulatory" sub-periods are similar to those during the "Pre-crisis" sub-period. These findings do not suggest that regulations reduced corporate bond market liquidity.

As shown in Table D.3,[145] some customer trades are reported as agency trades with zero commission. It is possible that those agency trades reflect transactions made on behalf of customer accounts that pay fees in lieu of commissions. If this is true, then for those agency trades, commissions may underestimate transaction costs. We observe that those zero commission agency trades are concentrated in smaller trade sizes throughout sub-periods. Thus,

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[144] For all figures and tables referenced in this section, we apply data filters in the trade reporting, the discretionary, and the price-based filters discussed in Appendix D.

[145] Table D.3 in Appendix D reports the average daily agency trades for customer trades by trade size across sub-periods. For Table D.3, we apply filters in the trade reporting and the discretionary filters discussed in Appendix D.

the inclusion of zero commission agency trades in estimating average transaction costs would result in biased (i.e., lower) transaction cost estimates for smaller trade size. We show our average transaction costs estimation results with and without zero commission agency trades in Figure 26 Panel A and Figure 26 Panel B, respectively; and tabulate the estimation results in Table 15 Panel A and Table 15 Panel B, respectively. For example, comparing Table 15 Panel A and Table 15 Panel B for the "Post-regulatory" sub-period, we note that the estimated average round-trip transaction costs for a trade size of $20,000 (smaller trade size) is approximately 0.15 percentage points higher ([27.7 bps – 20.3 bps] × 2) when zero commission agency trades are excluded in estimation, whereas there is little difference in the estimated round-trip costs for a trade size of $1,000,000 (larger trade size) (0.045% (4.5 bps) when zero commission agency trades are excluded vs. 0.046% (4.6 bps) when zero commission agency trades are included). Therefore, it may be important to exclude zero commission agency trades in estimating average transaction costs and Table 15 Panel A[146] and Figure 26 Panel A serve as our main transaction costs estimation results.

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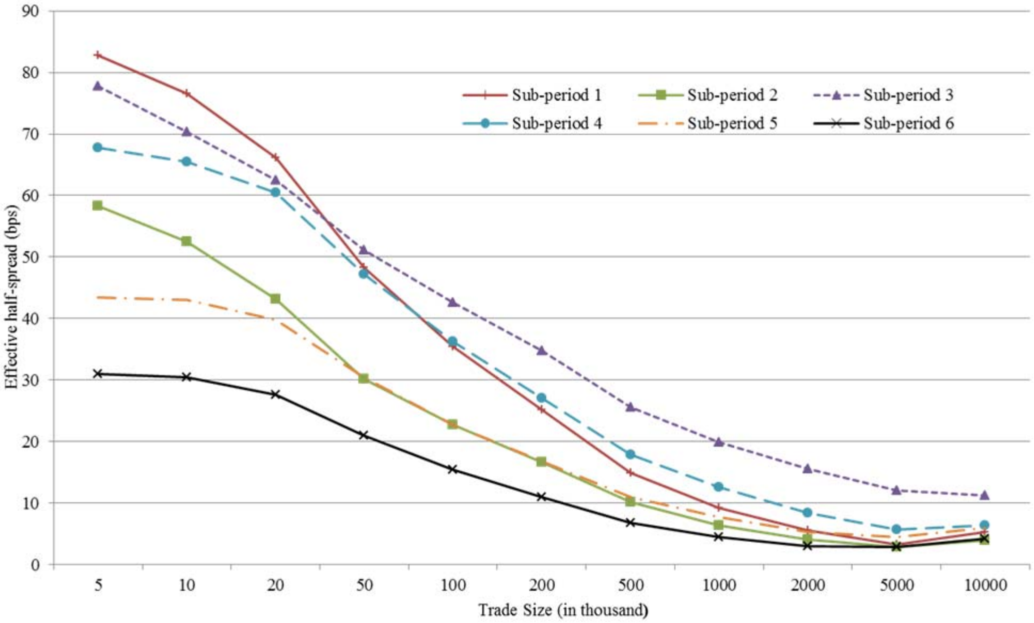
[146] Table D.4 Panels A through F in Appendix D report EHP transaction cost estimation results, including average and median transaction costs and the confidence interval for average transaction cost estimates for each sub-period.

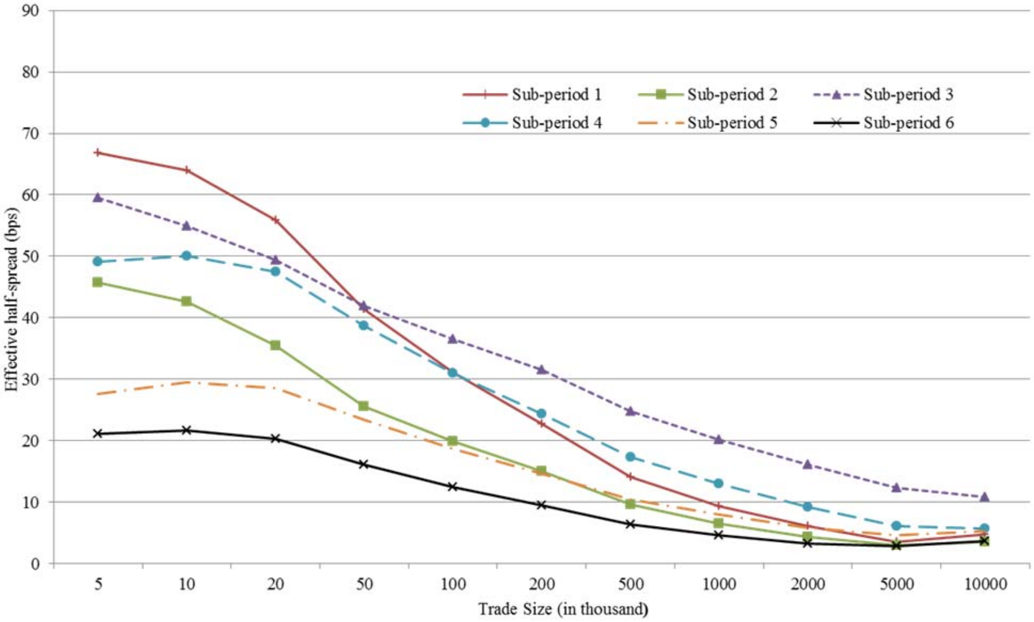
Figure 26. EHP average transaction costs

Panel A. Excluding zero commission agency trades



Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Panel B. All trades



Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Source: DERA analysis

We observe that the estimated average transaction costs for each sub-period decrease with trade size, which is consistent with findings in academic papers. For the “Post-regulatory” sub-period, the average round-trip transaction cost for a smaller trade size of $20,000 is 0.55% (27.7 bps × 2) of bond price, while a larger trade size of $1,000,000 is only 0.09% (4.5 bps × 2). This result may indicate that large traders have the market power to negotiate better prices than small traders or that broker-dealers price trades so that they can spread their fixed trading costs over volume, or both.[147]

We examine whether and how average transaction costs have changed over time. Figure 27 shows the estimated average round-trip transaction costs across six sub-periods for trade sizes of $20,000, $1,000,000, and $5,000,000, respectively. From Figure 27, we observe that, in general, the estimated average round-trip transaction costs increased during the “Crisis” sub-period and stayed elevated during the “Post-crisis” sub-period but have subsequently decreased throughout the “Regulatory” sub-period and the “Post-regulatory” sub-period. For instance, the estimated average round-trip transaction costs in Table 15 Panel A for a trade size of $1,000,000 increased from 0.13% (6.4 bps × 2) of bond price during the “Pre-crisis” sub-period to 0.40% (19.9 bps × 2) during the “Crisis” sub-period but have subsequently decreased to 0.09% (4.5 bps × 2) during the “Post-regulatory” sub-period. Lastly, based on EHP measures, we do not observe an increase in corporate bond transaction costs during the “Regulatory” and the “Post-regulatory” sub-periods. Rather, our empirical evidence is consistent with other studies on corporate bond liquidity (e.g., Mizrach (2015), Schestag (2016)), which conclude that corporate

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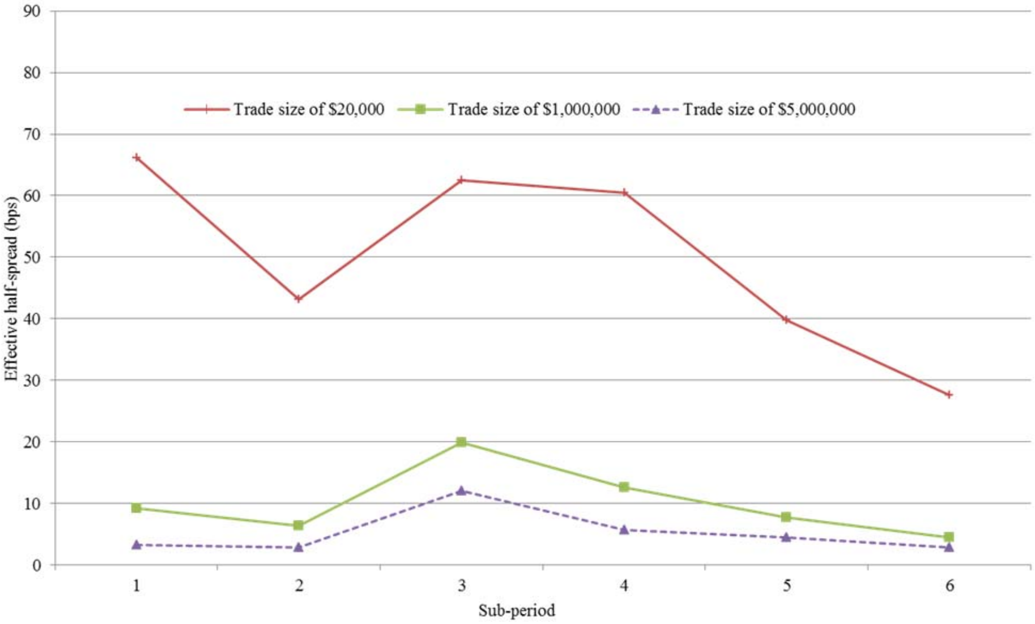
[147] Edwards, Harris, and Piwowar (2007) find that the difference in market power between large and small traders in negotiating prices is more important than dealers’ fixed cost management in explaining the shape of the average transaction cost curve for corporate bonds.

bond transaction costs have decreased since the financial crisis, which is not consistent with the argument that regulations reduced corporate bond market liquidity.

Figure 27. EHP average transaction costs by trade size



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Source: DERA analysis

Furthermore, by comparing the estimated average transaction cost curves for the “Pre-crisis” and the “Post-regulatory” sub-period in Figure 26 Panel A, the estimated average transaction costs for the “Post-regulatory” period are lower for almost all trade sizes. We note, however, that the reduction in corporate bond transaction costs is more pronounced in smaller trade sizes. For example, by comparing the estimated average transaction costs for the “Pre-crisis” and the “Post-regulatory” sub-periods, the estimated average round-trip transaction cost for a smaller trade size of $20,000 is lower by 0.31 percentage points ([43.2 bps – 27.7 bps] × 2) in the “Post-regulatory” sub-period, while the estimated average transaction costs are similar for a larger trade size of $5,000,000 (the estimated average round-trip transaction cost of 0.059%

(2.9 bps × 2) in the "Pre-crisis" sub-period versus 0.057% (2.8 bps × 2) in the "Post-regulatory" sub-period).

The sizable reduction in transaction costs for smaller trade size during the "Pre-crisis" sub-period could be attributable, in part, to enhancement in post-trade transparency with the introduction of TRACE reporting. Pricing information obtained via TRACE reporting could be valuable and result in lower transaction costs for small traders, such as retail investors, because they may otherwise lack alternative means to readily obtain useful pricing information on corporate bond transactions. In addition, the decrease in average transaction costs for smaller trade size after the "Post-crisis" sub-period may be attributable, in part, to the recent increase in electronic trading for corporate bonds and is inconsistent with the concern that regulations reduced corporate bond market liquidity. As discussed above, electronic trading could improve efficiency in managing inventory and searching for counterparties. In general, electronic trading may be more appropriate for executing smaller orders because the tradeoff between the cost of information leakage from displaying trading intentions and the reduction in search costs for finding a counterparty would be more favorable. Added efficiency in executing smaller orders via electronic trading would lower transaction costs for smaller corporate bond trades.[148] We discuss summary statistics for corporate bond quotations and trades on electronic trading venues (i.e., ATS) in Part B.IV.C.3 below.

b). Cross-Sectional Results

In this section, we examine how average transaction costs are related to cross-sectional bond characteristics and how those have changed over time. Many academic papers examine

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[148] Hendershott and Madhavan (2015) find that transaction costs for small trades on electronic venue are lower than those for "voice" intermediated trades.

how transaction costs are associated with various bond characteristics, and our cross-sectional subsample cuts are informed by well-established finance research.[149] Literature shows that larger and newer bond issues have lower transaction costs.[150] More complex bonds and a longer time-to-maturity are associated with higher transaction costs.[151] In addition, some studies find that higher credit risk is linked to higher transaction costs.[152] In this analysis, we consider five bond characteristics that the existing research associated with transaction costs: issue size, credit quality, age, original maturity, and complexity. For each bond characteristic, we estimate average transaction costs for bonds that are similar in characteristic by trade size over each sub-period. For ease of presentation, we show the estimated average transaction costs for the trade size of $1,000,000 and $5,000,000 for each bond characteristic,[153] except for complexity. For complexity, we present the estimated average transaction costs for the trade size of $20,000 and $5,000,000 for the reasons discussed below.[154]

For corporate bond trades with a trade size of $1,000,000, we find that, across all sub-periods, the estimated average transaction costs for bonds with an issue size greater than $500 million, bonds with a price above $95, bonds with an age of less than 2 years, bonds with an original maturity between 5 and 20 years, and bonds with zero or one complexity feature, are

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[149] *See* Chakravarty and Sarkar (2003), Hong and Warga (2000), Harris and Piwowar (2006), and Edwards, Harris, and Piwowar (2007).

[150] *See* Chakravarty and Sarkar (2003) and Hong and Warga (2000).

[151] *See* Harris and Piwowar (2006).

[152] *See* Chakravarty and Sarkar (2003), Hong and Warga (2000), and Harris and Piwowar (2006).

[153] We report the estimated average transaction costs for small (i.e., $20,000) size trades across sub-periods by bond characteristics (issue size, credit quality, age (time since issuance), original maturity, and complexity features in Appendix D. In general, for trades of size $20,000, our findings on the changes in the estimated average transaction costs across corporate bonds with different bond characteristics over sub-periods are qualitatively similar to the results for trades of size $1,000,000 discussed in this section. Furthermore, for small trades of size $20,000, in general, the estimated average transaction costs during the “Post-regulatory” sub-period across corporate bonds with different bond characteristics are lower than those in sub-periods prior to the “Crisis” sub-period. *See also* Figure D.1 Panel A through Panel D in Appendix D.

[154] The transaction cost estimates for trade size of $1,000,000 for bonds with complexity features of two or more and zero or one are similar across sub-periods. *See also* Figure D.2 in Appendix D.

lower than transaction costs for bonds with smaller issue sizes, a price below $95, other maturities and more than one complexity feature. However, we observe that the estimated average transaction costs for bonds with an issue size greater than $500 million are the highest during the "Crisis" sub-period compared to bonds with a smaller issue size. Furthermore, the average transaction cost estimates are higher for investment grade bonds with prices below $95 compared to those for high yield bonds with prices below $95 during the "Crisis" and the "Post-crisis" sub-period.

In general, we do not observe an increase in the estimated average transaction costs for large bond trades of size $5,000,000 during the "Regulatory" and the "Post-regulatory" sub-period. However, for large trade size of $5,000,000, the estimated average transaction cost estimates during the "Regulatory" and the "Post-regulatory" sub-period for corporate bonds with an issue size greater than $500 million, investment grade bonds with a price above $95, bonds younger than 2 years old, and bonds with an original maturity longer than 20 years are slightly higher than those in the sub-periods prior to the "Crisis" sub-period: the differences in the estimated average transaction costs are small (at most, 0.15 percentage points (15.2 bps)). We also acknowledge that our sample size in estimating average transaction costs for trades with trade size $5,000,000 is small because only a small portion of corporate bond trades have a large trade size of $5,000,000: from Table 17, across six sub-periods, the average daily portion of principal customer trades with trade size greater than $5,000,000 is at most, 6.8% (the "Pre-crisis" sub-period) and as small as 4.4% (the "Regulatory" sub-period). Estimating average transaction costs over a small sample of trades may result in less precise estimates.

Figure 28 Panels A through E and Figure 29 Panels A through E plot the estimated cross-sectional average transaction costs for each bond characteristic over six sub-periods for the trade size of $1,000,000 and $5,000,000, respectively.[155] Figure 28 Panel A compares the estimated average transaction costs for bonds with an issue size greater than $500 million, between $100 million and $500 million and smaller than $100 million for the trade size of $1,000,000. For almost all sub-periods, the average cost estimates are smaller for bonds with an issue size greater than $500 million than bonds with an issue size between $100 million and $500 million, but the differences in the estimated average transaction costs are small ranging from 0.03 percentage points ([5.9 bps - 4.2 bps] × 2 during the "Post-regulatory" sub-period) to 0.09 percentage points ([15.7 bps - 11.4 bps] × 2 during the "Post-crisis" sub-period). We observe that the estimated average cost is slightly higher for bonds with an issue size greater than $500 million during the "Crisis" sub-period.[156] Our trading activity analysis above shows that bonds with an issue size greater than $500 million are the most actively traded bonds during the "Crisis" sub-period. This indicates that the most actively traded segment of the corporate bond market also has the highest average transaction costs during the "Crisis" sub-period. The estimated average transaction costs for bonds with an issue size smaller than $100 million vary notably across sub-periods. The average transaction costs for bonds with an issue size smaller than $100 million are lower than bonds with an issue size greater than $100 million during the "Pre-crisis," the "Crisis," and the "Post-regulatory" sub-period but higher than bonds with an issue size greater than $100 million during the "TRACE Phase-in," the "Post-crisis," and the "Regulatory" sub-period.

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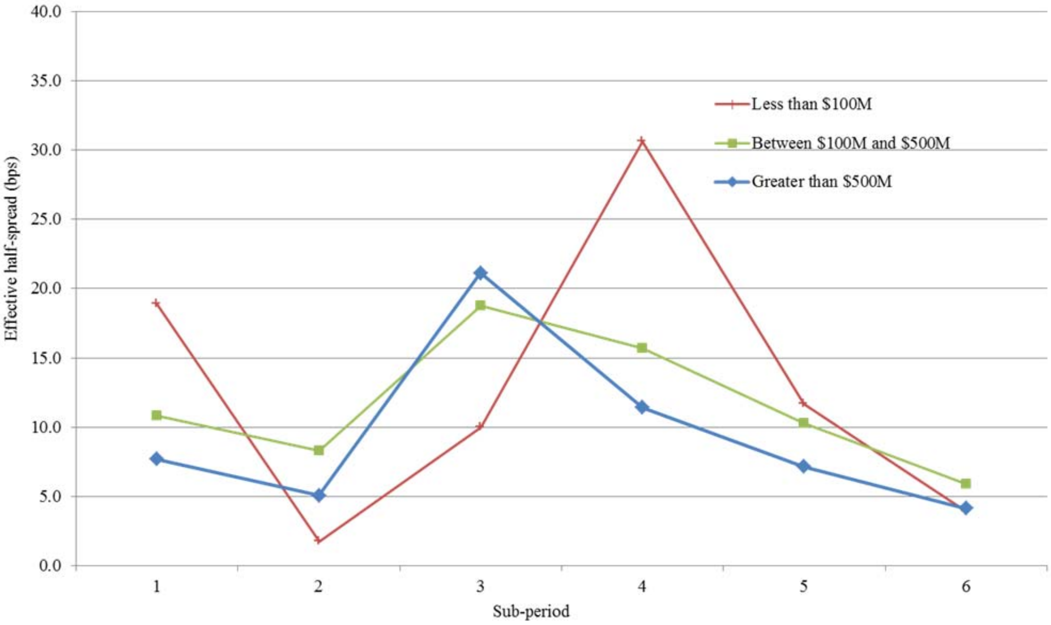
[155] Figure 28 Panel E reports the average transaction costs for the trade size of $20,000.

[156] Higher estimated average transaction costs for corporate bonds with an issue size greater than $500 million than those of smaller bonds during the "Crisis" sub-period may be due to bonds issued by financial firms. During the "Crisis" sub-period, a larger portion of corporate bonds with an issue size greater than $500 million consists of bonds issued by financial firms compared to corporate bonds with an issue size between $100 million and $500 million, and the estimated average transaction costs are higher for financial firms than for nonfinancial firms.

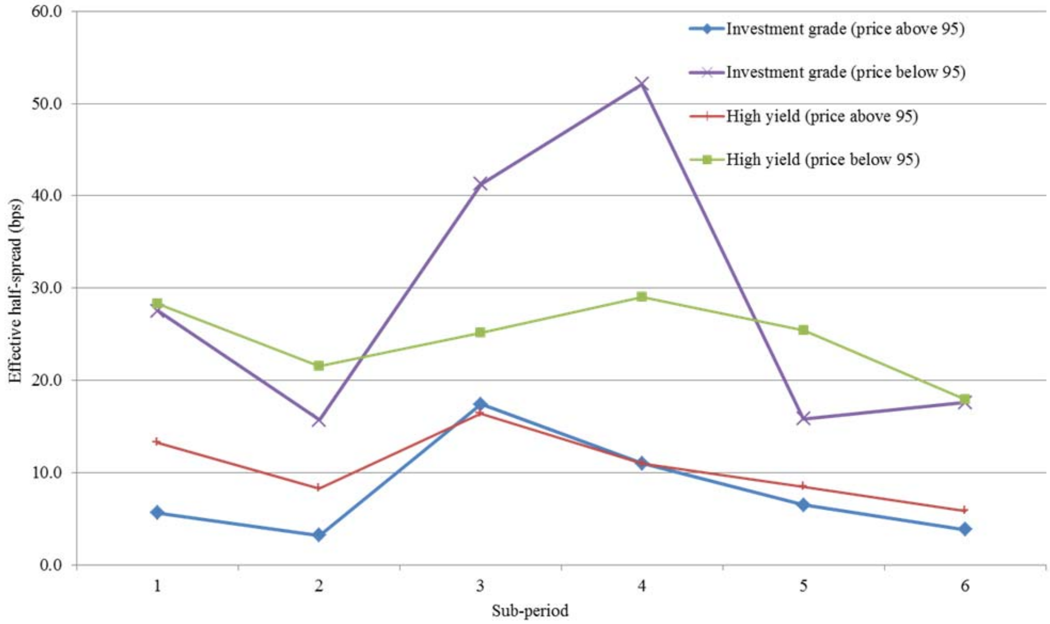
Figure 28. Cross-sectional EHP average transaction costs

Panel A. By issue size ($1,000,000 trade size)



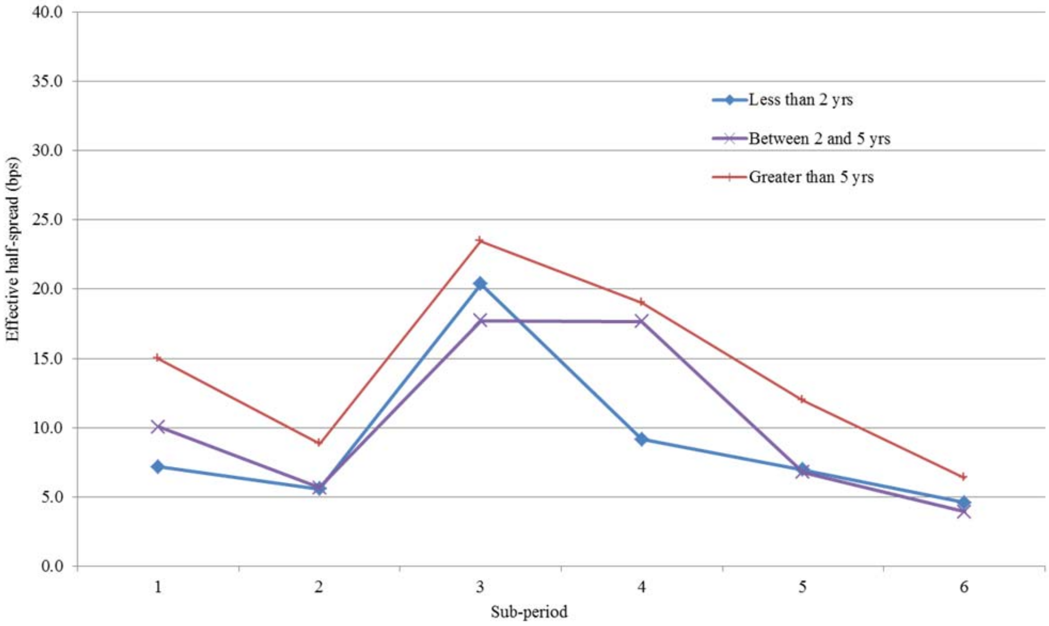
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel B. By Credit quality ($1,000,000 trade size)



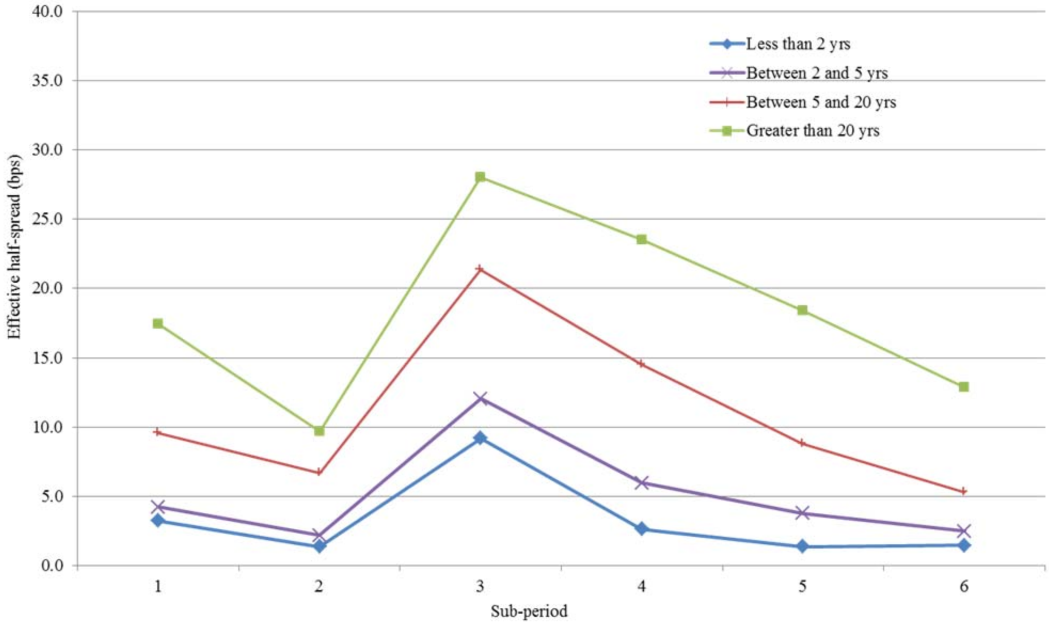
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel C. By age ($1,000,000 trade size)



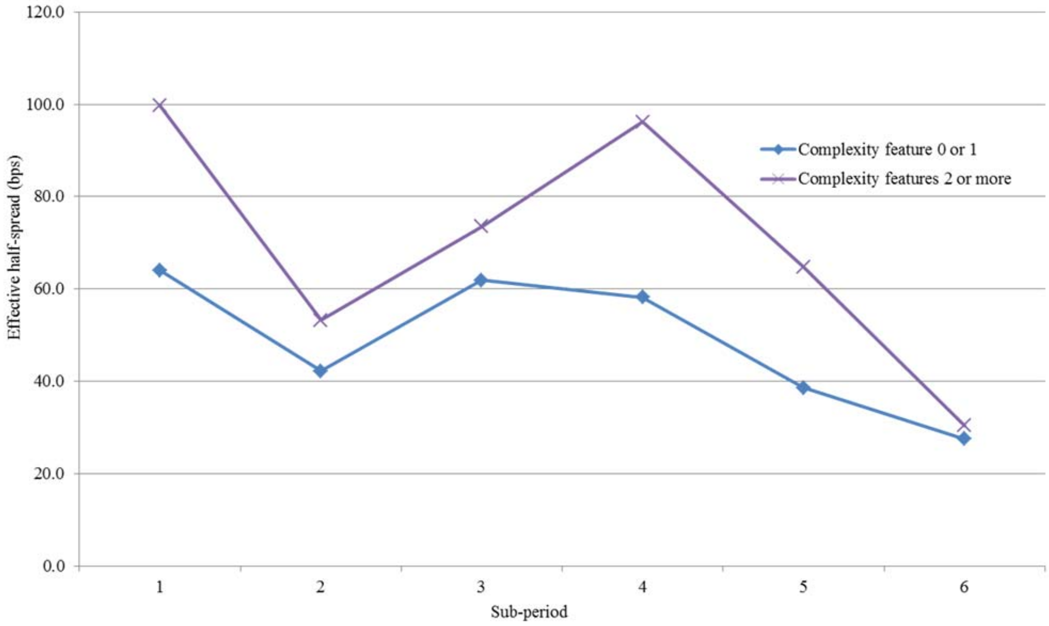
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel D. By maturity ($1,000,000 trade size)



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel E. By complexity ($20,000 trade size)



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”
Source: DERA analysis

Figure 29 Panel A shows the estimated average transaction costs for corporate bond trades of size $5,000,000 broken out by issue size. We observe that the estimated average transaction costs for larger trade size of $5,000,000 are generally lower than those for the trade size of $1,000,000 across sub-periods. For corporate bonds with issue size less than $500 million, the estimated average transaction costs for the trade size of $5,000,000 during the “Regulatory” and the “Post-regulatory” sub-period are lower or similar to those in the sub-periods prior to the “Crisis” sub-period (i.e., the “TRACE Phase-in” and the “Pre-crisis” sub-period). However, for corporate bonds with issue size greater than $500 million, we note that the estimated average transaction costs for trades with size $5,000,000 are slightly higher during the “Regulatory” and the “Post-regulatory” sub-period than those in the sub-periods prior to the financial crisis; the differences in the estimated average transaction costs are small—at most, 0.07 percentage points (6.8 bps).

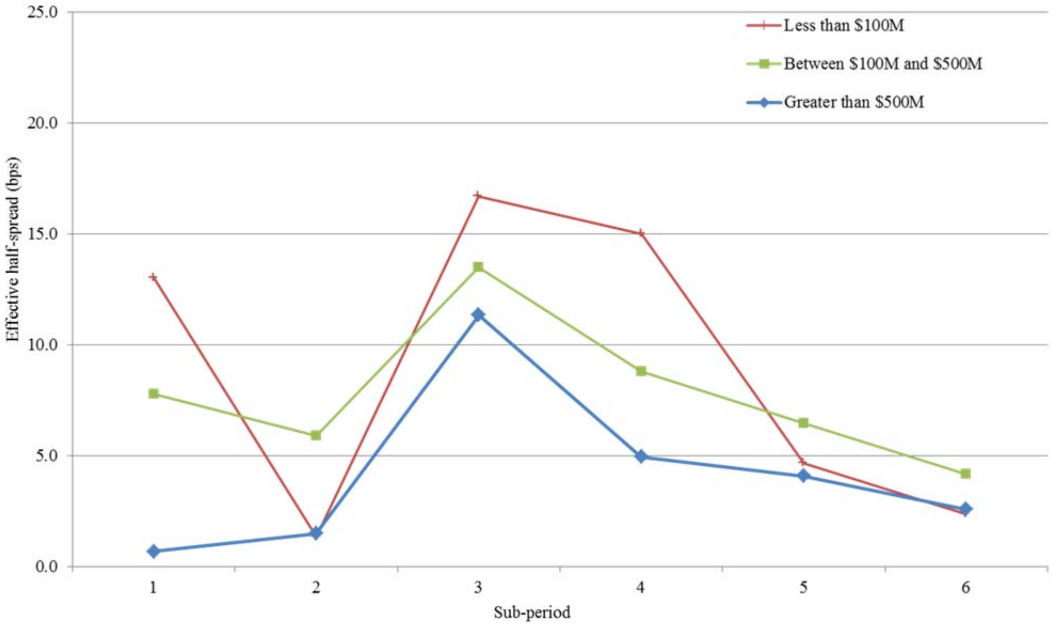
The estimated average transaction costs for investment grade and high yield bonds are shown in Figure 28 Panel B and Figure 29 Panel B. Overall, for corporate bond trades of the $1,000,000 size, transaction costs for both groups of bonds have declined in the "Regulatory" and the "Post-regulatory" sub-periods with the exception of investment grade bonds with a price below $95; however, the transaction cost difference for investment grade bonds with a price below $95 between the "Regulatory" and the "Post-regulatory" sub-periods is small, only an increase of 0.03 percentage points ([17.6 bps – 15.9 bps] × 2). We further subdivide investment grade and high yield bond samples into two groups, bonds with a par volume weighted average price below $95 (out of $100 par) and bonds with a par volume weighted average price above $95 over the given sub-period. We consider bonds with a par volume weighted average price below $95 to represent the segment of the corporate bond market with deteriorating credit quality, although we remain cognizant of potential confounding effects of other characteristics, such as interest rate risk exposure. In Figure 28 Panel B, we observe that the estimated average costs are similar for investment grade and high yield bonds with par volume weighted average price above $95 during the "Crisis," the "Post-crisis," and the "Regulatory," and the "Post-regulatory" sub-period. However, for both investment grade and high yield bonds, we observe substantially higher estimated average transaction costs for bonds with a par volume weighted average price below $95 than the estimated costs for bonds with a par volume weighted average price above $95 across all sub-periods. The differences in estimated average transaction costs for investment grade bonds with a par volume weighted average price above $95 and investment grade bonds with a par volume weighted average price below $95 during the "Crisis" and the

“Post-crisis” sub-period are substantially larger than other sub-periods. The difference between average transaction costs for investment grade bonds with a par volume weighted average price below $95 and investment grade bonds with a par volume weighted average price above $95 ranges from 0.48 percentage points ([41.3 bps - 17.5 bps] × 2 during the “Crisis” sub-period)) to 0.82 percentage points ([52.1 bps - 11.1 bps] × 2 during the “Post-crisis” sub-period). Subsequently, the differences in estimated average transaction costs for investment grade bonds with a par volume weighted average price above $95 and investment grade bonds with a par volume weighted average price below $95 narrowed to 0.19 percentage points ([15.9 bps - 6.5 bps] × 2) during the “Regulatory” sub-period. These results are consistent with the argument that the risk of adverse selection widened effective spreads in bonds with deteriorating credit quality during the “Crisis” and the “Post-crisis” sub-period.

We also note that the estimated average transaction cost for investment grade bonds with deteriorating credit quality (i.e., investment grade bonds with a par volume weighted average price below $95) is higher than for high yield bonds with a par volume weighted average price below $95 during the “Crisis” sub-period, and stays elevated during the “Post-crisis” sub-period. During the “Crisis” sub-period, investment grade bonds with deteriorating credit quality (i.e., investment grade bonds with a par volume weighted average price below $95) account for a substantially larger portion of trading activity compared to high yield bonds with deteriorating credit quality (i.e., high yield bonds with a price below $95). This is consistent with Bessembinder et al. (2016), which found that investment grade bonds have, on average, substantially higher block trading activity during the benchmark period but experienced the largest reduction in block trading during the crisis.

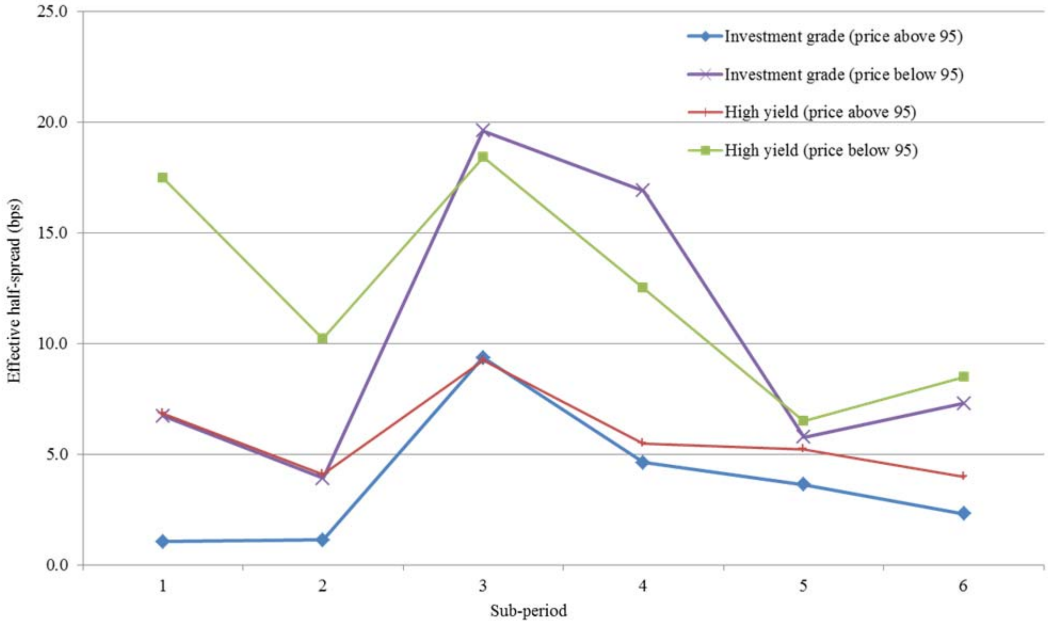
Figure 29. Cross-sectional EHP average transaction costs

Panel A. By issue size ($5,000,000 trade size)



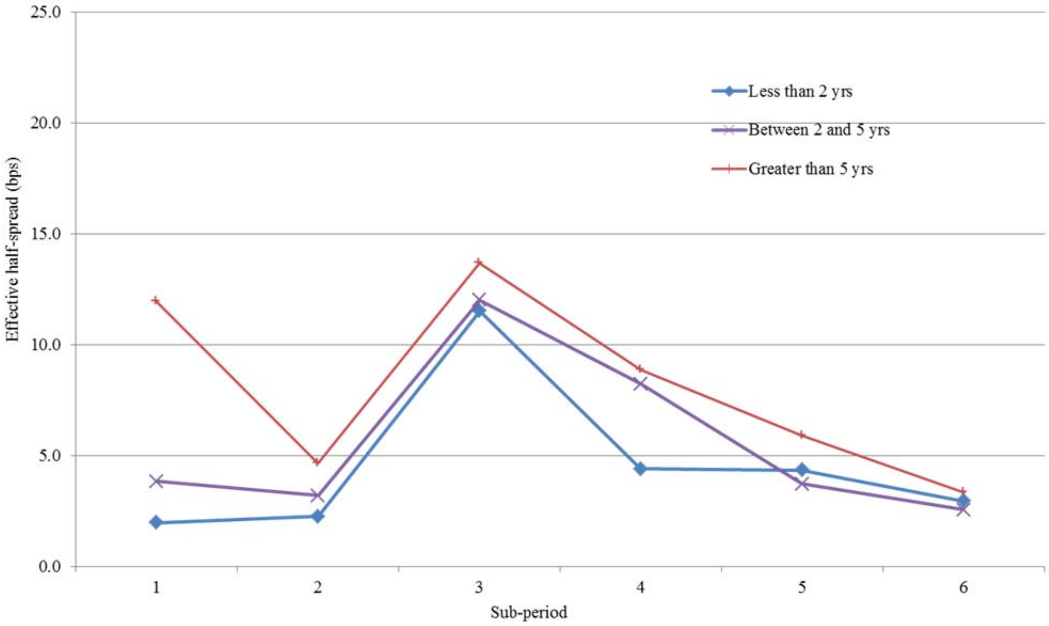
Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Panel B. By credit quality ($5,000,000 trade size)



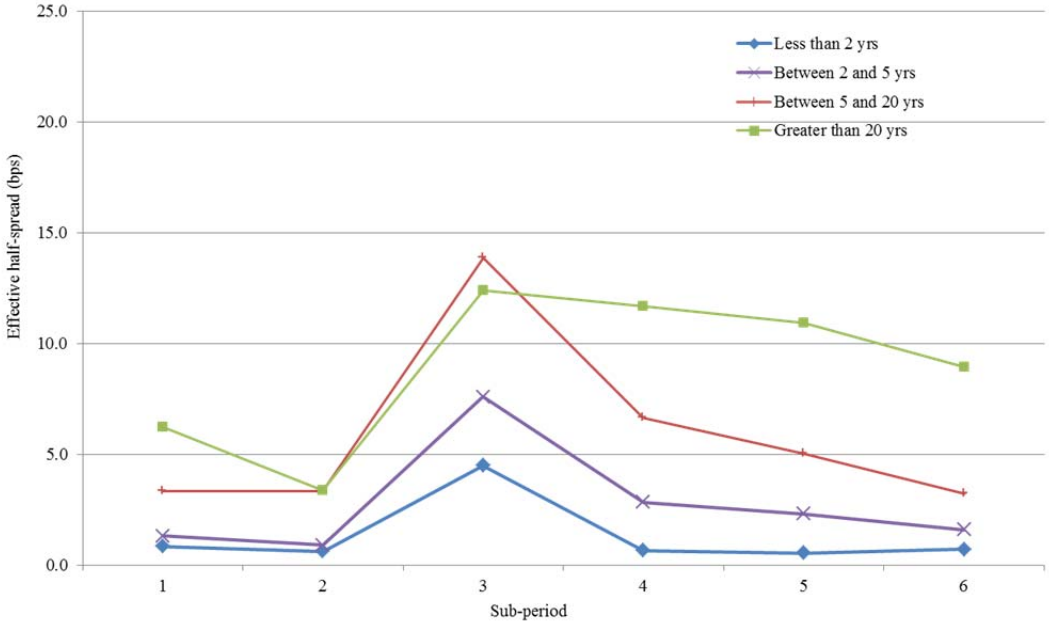
Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Panel C. By age ($5,000,000 trade size)



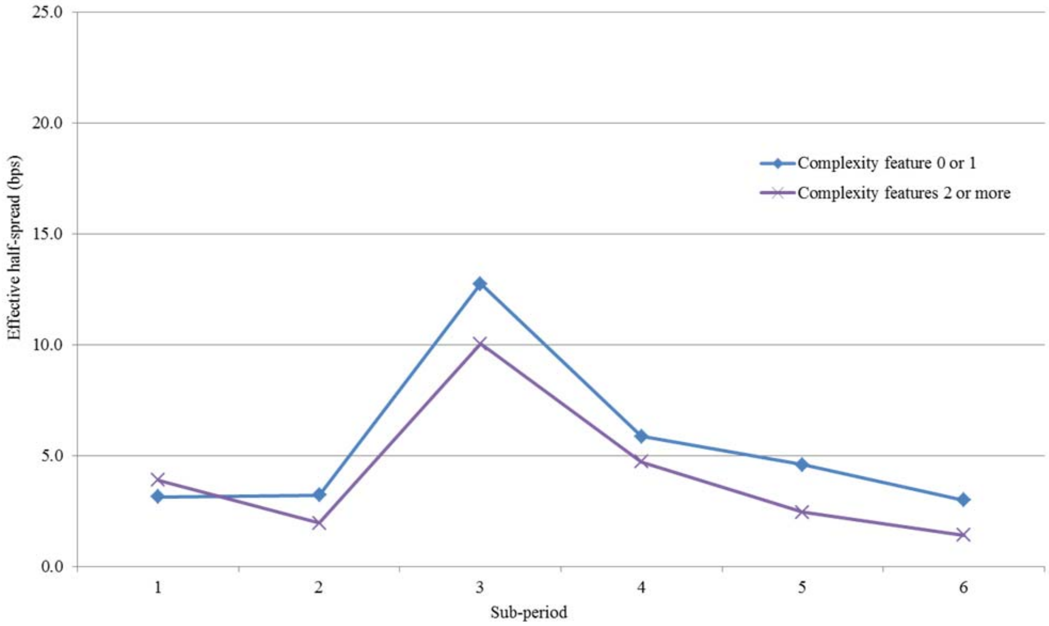
Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Panel D. By maturity ($5,000,000 trade size)



Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"

Panel E. By complexity ($5,000,000 trade size)



Note: Sub-period 1 – "TRACE Phase-in"; Sub-period 2 – "Pre-Crisis"; Sub-period 3 – "Crisis"; Sub-period 4 – "Post-crisis"; Sub-period 5 – "Regulatory"; Sub-period 6 – "Post-regulatory"
Source: DERA analysis

Figure 29 Panel B shows the estimated average transaction costs for corporate bond trades with size $5,000,000 broken out by credit quality. For investment grade bonds with a par volume weighted average price below $95 and high yield corporate bonds, the estimated average transaction costs for trades with large size of $5,000,000 during the "Regulatory" and the "Post-regulatory" sub-period are lower or similar to those in the sub-periods prior to the "Crisis" sub-period (i.e., the "TRACE Phase-in" and the "Pre-crisis" sub-period). On the other hand, for investment grade bonds with par volume weighted average price above $95, the estimated average transaction costs for trades with size $5,000,000 are slightly higher during the "Regulatory" and the "Post-regulatory" sub-period than those in the sub-periods prior to the financial crisis. However, the differences in the estimated average transaction costs are small—at most, 0.05 percentage points (5.2 bps).

Figure 28 Panel C and Figure 29 Panel C present results for bonds less than 2 years old, between 2 and 5 years old, and more than 5 years old for the trade size of $1,000,000 and $5,000,000, respectively. We observe that the estimated average transaction costs for bonds more than 5 years old are higher than younger bonds across all sub-periods. The estimated average transaction costs for bonds less than 2 years old and bonds between 2 and 5 years old are generally similar across all sub-periods except for during the “Post-crisis” sub-period. The estimated average transaction costs for bonds less than 2 years old is lower during the “Post-crisis” sub-period than the “Crisis” sub-period whereas the estimated average transaction costs for bonds between 2 and 5 years old remained high throughout the “Crisis” sub-period and “Post-crisis” sub-period. During the “Post-crisis” sub-period, for corporate bond trades with the trade size of $1,000,000, the estimated average transaction cost for bonds between 2 and 5 years old is higher by 0.17 percentage points ([17.7 bps – 9.2 bps] × 2) compared to bonds less than 2 years old.

From Panel C of Figure 29, for bond trades with large trade size of $5,000,000, the estimated average transaction costs for corporate bonds more than 2 years old are similar to or lower during the two recent sub-periods (the “Regulatory” and the “Post-regulatory” sub-period) than those of the sub-periods prior to the financial crisis. For corporate bonds younger than 2 years old, the estimated transaction costs during the “Regulatory” and the “Post-regulatory” sub-period are slightly higher than those in the sub-periods prior to the “Crisis” sub-period (i.e., the “TRACE Phase-in” and the “Pre-crisis” sub-period); but, the differences in the estimated average transaction costs are small— at most, 0.05 percentage points (4.8 bps).

Figure 28 Panel D and Figure 29 Panel D plot the cost estimates for various bond original maturities old for the trade sizes of $1,000,000 and $5,000,000, respectively. Across all sub-periods, we find that the average transaction cost estimates increase monotonically in bond maturities for trades with size $1,000,000. However, from the trading activity results above, we observe that bonds with an original maturity between 5 and 20 years account for the largest portion of trading activity across all sub-periods.

From Panel D of Figure 29, for bond trades with large trade size of $5,000,000, the estimated average transaction costs for corporate bonds with original maturity shorter than 20 years are similar to or lower during the two recent sub-periods (the "Regulatory" and the "Post-regulatory" sub-period) than those of the sub-periods prior to the financial crisis. On the other hand, for corporate bonds with original maturity longer than 20 years, the estimated transaction costs during the "Regulatory" and the "Post-regulatory" sub-period are higher than those in the sub-periods prior to the "Crisis" sub-period (i.e., the "TRACE Phase-in" and the "Pre-crisis" sub-period). However, the differences in the estimated average transaction costs are small—at most, 0.15 percentage points (15.2 bps).

Having multiple complexity features on a bond (e.g., convertible, putable, redeemable, sinking fund) could render bond pricing more difficult or complicated for less sophisticated traders (e.g., retail investors), potentially resulting in a larger mark-up or mark-down on retail trades in more complex bonds. Thus, we focus our examination of how complexity features and average transaction costs are related on smaller trade sizes. Figure 28 Panel E plots the estimated average transaction costs for the number of different complexity features for the trade size of $20,000 (instead of for the trade size of $1,000,000). We observe that the transaction cost estimates are substantially higher for bonds with two or more complexity features than for bonds with fewer than two complexity features across sub-periods prior to the "Post-regulatory" sub-period.[157] For instance, during the "Post-crisis" sub-period, the difference in the estimated costs for a smaller trade size of $20,000 was as large as 0.76 percentage points ([96.2 bps - 58.2 bps] × 2).

Figure 29 Panel E plots the estimated average transaction costs for the number of different complexity features for the trade size of $5,000,000. The estimated average transaction costs for trades of size $5,000,000 for bonds with two or more complexity features are lower than those for bonds with zero or one complexity feature during the most of sub-periods; however, the difference in the estimated average transaction costs are at most 0.05 percentage points (5 bps) for any sub-periods.

3. Dealer Activity

Several factors may influence dealer provision of liquidity, including changes in dealer risk aversion after the financial crisis, changing profitability of traditional dealer business models, evolving market structure and disintermediation, as well as regulatory impacts. Although, as discussed above, it is difficult to establish causality among the aforementioned factors and changes in dealer capacity to provide liquidity, this section focuses on how dealer inventory, dealer risk taking, dealer profitability, and dealer trading activity have changed over time. We find that aggregate corporate bond inventory held by dealer firms is lower during the "Regulatory" and the "Post-regulatory" sub-periods compared to earlier sub-periods. This could indicate that dealers' role as liquidity providers in the corporate bond market has diminished as a result of the regulations. This may also suggest that dealers have become more risk averse in recent sub-periods and could offload corporate bond inventory. Thus, inventory trends are not

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[157] The transaction cost estimates for a larger trade size of $1,000,000 for bonds with complexity features of two or more and zero or one are similar across sub-periods.

definitive and need to be considered in conjunction with other characteristics of dealer activity. We further document trends in dealer profitability, risk, and trading activity, which may point to post-crisis changes in the economics of traditional dealer business models.

a). Dealer Inventory, Risk Taking and Profitability[158]

Dealer inventory may reflect dealer capital commitment or capacity to provide liquidity. Below we examine how dealer corporate bond inventory has changed over time. To measure the level of dealer corporate bond inventory, we use the amount of corporate obligations held on the asset side of dealer firms' balance sheets (i.e., corporate obligations inventory) obtained from FOCUS reports. We exclude dealer firms using the Alternative Net Capital (ANC) computation because such filers do not report a data item that is comparable to the corporate obligations inventory item reported by other dealer firms for the duration of our sample.[159] Throughout our sample period, this filter excludes Goldman, Sachs & Co., Merrill Lynch, Pierce, Fenner & Smith Inc., Citigroup Global Markets Inc., Lehman Brothers Inc., Morgan Stanley & Co. LLC, J.P. Morgan Securities LLC (formerly Bear, Stearns & Co. Inc), J.P. Morgan Securities Inc., and Barclays Capital Inc. Therefore, we are unable to analyze the sample including both ANC and non-ANC filers. To the extent that ANC filers may have been more affected by regulations, we may underestimate the changes in activity around regulatory reforms. This evidence is, therefore, partial and suggestive and needs to be interpreted in conjunction with existing research on changes in the role of dealers in the corporate bond markets discussed above. Crucially, we note that our results on the evolution of aggregate dealer inventory and dealer inventory for dealers affiliated with bank holding companies (BHC) and dealers unaffiliated with BHC is

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[158] For all figures and tables referenced in this section, we apply the FOCUS data filters discussed in Appendix D.

[159] For ANC filers reporting ANC filings for at least one quarter during the sample period, we exclude these ANC filers for the duration of the sample period.

generally consistent with existing research, such as Bessembinder et al. (2016) and Bao et al. (2016). Our time period cutoffs for sub-periods remain substantially similar to prior sections and consistent with existing research.[160]

Figure 30 shows the plot of quarterly figures for the aggregate corporate obligations inventory from the first quarter of 2003 to the third quarter of 2016 (55 quarters).[161] Consistent with earlier findings, we observe a substantial build up in aggregate corporate obligations inventory during the "TRACE Phase-in" and the "Pre-crisis" sub-periods. The level of aggregate corporate obligations inventory peaked around $200 billion[162] during the early part of the "Crisis" sub-period, but subsequently dropped to approximately $50 billion towards the end of the "Crisis" sub-period. During the "Regulatory" and the "Post-regulatory" sub-periods, the aggregate amount of corporate obligations inventory held by dealer firms remained at around $50 billion or less. The lower levels of aggregate corporate obligations inventory held by dealer firms during the "Regulatory" and the "Post-regulatory" sub-periods could suggest that dealers have reduced their liquidity provision in corporate bonds. However, this is also consistent with dealers becoming more risk averse following the financial crisis and being able to offset corporate bond inventory in recent sub-periods.

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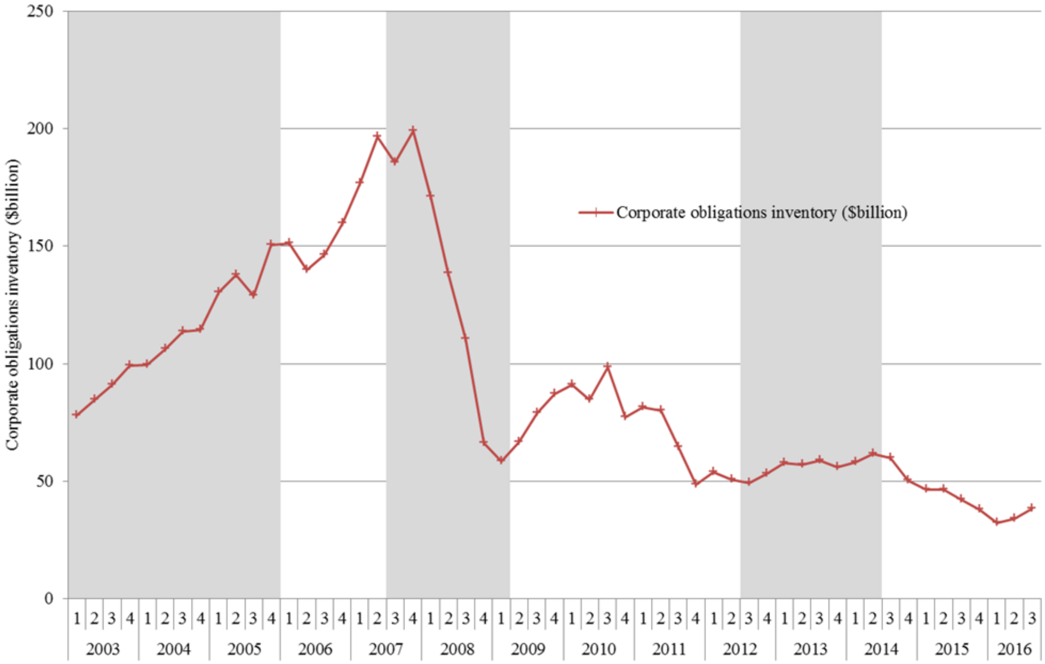
[160] Because we use quarterly data in FOCUS reports, the smallest time unit we use to subdivide our sample periods is a quarter: 1Q 2003 – 4Q 2005: "TRACE Phase-in"; 1Q 2006 – 2Q 2007: "Pre-crisis"; 3Q 2007 – 1Q 2009: "Crisis"; 2Q 2009 – 2Q 2012: "Post-crisis"; 3Q 2012 – 2Q 2014: "Regulatory"; 3Q 2014 – 3Q 2016: "Post-regulatory."

[161] We provide the underlying summary statistics for Figure 30 in Table D.5 Panel A in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional statistics on the amount of corporate obligations inventory, excluding ANC filers, in each sub-period.

[162] Figure D.3 in Appendix D shows the plot of aggregate corporate obligations inventory from the first quarter of 1980 to the third quarter of 2016. The peak aggregate corporate obligations inventory of around $200 billion during the early part of the "Crisis" period represents the multi-decade peak, as can be verified in Figure D.3 in Appendix D.

Figure 30. Corporate obligations inventory, excluding ANC filers



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"
Source: DERA analysis

To the extent that regulatory reforms impacted dealers affiliated with BHCs and dealers unaffiliated with BHCs differently, it is important to consider the evolution of activity by these two groups of dealers. To examine whether and how BHC-affiliated dealers changed their inventory over time relative to unaffiliated dealers, we construct a constant dealer sample excluding dealers that changed affiliation status during the sample period.

The use of a constant dealer sample enables us to consider the behavior of BHC-affiliated and unaffiliated dealers uncontaminated by entry and exit from the corporate bond market throughout our sample period. However, we recognize that the use of the constant dealer sample may affect our inference in several ways. For instance, if BHC-affiliated dealers most affected by regulatory costs exit the market or drop their affiliation with the BHC after regulations, the constant dealer sample may underestimate the reduction in BHC-affiliated dealer activity around the Volcker Rule. In this scenario, we may be more likely to identify changes in behavior of less affected BHC-affiliated dealers and underestimate adverse impacts of regulations. However, BHC-affiliated dealers that are members of financial groups may have moved market making activity into a BHC-unaffiliated dealer entity. To the extent that such BHC-unaffiliated dealers entered or increased their activity in corporate bond markets following regulatory reforms, we may underestimate the true scope of market making by BHC-unaffiliated dealers after regulatory reforms and overestimate adverse impacts of regulations.[163]

In constructing a constant dealer sample, we use the Federal Reserve System's National Information Center[164] to verify BHC affiliation status for dealer firms that submit FOCUS reports. We apply the following procedure. First, for each dealer firm that submitted FOCUS reports for every quarter between the first quarter of 2003 and the third quarter of 2016, we select dealer firms that do not change BHC status during our sample period. Second, for those selected dealer firms, we calculate the average of quarterly corporate obligations inventory for each year between 2003 and 2016.[165] Third, we select those dealer firms that rank in the top 25, measured by yearly average of quarterly corporate obligations inventory at least in one of the years between 2003 and 2016 and keep them in our constant dealer sample for the duration of the sample period. Fourth, we split the selected dealer firms into two groups: BHC-affiliated dealer

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[163] While Bao et al. (2016) find that non-BHC dealers stepped in to provide more liquidity in localized stress times after the reforms; however they still find an aggregate decline in measures of dealer liquidity supply during times of localized stress.

[164] For more information about the Federal Financial Institutions Examination Council (FFIEC), see https://www.ffiec.gov/nicpubweb/nicweb/NicHome.aspx.

[165] The calculation for the average quarterly amount of corporate obligations inventory for 2016 includes only the first, the second, and the third quarters.

firms and dealer firms with no BHC affiliation. This process yields 48 constant dealer firms for our sample:[166] 30 bank-holding-dealer firms and 18 non-bank-holding dealer firms.[167]

Panel A of Figure 31 shows plots for quarterly corporate obligations inventory level for BHC and non-BHC dealer firms in our constant dealer sample.[168] We observe that the amount of corporate obligations inventory held with BHC-affiliated dealer firms is larger than that of BHC-unaffiliated dealer firms. The difference in the amount of corporate obligations inventory is large and grows throughout the "TRACE Phase-in" and the "Pre-crisis" sub-periods. The difference peaks during the early part of the "Crisis" sub-period: at the peak, the difference in the size of corporate obligations inventory between dealer firms with BHC affiliation and dealer firms with no BHC affiliation is over $150 billion. However, the difference in the size of corporate obligations inventory level begins to shrink during the "Crisis" sub-period, and falls to about $20 billion during the "Post-regulatory" sub-period.

To account for differences in dealer capacity among BHC-affiliated and BHC-unaffiliated dealers, we normalize corporate obligations inventory level using data that reflects the size of dealer capacity (i.e., total capital and allowable subordinated liabilities).[169] Then, we compute the average of the normalized figures for dealer firms with BHC affiliation and dealer

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[166] Because the composition of the top 25 dealer firms is not necessarily the same for each year between 2003 and 2016, the process of selecting dealer firms produced more than 25 dealer firms in the end.

[167] Figure D.4 in Appendix D shows the share of corporate obligations inventory for dealer firms in our constant dealer sample in aggregate corporate obligations inventory for dealer firms that file FOCUS reports across sub-periods. Dealer firms in our constant dealer sample account for a substantial portion, ranging between 59% and 80%, of overall corporate obligations inventory across sub-periods. Repeating the procedure discussed above to add any number of dealer firms in the constant dealer sample beyond the top 25 dealer firms results in a gain of at most 0.4% in the share of aggregate corporate obligations inventory in any quarter. The portion of aggregate inventory not captured in this analysis is accounted for by dealer firms that did not have data for all 55 quarters of our sample period and dealer firms that changed bank holding affiliation status at least once during our sample period.

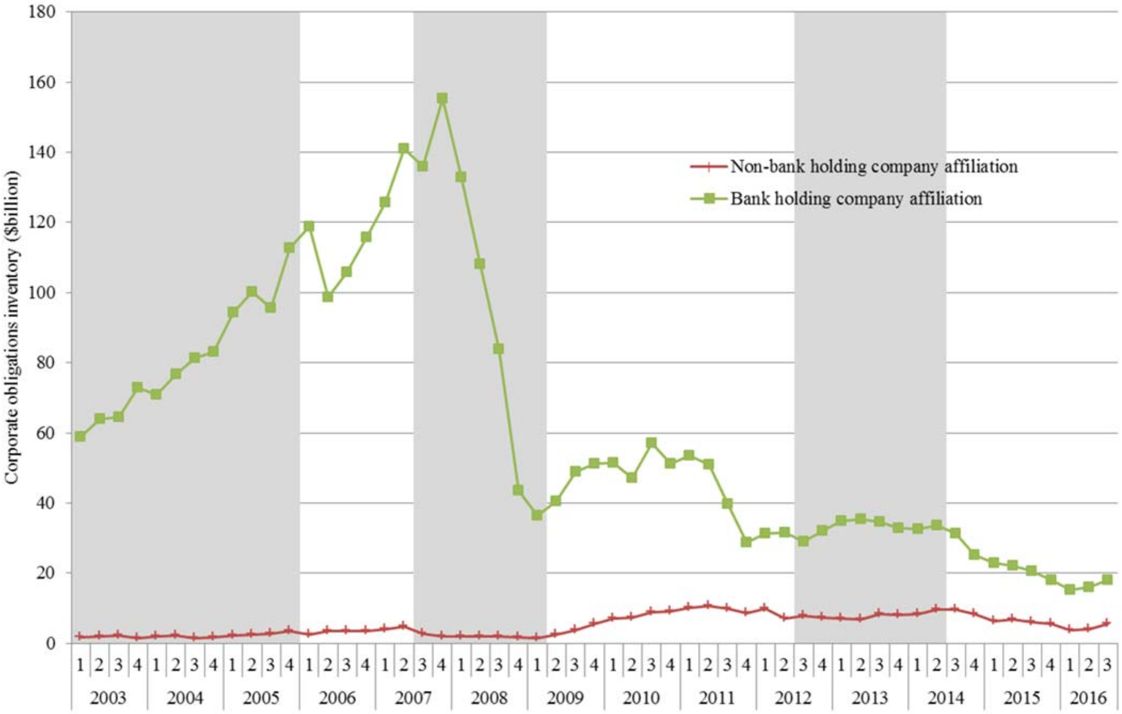
[168] We provide the underlying summary statistics for Panel A of Figure 31 in Table D.5 Panel B in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional statistics on the amount of corporate obligations inventory by bank holding company affiliation for each sub-period.

[169] The size of the dealer balance sheet is regulatorily constrained by the amount of dealer capital and allowable subordinated liabilities.

firms with no BHC affiliation. Panel B of Figure 31 shows the normalized corporate obligations inventory level for BHC-affiliated and BHC-unaffiliated dealers. In Panel B of Figure 31, we no longer observe the large build up in corporate obligations inventory for BHC-affiliated dealer firms during the “TRACE Phase-in” and the “Pre-crisis” sub-periods as in Panel A of Figure 31. This indicates that the large buildup in corporate obligations inventory during the “TRACE Phase-in” and the “Pre-crisis” sub-periods was accompanied by a large increase in the overall capacity of BHC dealers (with capacity measured with total capital and allowable subordinated liabilities). At the same time, we observe an increase in the normalized corporate obligations inventory for BHC-unaffiliated dealer firms during the “TRACE Phase-in” and the “Pre-crisis” sub-periods. Both BHC-affiliated and BHC-unaffiliated dealer firms reduced their normalized corporate obligations inventory during the “Crisis” period. Furthermore, we observe an increase in normalized corporate obligations inventory for BHC-affiliated dealers during the “Regulatory” period, with a subsequent decrease during the “Post-regulatory” sub-period.

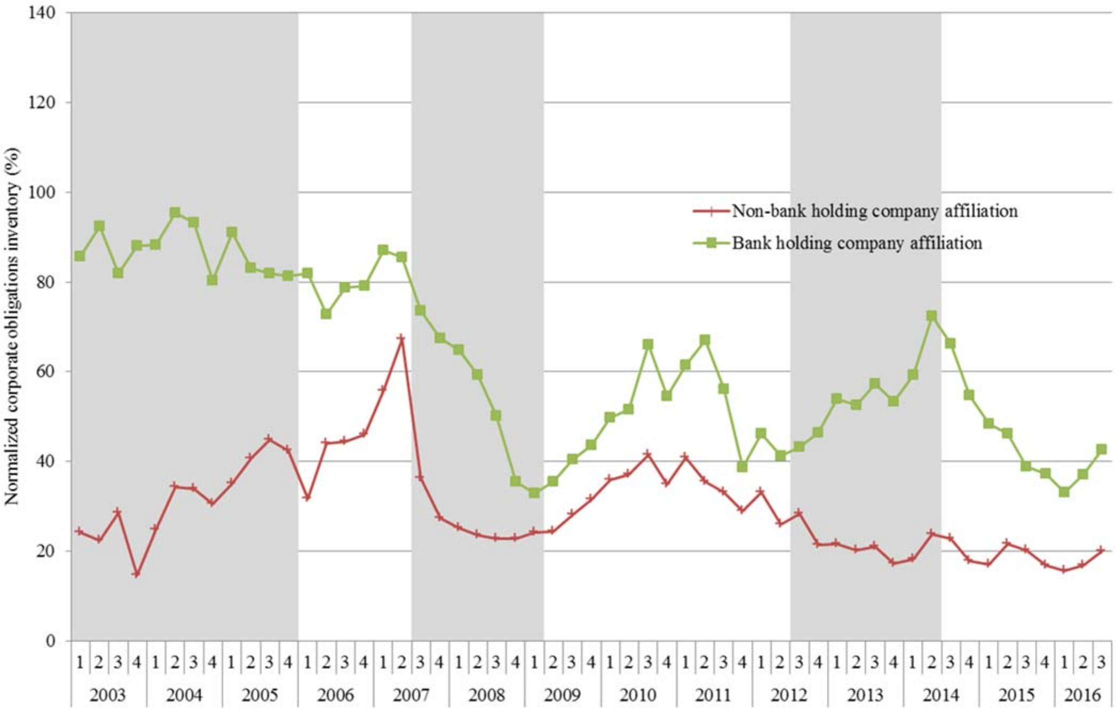
Figure 31. Corporate obligations inventory by affiliation. Top 25 constant dealer sample

Panel A. Total inventory



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"

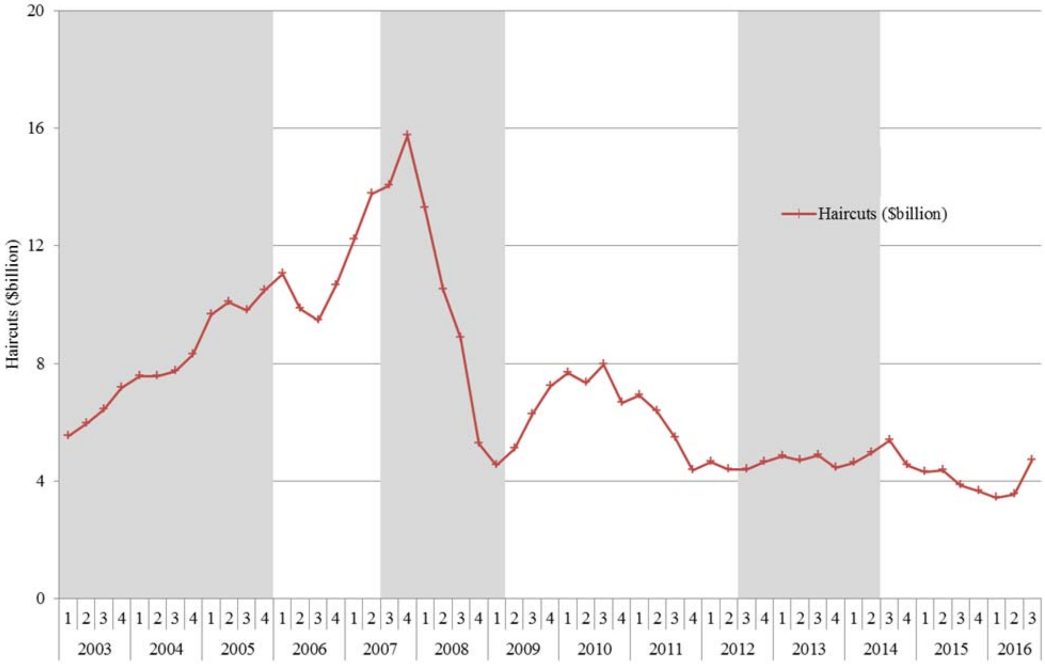
Panel B. Normalized inventory



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations – divided by Line Item 3530 – total capital and allowable subordinated liabilities. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"
Source: DERA analysis

We also examine the riskiness of dealers' securities positions, measured as haircuts on corporate obligations obtained from FOCUS reports. Holding market value of securities constant, larger haircuts would correspond to riskier securities. We note that this measure does not distinguish between the activities creating the risk. For example, the data does not distinguish between securities held in inventory for the purposes of market making from risk related to proprietary positions. Therefore, this measure may be broadly indicative of overall riskiness of dealer positions as opposed to the risk of any particular type of position. Figure 32 plots the quarterly aggregate figures for haircuts on corporate obligations from the first quarter of 2003 to the third quarter of 2016.[170]

Figure 32. Haircuts, excluding ANC filers



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3710 – haircuts on securities: corporate obligations. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"
Source: DERA analysis

Panel A of Figure 33 shows the plots of quarterly haircuts on corporate obligations for dealer firms affiliated with BHC and dealer firms without BHC affiliation in our constant dealer sample.[171] In Figure 32, we observe a substantial build up in aggregate haircuts for dealer firms throughout the "TRACE Phase-in" and the "Pre-crisis" sub-periods, peaking during the early part of the "Crisis" sub-period. This is similar to the pattern that we observe for aggregate

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[170] We provide the underlying summary statistics for Figure 32 in Table D.6 Panel A in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional statistics on the amount of haircuts, excluding ANC filers, in each sub-period.

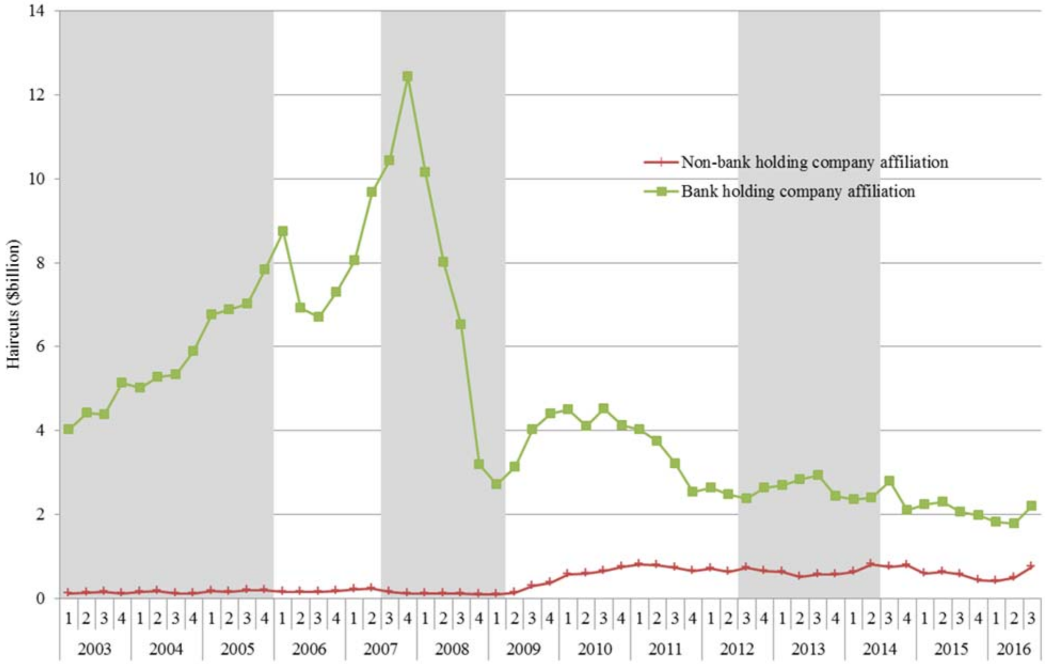
[171] We provide the underlying summary statistics for Panel A of Figure 33 in Table D.6 Panel B in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional statistics on the amount of haircuts by bank holding company affiliation for each sub-period.

corporate obligations inventory. Subsequently, aggregate haircuts on corporate obligations on dealer firms' balance sheets decreased and reached their lowest level during the "Post-regulatory" sub-period in our sample period. From Panel A of Figure 33, we observe that the large runup and the subsequent decrease in aggregate haircuts on corporate obligations was primarily driven by BHC-affiliated dealers in our constant dealer sample.

Next, we scale haircuts on corporate obligations by the total securities and spot commodities owned at market values and compute the average of the scaled figures for dealer firms with and without a BHC affiliation. Where trends in unscaled haircuts may be driven by the riskiness of securities, the size of the balance sheet, or both, scaled haircuts control for the size of the dealer's book. Thus, normalized haircuts reflect the riskiness of corporate obligations on a dealer's balance sheet, after accounting for the size of the aggregate exposure. Panel B of Figure 33 shows the plots for normalized quarterly haircuts on corporate obligations for BHC-affiliated and BHC-unaffiliated dealers in our constant dealer sample. Unlike in the plots for unadjusted haircuts on corporate obligations in Panel A of Figure 33, we do not observe an increase in normalized haircuts for BHC-affiliated dealers during the "TRACE Phase-in" and the "Pre-crisis" sub-periods. We do observe an increase in normalized haircuts on corporate obligations during the "Regulatory" and the "Post-regulatory" sub-periods for BHC-affiliated dealers, indicating that these dealer firms may be taking higher risk on corporate obligations following the Volcker Rule and other regulatory changes. This could suggest that BHC-affiliated dealers increased their role as liquidity providers in riskier corporate bond issues during the two recent sub-periods. At the same time, this could also reflect BHC-affiliated dealers' inability to offload risky issues from their inventory or a desire to further manage credit risk exposures on their balance sheets.

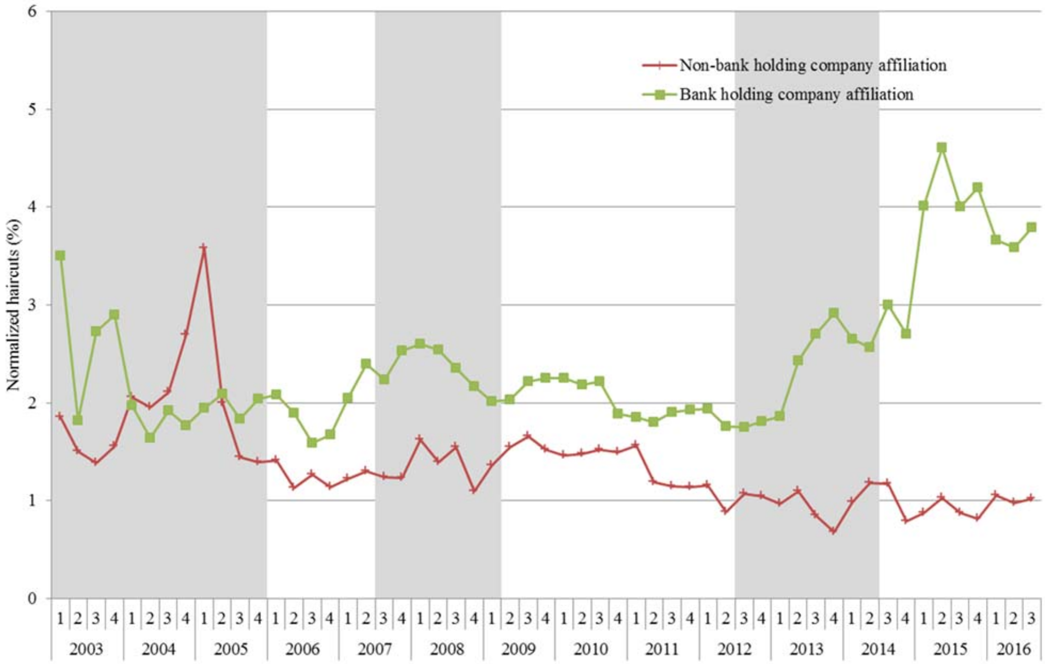
Figure 33. Haircuts by affiliation. Top 25 constant dealer sample

Panel A. Total haircuts



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3710 – haircuts on securities: corporate obligations. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"

Panel B. Normalized haircuts



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3710 – haircuts on securities: corporate obligations – divided by Line Item 850 – total securities and spot commodities owned, at market value. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"
Source: DERA analysis

Finally, we turn to the evolution in dealer profitability. To measure the profitability of dealer firms, we use gains or losses on securities trading accounts from trading debt securities for dealer firms (FOCUS reports).[172] Figure 34 plots the quarterly aggregate figures for gains or losses from trading in debt securities from the first quarter of 2003 to the third quarter of 2016.[173] Figure 35 shows the plots of quarterly gains or losses from trading debt securities for BHC-affiliated and BHC-unaffiliated dealers in our constant dealer sample.[174] In Figure 34, we

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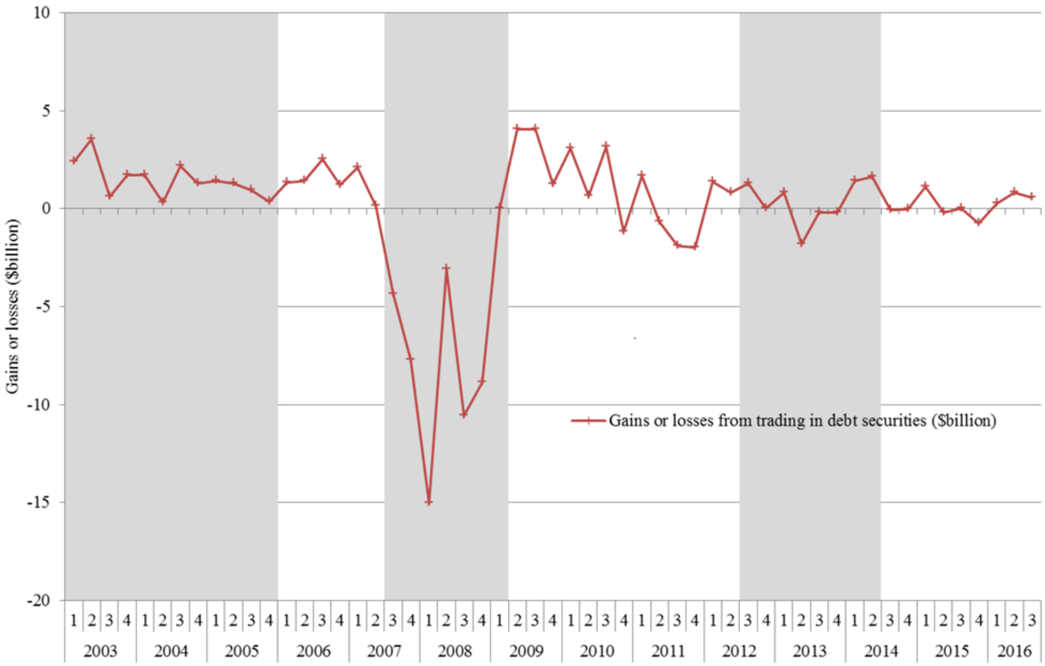
[172] FOCUS reports do not break out gains or losses on securities trading accounts from trading *corporate* debt securities for dealer firms.

[173] We provide the underlying summary statistics for Figure 34 in Table D.7 Panel A in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional statistics on the amount of gains or losses from trading in debt securities, excluding ANC filers, in each sub-period.

[174] We provide the underlying summary statistics for Figure 35 in Table D.7 Panel B in Appendix D. The table reports the number of dealer firms, the number of observations (i.e., dealer firm-quarter pairs), and the distributional [Footnote continued on next page]

observe large aggregate losses from trading debt securities for dealers during the “Crisis” period. We also observe smaller fluctuations in gains or losses from trading debt securities during the “Regulatory” and the “Post-regulatory” sub-periods. From Figure 35, we note that BHC-affiliated dealers were the main contributors to large aggregate losses from trading debt securities during the “Crisis” sub-period.

Figure 34. Gains or losses from trading in debt securities, excluding ANC filers



Note: Data represent quarterly broker-dealers’ responses to FOCUS Form Part II, Line Item 3944 – gains or losses on firm securities trading accounts from trading in debt securities. 1Q 2003 – 4Q 2005 (shaded) – “TRACE Phase-in”; 1Q 2006 – 2Q 2007 (non-shaded) – “Pre-crisis”; 3Q 2007 – 1Q 2009 (shaded) – “Crisis”; 2Q 2009 – 2Q 2012 (non-shaded) – “Post-crisis”; 3Q 2012 – 2Q 2014 (shaded) – “Regulatory”; 3Q 2014 – 3Q 2016 (non-shaded) – “Post-regulatory”
Source: DERA analysis

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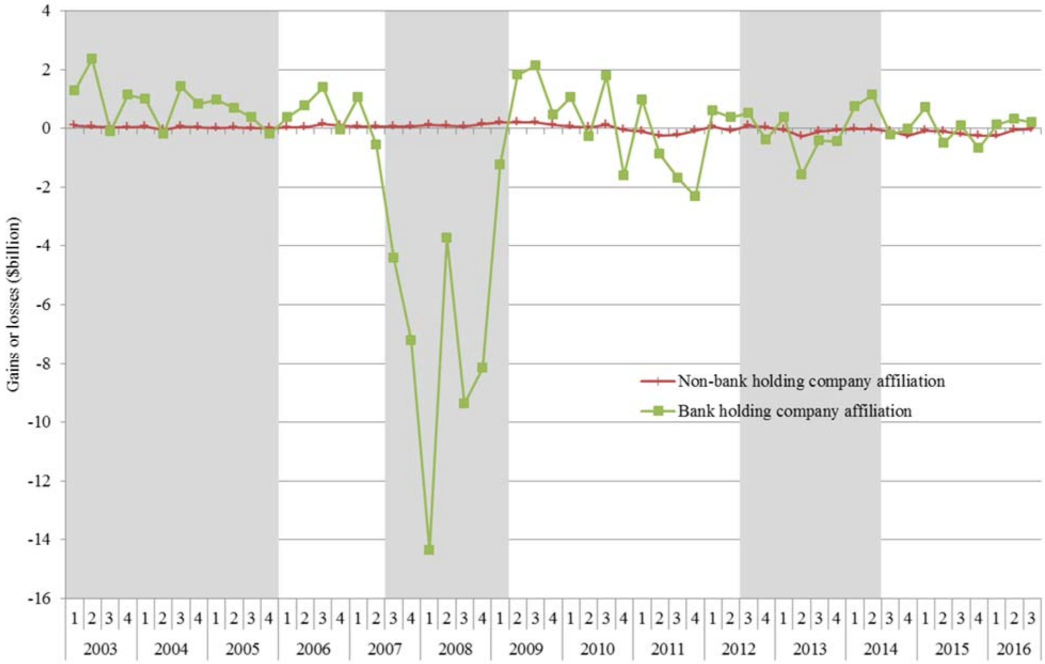
statistics on the amount of gains or losses from trading in debt securities by bank holding company affiliation for each sub-period.

Figure 35. Gains or losses from trading in debt securities by affiliation. Top 25 constant dealer sample



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3944 – gains or losses on firm securities trading accounts from trading in debt securities. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"

Source: DERA analysis

Overall, our analysis supports the evolving role of dealers in corporate bond markets, but we are unable to attribute the observed effects to a particular causal factor. In conjunction with the above results on dealer activity, this evidence is consistent with BHC-affiliated dealers experiencing crisis-related shocks to the profitability of fixed income market making. Aggregate macroeconomic conditions, including lower interest rates, after the financial crisis may have also impacted dealer profitability, consistent with our results on aggregate dealer profitability. Whether low interest rate and other macro shocks would have differential impacts on BHC-affiliated and BHC-unaffiliated dealer firms is unclear; however, the results are not inconsistent with macroeconomic effects on the risks and profitability of principal trading and carrying large inventory. Finally, differences in trends for BHC-affiliated and BHC-unaffiliated dealer firms limit our ability to rely on a differences-in-differences analysis to cleanly identify the causal impact of regulations.

b). Dealer Trading Activity

In this section,[175] we examine how dealer trading activity has changed across sub-periods. We do not observe large distributional changes in the number of dealers providing liquidity per corporate bond issue over time. Further, as shown below, we do not detect large changes in trade size distribution during the "Regulatory" and the "Post-regulatory" sub-period compared to earlier sub-periods.

We study dealer activity by examining the number of broker-dealers trading each corporate bond issue and principal versus agency trades broken out by trade size over six sub-periods. As mentioned above, the regulatory version of TRACE includes broker-dealer identifier (i.e., MPID). We identify each dealer by its MPID. Table 16[176] reports the distribution for the number of dealers reporting trades per corporate bond issue on each trading day averaged over each sub-period. We also report in Table 16 distributional statistics for overall, interdealer, and customer trades broken out by trade size. We observe that the number of dealers reporting trades varies notably across bond issues for any sub-period. Across sub-periods, the median number of dealers providing liquidity per corporate bond issue is 2 or 3 and corporate bonds in the 99th percentile have over 16 distinct dealers reporting trades. We do not observe large change in the number of dealers providing liquidity per corporate bond issues around changes in regulation. Furthermore, across sub-periods, we note that on average, more dealers trade in a small trade size (less than $100,000) than in larger trade sizes.

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[175] For all tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

[176] In Table 16, for each interdealer trade, we count both dealers reporting the trade.

The regulatory version of TRACE includes a broker-dealer capacity code that indicates whether a reporting dealer traded on principal or agency basis for each trade. Table 17[177] reports the number of customer trades and par volume per day averaged over each sub-period. In Table 17, we also break out the number of customer trades and par volume by dealer capacity and the portion of principal and agency customer trades across trade size for each sub-period. Across sub-periods, we observe that only a small portion of customer trades are reported as agency trades. The portion of customer trades executed on an agency basis has been generally increasing across six sub-periods: approximately 20% of customer trades are reported as agency trades in the "Post-regulatory" sub-period whereas only 10% of customer trades are executed on agency basis in the "TRACE Phase-in" sub-period. However, we note that the par volume from agency customer trades is, at most, 3.5% of total customer trade par volume in any sub-period. A large portion of principal trades has a smaller trade size: over 58% of principal trades have a trade size of less than $100,000 in any sub-period. For agency trades, approximately 90% of trades are concentrated in smaller trade sizes (less than $100,000 in recent sub-periods, specifically the "Regulatory" and the "Post-regulatory" sub-period). We note that the portion of principal trades with smaller trade size is larger during the "Crisis" and the "Post-crisis" sub-period. Furthermore, the portion of block size (greater than $5,000,000) principal trades is

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[177] Table D.8 Panel A through Panel E in Appendix D report the distribution of customer principal trades by trade size across five bond characteristics (issue size, credit quality, age (time since issuance), original maturity, and complexity features) over six sub-periods. We observe that the portion of customer principal trades with larger trade size (larger than $5,000,000) is higher for corporate bonds with issue size greater than $500 million for any sub-period compared to those of corporate bonds with smaller issue size. For investment grade corporate bonds, we observe that the portion of medium and large trades (trade size range in $100,000 - $1,000,000 and $1,000,000 - $5,000,000) is slightly higher and the portion of small trades (trade size less than $100,000) is somewhat lower during the recent sub-periods, the "Regulatory" and the "Post-regulatory" sub-period, than those in earlier sub-periods. On the contrary, for high yield bonds, a larger portion of trades have smaller trade size (trade size less than $100,000) in the sub-periods after the "Crisis" sub-period. Furthermore, we note that the portion of customer principal trades with larger trade size (larger than $1,000,000) is higher for younger corporate bonds (age less than 2 years) for any sub-period compared to those of corporate bonds older than 2 years.

similar across sub-periods and the portion of medium size ($100,000 - $1,000,000) principal trades is larger during the "Regulatory" and the "Post-regulatory" sub-period.

4. Electronic Venues

Electronic trading may facilitate the management of dealer inventory and reduce counterparty search costs. As referenced above, the usage of electronic venues in corporate bond trading may have become more prevalent in recent years. ATS[178] represent one type of electronic venue that hosts corporate bond trading. In this section, we characterize dealer quotations on ATS, the types of corporate bonds with dealer quotations on ATS, corporate bond trades on ATS, and the amount of pre-trade information (e.g., price quotes) disseminated on ATS.[179] Further, we use dealer quotations on ATS to estimate corporate bond transaction costs. We find that corporate bonds with any dealer quotations on ATS are larger issues. Corporate bonds with both dealer bids and offers on a given day are even larger issues, with a median issue size of around $380 million. Further, ATS trades are small in size, with over 90% of ATS corporate bond trades having a trade size of less than $100,000. During our sample period, ATS host 37% of interdealer trades, but ATS trades account for only 7% of total par volume for interdealer trades. Furthermore, during our sample period, at least 50% of customer trades are executed outside of the best quoted spreads—an effect primarily driven by small trades (trade

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[178] Generally, an ATS is defined as any organization, association, person, group of persons, or system that meets the definition of "exchange" within the meaning of Section 3(a)(1) of the Exchange Act and Rule 3b-16 thereunder, but does not: (a) set rules governing the conduct of subscribers other than the conduct of such subscribers trading on the ATS; or (b) discipline subscribers other than by exclusion from trading. An ATS that complies with Regulation ATS, which includes, among other things, registering as a broker-dealer and filing a Form ATS with the Commission, is not required to register as a national securities exchange under Section 5 of the Exchange Act.

[179] We do not analyze corporate bond quotations and trades on the New York Stock Exchange. During our sample period, we estimate that approximately 1,300 corporate bond issues are quoted and approximately 400 corporate bond trades are executed on the NYSE. Our ATS quotations and trades data is more comprehensive: from Panel A of Table 18, over 16,000 TRACE-eligible bonds are quoted on ATS during our sample period. In addition, from Table 20, we observe that ATS host over 193,000 interdealer trades (approximately 37% of interdealer trades reported to TRACE) during our sample period.

size of less than $100,000). As discussed below, the sample period for this analysis is relatively short and does not enable us to analyze changes in corporate bond liquidity through the time series. However, these results suggest there may be notable cross-sectional heterogeneity in ATS activity for different types of bond issues and indicate that electronification may be associated with lower trade sizes.

a). Descriptive Statistics for Dealer Quotations on ATS[180]

First, we consider corporate bond quotes, using quotation data between August 1, 2014 and November 28, 2014 (84 business days)[181] collected from KCG and TMC in support of corporate bond trading. Our quotation data include the following information: bond identifier (CUSIP), quoted price, quoted size, an indicator that specifies whether a quote is a bid or an offer, a broker-dealer identifier (MPID), date of quotation, time stamps for quote messages, and messages (e.g., quote cancellation and modification). We include the following summary statistics on corporate bond quotations: the number of dealer quotations, the number of bond issues (CUSIPs) with dealer quotations, the number of days with dealer quotations, quoted time length, and quote size.

We identify dealers that post quotations on ATS using MPIDs. We count the number of dealer quotations in the following way: on a given day, we count the number of unique MPID-CUSIP pairs. Panel A of Table 18 reports the number of dealer quotations and the number of bonds quoted broken out by quoted side, offer, or bid. We observe that there are approximately

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[180] For all tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

[181] In analyzing dealer quotations on ATS, we drop 2 days in our sample, August 29, 2014 and November 26, 2014, because of an error in the data feed that includes TRACE-eligible bond issues. Thus, Tables 18, 19, and 23 do not include August 29, 2014, and November 26, 2014.

3.2 million dealer offer quotations for 13,740 distinct bond issues[182] (CUSIPs) over 84 business days from August 1 to November 28, 2014. Furthermore, we observe a substantially larger number of dealer bid quotations than dealer offer quotations: there are 16,461 distinct bond issues (CUSIPs) with over 6.1 million dealer bid quotations.

Panel B of Table 18 shows the distribution for the number of TRACE-eligible bond issues (CUSIPs) per day, the portion of TRACE-eligible bond issues (CUSIPs) quoted per day, the number of dealer quotations per day, and the number of days quoted per bond issue (CUSIP). The median number of TRACE-eligible bond issues per day is approximately 28,000. On an average day, over 50% of TRACE-eligible bond issues have dealer bid quotations. On the other hand, approximately 35% of TRACE-eligible bond issues have dealer offer quotations on a given day. We observe both dealer bid and offer quotations on a given day for approximately 35% of TRACE-eligible bond issues. The median number of dealer quotations (bid or offer) is over 116,000 per day. The median number of dealer bid and offer quotations per day is over 75,000 and 39,000, respectively, and on a given day, we observe twice as many dealer bid quotations as dealer offer quotations. We include only TRACE-eligible bond issues with at least one dealer quotation during the sample period in deriving the distribution for the number of days with dealer quotation per bond issue (CUSIP) in Panel B of Table 18. We observe that at least 75% of TRACE-eligible bond issues quoted during the sample period have either dealer bid or offer quotation on at least 82 out of 84 business days.

Panel C of Table 18 shows the distribution of duration for which a dealer quotes a bond issue per day (i.e., quote duration) and quote size. ATS business hours for our sample are from 8 a.m. to 5:15 p.m., for a total length of time of 9.25 hours. We observe that the median for quote

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[182] As in earlier sections, we exclude Rule 144A corporate securities from our analysis.

duration for dealer bid or offer quotation is 9.25 hours per day, so the majority of dealers quote for an entire trading day. We also note that 90% of dealer quotations are posted for at least 8 hours per day. From the lower section of Table 18 Panel C, the median quote size is larger for dealer bid than offer quotations ($250,000 versus $130,000).

b). Types of Corporate Bonds Quoted on ATS[183]

Now we turn to the analysis of the types of corporate bonds that have dealer quotations and also examine the types of corporate bonds with two-sided (both bid and offer vs. only one-side, bid or offer) dealer quotations on a given day. To this end, we examine the cross-sectional bond characteristics of corporate bonds quoted on ATS. As above, we consider the following five bond characteristics: issue size, credit quality, age (time since issuance), original maturity, and complexity features.

As can be seen in Table 19, quotation activity is concentrated in bond issues with larger issue size, investment grade, longer original maturity, and less complexity features. On a given day, we note that the average issue size ($358.2 million) for corporate bonds quoted on ATS is larger than the average issue size ($221.3 million) of TRACE-eligible bond issues. Furthermore, the average issue size ($358.2 million) for corporate bonds quoted on ATS is substantially larger than the average issue size ($56.9 million) for corporate bonds that are not quoted on ATS on a given day. Further, at least 75% of corporate bonds that have dealer quotations on ATS have an investment grade credit rating, whereas at least 50% of corporate bonds that are not quoted on ATS on a given day are high yield bonds.

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[183] For all tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

While issues quoted on ATS have longer original maturity than those not quoted on ATS, we note little difference in the average age (time since issuance) between the two groups of corporate bonds (although the median age for corporate bonds that are quoted is slightly older than those not quoted on ATS (3.3 years for corporate bonds quoted vs. 1.7 years for corporate bonds not quoted), the difference in the median age is small). We observe that the average original maturity (14.3 years) of corporate bonds quoted is longer than that (8.5 years) of corporate bonds not quoted on ATS on a given day.

Corporate bonds quoted on ATS are less likely to be complex. From Table 19, at least 10% of corporate bonds quoted have two or more complexity features whereas at least 25% of corporate bonds that are not quoted on ATS on a given day have two or more complexity features. Table 19 also reports distributional statistics on bond characteristics for corporate bonds with two-sided (both bid and offer) dealer quotations and for corporate bonds with dealer quotation only on one side (only bid or only offer) on a given day.

Finally, we explore cross-sectional characteristics of corporate bonds with one-sided and two-sided dealer quotes. We observe little difference in the median and average values across bond characteristics on a given day for the two groups, with the exception of issue size. The average issue size for corporate bonds with two-sided dealer quotations on a given day is $518.6 million while the average issue size for corporate bonds with dealer quotation only on one side is $71.5 million.

c). Corporate Bond Trades on ATS[184]

In examining corporate bond trades on ATS, we use regulatory TRACE. The ATS trade indicator in the regulatory version of TRACE enables us to distinguish corporate bond trades executed on ATS from non-ATS trades. The sample period for our analysis on ATS trades is different from the sample period for our analysis of dealer quotations on ATS because the inclusion of the ATS trade indicator in the regulatory version of TRACE commenced on August 1, 2016, limiting the sample period for our analysis to August 1, 2016, to September 19, 2016.

We first examine trade size and the types of corporate bonds that trade on ATS. We find that a large fraction of ATS trades are interdealer trades, but they represent a small share of interdealer par volume. Table 20 reports the distribution of trade counts and par volume across different trade sizes for ATS interdealer trades and non-ATS interdealer trades. We exclude customer trades from our analysis of ATS trades because there are few customer trades executed on ATS. From Table 20, we note that ATS host 37.5% of all interdealer trades during the sample period. However, the par volume share for ATS is less than 7% of total interdealer trade par volume. Further, ATS trades are smaller than non-ATS trades. Over 92% of interdealer trades executed on ATS are small trades (less than $100,000 in size), whereas 69% of non-ATS interdealer trades have a trade size of less than $100,000.

In examining the types of corporate bonds traded on ATS, as above, we consider the following five bond characteristics: issue size, credit quality, age, original maturity, and complexity features. Table 21 shows the distributional statistics of bond characteristics for interdealer trades executed on ATS and non-ATS interdealer trades. We observe little difference

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[184] For all tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

in the median and average values across bond characteristics for ATS interdealer trades and non-ATS interdealer trades.

d). Pre-trade Information[185]

We examine the amount of pre-trade information (e.g., price quotes) disseminated on ATS. To this end, we use dealer quotation data from August 1, 2014, to November 28, 2014, and customer trades from the regulatory version of TRACE for the same period. In general, dealers have access to dealer quotations. However, institutional (e.g., small institutional investors) and individual investors may not have access to dealer quotations. Our analysis addresses whether a dealer quote (i.e., price quote) is available and observable prior to the trade. We match quoted prices with trades to evaluate whether the quoted price had been available around the time of trade execution. In matching quoted prices with trades, we require quoted price to stand for at least 30 minutes prior to the time of trade execution to ensure that dealers have had the time to observe the quoted price.[186]

Table 22[187] reports the number of customer trades with pre-trade information (i.e., standing quoted price) at the time of trade execution and the distributional statistics for five bond characteristics (issue size, credit quality, age (time since issuance), original maturity, and complexity features) for corporate bonds with pre-trade information (i.e., standing quoted price).

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[185] For all tables referenced in this section, we apply data filters in the trade reporting and the discretionary filters discussed in Appendix D.

[186] We repeat this analysis requiring quoted price to stand for at least 2 seconds (instead of 30 minutes). The results are tabulated in Table D.9 in Appendix D. The findings in Table D.9 in Appendix D are similar to those in Table 22.

[187] Our analysis reported in Table 22 includes only corporate bond trades between 8:30 a.m. and 5:15 p.m., because we require quoted price to stand for at least 30 minutes prior to the time of trade execution (the earliest time a dealer can post a quotation is 8:00 a.m., and the latest time that a dealer can post a quotation on an ATS is 5:15 p.m.). The total number of customer trades between August 1, 2014, and November 28, 2014, is 1,709,298. Of the 1,709,298 customer trades, 54,581 (approximately 3.2% of 1,709,298) customer trades are executed either before 8:30 a.m. or after 5:15 p.m.

The number of customer trades (not reported in Table 22) between 8:30 a.m. and 5:15 p.m. from August 1, 2014, to November 28, 2014, is approximately 1.7 million.

We find that most customer trades in our sample had pre-trade information and that bonds with pre-trade information tend to be larger issues and less complex bonds. From Table 22, we note that a large portion of customer trades had pre-trade information (i.e., standing quoted price): over 90% of customer trades had standing quoted price at the time of trade execution during the sample period. The median and average issue size for corporate bonds that had pre-trade information (i.e., standing quoted price) is approximately $750 million and $1 billion, respectively, which are notably larger than those for corporate bonds with no pre-trade information. We observe that most of the corporate bonds with pre-trade information (i.e., standing quoted price) have zero or one complexity feature. Furthermore, at least 25% of customer trades that had pre-trade information (i.e., standing quoted price) are high yield bonds.

e). Transaction Costs: Quoted Spread, Effective Spread, and Price Improvement[188]

Finally, we turn to the analysis of transaction costs using dealer quotations. We examine the following three transaction cost measures constructed using dealer quotations on ATS and corporate bond trades: time-weighted quoted spread, effective spread, and price improvement to quoted spread. We study transaction cost differences across corporate bonds by examining the distribution of time-weighted quoted spreads[189] for corporate bonds with different bond

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[188] For all tables referenced in this section, we apply data filters in the trade reporting, the discretionary, and the price-based filters discussed in Appendix D.

[189] The definition of quoted spread is as follows:

$$quoted\ spread = \frac{best\ dealer\ offer\ price - best\ dealer\ bid\ price}{mid\text{-}point}$$

[Footnote continued on next page]

characteristics. In constructing daily time-weighted quoted spreads, for each corporate bond issue, we use the best continuously quoted bid and offer price between 8 a.m. and 5:15 p.m. weighted by price quote duration.[190] As above, we consider five bond characteristics: issue size, credit quality, age (time since issuance), original maturity, and complexity features.

Table 23[191] reports the distributional statistics of time-weighted quoted spreads for corporate bonds across five bond characteristics for the period between August 1, 2014, and November 28, 2014. We observe that the median time-weighted quoted spread decreases monotonically with increases in issue size. The median time-weighted quoted spread is 0.4% (39.7 bps) for corporate bonds with issue size greater than $500 million, whereas the median time-weighted quoted spread is 1.23% (123.2 bps) for bonds with issue size less than $100 million. We note that the median time-weighted quoted spread for investment grade corporate bonds is 0.43 percentage points lower than the median time-weighted quoted spread for high yield corporate bonds (65.5 bps versus 108.4 bps). The median time-weighted quoted spread is smaller for corporate bonds younger than 5 years compared to that of bonds older than 5 years. Corporate bonds with an original maturity of less than 2 years have a substantially larger median time-weighted quoted spread, 2.1% (209.4 bps), than those with an original maturity longer than 2 years.[192] For corporate bonds with an original maturity longer than 2 years, the median time-

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where *mid-point* is the average of *best dealer offer price* and *best dealer bid price*. To express quoted spread in basis points, we multiply the quantity by 10,000.

[190] In computing time-weighted quoted spread, we do not include cases where only one side of the market is quoted. Furthermore, we drop cases for locked and crossed markets in computing time-weighted quoted spread.

[191] The average time-weighted quoted spread of 172.9 bps reported in Table 23 is somewhat smaller than the average quoted spread of 260 bps reported in Harris (2015). This difference may be due to the differences in data source, bond sample selection, sample period, and computational methods.

[192] Large median time-weighted quoted spreads for corporate bonds with an original maturity less than 2 years is primarily due to large time-weighted quoted spreads for corporate bonds with two or more complexity features. For corporate bonds with an original maturity of less than 2 years, the median time-weighted quoted spread for bonds with zero or one complexity feature is only 0.2 % (20.3 bps) while the median time-weighted quoted spread for bonds with two or more complexity features is 4.01% (401.1 bps).

weighted quoted spread increases monotonically with original maturity. Furthermore, corporate bonds with zero or one complexity feature have a substantially smaller time-weighted quoted spread than corporate bonds with two or more complexity features (67.6 bps versus 144.8 bps).

Effective spread[193] measures the transaction cost of a round-trip trade. We match the best two-sided quoted prices available around the time of a trade execution. To ensure that quoted price was available at the time of trade execution, we require two-sided quote prices to stand for at least 1 second before the time of trade execution, because corporate bond trades in the regulatory version of TRACE are time-stamped only to the second. Table 24[194,195] shows the distribution of effective spreads broken out by interdealer and customer trades and across different trade size for customer trades. The average and median effective spread for customer trades is larger by 0.67 percentage points (76.6 bps versus 143.1 bps) and 0.24 percentage points (42.0 bps versus 65.9 bps), respectively, than those for interdealer trades. The median and average effective spread for smaller customer trades with trade size less than \$100,000 are substantially larger than those for trades with trade size greater than \$100,000. Furthermore, we observe that customer trades with trade size larger than \$5,000,000 have the smallest effective spreads.

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[193] The definition of effective spread as follows:

$$effective\ spread = 2\ \times \left[\frac{(price - mid\text{-}point) \times D}{mid\text{-}point}\right]$$

where *mid-point* is the average of *best dealer offer price* and *best dealer bid price*. $D = 1$ if trade is buyer initiated (i.e., $price \geq mid\text{-}point$) and $D = -1$ if trade is seller initiated (i.e., $price < mid\text{-}point$). To express effective spread in basis points, we multiply the quantity by 10,000.

[194] For corporate bond trades in Table 24, we apply all filters in the trade reporting filters, the discretionary filters, and the price-based filters discussed in Appendix D. Furthermore, we exclude all trades executed before 8 a.m. or after 5:15 p.m.

[195] The average values for effective spread reported in Table 24 are qualitatively similar to those reported in Harris (2015). The differences in the average values for effective spreads between ours and Harris (2015) may be due to the differences in data source, bond sample selection, sample period, and computational methods.

Table 25[196] reports the distributional statistics of effective spreads across five bond characteristics (issue size, credit quality, age (time since issuance), original maturity, and complexity features). We observe that the average and median effective spread decreases monotonically with issue size. The median effective spread for corporate bonds with an issue size greater than \$500 million is 0.38% (37.5 bps) while the median effective spread for bonds with an issue size less than \$100 million is 1.26% (125.5 bps). The median effective spread for investment grade corporate bonds is 0.5 percentage points lower than the median effective spread for high yield corporate bonds (38.4 bps versus 87.9 bps). Although the median effective spread is increasing monotonically with age (time since issuance), we note that the differences in effective spreads are small. For corporate bonds with original maturity longer than 2 years, the median effective spread increases monotonically with original maturity years. Furthermore, the median effective spread for corporate bonds with zero or one complexity feature is 0.64 percentage points smaller than that of corporate bonds with two or more complexity features (50.4 bps versus 114.8 bps).

Finally, we compute price improvement[197] for a corporate bond trade using the best two-sided quoted prices available at the time of trade execution. The procedure of matching trades with the best two-sided quoted prices in computing price improvement is the same as the one

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[196] For corporate bond trades in Table 25, we apply all filters in the trade reporting filters, the discretionary filters, and the price-based filters discussed in Appendix D. Furthermore, we exclude all trades executed before 8 A.M. or after 5:15 P.M.

[197] The definition of price improvement as follows. For buyer initiated trades (i.e., $price \geq mid\text{-}point$, where $mid\text{-}point$ is the average of $best\ dealer\ offer\ price$ and $best\ dealer\ bid\ price$),

$$price\ improvement = 2 \times \left[\frac{best\ dealer\ offer\ price - price}{mid\text{-}point}\right]$$

For seller initiated trades (i.e., $price < mid\text{-}point$, where $mid\text{-}point$ is the average of $best\ dealer\ offer\ price$ and $best\ dealer\ bid\ price$),

$$price\ improvement = 2 \times \left[\frac{price - best\ dealer\ bid\ price}{mid\text{-}point}\right]$$

To express price improvement in basis points, we multiply the quantity by 10,000.

used to compute effective spreads above. Price improvement of 0 indicates that the trade was executed *at* the quoted price. Negative price improvement measure indicates that the trade was executed *outside* of the best two-sided quote prices, whereas positive price improvement indicates that the trade was executed *inside* of the best quoted spread. Table 26[198] Panel A shows the distribution of price improvement to the quoted price broken out by interdealer and customer trades and across different trade size for customer trades. Both average and median price improvement for customer trades are negative, indicating that the majority of customer trades are executed outside of the best quoted prices, whereas the average and median price improvement for interdealer trades are positive, indicating that the majority of interdealer trades are executed inside of the best quoted spread. The difference in median price improvement between customer and interdealer trades is 0.17 percentage point (0.0 bps – (-17.0 bps)). The negative median price improvement for customer trades may be driven by small trades. The average and median price improvement for customer trades with trade size smaller than $100,000 is negative, -1.18%(-117.7 bps) and -0.49% (-48.6 bps), respectively, whereas the median and average price improvement for larger customer trades (trade size larger than $1,000,000) are positive. We note that at least 75% of customer trades with a trade size smaller than $100,000 are executed outside of the best quoted spreads (i.e., negative price improvement). Based on the average and median price improvement figures, customer trades with a trade size between $1,000,000 and $5,000,000 receive the largest price improvement.

Panel B of Table 26 reports the distribution of price improvement scaled by the quoted spread at the time of trade execution broken out by interdealer and customer trades and across

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[198] For corporate bond trades in Table 26, we apply all filters in the trade reporting filters, the discretionary filters, and the price-based filters discussed in Appendix D. Furthermore, we exclude all trades executed before 8 a.m. or after 5:15 p.m.

different trade sizes for customer trades. The upper bound for scaled price improvement is one (for trades executed at mid-point). The value of zero for scaled price improvement indicates that the trade is executed at the quoted price. As above, a negative value for scaled price improvement indicates that a trade is executed outside of the best quoted spread. The median scaled price improvement for small (trade size less than $100,000) customer trade is -1.33 indicating that the median mark-up to the best quoted price for small customer trade is 133% of quoted spread. The median mark-up is zero (i.e., traded at quoted price) for customer trade with a size between $100,000 and $1,000,000. The median scaled price improvement for a larger customer trade with a size between $1,000,000 and $5,000,000 and greater than $5,000,000 is 0.18 and 0.15, respectively: this indicates that price improvement to the best quoted price at the time of trade execution is 18% and 15% of the quoted spread, respectively.

D. Summary

Overall, empirical evidence on the direction, magnitude, and factors behind observed changes in corporate bond market liquidity is mixed. While some measures of liquidity, such as dealer capital commitment and principal trading have declined, other measures of liquidity, such as trading activity and transaction cost metrics have improved. As discussed above, observed changes point to an evolving role of dealers in corporate bond markets, reduced transaction costs and an increased importance of disintermediated trading. The observed effects are consistent with a number of alternative explanations, as discussed above.

E. Tables on Corporate Bond Liquidity

Table 11. Bond issues per issuer (number of CUSIPs per firm)

		Number of bond issues per issuer							
		Mean	1st percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	99th percentile
"TRACE Phase-in" period	Sub-period 1	8.6	1	1	1	2	4	10	115
"Pre-crisis" period	Sub-period 2	9.4	1	1	1	2	4	9	136
"Crisis" period	Sub-period 3	10.6	1	1	1	2	4	10	151
"Post-crisis" period	Sub-period 4	13.2	1	1	1	2	4	11	151
"Regulatory" period	Sub-period 5	10.5	1	1	1	2	4	10	116
"Post-regulatory" period	Sub-period 6	11.3	1	1	1	2	4	11	135

Source: DERA analysis

Table 12. Bond issues, trades, and par volume

		(1) Number of TRACE eligible issuers (firms)	(2) TRACE eligible issuers with trades (%)	(3) Number of TRACE eligible bond issues (CUSIPs)	(4) TRACE eligible bond issues with trades (%)	(5) Number of trades (counts)	(6) Par volume (in $billion)
"TRACE Phase-in" period	Sub-period 1	4,306	31.1	30,466	14.6	22,470	16.2
"Pre-crisis" period	Sub-period 2	4,547	29.5	36,576	12.5	19,799	15.9
"Crisis" period	Sub-period 3	4,694	25.5	44,640	9.2	25,761	14.5
"Post-crisis" period	Sub-period 4	4,837	30.5	55,385	10.5	38,306	17.8
"Regulatory" period	Sub-period 5	3,306	46.4	27,016	20.8	37,351	17.6
"Post-regulatory" period	Sub-period 6	3,185	49.0	29,561	20.0	37,836	19.7

Source: DERA analysis

Table 13. Trading activity

Panel A. Portion of days with trades per bond issue

		Portion of days with trades per bond issue (%)							
		Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
"TRACE Phase-in" period	Sub-period 1	13.2	0	0	0	2.3	15.6	45.1	68.9
"Pre-crisis" period	Sub-period 2	10.8	0	0	0	0	9.3	38.9	64.8
"Crisis" period	Sub-period 3	9.2	0	0	0	0	6.3	31.0	60.0
"Post-crisis" period	Sub-period 4	10.0	0	0	0	0	3.7	39.6	77.5
"Regulatory" period	Sub-period 5	18.6	0	0	0	2.1	25.2	73.3	91.3
"Post-regulatory" period	Sub-period 6	17.6	0	0	0	1.3	22.7	71.9	90.3

Panel B. Distribution of bond issues by the number of daily trades

			Portion of bond issues (%)							
		Trades per day	Mean	1st percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	99th percentile
"TRACE Phase-in" period	Sub-period 1	0 trade	85.4	81.8	83.1	84.1	85.2	86.3	87.3	94.4
		1 - 3 trades	9.4	4.4	8.5	8.9	9.5	10.0	10.4	11.0
		4 - 9 trades	3.5	1.0	2.9	3.3	3.6	3.9	4.2	4.8
		10+ trades	1.7	0.3	1.1	1.4	1.7	1.9	2.3	2.7
"Pre-crisis" period	Sub-period 2	0 trade	87.5	85.4	86.1	86.6	87.3	88.0	88.9	92.3
		1 - 3 trades	8.3	5.8	7.6	8.0	8.4	8.7	9.0	9.5
		4 - 9 trades	3.0	1.5	2.5	2.8	3.0	3.3	3.5	3.8
		10+ trades	1.2	0.4	0.9	1.1	1.2	1.4	1.5	1.7
"Crisis" period	Sub-period 3	0 trade	90.8	88.2	89.1	90.0	90.8	91.4	92.2	95.9
		1 - 3 trades	5.5	2.6	4.4	4.7	5.5	6.4	7.0	7.7
		4 - 9 trades	2.4	0.9	2.0	2.2	2.4	2.6	2.7	3.0
		10+ trades	1.3	0.2	0.9	1.1	1.2	1.6	2.0	2.3
"Post-crisis" period	Sub-period 4	0 trade	89.5	77.5	79.6	89.8	90.7	91.6	92.3	96.5
		1 - 3 trades	5.4	2.3	4.0	4.4	4.7	5.2	10.6	11.5
		4 - 9 trades	3.1	0.9	2.3	2.5	2.8	3.1	6.1	6.8
		10+ trades	2.0	0.3	1.3	1.5	1.8	2.1	3.5	4.4
"Regulatory" period	Sub-period 5	0 trade	79.2	76.1	77.3	78.0	78.7	79.7	81.0	91.2
		1 - 3 trades	11.0	6.1	10.4	10.8	11.1	11.4	11.7	12.2
		4 - 9 trades	6.3	2.1	5.6	6.1	6.4	6.7	7.0	7.6
		10+ trades	3.5	0.6	2.9	3.3	3.7	4.0	4.2	4.7
"Post-regulatory" period	Sub-period 6	0 trade	80.0	77.3	78.3	79.0	79.6	80.4	81.4	90.5
		1 - 3 trades	10.3	6.1	9.1	9.6	10.4	11.1	11.5	12.1
		4 - 9 trades	6.2	2.3	5.7	6.1	6.4	6.7	6.9	7.3
		10+ trades	3.5	0.5	2.7	3.1	3.5	4.0	4.4	5.2

Source: DERA analysis

Table 14. Bond issues and trades by bond characteristics

Panel A. Issue size

			Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)
"TRACE Phase-in" period	Sub-period 1	Less than $100M	18,263	6.7
		Between $100M and $500M	10,504	21.5
		Greater than $500M	1,699	56.1
"Pre-crisis" period	Sub-period 2	Less than $100M	23,441	5.9
		Between $100M and $500M	10,843	19.0
		Greater than $500M	2,293	48.8
"Crisis" period	Sub-period 3	Less than $100M	30,041	3.7
		Between $100M and $500M	11,603	14.7
		Greater than $500M	2,996	43.2
"Post-crisis" period	Sub-period 4	Less than $100M	39,028	3.5
		Between $100M and $500M	12,436	18.6
		Greater than $500M	3,921	48.9
"Regulatory" period	Sub-period 5	Less than $100M	16,690	5.7
		Between $100M and $500M	7,044	32.8
		Greater than $500M	3,281	71.9
"Post-regulatory" period	Sub-period 6	Less than $100M	18,770	3.9
		Between $100M and $500M	6,908	34.1
		Greater than $500M	3,883	72.7

Panel B. Credit quality

			Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)
"TRACE Phase-in" period	Sub-period 1	Investment Grade, price below 95	7,949	3.8
		Investment Grade, price above 95	15,334	20.4
		High Yield, price below 95	3,621	10.6
		High Yield, price above 95	2,648	26.7
"Pre-crisis" period	Sub-period 2	Investment Grade, price below 95	13,087	3.6
		Investment Grade, price above 95	12,522	20.3
		High Yield, price below 95	6,014	10.9
		High Yield, price above 95	3,450	26.6
"Crisis" period	Sub-period 3	Investment Grade, price below 95	20,701	5.6
		Investment Grade, price above 95	10,469	17.1
		High Yield, price below 95	11,814	7.5
		High Yield, price above 95	1,657	16.8
"Post-crisis" period	Sub-period 4	Investment Grade, price below 95	18,278	1.9
		Investment Grade, price above 95	14,567	25.1
		High Yield, price below 95	18,539	4.3
		High Yield, price above 95	4,001	21.1
"Regulatory" period	Sub-period 5	Investment Grade, price below 95	3,843	2.1
		Investment Grade, price above 95	12,361	33.7
		High Yield, price below 95	5,190	3.7
		High Yield, price above 95	5,622	21.3
"Post-regulatory" period	Sub-period 6	Investment Grade, price below 95	3,629	6.1
		Investment Grade, price above 95	12,364	34.6
		High Yield, price below 95	7,298	6.0
		High Yield, price above 95	6,270	15.5

Panel C. Age

			Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)
"TRACE Phase-in" period	Sub-period 1	Less than 2 years	10,205	18.3
		Between 2 years and 5 years	7,922	17.9
		Greater than 5 years	12,275	9.6
"Pre-crisis" period	Sub-period 2	Less than 2 years	11,158	12.3
		Between 2 years and 5 years	12,346	17.2
		Greater than 5 years	12,442	8.8
"Crisis" period	Sub-period 3	Less than 2 years	13,517	8.9
		Between 2 years and 5 years	14,590	11.3
		Greater than 5 years	16,491	7.5
"Post-crisis" period	Sub-period 4	Less than 2 years	12,620	13.0
		Between 2 years and 5 years	16,970	12.2
		Greater than 5 years	25,759	8.5
"Regulatory" period	Sub-period 5	Less than 2 years	10,639	19.1
		Between 2 years and 5 years	6,355	28.9
		Greater than 5 years	10,016	17.6
"Post-regulatory" period	Sub-period 6	Less than 2 years	11,877	16.5
		Between 2 years and 5 years	8,709	26.1
		Greater than 5 years	8,963	18.7

Panel D. Maturity

			Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)
"TRACE Phase-in" period	Sub-period 1	Less than 2 years	1,322	1.5
		Between 2 years and 5 years	4,820	9.5
		Between 5 years and 20 years	19,544	16.1
		Greater than 20 years	4,713	17.4
"Pre-crisis" period	Sub-period 2	Less than 2 years	2,597	0.6
		Between 2 years and 5 years	5,946	6.5
		Between 5 years and 20 years	21,760	15.2
		Greater than 20 years	5,637	15.3
"Crisis" period	Sub-period 3	Less than 2 years	7,620	0.3
		Between 2 years and 5 years	7,433	3.6
		Between 5 years and 20 years	23,388	12.5
		Greater than 20 years	6,150	14.4
"Post-crisis" period	Sub-period 4	Less than 2 years	14,162	0.4
		Between 2 years and 5 years	8,875	5.2
		Between 5 years and 20 years	25,748	14.7
		Greater than 20 years	6,558	19.7
"Regulatory" period	Sub-period 5	Less than 2 years	2,215	1.4
		Between 2 years and 5 years	3,757	12.2
		Between 5 years and 20 years	15,268	25.5
		Greater than 20 years	5,765	21.8
"Post-regulatory" period	Sub-period 6	Less than 2 years	2,196	1.1
		Between 2 years and 5 years	5,304	9.6
		Between 5 years and 20 years	16,202	25.0
		Greater than 20 years	5,834	22.7

Panel E. Complexity

			Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)
"TRACE Phase-in" period	Sub-period 1	Complexity feature 0 or 1	21,491	17.1
		Complexity features 2 or more	8,975	7.8
"Pre-crisis" period	Sub-period 2	Complexity feature 0 or 1	25,045	14.6
		Complexity features 2 or more	11,531	7.1
"Crisis" period	Sub-period 3	Complexity feature 0 or 1	33,091	10.2
		Complexity features 2 or more	11,549	5.8
"Post-crisis" period	Sub-period 4	Complexity feature 0 or 1	42,331	11.7
		Complexity features 2 or more	13,055	6.1
"Regulatory" period	Sub-period 5	Complexity feature 0 or 1	19,731	25.2
		Complexity features 2 or more	7,285	7.7
"Post-regulatory" period	Sub-period 6	Complexity feature 0 or 1	21,207	25.3
		Complexity features 2 or more	8,354	5.2

Source: DERA analysis

Table 15. EHP average transaction costs

Panel A. Excludes zero commission customer agency trades

Trade size (in thousand)	"TRACE Phase-in" period Sub-period 1 Effective half-spread (bps)	"Pre-crisis" period Sub-period 2 Effective half-spread (bps)	"Crisis" period Sub-period 3 Effective half-spread (bps)	"Post-crisis" period Sub-period 4 Effective half-spread (bps)	"Regulatory" period Sub-period 5 Effective half-spread (bps)	"Post-regulatory" period Sub-period 6 Effective half-spread (bps)
5	82.8	58.3	77.8	67.8	43.5	31.0
10	76.5	52.5	70.4	65.5	43.0	30.5
20	66.2	43.2	62.4	60.4	39.8	27.7
50	48.3	30.2	51.2	47.3	30.5	21.0
100	35.4	22.8	42.6	36.2	22.8	15.4
200	25.2	16.7	34.8	27.0	16.7	11.0
500	14.9	10.2	25.7	17.9	11.0	6.8
1000	9.2	6.4	19.9	12.6	7.7	4.5
2000	5.6	4.1	15.5	8.4	5.3	3.0
5000	3.2	2.9	12.1	5.8	4.4	2.8
10000	5.3	4.0	11.3	6.3	5.9	4.3

Panel B. All trades

Trade size (in thousand)	"TRACE Phase-in" period Sub-period 1 Effective half-spread (bps)	"Pre-crisis" period Sub-period 2 Effective half-spread (bps)	"Crisis" period Sub-period 3 Effective half-spread (bps)	"Post-crisis" period Sub-period 4 Effective half-spread (bps)	"Regulatory" period Sub-period 5 Effective half-spread (bps)	"Post-regulatory" period Sub-period 6 Effective half-spread (bps)
5	66.9	45.7	59.5	49.1	27.7	21.1
10	64.0	42.6	55.0	50.1	29.5	21.7
20	55.9	35.5	49.4	47.5	28.5	20.3
50	41.4	25.6	41.9	38.7	23.5	16.1
100	31.1	19.9	36.5	31.0	18.7	12.5
200	22.8	15.0	31.5	24.3	14.7	9.5
500	14.2	9.7	24.8	17.3	10.5	6.4
1000	9.3	6.5	20.2	13.0	8.0	4.6
2000	6.1	4.4	16.2	9.3	5.9	3.3
5000	3.6	3.0	12.3	6.2	4.6	2.8
10000	4.8	3.5	10.8	5.8	5.3	3.7

Source: DERA analysis

Table 16. Number of broker-dealers (MPIDs) per bond issue

				Daily number of broker-dealers per bond issue					
				Mean	1st percentile	10th percentile	Median	90th percentile	99th percentile
"TRACE Phase-in" period	Sub-period 1	Overall		3.4	1	1	2	7	20
		Interdealer		3.5	2	2	2	6	14
		Customer (trade size)	<$100,000	2.0	1	1	1	4	12
			$100,000 - $1,000,000	1.5	1	1	1	3	6
			$1,000,000 - $5,000,000	1.5	1	1	1	3	6
			>$5,000,000	1.4	1	1	1	2	5
"Pre-crisis" period	Sub-period 2	Overall		3.2	1	1	2	7	16
		Interdealer		3.3	2	2	2	6	12
		Customer (trade size)	<$100,000	1.8	1	1	1	4	9
			$100,000 - $1,000,000	1.4	1	1	1	2	4
			$1,000,000 - $5,000,000	1.4	1	1	1	2	5
			>$5,000,000	1.3	1	1	1	2	5
"Crisis" period	Sub-period 3	Overall		3.7	1	1	2	8	21
		Interdealer		3.7	2	2	3	7	17
		Customer (trade size)	<$100,000	2.2	1	1	1	5	13
			$100,000 - $1,000,000	1.5	1	1	1	3	6
			$1,000,000 - $5,000,000	1.4	1	1	1	2	5
			>$5,000,000	1.3	1	1	1	2	5
"Post-crisis" period	Sub-period 4	Overall		4.5	1	1	3	10	24
		Interdealer		4.1	2	2	3	8	18
		Customer (trade size)	<$100,000	2.4	1	1	1	5	13
			$100,000 - $1,000,000	1.6	1	1	1	3	6
			$1,000,000 - $5,000,000	1.4	1	1	1	2	5
			>$5,000,000	1.3	1	1	1	2	5
"Regulatory" period	Sub-period 5	Overall		4.3	1	1	3	9	23
		Interdealer		4.0	2	2	3	7	18
		Customer (trade size)	<$100,000	2.2	1	1	1	5	12
			$100,000 - $1,000,000	1.6	1	1	1	3	6
			$1,000,000 - $5,000,000	1.4	1	1	1	2	5
			>$5,000,000	1.3	1	1	1	2	4
"Post-regulatory" period	Sub-period 6	Overall		4.2	1	1	3	9	20
		Interdealer		3.8	2	2	3	7	15
		Customer (trade size)	<$100,000	2.2	1	1	1	4	10
			$100,000 - $1,000,000	1.5	1	1	1	3	5
			$1,000,000 - $5,000,000	1.4	1	1	1	2	5
			>$5,000,000	1.2	1	1	1	2	4

Source: DERA analysis

Table 17. Number of trades and par volume by trade size

		Dealer capacity			
		Trade count		Par volume	
		Principal	Agency	Principal	Agency
"TRACE Phase-in" period	Customer trade count / Par volume ($billion)	14,500	1,621	12.3	0.4
	Portion (%)	89.9	10.1	97.0	3.0
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	65.4	84.9	1.8	7.6
	$100,000 - $1,000,000	15.7	10.7	5.8	14.3
	$1,000,000 - $5,000,000	13.6	3.1	32.0	27.0
	>$5,000,000	5.3	1.3	60.5	51.1
"Pre-crisis" period	Customer trade count / Par volume ($billion)	11,418	1,614	11.8	0.3
	Portion (%)	87.6	12.4	97.5	2.5
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	62.6	87.5	1.4	10.6
	$100,000 - $1,000,000	16.2	9.8	4.9	15.9
	$1,000,000 - $5,000,000	14.4	1.9	29.0	22.2
	>$5,000,000	6.8	0.9	64.7	51.3
"Crisis" period	Customer trade count / Par volume ($billion)	13,737	2,495	11.2	0.2
	Portion (%)	84.6	15.4	98.0	2.0
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	66.8	92.4	1.9	23.8
	$100,000 - $1,000,000	15.5	6.2	5.7	19.3
	$1,000,000 - $5,000,000	12.1	0.9	29.3	19.1
	>$5,000,000	5.7	0.5	63.0	37.8
"Post-crisis" period	Customer trade count / Par volume ($billion)	18,926	3,405	13.3	0.2
	Portion (%)	84.8	15.3	98.3	1.7
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	67.2	92.4	2.3	23.7
	$100,000 - $1,000,000	17.9	6.3	8.0	24.0
	$1,000,000 - $5,000,000	10.6	1.1	31.3	27.1
	>$5,000,000	4.3	0.2	58.5	25.2
"Regulatory" period	Customer trade count / Par volume ($billion)	18,213	4,120	13.4	0.4
	Portion (%)	81.6	18.5	96.9	3.1
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	62.1	90.3	2.2	15.8
	$100,000 - $1,000,000	21.8	7.7	9.6	20.6
	$1,000,000 - $5,000,000	11.8	1.6	33.5	29.7
	>$5,000,000	4.4	0.4	54.8	33.9
"Post-regulatory" period	Customer trade count / Par volume ($billion)	17,924	4,468	14.7	0.5
	Portion (%)	80.1	20.0	96.5	3.5
	Trade size	(%)	(%)	(%)	(%)
	<$100,000	58.1	88.7	1.9	13.4
	$100,000 - $1,000,000	23.9	8.7	9.5	20.7
	$1,000,000 - $5,000,000	13.1	2.1	33.5	32.6
	>$5,000,000	4.9	0.5	55.2	33.4

Source: DERA analysis

Table 18. Descriptive statistics for dealer quotations on ATS

Panel A. Number of dealer quotations and corporate bond issues quoted

	Number of Quotations (in million)	Number of TRACE eligible bond issues (CUSIPs)
Quote (bid or offer)	9.4	16,717
Bid	6.1	16,461
Offer	3.2	13,740

Panel B. Number of dealer quotations per day, bond issues quoted per day, and number of days quoted per bond issue

	Daily distribution							
	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Number of TRACE eligible bonds (CUSIPs)	28,073	27,788	27,801	27,855	28,076	28,251	28,357	28,388
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
TRACE eligible bonds with bid	53.9	53.0	53.2	53.6	54.1	54.5	54.6	54.6
TRACE eligible bonds with offer	35.7	35.1	35.3	35.5	35.7	36.1	36.4	36.4
TRACE eligible bonds with both bid & offer	35.0	34.5	34.6	34.9	35.1	35.4	35.6	35.7
Number of quotes	114,097.6	103,551	105,509	113,646	116,022	119,892	122,159	122,253
Bid	74,748	65,341	67,009	72,892	75,776	80,284	81,822	82,693
Offer	39,349	36,732	37,075	38,736	39,942	41,173	41,815	42,175
Number of days quoted per bond (CUSIP)	75.2	18	55	82	82	82	82	82
Bid	75.3	23	57	81	82	82	82	82
Offer	59.8	3	8	35	80	82	82	82

Panel C. Quote duration and quote size

		Distribution							
		Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Quote duration (in hour)	Bid	9.1	8.49	8.89	9.20	9.25	9.25	9.25	9.25
	Offer	8.9	7.38	8.58	9.00	9.25	9.25	9.25	9.25
	Both bid & offer	8.8	6.96	8.41	8.95	9.25	9.25	9.25	9.25
Quote size (in thousand)	Bid	NM	25	50	100	250	250	300	500
	Offer	NM	6	14	65	130	250	500	825

Source: DERA analysis

Table 19. Bond characteristics of corporate bonds quoted on ATS

			Distribution							
			Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Issue size (in $million)	Overall TRACE eligible bonds		221.3	0.3	0.7	2.0	10.0	300	700	1,000
	Not quoted		56.9	0.2	0.4	1.1	3.1	13.7	150	300
	Quoted		358.2	0.6	1.2	5.4	200	500	1,000	1,250
	Quoted	One-side	71.5	0.3	0.5	1.3	4.5	30	250	400
		Two-side	518.6	2.9	7.0	142	385	700	1,200	1,500
Credit quality	Overall TRACE eligible bonds		NM	HY	HY	HY	IG	IG	IG	IG
	Not quoted		NM	HY	HY	HY	HY	IG	IG	IG
	Quoted		NM	HY	HY	IG	IG	IG	IG	IG
	Quoted	One-side	NM	HY	HY	IG	IG	IG	IG	IG
		Two-side	NM	HY	IG	IG	IG	IG	IG	IG
Age (in years)	Overall TRACE eligible bonds		4.9	0.2	0.4	1.0	2.6	7.0	13.0	17.8
	Not quoted		4.6	0.1	0.2	0.7	1.7	6.8	14.2	19.2
	Quoted		5.1	0.4	0.7	1.6	3.3	7.1	11.7	17.3
	Quoted	One-side	5.4	0.4	0.6	1.5	3.1	7.9	14.9	18.5
		Two-side	5.0	0.4	0.7	1.7	3.4	6.8	11.2	16.6
Maturity (in years)	Overall TRACE eligible bonds		11.7	1.5	2.0	5.1	9.5	15.2	30.4	30.5
	Not quoted		8.5	1.1	1.5	2.0	5.1	10.2	20.3	30.4
	Quoted		14.3	4.1	5.1	7.1	10.2	20.3	30.5	30.5
	Quoted	One-side	13.7	4.0	5.1	7.1	10.2	18.3	30.4	30.5
		Two-side	14.6	4.1	5.1	7.2	10.2	20.3	30.5	30.5
Complexity	Overall TRACE eligible bonds		NM	0	0	0	0	1	1	1
	Not quoted		NM	0	0	0	0	1	1	1
	Quoted		NM	0	0	0	0	0	1	1
	Quoted	One-side	NM	0	0	0	0	1	1	1
		Two-side	NM	0	0	0	0	0	1	1

Note: The value 0 for the complexity variable indicates that a corporate bond issue has zero or one complexity feature and the value 1 for the complexity variable indicates that a corporate bond issue has two or more complexity features.
Source: DERA analysis

Table 20. Corporate bond trades on ATS and trade size

	Number of Interdealer trades			Par volume of Interdealer trades (in $billion)		
	Overall	ATS	Non-ATS	Overall	ATS	Non-ATS
Total	515,817	193,562	322,255	93.4	6.5	87.0
Portion (%)		37.5	62.5		6.9	93.1
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	77.7	92.2	69.0	9.0	52.0	5.7
$100,000 - $1,000,000	17.3	7.7	23.1	27.2	42.1	26.0
$1,000,000 - $5,000,000	4.5	0.1	7.1	43.1	5.8	45.9
>$5,000,000	0.5	0.0	0.8	20.8	0.2	22.3

Source: DERA analysis

Table 21. Bond characteristics for corporate bond trades on ATS

		Distribution							
		Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Issue size (in $million)	Interdealer trades	1028.9	34.8	250	400	750	1,300	2,250	2,750
	Non-ATS	1066.1	45.0	250	425	750	1,400	2,250	2,750
	ATS	967.0	27.9	250	400	700	1,250	2,000	2,500
Credit quality	Interdealer trades	NM	HY	HY	IG	IG	IG	IG	IG
	Non-ATS	NM	HY	HY	IG	IG	IG	IG	IG
	ATS	NM	HY	HY	IG	IG	IG	IG	IG
Age (in years)	Interdealer trades	4.9	0.7	1.2	2.1	3.7	6.0	9.6	14.8
	Non-ATS	4.7	0.7	1.1	2.0	3.5	5.9	9.4	14.1
	ATS	5.2	0.8	1.3	2.2	3.9	6.2	9.9	17.1
Maturity (in years)	Interdealer trades	13.2	4.7	5.1	7.2	10.2	11.2	30.5	30.5
	Non-ATS	13.3	4.4	5.1	7.2	10.2	11.8	30.5	30.5
	ATS	13.0	5.1	5.1	7.3	10.2	11.0	30.4	30.5
Complexity	Interdealer trades	NM	0	0	0	0	0	0	0
	Non-ATS	NM	0	0	0	0	0	0	0
	ATS	NM	0	0	0	0	0	0	0

Note: The value 0 for the complexity variable indicates that a corporate bond issue has zero or one complexity feature and the value 1 for the complexity variable indicates that a corporate bond issue has two or more complexity features.
Source: DERA analysis

Table 22. Amount of pre-trade information

						Distribution				
		Number of Trades	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Issue size	Without quote	91,920	416.5	1.6	3.3	22.0	253	500	1,025	1,500
(in $million)	With quote	1,562,797	1,052.5	69.0	250	450	750	1,339	2,250	2,750
Credit quality	Without quote	91,916	NM	HY	HY	HY	HY	IG	IG	IG
	With quote	1,562,786	NM	HY	HY	HY	IG	IG	IG	IG
Age	Without quote	91,907	1.9	0.0	0.0	0.1	0.9	2.3	4.9	8.2
(in years)	With quote	1,562,767	3.8	0.2	0.4	1.3	2.6	4.8	8.1	11.4
Maturity	Without quote	91,379	10.3	1.7	3.0	4.3	7.0	12.0	28.9	30.0
(in years)	With quote	1,561,571	12.1	4.4	5.0	6.6	10.0	10.2	30.0	30.1
Complexity	Without quote	91,920	NM	0	0	0	0	1	1	1
	With quote	1,562,797	NM	0	0	0	0	0	0	1

Note: The value 0 for the complexity variable indicates that a corporate bond issue has zero or one complexity feature and the value 1 for the complexity variable indicates that a corporate bond issue has two or more complexity features.

Source: DERA analysis

Table 23. Transaction costs: Quoted spread and bond characteristics

		Distribution of time-weighted quoted spread (in bps)							
		Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Overall									
	Time-weighted quoted spread	172.9	12.2	18.2	35.4	73.7	145.6	275.8	430.7
By bond characteristics									
Issue size	Less than $100M	248.1	26.3	37.9	67.4	123.2	218.3	394.0	579.3
	Between $100M and $500M	190.0	17.1	24.4	43.9	84.3	158.5	297.0	465.1
	Greater than $500M	94.7	8.1	11.5	20.3	39.7	76.8	133.0	190.4
Credit quality	Investment grade	115.3	11.1	16.3	30.9	65.5	131.0	240.4	353.9
	High yield	408.1	27.5	37.9	62.0	108.4	214.2	480.5	883.6
Age	Less than 2 years	129.1	12.2	18.0	34.9	72.6	142.1	267.8	417.9
	Between 2 years and 5 years	139.6	11.9	17.6	34.3	69.7	131.1	235.1	352.2
	Greater than 5 years	247.8	12.6	19.1	37.1	80.7	167.1	325.6	523.5
Maturity	Less than 2 years	242.0	5.3	5.7	23.1	209.4	426.7	494.0	522.3
	Between 2 years and 5 years	113.1	7.7	10.7	17.6	31.7	70.9	161.6	285.4
	Between 5 years and 20 years	158.4	11.1	16.3	30.0	58.7	113.6	214.1	335.7
	Greater than 20 years	219.8	34.3	48.4	79.3	130.4	227.2	408.7	624.9
Complexity	Complexity feature 0 or 1	155.5	11.7	17.3	33.0	67.6	130.6	238.7	362.1
	Complexity features 2 or more	296.7	21.9	35.9	72.4	144.8	279.6	522.4	771.1

Source: DERA analysis

Table 24. Transaction costs: Effective spread and trade size

	Distribution of effective spread (in bps)							
	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Overall								
All trades	115.3	4.4	8.7	21.3	52.0	133.9	306.3	437.8
Interdealer trades	76.6	4.6	8.7	19.4	42.0	85.4	161.0	238.6
Customer trades	143.1	4.3	8.7	23.3	65.9	197.2	387.8	492.9
Customer trades by trade size								
<$100,000	189.5	7.2	14.1	38.2	117.3	283.2	453.5	544.1
$100,000 - $1,000,000	80.2	2.7	5.6	14.4	35.8	88.0	199.9	307.9
$1,000,000 - $5,000,000	79.8	2.5	5.4	14.8	37.0	84.7	169.4	267.3
>$5,000,000	68.2	2.4	5.1	13.6	32.5	73.2	143.2	217.3

Source: DERA analysis

Table 25. Transaction costs: Effective spread and bond characteristics

		Distribution of effective spread (in bps)							
		Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Overall									
	Effective spread	115.3	4.4	8.7	21.3	52.0	133.9	306.3	437.8
By bond characteristics									
Issue size	Less than $100M	197.9	15.7	27.2	57.9	125.5	264.3	463.2	576.1
	Between $100M and $500M	155.5	8.0	15.4	36.3	82.7	193.4	383.7	508.2
	Greater than $500M	86.5	3.4	6.7	16.1	37.5	91.6	233.2	358.7
Credit quality	Investment grade	85.2	3.5	6.8	16.3	38.4	96.5	229.8	344.9
	High yield	170.3	9.3	17.9	39.9	87.9	215.1	424.6	543.9
Age	Less than 2 years	108.6	4.2	8.3	20.3	48.5	124.2	304.7	429.0
	Between 2 years and 5 years	118.6	4.4	8.7	21.5	52.9	134.8	305.4	436.5
	Greater than 5 years	120.2	4.8	9.2	22.6	57.3	146.3	309.6	454.2
Maturity	Less than 2 years	168.0	1.9	2.4	4.7	61.1	409.3	473.9	496.8
	Between 2 years and 5 years	74.7	1.9	4.0	10.0	23.3	63.0	177.5	287.6
	Between 5 years and 20 years	104.6	4.1	8.2	19.6	46.2	116.3	276.4	398.8
	Greater than 20 years	170.1	10.8	20.6	47.0	100.2	224.0	442.3	535.6
Complexity	Complexity feature 0 or 1	111.2	4.3	8.5	20.8	50.4	128.2	296.3	426.7
	Complexity features 2 or more	203.6	7.8	16.7	45.4	114.8	263.8	497.1	663.3

Source: DERA analysis

Table 26. Transaction costs: price improvement

Panel A. Price improvement to quoted price and trade size

	Distribution of price improvement (in bps)							
	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Overall								
All trades	-43.8	-331.6	-207.7	-50.1	-5.1	6.6	36.7	69.9
Interdealer trades	-7.9	-97.1	-54.1	-16.3	0.0	4.0	27.9	55.9
Customer trades	-69.7	-401.0	-299.7	-114.0	-17.0	9.0	43.0	79.2
Customer trades by trade size								
<$100,000	-117.7	-438.8	-376.0	-209.0	-48.6	-3.5	16.1	39.6
$100,000 - $1,000,000	-14.7	-210.8	-111.3	-25.4	0.0	21.5	57.3	94.2
$1,000,000 - $5,000,000	13.8	-113.8	-63.5	-16.4	5.6	37.7	90.7	147.1
>$5,000,000	10.8	-97.9	-56.3	-17.2	4.3	30.3	73.3	120.8

Panel B. Scaled price improvement to quoted price and trade size

	Distribution of price improvement (the ratio of price improvement to quoted spread)							
	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Overall								
All trades	-167.7	-11.26	-5.94	-1.63	-0.16	0.20	0.67	0.84
Interdealer trades	-373.7	-4.20	-2.13	-0.59	0.00	0.12	0.60	0.80
Customer trades	-19.2	-15.48	-8.70	-2.94	-0.48	0.28	0.71	0.86
Customer trades by trade size								
<$100,000	-31.7	-20.69	-12.13	-4.99	-1.33	-0.10	0.44	0.71
$100,000 - $1,000,000	-2.1	-7.77	-3.86	-0.96	0.00	0.53	0.82	0.91
$1,000,000 - $5,000,000	-1.7	-3.97	-2.03	-0.54	0.18	0.63	0.86	0.93
>$5,000,000	-1.1	-4.31	-2.22	-0.63	0.15	0.62	0.85	0.93

Source: DERA analysis

V. Single-name Credit Default Swaps (CDS)

A. Introduction

Single-name CDS are financial contracts that enable market participants to transfer the credit risk of an issuer by buying and selling credit protection.[199] The single-name CDS market experienced expansive growth in the mid-2000s and a decline in activity after the financial crisis. In this section, we study the evolution of transaction activity and liquidity in single-name CDS.

The examination of liquidity in Treasury and corporate bond markets would be incomplete without an analysis of the single-name CDS market for two primary reasons. First, the market for single-name CDS is an important credit risk market and provides an alternative risk transfer mechanism. Because single-name CDS allow market participants to gain exposure to the credit risk of underlying bonds, CDS prices contain information about the market's expectation of reference entity credit risks. As we discuss below, single-name CDS may even lead corporate bonds in price discovery.[200]

Second, transaction activity in the single-name CDS market may have an impact on the efficiency and liquidity of the corporate bond market. Since the payoffs on single-name CDS are dependent upon the value of underlying securities, activity in the CDS market can be correlated with activity in underlying securities markets. In addition, market participants may be able to partially or fully replicate exposure to Treasury securities with positions in corporate bonds and single-name CDS, and single-name CDS prices reflect the spread between corporate and Treasury bonds with comparable interest rate risk exposures.[201] Thus, single-name CDS contracts can be used as part of arbitrage strategies to eliminate perceived inefficiencies in the

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[199] *See* Basulto and Lee (2016).

[200] *See* Longstaff et al. (2005), Blanco et al. (2005), Ashcraft and Santos (2009), Das et al. (2014).

[201] *See,* e.g., Duffie (1999), Bai et al. (2013), Kim et al. (2017).

bond market. Informational efficiency, pricing, and liquidity in the single-name CDS market can, therefore, affect bond markets.[202]

From the outset, the direction of liquidity spillovers between corporate bond and single-name CDS markets is unclear. On the one hand, single-name CDS can be used to hedge the credit risk of reference securities, allowing market participants to buy credit protection rather than selling these securities to manage their credit risk exposures to a given issuer. Further, if dealers can hedge bond exposure with actively traded single-name CDS, they may be able to hold larger bond inventories, enhancing market making in corporate bonds.[203] As a result, there may be complementarities between activity in single-name CDS and bond markets. On the other hand, the existence of two markets to trade credit risk exposures may fragment liquidity across credit risk instruments, forcing large institutions and other sophisticated traders to choose a market in which to transact. To the extent that transacting in single-name CDS may involve lower costs and higher liquidity than transacting in the bond market, market participants may prefer to trade on credit risk in the single-name CDS market over the bond market. In that context, there may be substitution between trading in single-name CDS and corporate bonds.

Below we examine existing research regarding spillovers between corporate bond and single-name CDS markets and report findings on changes in the volume and structure of single-name CDS market activity over time. We recognize that our empirical analysis of activity in single-name CDS markets faces three primary limitations. First, available data limit the extent to which we can quantitatively characterize the market, and we face constraints concerning the time period and metrics for which data are available. Specifically, a part of our analysis is based on

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[202] *See* Rel. No. 34-75611, *Registration Process for Security-Based Swap Dealers and Major Security-Based Swap Participants* (Aug. 5, 2015) 80 FR at 49003 (Registration Adopting Release). *See also* Massa and Zhang (2012), Das et al. (2014), Oehmke and Zawadowski (2017), Boehmer et al. (2015).

[203] *See,* e.g., CFA Institute (2016).

data obtained from the Depository Trust & Clearing Corporation (DTCC) Derivatives Repository Limited Trade Information Warehouse (TIW), including data regarding the activity of market participants in the single-name CDS market during the period from 2008 to 2016. The data available to us from TIW do not encompass those CDS transactions that both: (1) do not involve U.S. counterparties;[204] and (2) are based on non-U.S. reference entities. Notwithstanding this limitation, we believe the TIW data provides sufficient information to permit us to identify the types of market participants active in the single-name CDS market and the general pattern of dealing within that market.[205] To supplement TIW data analysis, we use subscription data from the ICE Data Services CMA database. This database includes tick-level quote information for 2008 through the third quarter of 2016 but does not include dealer names or identifiers, and so we are unable to measure the number of dealers issuing quotes or making markets. To further supplement this analysis and extend data coverage to an earlier time period, we also use semiannual statistics on gross market values and notionals published by the Bank for International Settlements (BIS) dating back to 2004.

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[204] Following publication of the Warehouse Trust Guidance on CDS data access, TIW surveyed market participants, asking for the physical address associated with each of their accounts (i.e., where the account is organized as a legal entity). This physical address is designated the registered office location by TIW. When an account reports a registered office location, we have assumed that the registered office location reflects the place of domicile for the fund or account. When an account does not report a registered office location, we have assumed that the settlement country reported by the investment adviser or parent entity to the fund or account is the place of domicile. Thus, for purposes of this analysis, we have classified accounts as "U.S. counterparties" when they have reported a registered office location in the United States. We note, however, that this classification is not necessarily identical in all cases to the definition of "U.S. person" under Exchange Act Rule 3a71-3(a)(4).

[205] The challenges we face in estimating measures of current market activity stem, in part, from the absence of comprehensive reporting requirements for security-based swap market participants. The Commission has recently adopted rules regarding trade reporting, data elements, and public reporting for security-based swaps (Regulation SBSR) that are designed, when fully implemented, to provide the Commission with additional measures of market activity that will allow us to better understand and monitor activity in the security-based swap market. *See* Rel. No. 34-74244, *Regulation SBSR—Reporting and Dissemination of Security-Based Swap Information* (Feb. 11, 2015) 80 FR at 14699-14700 (Regulation SBSR Adopting Release); *See also* Rel No. 34-78321, *Regulation SBSR—Reporting and Dissemination of Security-Based Swap Information* (July 14, 2016) 81 FR 53546.

Second, it is not clear whether single-name CDS activity before the crisis appropriately reflects market liquidity under normal conditions, and the selection of a benchmark period may significantly affect the analysis. From the buyers' standpoint, single-name CDS provide short exposure to the credit risk inherent in corporate bonds, and investor demand for single-name CDS may increase as the risk of credit events on existing reference obligations rises. At the same time, sellers may use CDS contracts to obtain long exposures to corporate bonds, particularly when bonds are illiquid or hard to obtain. The analysis below considers both liquidity demand and liquidity supply explanations of observed changes in single-name CDS market activity and recognizes the sensitivity of potential interpretations of observed time series patterns to the selection of the benchmark period.

Third, the analysis of changes in single-name CDS activity in connection with regulatory events faces a number of empirical challenges. As discussed below, relevant regulatory changes in the CDS market were proposed, enacted, and adopted over a prolonged period of time. In addition, the reforms of interest impacted large groups of single-name CDS market participants at the same time (e.g., all single-name CDS dealers and major participants, or all market participants). Therefore, we do not have cleanly identified and otherwise comparable "treatment" and "control" groups of market participants.

Lastly, regulatory reforms of interest coincided with a portfolio of other policy interventions, such as large scale infusions of liquidity and low interest rates, which are likely to have directly impacted single-name CDS activity before and after regulatory reforms. It is difficult to disentangle those effects from the impacts of Dodd-Frank, including the Volcker Rule, and Basel III on observed changes in CDS liquidity. While we are unable to make causal inferences with respect to the transaction activity in CDS, we present a multifaceted analysis of the current state and recent changes in transaction activity and participation in the single-name CDS market.

The analysis below is informed by our understanding of both single-name and index CDS markets. We have considered existing research on index CDS liquidity in the aftermath of the Dodd-Frank reforms;[206] however, this section focuses on single-name CDS. A single-name CDS contract covers default events for a single reference entity or reference security. In contrast, index CDS contracts and related products make payouts that are contingent on the default of index components, and allow participants in those instruments to gain exposure to the credit risk of the basket of reference entities that comprise the index. A default event for a reference entity that is an index component will result in payoffs on both single-name CDS written on the reference entity and index CDS written on indices that contain the reference entity. Because of this relationship between the payoffs of single-name CDS and index CDS products, prices of these products depend upon one another, creating trading opportunities across these markets. However, while Treasuries, corporate bonds and single-name CDS contracts present clear arbitrage opportunities, index CDS are less direct instruments for cross-market arbitrage of mispricings in corporate bonds and Treasuries and may be less likely to directly impact liquidity in these markets. Further, single-name CDS contracts are security-based swaps subject to Commission oversight, while broad-based index CDS contracts are swaps subject to CFTC oversight.

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[206] Loon and Zhong (2016) find decreases in transaction costs and increases in liquidity in index CDS following the implementation of some of the Dodd-Frank reforms. Specifically, the paper found (1) liquidity improvements following public dissemination of OTC derivative trades; (2) reductions in trading costs, price impact, and price dispersion for cleared trades, trades executed on exchange-like venues, end-user trades, and bespoke trades. We have also considered evidence on the impacts of the Dodd-Frank Act on other over-the-counter derivative markets.

B. Limitations on Analysis of Causal Impacts

An important feature of the Commission's regulation of the single-name CDS market is that it constitutes one part of a broader set of OTC derivative market reforms. Title VII of the Dodd-Frank Act provides a statutory framework for the OTC derivatives market and divided authority to regulate that market between the CFTC (which regulates swaps, including broad-based index CDS) and the Commission (which regulates security-based swaps, including single-name CDS and narrow-based index CDS).[207] The Dodd-Frank Act directed the Commission to establish a regulatory regime governing activities of security-based swap dealers and major security-based swap participants, as well as other market participants. As can be seen in Appendix B, between 2010 and 2016 the Commission has proposed and adopted a variety of rules impacting single-name CDS markets (e.g., dealer definitions, product definitions, dealer registration, cross-border activity, swaps data repository registration, business conduct standards) and proposed but not yet adopted others (e.g., capital and margin and swap execution facilities). Appendix B presents a summary of the Commission's proposed and adopted rules under Title VII.

Single-name CDS and index CDS markets are characterized by extensive cross-market participation. Out of approximately 4,241 DTCC-TIW accounts that participated in the market for single-name CDS in 2015, approximately 2,871 accounts, or 68%, also participated in the market for index CDS. Of the accounts that participated in both markets, data regarding transactions in 2015 suggest that, conditional on an account transacting in notional volume of index CDS in the top tercile of accounts, the probability of the same account landing in the top tercile in terms of single-name CDS notional volume is approximately 59%. By contrast, the

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[207] *See* 15 U.S.C. § 8302.

probability of the same account landing in the bottom tercile of single-name CDS notional volume is only 10%. In addition, the Commission previously estimated that the majority of entities expected to trigger requirements for registration with the Commission as security-based swap dealers or major security-based swap participants are currently registered with the CFTC as swap dealers or major swap participants.[208]

Therefore, many single-name CDS market participants that would become subject to the Commission's Title VII regime are also affected by the CFTC's regulatory reforms and oversight over the index CDS market. While the Commission has not yet made any mandatory clearing determinations for single-name CDS and not all of the substantive Title VII rules governing the single-name CDS market have been adopted (e.g., capital and margin requirements for dealers and major participants), and compliance with most Title VII single-name CDS rules is not yet required (e.g., dealer registration, business conduct standards), many of these regulatory requirements are in force in the index CDS market.[209] Market participants active in both single-name and index CDS markets may have adjusted some of their business practices in response to the CFTC's index CDS regime.

As a result of a protracted event timeline and the potential that market participants broadly anticipated regulatory reforms, prevailing econometric methods used to establish causal inference are not suited to the study of single-name CDS markets. Further, because the period of interest includes changes in the regulation of closely-related markets, we lack clean "treatment" and "control" groups of otherwise comparable dealers and non-dealer market participants in the single-name CDS market.

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[208] *See* Rel. No. 34-77617, *Business Conduct Standards for Security-Based Swap Dealers and Major Security-Based Swap Participants* (Apr. 14, 2016) (Business Conduct Standards Adopting Release).

[209] *See,* e.g., Loon and Zhong (2016); Business Conduct Standards Adopting Release.

Moreover, macroeconomic effects may confound our ability to infer the effects of regulatory reform on trading activity in this market. Buyers of single-name CDS receive short exposure to the credit risk of underlying reference securities, and the post Dodd-Frank period is characterized by economic recovery—potentially reducing demand for protection against corporate default; and low interest rates—providing market participants incentives to shift into riskier asset classes and reducing the profitability of traditional dealer business models. These circumstances confound the tests of the causal impacts of the Dodd-Frank Act or its component reforms on the size, trading activity, or liquidity in single-name CDS markets. Nevertheless, as discussed in the following section, we recognize the close relationship between the single-name CDS markets and corporate bond markets and the potential for regulatory activities in the single-name CDS market to impact access to capital and market liquidity. Hence, we describe changes in the single-name CDS market over time and consider these statistics alongside evidence in prior sections.

C. Spillovers between Bonds and Single-Name CDS

Existing research on single-name CDS examines a wide range of issues, including CDS pricing, the relationship between CDS and the bond and equity markets, and the impact of CDS contracts on corporate finance.[210] Our analysis below is focused on the interaction between the CDS and the bond markets, particularly the potential impact of the CDS market on bond liquidity. The introduction of single-name CDS created an alternative market for investors to trade credit risk. While this market may enable participants to hedge the risk of underlying bonds, it may also fragment liquidity.

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[210] For a comprehensive literature review on single-name CDS, *see* Augustin et al. (2014), Culp et al. (2016).

Single-name CDS may lead corporate bonds in price discovery. In other words, new information about a reference entity's credit risk may be reflected in single-name CDS written on the reference entity's bonds before it is reflected by the price of the bonds themselves. There are a number of different theories that support this conclusion. For example, trading frictions may be relatively lower in the single-name CDS market, or differences in the composition of the two markets may mean that the single-name CDS market has more informed traders than the corporate bond market.

Academic research has also found empirical evidence consistent with the hypothesis that the single-name CDS market leads the corporate bond market in price discovery. Blanco et al. (2005) analyze a sample of 33 reference entities and find that for 27 of them the CDS market contributes, on average, 80% of the price discovery. Further, in four of the remaining six cases, changes in CDS prices Granger-cause[211] changes in credit spreads. They attribute the price discovery role of the CDS market to microstructure factors and suggest that participants in cash and derivative markets trade for different reasons. Bilateral CDS transactions involve counterparty risk, as transactions may settle over a period of years and therefore are concentrated among institutions with relatively high credit ratings. By contrast, a transaction in cash bonds involves relatively little counterparty risk as transactions typically settle within 3 days during the Report period, accommodating the participation of less sophisticated retail investors.

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[211] Granger causality tests show whether past values of one variable help predict another variable (after controlling for past values of that other variable). As Wooldridge (2013) notes, this notion of causality should be interpreted with caution. Specifically, this definition of causality does not refer to contemporaneous relationships between two variables, and does not allow us to determine exogeneity or endogeneity of contemporaneous relationships between variables. Granger causality, therefore, does not apply in purely cross-sectional contexts. Instead, it allows us to conclude whether past values of an independent variable, after controlling for past values of the dependent variable, help predict future values of a dependent variable. For more, *see* Wooldridge (2013), Ch.18, p. 590.

Importantly, the paper finds that the CDS market leads in the short-term, but in the long-term the CDS and bond markets price risk equally quickly, on average.

Price discovery in single-name CDS may reduce informational efficiency in the corporate bond market. Using an extensive sample of CDS and bond trades between 2002 and 2008, Das et al. (2014) find that the sensitivity of bond returns to lagged information is higher after the introduction of CDS, indicating that bond market efficiency relative to other securities deteriorates after the introduction of CDS on a given underlier. The paper argues that the introduction of CDS leads to a decrease in bond market efficiency and no reduction in pricing errors or improvements in bond liquidity. Similar to Blanco et al. (2005), they argue that the effect may be driven by differentially informed participants being active in the two markets, with the CDS market being dominated by more informed institutional traders. Das et al. (2014) also address a shift by large institutional traders from participation in the bond market to transacting in CDS. They find bond transaction costs for institutional investors increased after the introduction of CDS, which they explain by a migration of institutional investors to the CDS market.

Biswas et al. (2015) offer a transaction cost explanation for the migration of price discovery from cash to the derivatives market. The paper compares single-name CDS and bond transaction costs for trades with different trade sizes. Although for institutional-size trades up to $500K, bonds are three times as expensive to trade as the corresponding CDS, at large trade sizes bonds are no more expensive to trade than the CDS contracts written on them. By showing that CDS are less expensive to trade for a range of trade sizes, the paper provides a potential explanation for the shift in price discovery from cash to derivatives (Blanco et al. (2005), Norden and Wagner (2008), Norden and Weber (2009), Forte and Pena (2009), and Das et al. (2014)).

However, the source of this transaction cost differential between an opaque derivatives market and a more transparent bond market remains unclear.

Evidence on the relationship between CDS market liquidity and underlying bond liquidity is mixed. Massa and Zhang (2012) argue that CDS improve bond liquidity by reducing investors' need to liquidate the bonds should the issuer's credit deteriorate and fire sales occur. Consistent with this argument, the paper finds that the presence of CDS contracts increase investors' willingness to pay for underlying bonds, reducing the bond yield spread by 22 bps for investment grade firms, and increases the liquidity in investment grade bonds for a comprehensive sample of U.S. corporate bonds over the 2001 to 2009 period. This explanation is consistent with investors requiring less compensation for bond illiquidity when they are able to buy credit protection in the CDS market. It is worth noting that this finding is based entirely on the illiquidity measure of Bao et al. (2011), which is essentially an implied bid-ask spread measure. The paper also finds that the presence of CDS contracts reduces the drop in bond liquidity and the rise in yield spreads during exogenous fire sales (bond rating downgrades and insurance company sales after hurricane Katrina).

Similarly, Nashikkar et al. (2011) investigates the interaction between CDS market liquidity and the price of credit risk. They find that bonds with more liquid CDS tend to have lower yields than comparable bonds with less liquid CDS contracts. They also validate a measure of a bond's latent liquidity, which reflects the accessibility of a bond to market participants through various funds and is defined as the weighted average turnover of funds holding the bond. The paper finds that CDS market liquidity has explanatory power for a bond's latent liquidity. While these findings suggest that there may be positive liquidity spillovers from the CDS market to the corporate bond market, this paper does not definitively address endogeneity issues, limiting our inference. In other words, the evidence presented by the authors cannot rule out the possibility that liquidity in the corporate bond market determines CDS market liquidity, or that liquidity in both markets are co-determined by unobservable factors.

Since the single-name CDS market serves as a market in which investors can trade credit risk, fixed income traders may reduce their participation in bond markets, and therefore, liquidity in single-name CDS may have a negative spillover on corporate bond market liquidity. As referenced earlier, Das et al. (2014) test the impact of CDS trading on bond liquidity, and find some liquidity measures (trade size and turnover) in certain bond underliers deteriorated after the introduction of CDS on these underliers. At the same time, the paper finds that other measures, such as the number of daily trades and trading volume rose, while Amihud and Roll measures of illiquidity remained unaffected. Overall, the paper finds mixed results regarding the effect of CDS introduction on bond liquidity.

Oehmke and Zawadowski (2015) develop a liquidity-based model of CDS and bond markets. In their model, the presence of CDS reduces demand for bonds (substitution effect) but also allows long-term investors to become levered basis traders and buy more illiquid bonds (allocation effect). The introduction of a CDS on a given underlier involves a tradeoff: it crowds out existing demand for the bond but also improves bond allocation by allowing long-term investors to absorb more bond supply by providing them a means of sharing credit risk with short-term investors. In Oehmke and Zawadowski (2017), CDS markets emerge as "alternative trading venues" conducive to standardization and liquidity. They argue that the CDS market may be particularly attractive to participants when the underlying bond market is fragmented and involves higher trading frictions. To test this hypothesis, the paper relies on aggregated CDS position and trading data from DTCC, and reports three main results. First, CDS positions and trading volume are larger when the reference entity bonds are fragmented into many separate issues and have heterogeneous contractual terms. Second, bond fragmentation is associated with higher trading costs and lower turnover in the underlying bonds. Third, CDS-bond basis trades help to absorb a liquidity shock to bonds when selling pressure exists. Thus, they reach similar conclusions to Massa and Zhang (2012) that the introduction of CDS may enhance bond liquidity.

Sambalaibat (2015) builds a dynamic search model to explore the liquidity spillover between bond and CDS markets. The analysis shows that, in the short run, because the aggregate capital invested in the credit markets remain fixed, speculative CDS purchases attract liquidity away from the bond market. However, in the long run, speculative CDS purchases attract investors who are willing to take the opposite side of these trades by either selling credit protection or buying underlying bonds. Because of search frictions in both the CDS market and the bond market, these investors are willing to trade in both markets, causing liquidity in the CDS market to spill over into the bond market. In that model, CDS exist not necessarily because of their inherent liquidity, but because CDS contracts allow investors to "short" bonds cheaply.

We note that most existing empirical studies take CDS liquidity as a given. Loon and Zhong (2016) examine changes in CDS liquidity and activity around the initiation of central clearing. They find that CDS liquidity and trading activity on cleared reference entities improves after central clearing. Qiu and Yu (2012) investigate the determinants of single-name CDS liquidity. Using the number of quote providers as a measure of CDS liquidity, they find that large firms and firms near the investment grade/speculative grade cutoff tend to be the most liquid. They also show that CDS liquidity is positively related to the amount of information flow from the CDS market to the stock market. Their findings underscore the important role of information heterogeneity in the determination of CDS market liquidity.

In sum, a body of finance research has explored the emergence of single-name CDS and the impact of activity in this market on price discovery and liquidity in underlying bonds. As discussed above, existing studies do not reach a consensus on the direction and drivers of the effects.

D. Exposures, Participants and Liquidity

As discussed throughout the Report, liquidity is multifaceted and can be measured using a number of empirical approaches. Liquid markets "are generally viewed as those which accommodate trading with the least effect on price" (O'Hara (1997)) and where market participants have "the ability to trade large sizes quickly, at low cost, when [they] want to trade" (Harris (2003)). The analysis below relies on three different sets of measures. First, we examine the volume of activity in single-name CDS markets using BIS data for different groups of market participants, by credit rating category and tenor. Second, we use DTCC-TIW data to quantify changes in the role of various hand-classified groups of market participants, the frequency of trades, the fraction of trading days with no transactions and the evolution of trade sizes, among others. Third, we use ICE Data Services CMA quote data to document the number of quoted underliers, quotes per underlier, and quoted spreads in the cross section and over time.

1. Volume of Activity

First, we consider the evolution of global notional amounts outstanding and gross market value of single-name CDS using semiannual OTC statistics reported by the Bank of International

Settlements.[212] Notional amount outstanding represents the nominal value of all the deals concluded and not yet settled on the reporting date (Tissot (2015)), while gross market value represents the costs of replacing all outstanding contracts at market prices prevailing on the reporting date and reflects maximum losses in the event of default on the reporting date.[213] While the gross notional value remains fixed through the life of a contract, market value fluctuates with changes in the default risk of the underlier: if default becomes more likely, the market value of the CDS increases, and vice versa.[214] Further, trade compression results in fluctuation in outstanding notional, but not market value.[215] Figure 36 plots the evolution in the total amounts of outstanding notional and market values between 2004 and mid 2016 based on the BIS semiannual derivative statistics. We observe that the total amount of outstanding notional in single-name CDS has peaked during and in the immediate aftermath of the financial crisis. Importantly, where notional amounts fell in 2008, gross market values almost tripled, consistent with a dramatic increase in the default risk of reference names. The evidence in Figure 36 is consistent with single-name CDS serving as a means of sharing credit risk: the demand for CDS may peak when aggregate credit risk as well as the credit risk of various groups of individual issuers is high.

Figure 37 presents the dynamics of CDS market activity, as captured by global net notional amounts outstanding as a function of the industry and credit risk quality of the

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[212] BIS statistics, *available at* http://stats.bis.org/statx/toc/DER.html

[213] When positions are offset by entering a new contract, notional amounts may be inflated, particularly after the emergence of central clearing (under which an alpha transaction is replaced with a beta and an offsetting gamma transaction) in the latter parts of the sample period. However, portfolio compression allows early termination of redundant contracts, which reduces notional amounts. The gross market value is calculated as the sum of the absolute value of gross positive market values and gross negative market values. It provides a more meaningful measure of amounts at risk than notional amounts. *See* BIS Statistical Release (Nov. 2015), *available at* http://www.bis.org/publ/otc_hy1511.pdf.

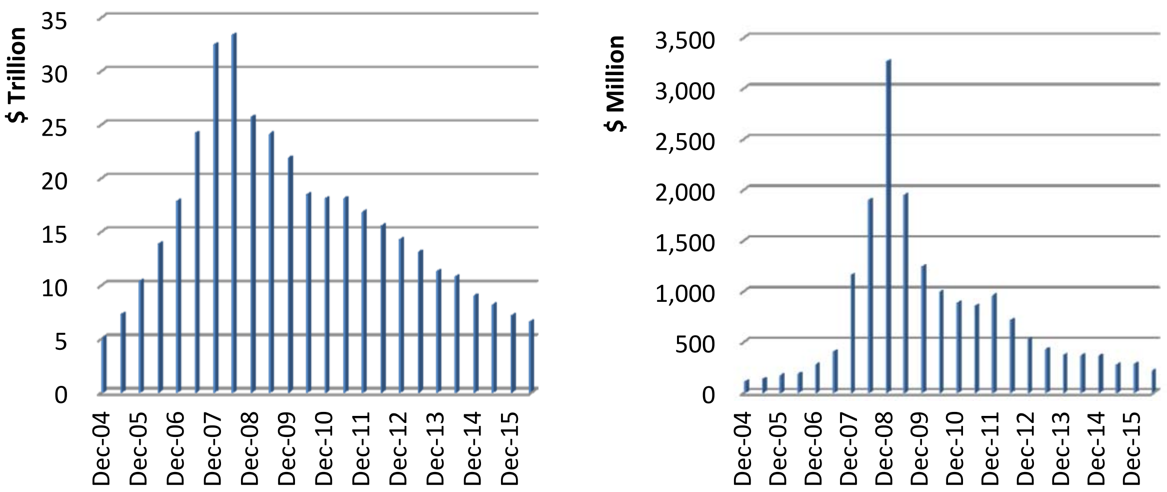
[214] See, e.g., Stulz (2010).

[215] Portfolio compression reduces the number and notional amounts of outstanding contracts without changing underlying economic exposure.

underlying. Single-name CDS activity in nonfinancials and in the A/BBB class appears to have experienced a large increase in global net notional in the first half of 2011, declining substantially afterwards. An increase in outstanding notional amounts seems to coincide with the timing of the proposal of rules implementing the Volcker Rule.

However, there are three other considerations that could also explain the observed changes in activity. First, single-name CDS are security-based swaps, and a number of rules implementing Title VII of the Dodd-Frank Act were proposed in 2011. These included rules defining security-based swaps subject to Title VII of the Dodd-Frank Act (June 1, 2011), business conduct standards for security-based swap dealers and major security-based swap participants (June 29, 2011), and rules governing the registration of security-based swap dealers and major security-based swap participants (October 12, 2011). Second, Qiu and Liu (2012) finds that CDS liquidity provision is concentrated around the investment grade / speculative grade cutoff, reflecting investors' hedging demand or dealers' risk of supplying liquidity, or both. Changes in the level of credit risk of non-financial and low investment grade issuers, a potential increase in risk appetite among market participants reaching for yield during low interest rate cycles, and a decrease in the demand for single-name CDS on certain underliers during market booms could all have contributed to the observed effects. Lastly, changes in gross notional amounts post-crisis documented in Figure 36 are driven, at least in part, by compression activity. Overall, it is difficult to attribute the findings to just one of the multiple drivers referenced above.

Figure 36. Volume of activity in single-name CDS

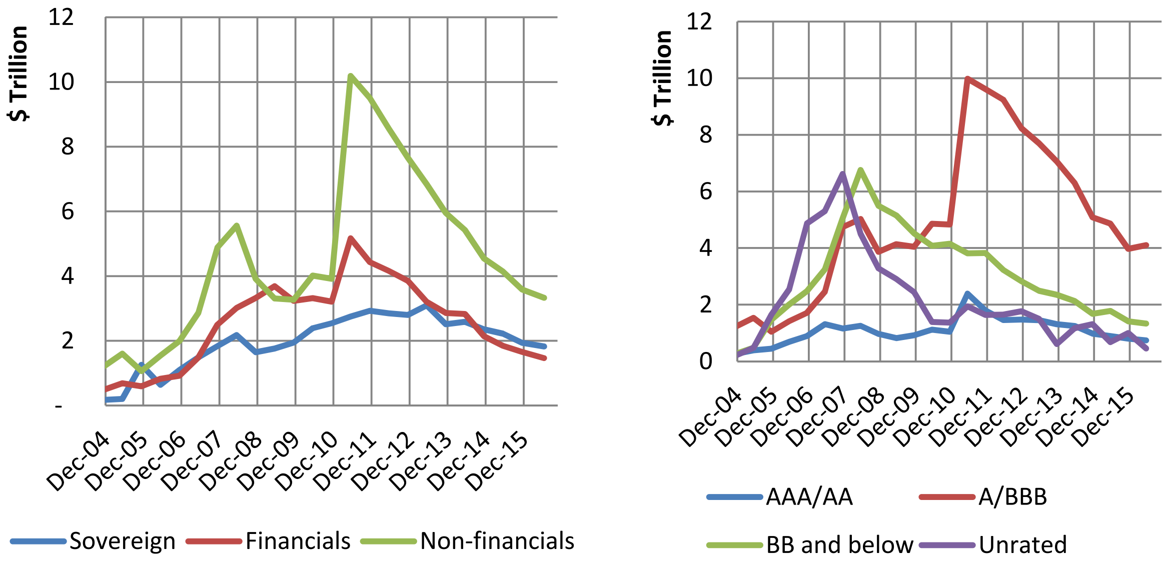


Notional outstanding

Gross market values

Source: DERA analysis. BIS data for "outstanding – notional amounts", and outstanding – gross market values."

Figure 37. Net notional amounts in single-name CDS by industry and credit



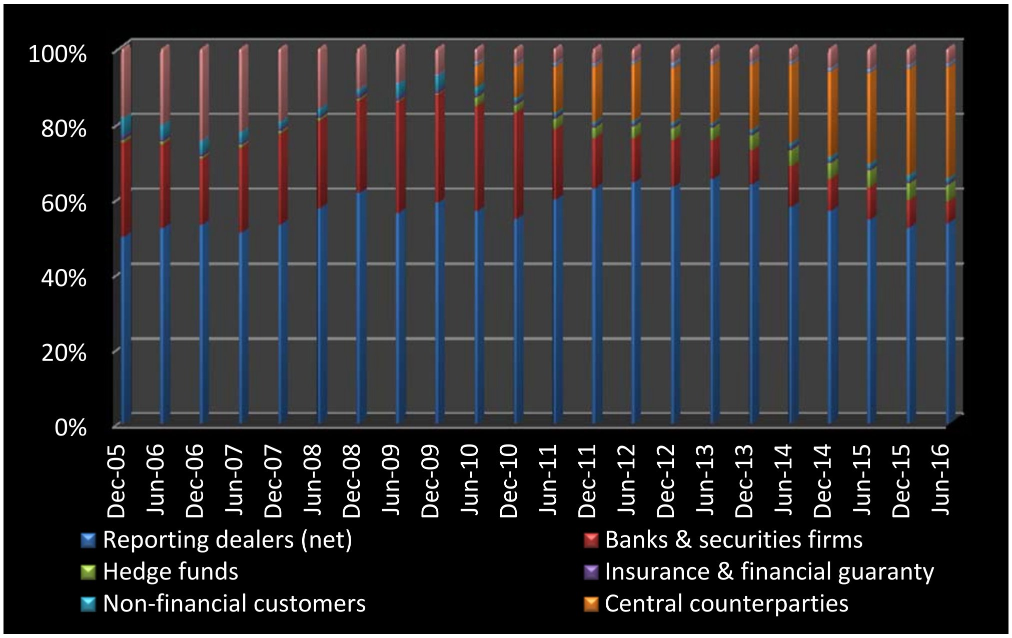
Underlier industry

Credit rating

Source: DERA analysis. BIS data for "outstanding – notional amounts, single-name CDS, all counterparties (net)."

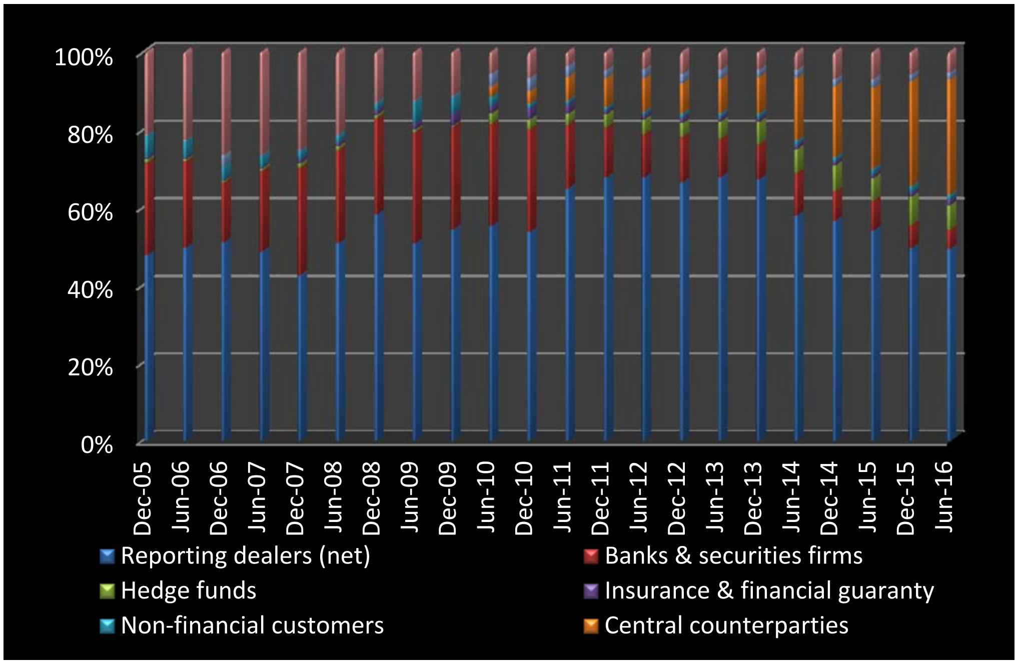
Next, we consider the role of various groups of market participants in the single-name CDS market. The Bank for International Settlements reports global notionals for reporting dealers (net), hedge funds, banks and securities firms, nonfinancial customers, insurance and financial guaranty, central counterparties (CCP), special purpose vehicles, companies and entities (SPV, SPC, and SPE, respectively), and other financial institutions. In Figures 38 and 39 we present notionals and gross market values of single-name CDS activity by reporting dealers (net), hedge funds, banks, insurance firms, and nonfinancial customers and other participants. We observe a decrease in the activity of banks and securities dealers, and an increase in the role of hedge funds and central counterparties in both global notionals and gross market values of single-name CDS. The relative importance of dealers has remained relatively stable over time, and dealers represented approximately half of all single-name CDS notional outstanding and market value as of mid-2016.

Figure 38. Outstanding notional by participant type



Source: DERA analysis. BIS data, available at http://stats.bis.org/statx/toc/DER.html.

Figure 39. Gross market value by participant type



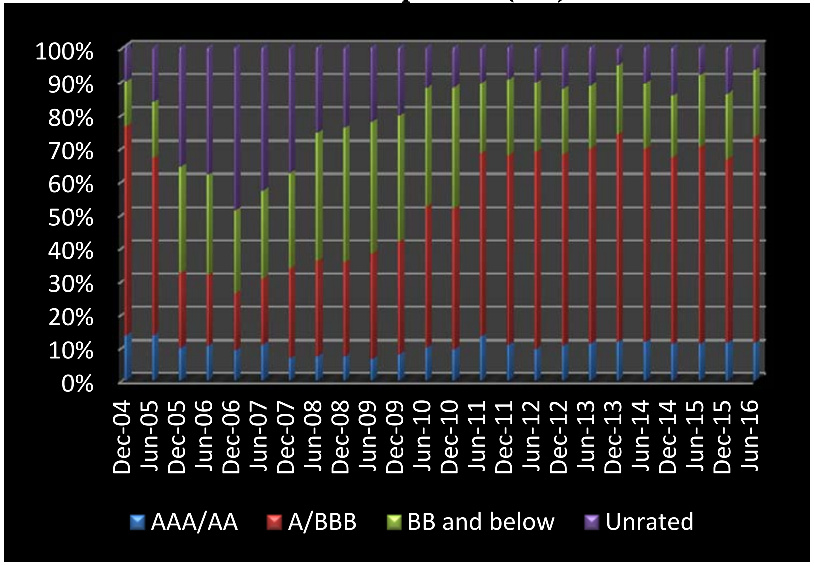
Source: DERA analysis. BIS data, available at http://stats.bis.org/statx/toc/DER.html.

Market participation of dealers, banks and securities firms, hedge funds, and others in single-name CDS varies notably across credit quality tiers and over time. Figure 40 reports single-name CDS notional by credit rating for all market participants, dealers, banks and securities firms, and hedge funds. First, the structure of market activity has changed over time. Approximately 75% of notional was concentrated in unrated and high yield underliers prior to the recent crisis, compared to about 25% in 2004. Meanwhile, approximately half of all notional was concentrated in medium–low investment grade categories of A and BBB in 2011 and onwards, a large increase from a nadir of 17% in 2006. Second, market participants vary widely in their activity across credit quality categories. Pre-crisis, a greater fraction of dealer exposure was concentrated in the CDS of unrated issuers (e.g., about 49% at the end of 2006). In recent years, dealers and banks and securities firms are primarily exposed to CDS on investment grade underliers. In addition, hedge funds accumulated larger exposures to CDS on AAA and AA underliers prior to the financial crisis (2006-2007), and shifted into high yield names (BB and below) in 2010. These observations are generally consistent with the interpretation that market participants with various levels of risk tolerance and informational advantages are transacting on credit risk of different underliers over time, and endogenously demand liquidity in single-name CDS on different groups of underliers at various points in time. We also recognize that time series patterns of compression activity may influence gross notionals.

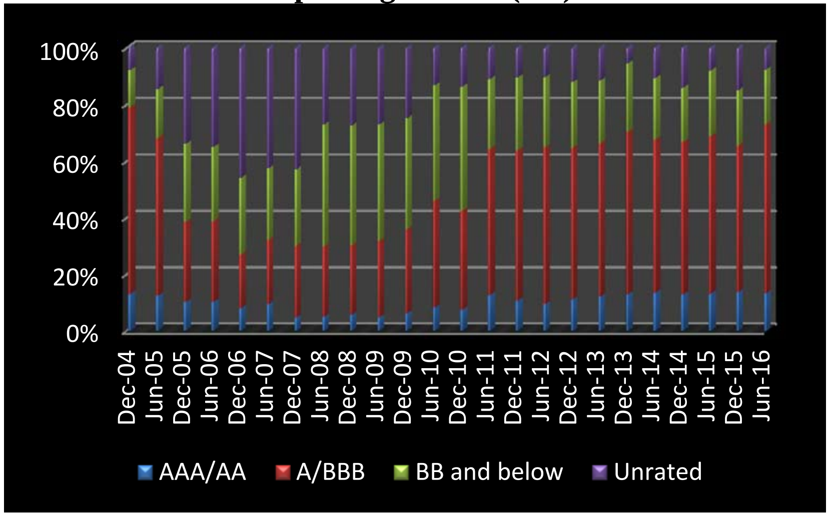
Single-name CDS are credit risk transfer instruments, the value of which depends on the expectations of market participants concerning the probability of a credit event and the recovery rate during the life of the CDS contract. As a result, the prices and volumes of activity in single-name CDS with varying tenors may reflect market expectations concerning the term structure of credit risk of a given underlier, as well as liquidity demand in certain maturities. Figure 41 reports single-name CDS notional outstanding by tenor for reporting dealers, banks and securities firms, and hedge funds. We observe a large decline in exposure in contracts with tenors of greater than 5 years and a corresponding increase in dealer and bank exposure in tenors of less than 1 year.

Figure 40. Single-name CDS notional outstanding by rating

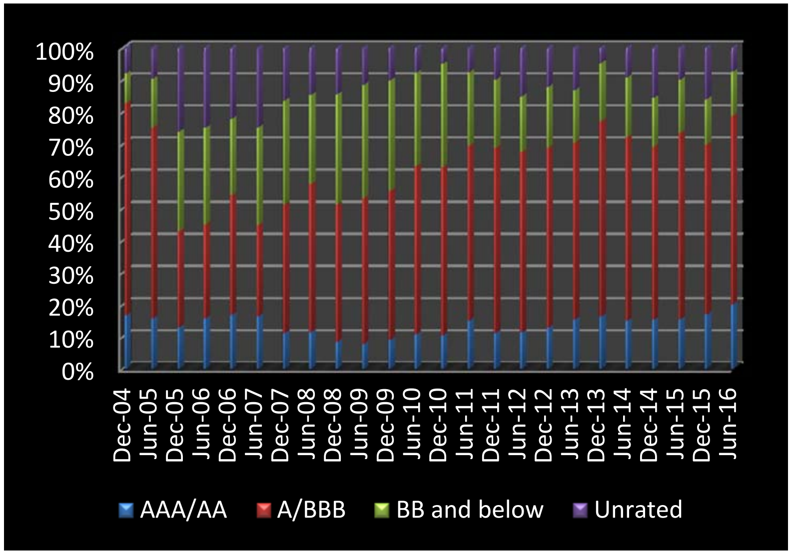
All counterparties (net)



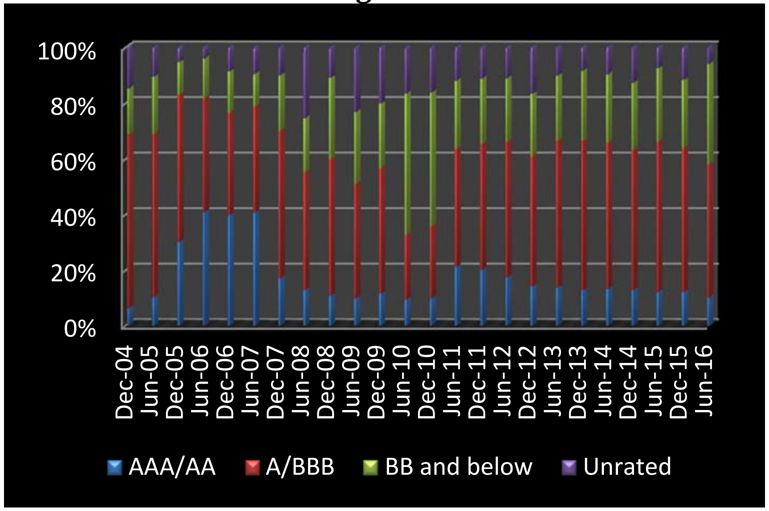
Reporting dealers (net)



Banks & securities firms



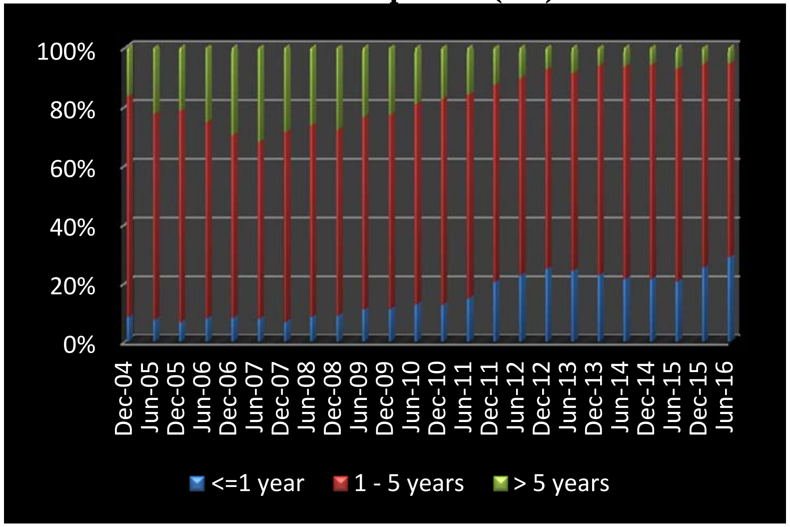
Hedge funds



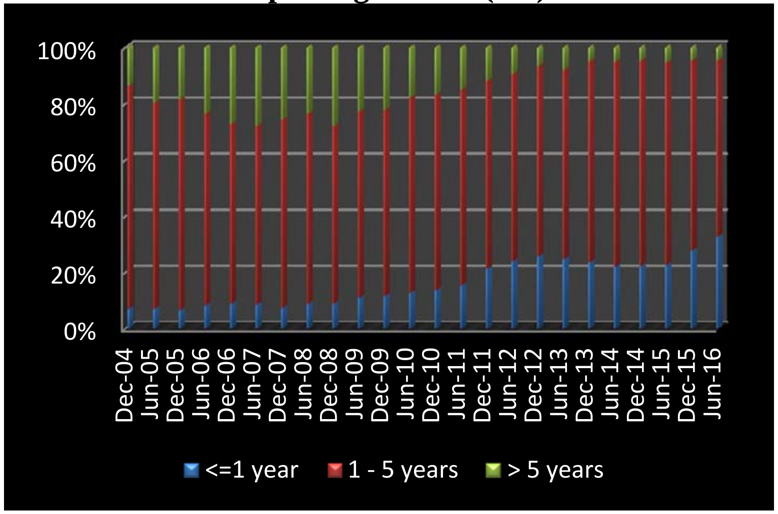
Source: DERA analysis. BIS data, available at http://stats.bis.org/statx/toc/DER.html

Figure 41. Single-name CDS notional outstanding by tenor[216]

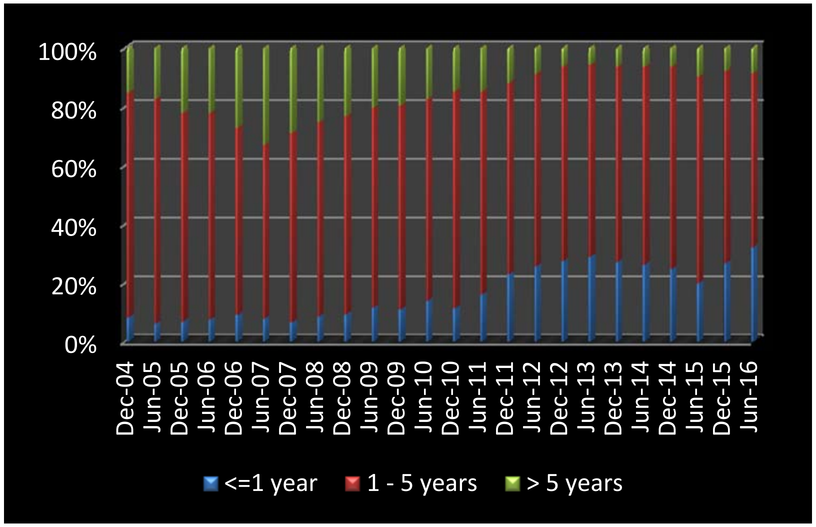
All counterparties (net)



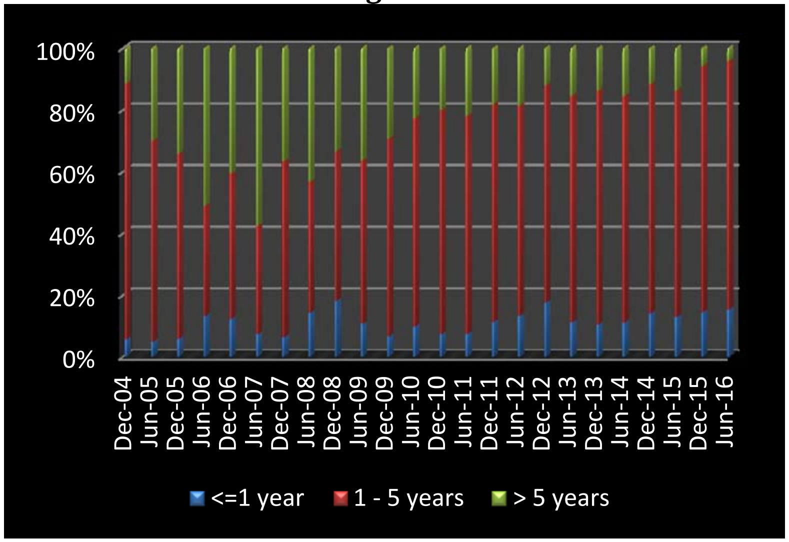
Reporting dealers (net)



Banks & securities firms



Hedge funds



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[216] Source: DERA analysis. BIS data, available at http://stats.bis.org/statx/toc/DER.html

2. Market Participants

The analysis above relies on BIS participant classifications and provides aggregated statistics on participant activity in single-name CDS. We now turn to the analysis of transaction-level data from DTCC-TIW. DTCC provides clearing, settlement, and other services for OTC derivatives. TIW was established in November 2006 as a centralized global repository for trade reporting and post-trade processing of OTC credit derivatives contracts. According to the DTCC, TIW data contain approximately 98% of all credit derivative transactions in the global marketplace. Our sample period spans from November 2006 to December 2016.[217]

In addition to dealers, thousands of other participants appear as counterparties to single-name CDS in our sample, and include, but are not limited to, investment companies, pension funds, private (hedge) funds, sovereign entities, and industrial companies. We use machine matching and hand classification of TIW accounts to categorize market participants.[218] We observe that most non-dealer users of security-based swaps do not engage directly in the trading of swaps, but trade through banks, investment advisers, or other types of firms acting as dealers or agents. Based on an analysis of the counterparties to trades reported to the TIW, our sample includes 1,957 entities that engaged directly in trading during the sample period. As shown in

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[217] We recognize certain time series limitations of TIW transaction data. While TIW coverage dates back to November 2006, the combined trade notional of those transactions is a fraction of the global notional reported in publicly reported semiannual BIS notional statistics. While we believe backfilled data for 2006 through 2007 may be indicative of pre-crisis activity in single-name CDS, we are cautious in our interpretation of reported statistics for the 2006-2008 period. We, therefore, consider evidence from TIW activity statistics in conjunction with BIS data.

[218] These 2,038 entities, which are presented in more detail in Table 27, below, include all DTCC-defined "firms" shown in TIW as transaction counterparties that report at least one transaction to TIW as of December 2016. The staff in the Division of Economic and Risk Analysis classified these firms, which are shown as transaction counterparties, by machine matching names to known third-party databases and by manual classification. *See,* e.g., Rel. No. 34-72472, *Application of "Security-Based Swap Dealer" and "Major Security-Based Swap Participant" Definitions to Cross-Border Security-Based Swap Activities* (Jun. 25, 2014) 79 FR 47277, n.139 (Cross-Border Adopting Release); id. at n.1304. Manual classification was based in part on searches of the EDGAR and Bloomberg databases, the SEC's Investment Adviser Public Disclosure database, and a firm's public website or the public website of the account represented by a firm. The staff also referred to ISDA protocol adherence letters available on the ISDA website.

Table 27, below, close to three-quarters of these entities (DTCC-defined "firms" shown in TIW, which we refer to here as "transacting agents") were identified as investment advisers, of which approximately 40 percent (about 31 percent of all transacting agents) were registered as investment advisers under the Investment Advisers Act of 1940.[219] Although investment advisers comprise the vast majority of transacting agents, the transactions they executed account for only 12.3 percent of all single-name CDS trading activity reported to the TIW, measured by number of transaction-sides (each transaction has two transaction sides, i.e., two transaction counterparties). The vast majority of transactions (83.8 percent) measured by number of transaction-sides were executed by International Swaps and Derivatives Association (ISDA)-recognized dealers.[220] Panel B reports changes in market participants over time. Similar to the results above, we find that banks excluding G16 dealers have reduced their participation in single-name CDS markets as measured by transaction share in the latter 3 years in the sample period.

3. Transaction Activity

We now turn to the evolution in the levels and structure of transaction activity of various market participants. Using TIW data, we consider the volume of price-forming transactions by dealers and nondealers, using Markit Red6 codes to identify unique underlier firms. We note that TIW serves as the gold record repository for CDS transactions. Because it includes both

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[219] *See* 15 U.S.C. 80b1–80b21. Transacting agents participate directly in the security-based swap market, without relying on an intermediary, on behalf of principals. For example, a university endowment may hold a position in a security-based swap that is established by an investment adviser that transacts on the endowment's behalf. In this case, the university endowment is a principal that uses the investment adviser as its transacting agent.

[220] For the purpose of this analysis, the ISDA-recognized dealers are those identified by ISDA as belonging to the G14 or G16 dealer group during the period: JP Morgan Chase NA (and Bear Stearns), Morgan Stanley, Bank of America NA (and Merrill Lynch), Goldman Sachs, Deutsche Bank AG, Barclays Capital, Citigroup, UBS, Credit Suisse AG, RBS Group, BNP Paribas, HSBC Bank, Lehman Brothers, Société Générale, Credit Agricole, Wells Fargo and Nomura. *See, e.g.*, 2010 ISDA Operations Benchmarking Survey, available at: http://www.isda.org/c_and_a/pdf/ISDA-Operations-Survey-2010.pdf.

transactions that do and do not affect participants' market risk positions, we apply a filter to include only "price-forming" transactions. Price-forming transactions include new trades between two counterparties, terminations of existing trades, and assignments to a third counterparty. These transactions provide information about the price of credit risk and so allow us to focus on single-name CDS market activity that results in the transfer of credit risk among participants by excluding trades that do not reflect changes in participants' exposure to credit risk. Specifically, for the purposes of this analysis and similar to Biswas et al. (2015) and Porter (2015), we exclude:[221]

(1) transactions caused by the reorganization of a participant;

(2) terminations and trades due to third-party compression and netting services;

(3) records reflecting clearing of pre-existing bilateral trades;

(4) trades between two affiliated entities;

(5) duplicate reporting of trades conducted by prime brokers on behalf of their clients;

(6) assignments that do not affect the pricing terms, and

(7) post-Big Bang[222] trades with standardized coupons, but no upfront payments.

Figure 42 Panel A reports transaction activity as measured by combined trade sizes of all price-forming transactions by year and participant group, and accounts are identified by their firm identifier and matched against the ISDA 16 dealer group. "Other" represents transactions among firm accounts that are not identified as dealers, therefore reflecting customer – customer

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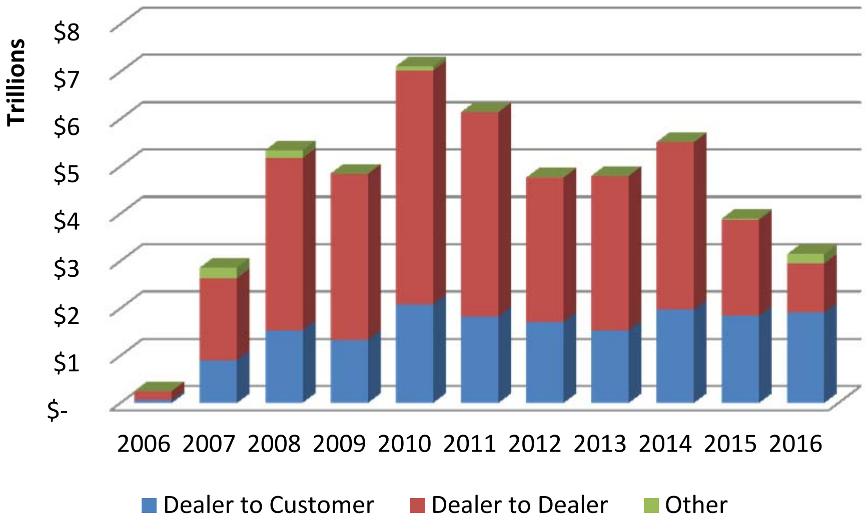
[221] For 2015, the filter considers 31% (or 771,718 transactions) of transactions in the TIW to be price-forming ones. This is almost 19% (or $3.90 trillion) of the total trade size for 2015.

[222] The "CDS Big Bang" refers to global and North American changes to CDS contracts and quoting conventions that occurred on April 8, 2009. Global contract changes included changes to the effective dates for all CDS contracts, determination committees of credit and succession events and auction terms, and hardwiring of the auction mechanism for CDS following credit events. Additional changes to North American CDS included a move to trading with a fixed coupon. *See* Markit, *The CDS Big Bang* (Spring 2009), *at* https://www.markit.com/assets/en/docs/markit-magazine/issue-4/60-cds-big-bang.pdf.

transaction activity in single-name CDS. Figure 42 Panel B repeats the analysis, tabulating transaction activity by month. We observe a large spike in interdealer activity (measured based on price-forming transactions) immediately prior to the financial crisis, and a dramatic decline in interdealer single-name CDS transaction volume after 2008, while at the same time, dealer-customer activity remained stable.[223] This may suggest that dealers are less able to find liquidity to offload positions in the interdealer market. Alternatively, efficiencies in the search for counterparties may have shortened dealer intermediation chains, with fewer interdealer trades necessary to connect natural customer buys to customer sells. We note that dealers continue to play a central role in intermediating customer transactions in single-name CDS, and direct transaction activity among customers remains a negligible part of the market.

Figure 42. Trade volume

Panel A. Annual



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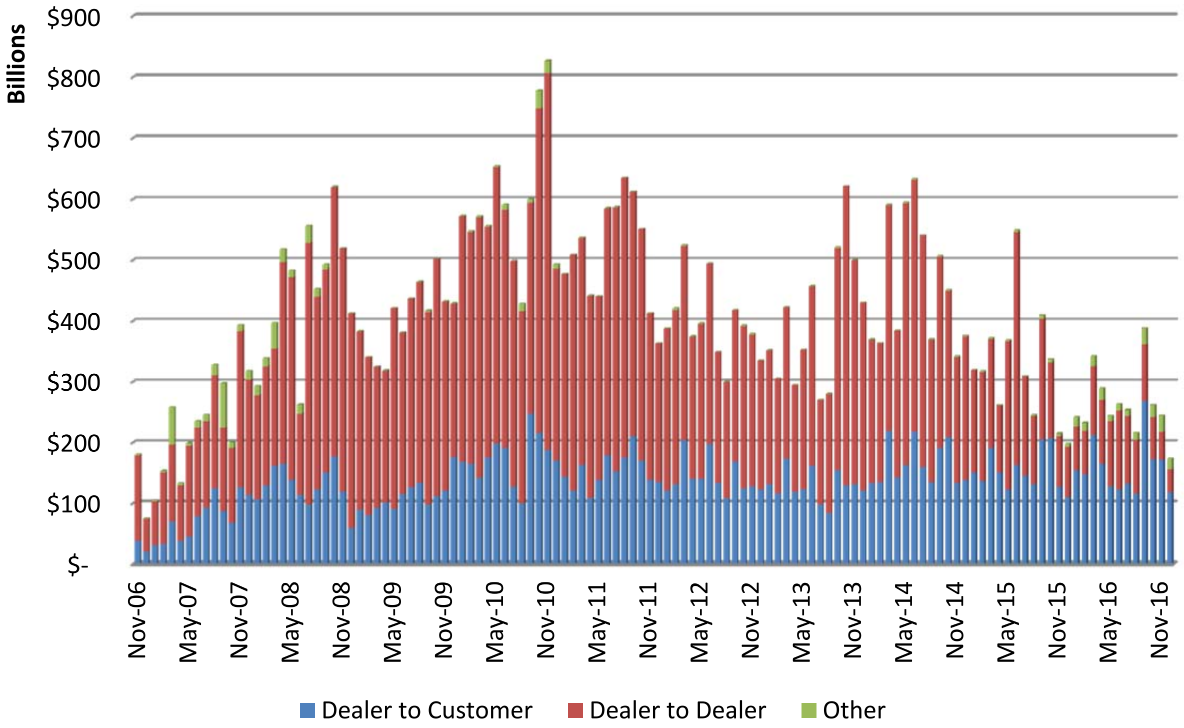
[223] We note that the decline in interdealer activity in 2016 was largely explained by an accompanying increase in the volume of cleared trades, which is classified as "other" in Figure 42.

Panel B. Monthly

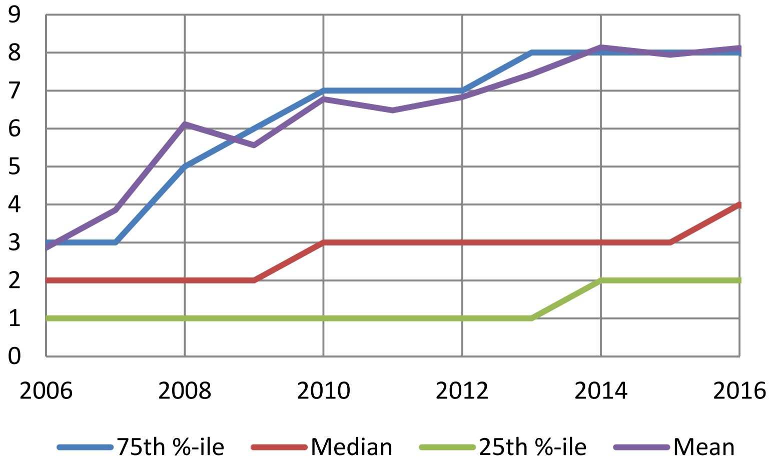


Source: DERA analysis.

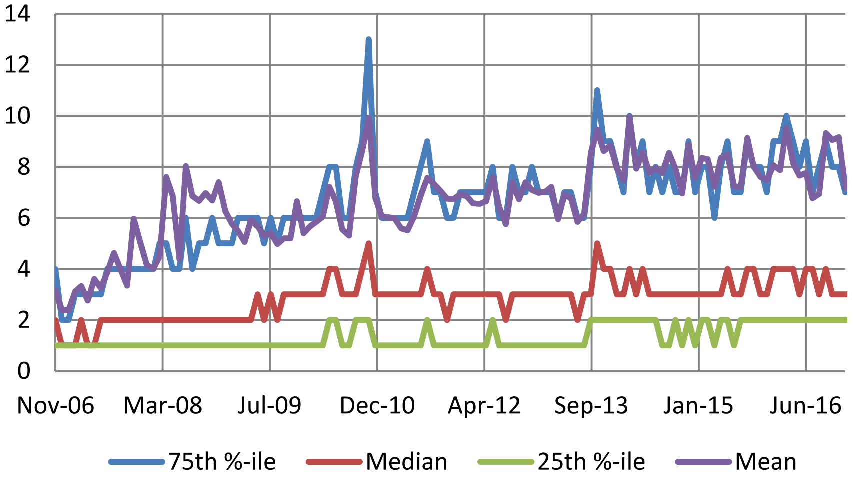
The fraction of zero trading days (i.e., the number of days with no trading as a fraction of all available trading days) is another measure of trading activity. While it does not differentiate between liquidity supply and liquidity demand explanations, the fraction of zero trading days may capture the relative illiquidity of a particular single-name CDS in the sense that a more (less) illiquid single-name CDS trades less (more) often and thus has a higher (lower) fraction of zero trading days. In Figure 43, we show the number of days with at least one transaction in a given underlier per year and per month, reporting the evolution of the median, mean, top and bottom quartiles of the measure over time.

Figure 43. Nonzero trading days

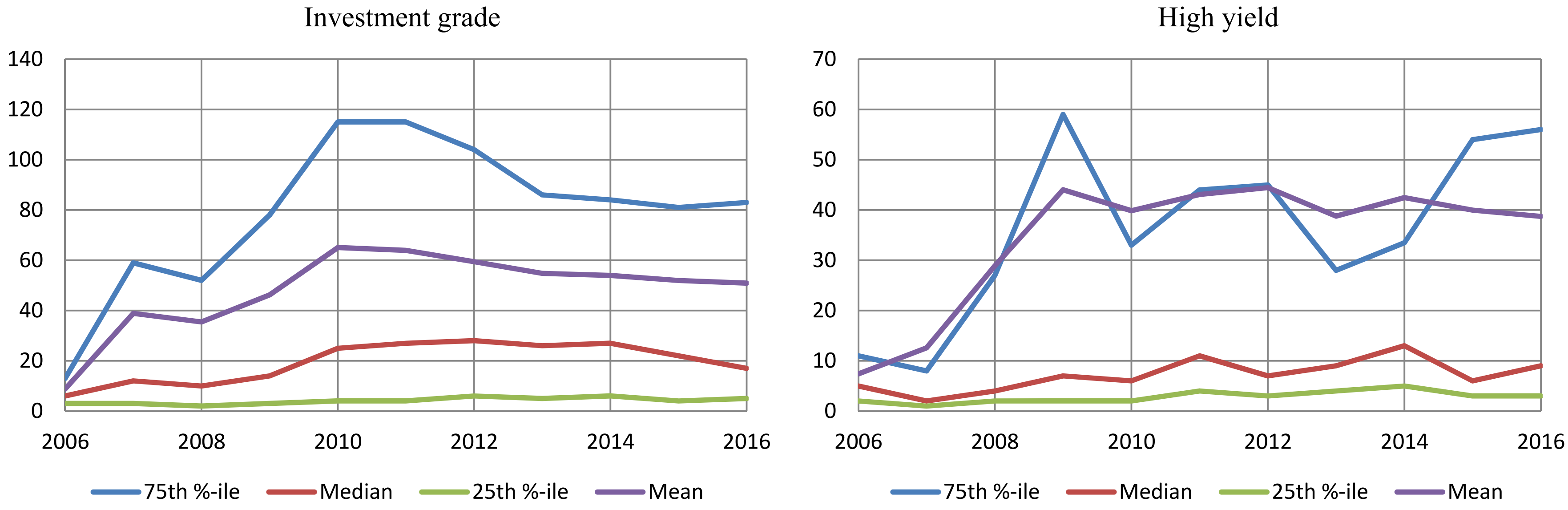
Panel A. Annual



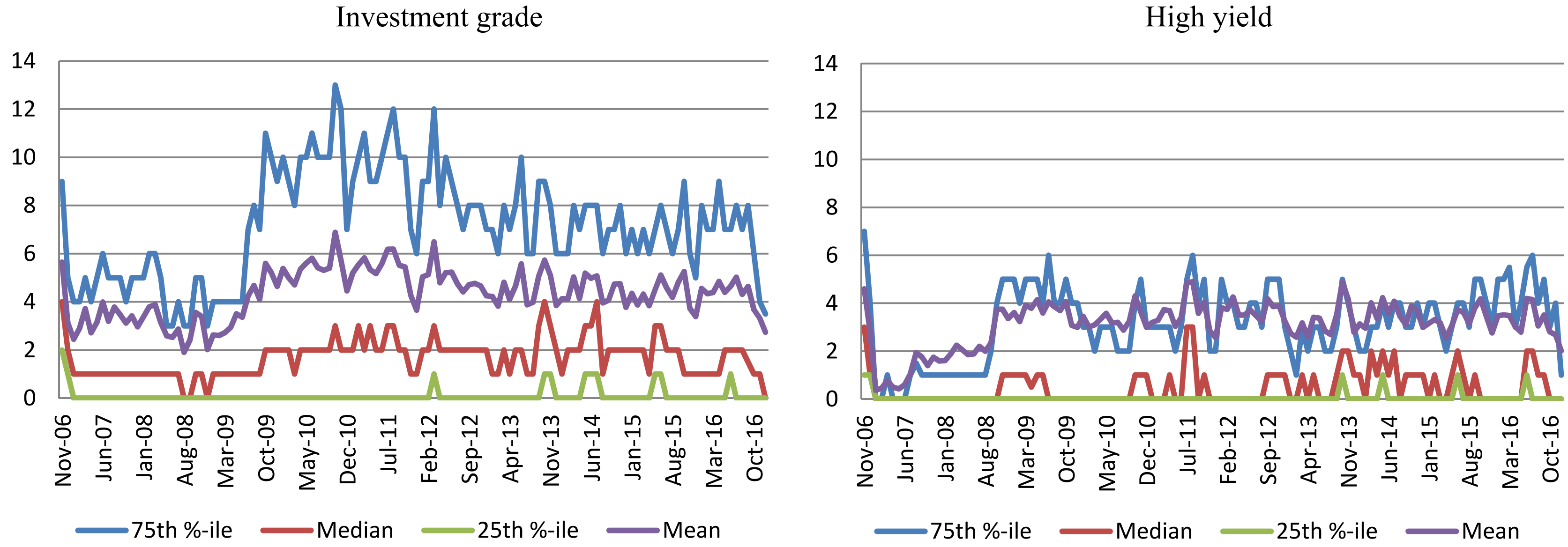
Panel B. Monthly



Panel C. Annual, by credit



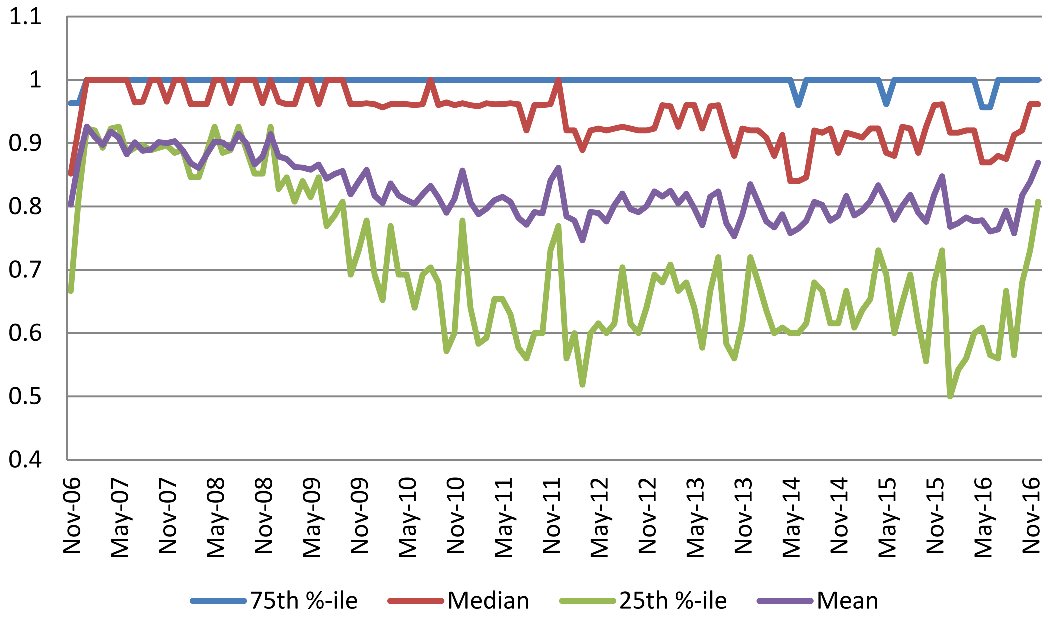
Panel D. Monthly, by credit



Source: DERA analysis.

In Figure 44, we estimate the fraction of days per month that a given underlier does not trade, and report the distribution of that measure. We note two key patterns in the data. First, single-name CDS are generally inactively traded instruments. For instance, the median single-name CDS had between 8 and 32 nonzero trading days per year during our sample period and did not have a single trade between 80- 90% of the time in monthly data. Second, the more actively traded quartile of single-name CDS experienced a large increase in transaction activity through 2012 and remained flat afterwards. Breaking down by underlying bond, we observe a slight decline in the measure of trading activity for the more liquid names in the investment grade category and some increase in activity in the right tail of the high yield distribution in the last few years in our sample. At the same time, the least actively traded quartile is illiquid and remains so in the post-reform period across credit categories.

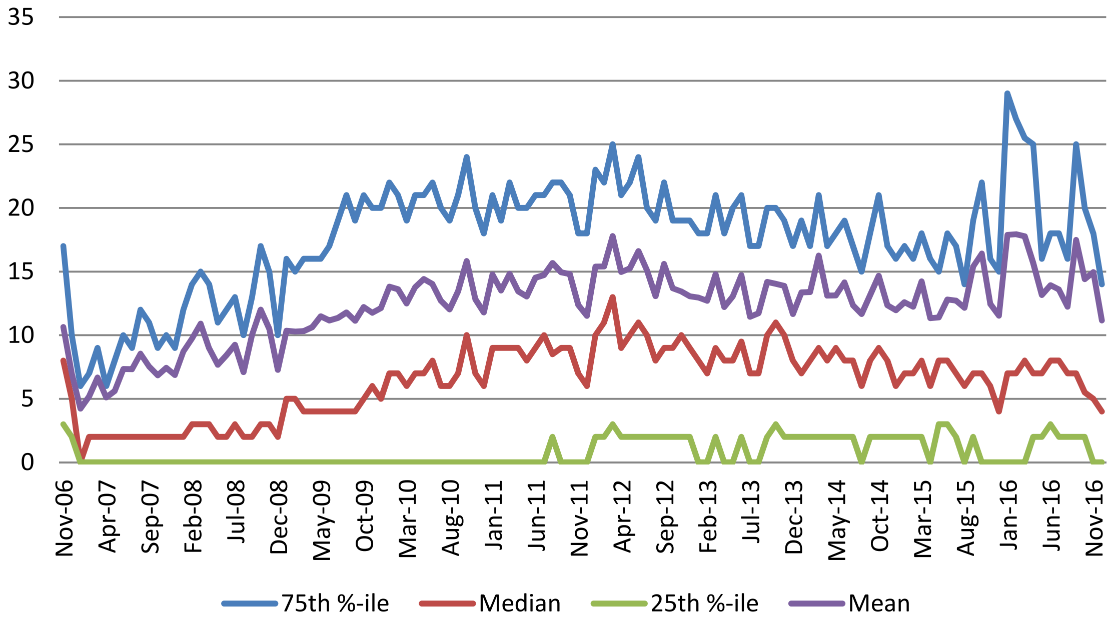
Figure 44. Fraction of zero trading days per month



Source: DERA analysis.

Figure 45 reports the number of accounts transacting in a given underlier for underliers with different levels of trading activity. Similar to our prior findings, the median underlier is traded by between 0 and 6 accounts, whereas the top quartile of the measure ranges between 10 and 18 during the post-crisis period. Importantly, we do not observe notable changes in the number of market participants transacting in various underliers in TIW data after the passage of the Dodd-Frank Act.

Figure 45. Accounts trading per underlier

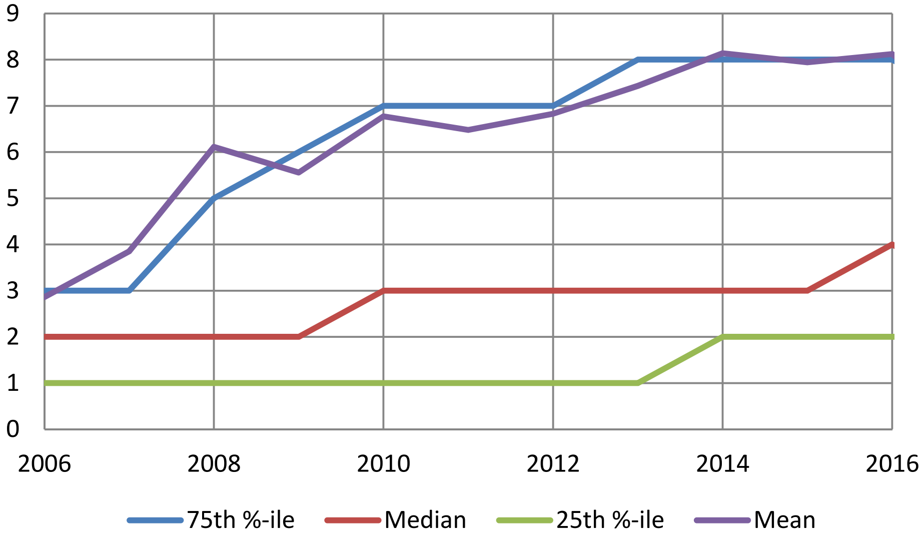


Source: DERA analysis.

In Figure 46, we plot the average number of price-forming trades on a given day for traded underliers. While the overall magnitude of the figure remains relatively low and driven by the more actively traded underliers, we observe a spike in this measure of trading activity during the financial crisis, after the passage of the Dodd-Frank Act (end of 2010) and some increase in this measure in the last 3 years of our sample period (2013 through 2015).

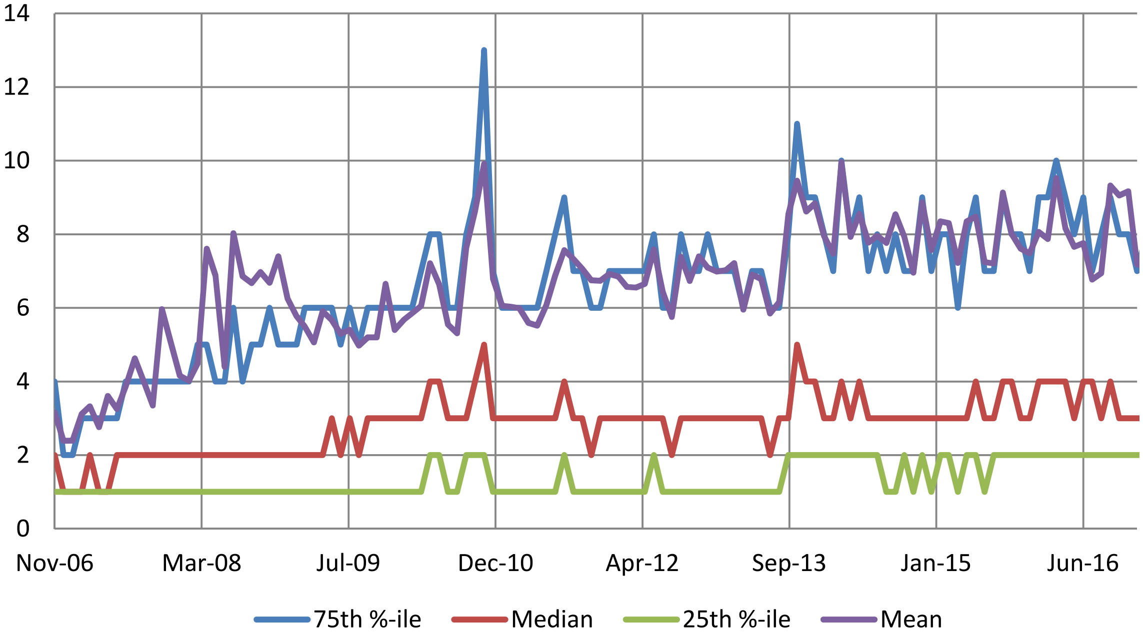
Figure 46. Number of trades per day

Panel A. Annual



Source: DERA analysis.

Panel B. Monthly

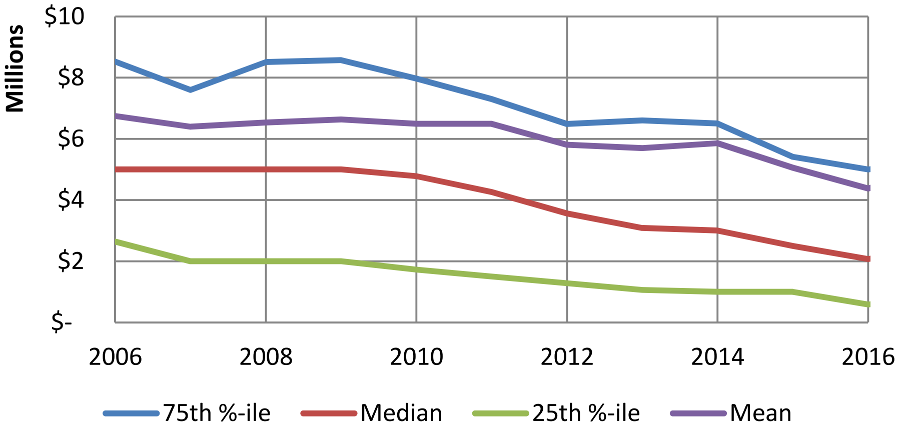


Source: DERA analysis.

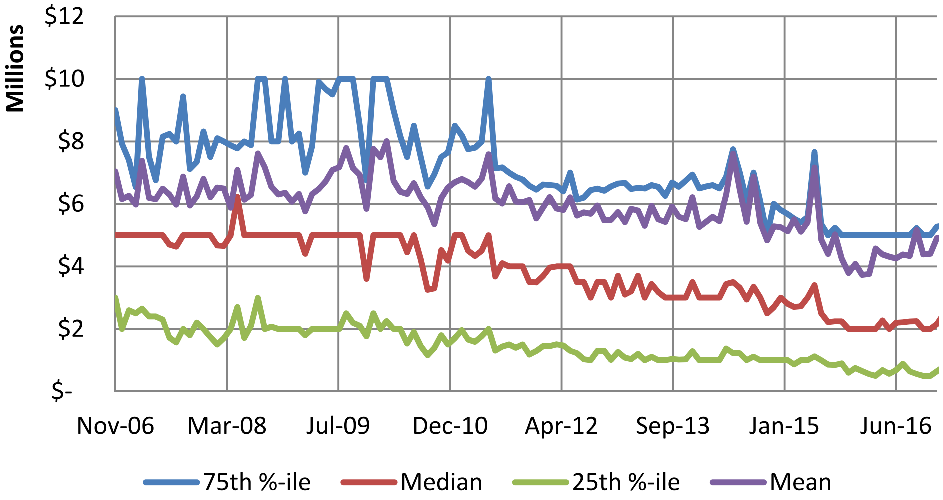
Finally, in Figure 47 we analyze average transaction sizes for traded underliers, aggregated to annual and monthly frequencies and broken down into dealer-to-dealer and dealer-to-customer trades. We observe that trade sizes have declined over time, with median interdealer trade size beginning to decline after 2010, but median dealer-to-customer trade sizes beginning to decline after the onset of the financial crisis in 2008. A decrease in transaction size may point to a decrease in liquidity of larger trades, as participants become less able to transact large blocks without significant price impact and choose to split block trades into multiple trades. A less active single-name CDS market with a large number of counterparties, few trades, and less demand for liquidity in short credit quality products is also consistent with economic booms. Crucially, the timing of the declines in dealer-customer trade sizes may suggest that changing risk tolerances around the financial crisis served as a contributing factor.

Figure 47. Trade size, price forming transactions

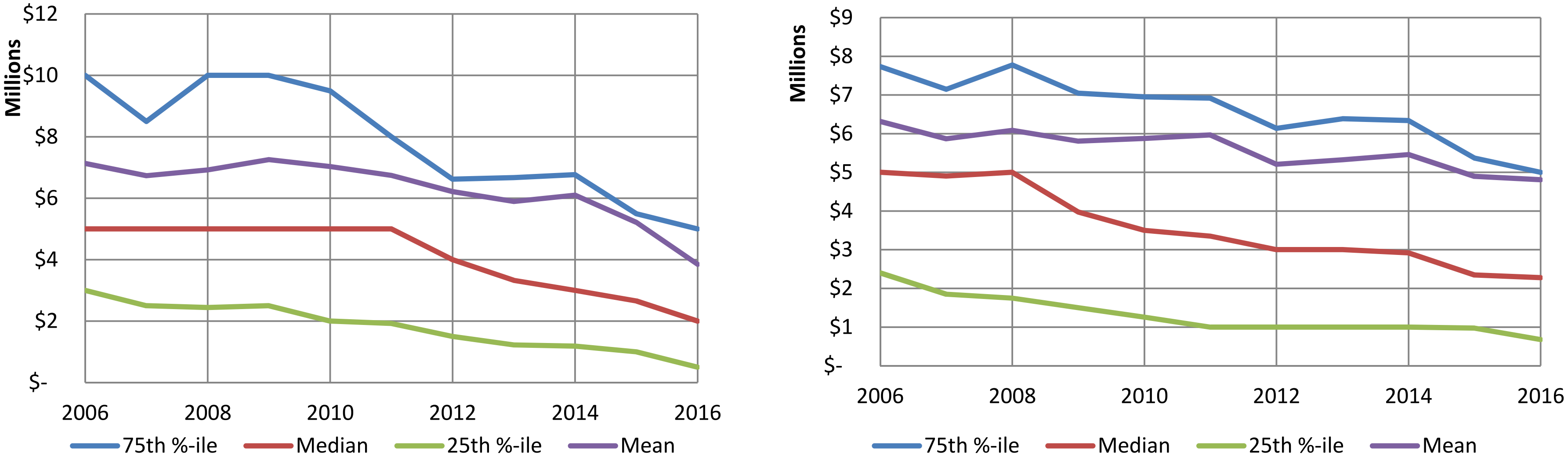
Panel A. Annual



Panel B. Monthly



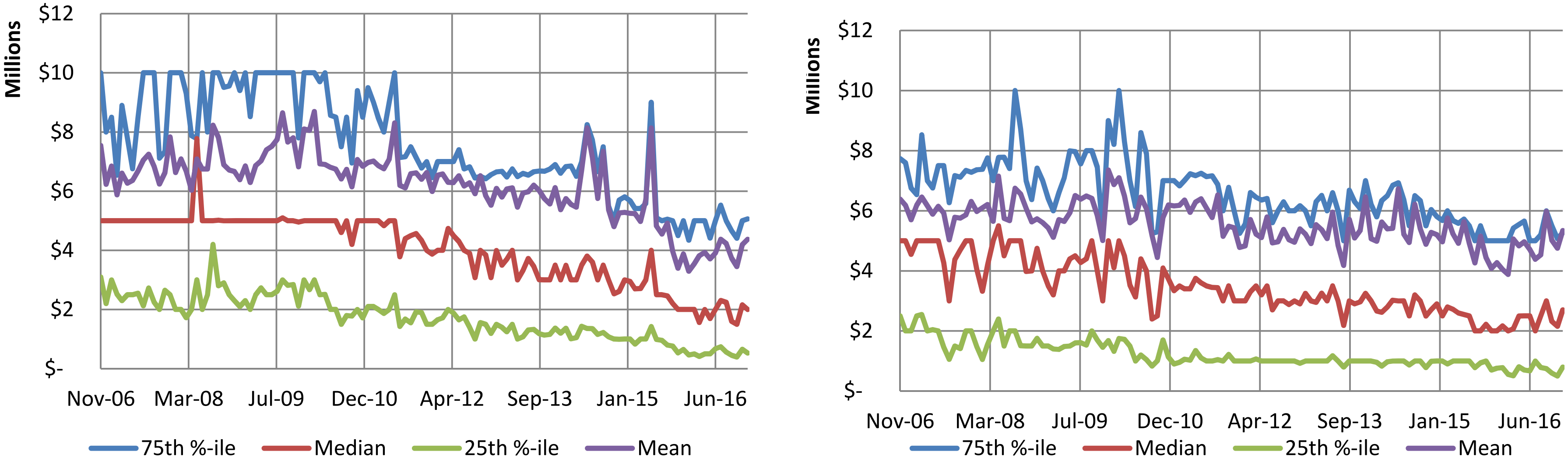
Panel C. Annual, by type



Dealer to dealer

Dealer to customer

Panel D. Monthly, by type



Dealer to dealer

Dealer to customer

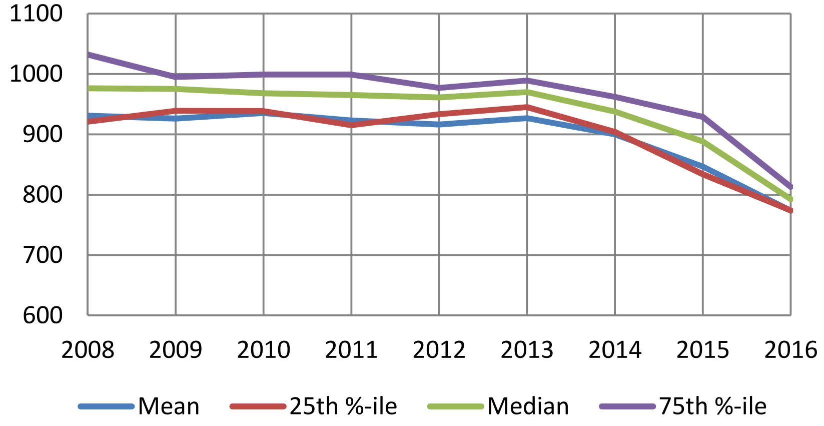
Source: DERA analysis.

4. Quotes and Quoted Spreads

Finally, we complement the analysis of trade-based measures with intraday quote data from ICE Data Services CMA (CMA) for January 1, 2008, through September 29, 2016. Dealers play a central role in liquidity provision and the number of quotes may be correlated with trading volume and dealer willingness to provide liquidity.[224] We note that quote-based metrics could also reflect liquidity demand.

We consider the overall volume of quotation activity in single-name CDS both at the market and underlier level. Figure 48 and Table 28 present the number of quoted underliers and quotes per underlier on a given trading day through the time series. We note a gradual decline in the measure in 2013 onwards. As shown in Table 28, over the course of the period, the median number of quoted underliers decreased from 976 in 2008 to 888 in 2015.

Figure 48. Daily quoted underliers



Source: DERA analysis.

Figure 49 and Panels B and C of Table 28 report the evolution in daily quotes for each underlier by credit quality and by tenor. Not surprisingly, single-name CDS on high yield underliers have more quote activity – higher default rates among riskier names may give rise to

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[224] Qiu and Yu (2012) also use the number of quote provider as a measure for the proxy of the CDS market.

greater credit risk hedging and more active re-pricing. Interestingly, investment grade quote activity has been steadily decreasing since 2010, whereas daily quotes per underlier on high yield names peak in 2012. Since the Dodd-Frank and Basel reforms discussed above could have impacted single-name CDS in both investment grade and high yield underliers, these data could point to demand driven explanations of changes in CDS quote activity. For instance, the current environment of low interest rates and default rates might have reduced the demand for CDS instruments. In addition, although the single-name CDS activities seemed to have declined since 2008 in terms of the metrics on quotes, the 2016 figure is not substantially lower than that in 2008, the peak of the crisis.

Next, we group quotes by tenor and report the median number of quotes per underlier per day for a tenor of less than 5 years, 5 years, and longer than 5 years. We note that quotes on CDS with standard 5-year tenors have been on the decline since 2010; however, quotes on shorter term tenors have more than doubled between 2010 and 2014. Since differences in prices across tenors of single-name CDS contracts reflect market expectations about the term structure of default risk of underliers, changes in quote activity across various tenors may reflect fundamental macroeconomic shifts in credit risk. At the same time, a shift towards voluntary clearing and accompanying standardization of single-name CDS contracts predicts greater concentration of activity in standardized tenors.

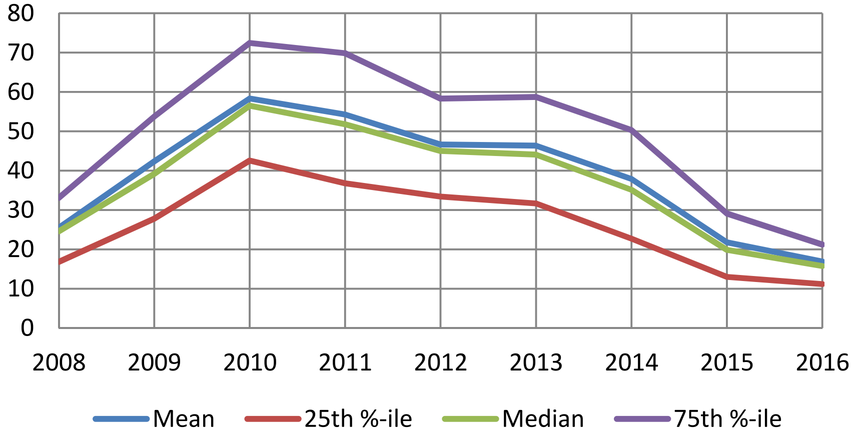
Relative quoted spreads also may be indicative of liquidity in single-name CDS. In Figure 50, we plot the end-of-day relative quoted spreads by credit and tenor. For the purposes of this analysis, we define relative quoted spread as the end of day quoted bid-ask spread scaled by the quote midpoint, and determine credit quality based on the size of the standardized coupon of a given instrument. Our findings are threefold. First, median quoted spreads for investment grade as well as liquid high yield underliers rose between 2011 and 2014 and have remained flat since. Second, quoted spreads for the most illiquid high yield underliers have increased substantially since 2013. Third, the widening of quoted spreads is heavily concentrated in CDS with short tenors, with the most illiquid single-name CDS with tenors under 5 years experiencing an almost threefold increase in the spread since 2013.

The source of these observed changes is unclear. As discussed earlier and shown in Appendix A of this report, a number of significant regulatory changes have, indeed, occurred in 2013: the beginning of the Basel III phase-in, the adoption of the final Basel III rule by the FRB, the OCC, and the FDIC, and the adoption of the final Volcker rules. However, our evidence indicates the widening of the quoted spreads in 2013 was concentrated primarily in the most illiquid high yield single names and in short tenors, which may point to greater uncertainty about short-term credit risk of a subset of the underlying single names.

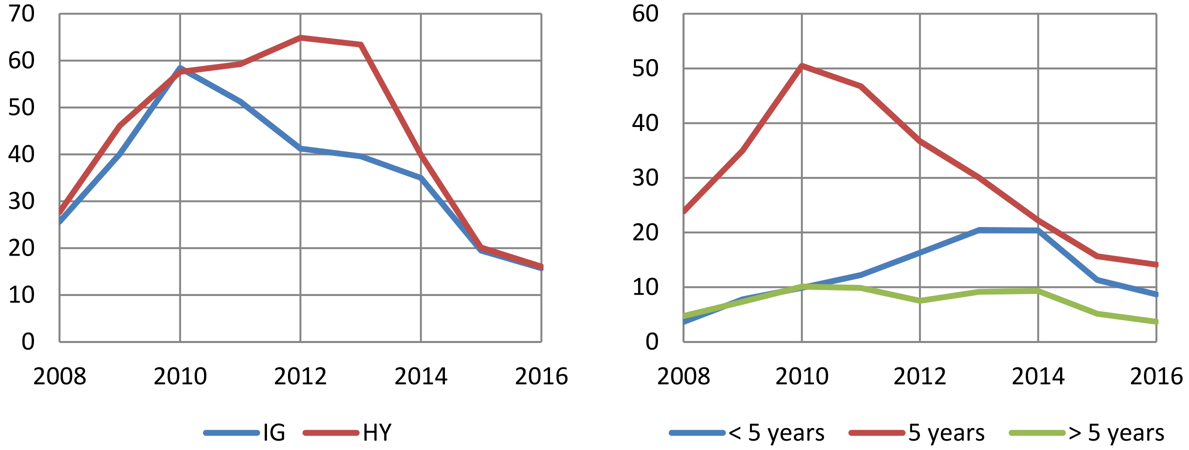
While existing studies use indicative quoted spreads to capture CDS transaction costs and to capture liquidity (e.g., Acharya and Johnson (2007)), we recognize that the midpoint may not accurately reflect the true price and that effective spreads may be a more precise measure of transaction costs. Biswas et al. (2015) find that indicative quoted spreads are, on average, twice as large as effective spreads and that quoted spreads explain cross-sectional variation in effective spreads primarily for trades between dealers and customers on North American investment grade bonds. The paper estimates individual round-trip transaction costs (effective half-spreads) of 14 bps notional for dealer-customer trades in a sample of 851 single-name CDS during 2009-2014, and 12 bps for interdealer trades in the same sample, with wider effective spreads for more actively traded contracts and contracts with higher valuation uncertainty.

Figure 49. Daily quotes per underlier

Panel A. All Quotes



Panel B. By credit quality and tenor (at the median)



Source: DERA analysis.

Figure 50. Quoted spreads scaled by midpoint

All

Investment grade

High yield

< 5 years

5 years

> 5 years

Source: DERA analysis.

E. Summary

Our examination of various metrics on CDS market liquidity has yielded mixed results. While outstanding notionals have decreased relative to pre-crisis years, gross market values of CDS outstanding remain generally comparable with pre-crisis levels, consistent with underlying economic exposure in CDS remaining comparable with pre-crisis levels. Dealers continue to play a critical role in the single-name CDS market, and the decrease in positions of banks and securities firms after the crisis has been accompanied by continued hedge fund participation and a rise in clearing activity. While interdealer trade activity has declined after 2010, dealer-customer activity has remained stable. This is consistent with alternative explanations that are not mutually exclusive: (1) a reduced ability by dealers to find CDS liquidity on the interdealer market, and (2) greater efficiency in dealer intermediation chains matching CDS buyers to CDS sellers. We have also shown that the number of participants transacting in a given underlier has remained relatively flat, the fraction of zero trading days has decreased, and the frequency of trading for active underliers has remained flat or elevated after the financial crisis and reforms that followed. These observations suggest that liquidity in this market has remained stable or improved. At the same time, however, we have also shown that trade sizes have decreased somewhat, quoting activity has declined, and quoted spreads for the least liquid high yield underliers have risen, supportive of a conclusion that liquidity in at least some portions of this market has deteriorated.

In conclusion, we have considered a large body of rigorous academic research and have presented a multifaceted data analysis on the evolution of trading activity and liquidity in single-name CDS. The evidence on aggregate trends in market activity and liquidity is mixed, and, in light of the methodological challenges discussed above, it is difficult to disentangle causal impacts. Crucially, changes in both liquidity supply and liquidity demand may be driving observed trends, and other factors, such as macroeconomic conditions, resolution of uncertainty concerning systematic and idiosyncratic credit risk, and policy interventions coinciding with and unrelated to Dodd Frank, including Volcker, and Basel III, may have impacted CDS activity in various underliers. As discussed above, it is unclear that the crisis period, and the corresponding rise in default risk and uncertainty, is an appropriate benchmark period for trading activity in short credit risk instruments, and the trend analysis is sensitive to the choice of the benchmark period.

F. Tables on Single-name CDS

Table 27. The number of transacting agents by counterparty type and the fraction of total trading activity, from November 2006 through December 2016, represented by each counterparty type.[225]

Panel A. 2006-2016

Transacting Agents	I	II	III
Investment Advisers	1,571	77.1%	12.3%
- SEC registered	629	30.9%	8.2%
Banks	256	12.6%	3.5%
Pension Funds	29	1.4%	0.1%
Insurance Companies	42	2.1%	0.2%
ISDA-Recognized Dealers[226]	17	0.8%	83.8%
Other	123	6.0%	0.2%
Total	2,038	100.0%	100%

I – number of participants, II – percent of participants, III – transaction share

Panel B. By time period

	2006-2009			2010-2012			2013-2016		
Transacting Agents	I	II	III	I	II	III	I	II	III
Investment Advisers	899	*76.1%*	11.1%	1067	*74.3%*	13.0%	1055	*78.2%*	13.2%
- SEC registered	*363*	*30.7%*	*6.6%*	*447*	*31.1%*	*9.2%*	*457*	*33.9%*	*9.6%*
Banks (excluding G16)	178	*15.1%*	4.3%	219	*15.2%*	4.8%	168	*12.4%*	1.0%
Pension Funds	20	*1.7%*	0.1%	22	*1.5%*	0.1%	19	*1.4%*	0.2%
Insurance Companies	20	*1.7%*	0.4%	29	*2.0%*	0.1%	28	*2.1%*	0.0%
ISDA - Recognized Dealer	17	*1.4%*	83.9%	16	*1.1%*	81.8%	17	*1.3%*	85.4%
Other	46	*3.9%*	0.2%	83	*5.8%*	0.1%	63	*4.7%*	0.1%
Total	1,181	*100.0%*	100.0%	1,437	*100.0%*	100.0%	1,350	*100.0%*	100.0%

I – number of participants, II – percent of participants, III – transaction share

Source: DERA analysis.

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[225] The figures in this table exclude clearing counterparties.

[226] For the purpose of this analysis, the ISDA-recognized dealers are those identified by ISDA as belonging to the G14 or G16 dealer group during the period: JP Morgan Chase NA (and Bear Stearns), Morgan Stanley, Bank of America NA (and Merrill Lynch), Goldman Sachs, Deutsche Bank AG, Barclays Capital, Citigroup, UBS, Credit Suisse AG, RBS Group, BNP Paribas, HSBC Bank, Lehman Brothers, Société Générale, Credit Agricole, Wells Fargo and Nomura. *See, e.g.*, 2010 ISDA Operations Survey, available at: http://www.isda.org/c_and_a/pdf/ISDA-Operations-Survey-2010.pdf.

Table 28. Daily quotes

Panel A. Quoted underliers

Year	Mean	25th %-ile	50th %-ile	75th %-ile
2008	931	921	976	1032
2009	926	939	975	995
2010	935	939	968	999
2011	923	915	965	999
2012	916	934	961	977
2013	927	945	970	989
2014	900	904	938	962
2015	847	834	888	929
2016	773	774	793	813

Panel B. Quotes per underlier

Year	Mean	25th %-ile	50th %-ile	75th %-ile
2008	25	17	25	33
2009	42	28	39	54
2010	58	43	57	72
2011	54	37	52	70
2012	47	33	45	58
2013	46	32	44	59
2014	38	23	35	50
2015	22	13	20	29
2016	17	11	16	21

Panel C. Quotes per underlier: by credit quality

	Investment grade				High yield			
Year	Mean	25th %-ile	50th %-ile	75th %-ile	Mean	25th %-ile	50th %-ile	75th %-ile
2008	26	18	26	34	29	17	28	40
2009	43	29	40	54	51	31	46	66
2010	60	45	58	73	62	41	58	79
2011	53	38	51	67	65	38	59	86
2012	42	31	41	52	69	46	65	88
2013	41	29	40	52	68	45	63	87
2014	37	22	35	50	44	26	40	57
2015	21	13	19	28	23	13	20	31
2016	17	11	16	21	18	10	16	23

Panel D. Quotes per underlier: by tenor

	< 5 years			5 years			> 5 years		
Year	25th %-ile	50th %-ile	75th %-ile	25th %-ile	50th %-ile	75th %-ile	25th %-ile	50th %-ile	75th %-ile
2008	2	4	6	16	24	32	3	5	8
2009	4	8	14	26	35	47	4	7	13
2010	5	10	19	39	50	62	5	10	18
2011	6	12	22	34	47	59	5	10	17
2012	10	16	25	28	37	46	5	8	12
2013	12	20	32	23	30	38	5	9	14
2014	12	20	30	16	22	29	5	9	14
2015	6	11	17	11	16	21	3	5	8
2016	5	9	13	10	14	18	2	4	5

Source: DERA analysis.

Table 29. Relative quoted spreads (quoted spread scaled by the midpoint)

Panel A. Quoted spreads

Year	Mean	25th %-ile	50th %-ile	75th %-ile
2008	13%	10%	12%	15%
2009	13%	10%	13%	16%
2010	11%	9%	10%	12%
2011	11%	8%	10%	12%
2012	15%	11%	13%	17%
2013	19%	14%	18%	22%
2014	22%	15%	19%	25%
2015	24%	14%	17%	25%
2016	27%	13%	17%	26%

Panel B. Quoted spreads: by credit

	Investment grade			High yield		
Year	25th %-ile	50th %-ile	75th %-ile	25th %-ile	50th %-ile	75th %-ile
2008	11%	13%	16%	6%	8%	10%
2009	11%	13%	16%	8%	11%	16%
2010	9%	10%	12%	8%	10%	13%
2011	9%	10%	12%	7%	10%	15%
2012	10%	12%	15%	11%	16%	23%
2013	15%	18%	22%	13%	17%	23%
2014	17%	20%	24%	12%	17%	32%
2015	15%	17%	20%	11%	18%	41%
2016	14%	17%	23%	12%	17%	41%

Panel C. Quoted spreads: by tenor

	< 5 years			5 years			> 5 years		
Year	25th %-ile	50th %-ile	75th %-ile	25th %-ile	50th %-ile	75th %-ile	25th %-ile	50th %-ile	75th %-ile
2008	11%	13%	16%	10%	12%	15%	8%	9%	11%
2009	18%	23%	28%	10%	12%	15%	11%	13%	16%
2010	19%	24%	31%	8%	10%	11%	10%	11%	13%
2011	22%	27%	36%	8%	9%	11%	9%	10%	12%
2012	31%	38%	48%	10%	12%	14%	12%	14%	16%
2013	45%	52%	61%	12%	13%	16%	15%	16%	19%
2014	42%	49%	63%	12%	14%	16%	15%	16%	18%
2015	40%	48%	71%	13%	14%	16%	16%	18%	20%
2016	38%	49%	109%	13%	15%	17%	14%	15%	17%

Source: DERA analysis.

VI. Funds

A. Introduction

While corporate and Treasury bonds are directly owned by several types of investors—including households, pension plans, insurance companies, and other institutions—investors can also gain exposure to bonds indirectly via investment companies.[227] Investment companies are therefore an alternative channel through which investors finance the real investment activity of firms in the economy. Open-end funds (OEFs), closed-end funds (CEFs), and, more recently, ETFs, all actively participate in corporate and Treasury bond markets.[228] In this section, we explore trends in bond ownership and important limitations to the interpretation of those trends.

B. Evidence on Bond Liquidity from Bond Ownership

Liquidity in underlying bond markets may affect the portfolio decisions of the investors who participate in those markets. For example, households may respond to changes in bond market liquidity by adjusting the relative quantity of bonds they hold directly and bonds they hold through funds. In particular, a decrease in bond market liquidity, which would increase the cost of transacting in bond markets directly, could lead investors to increase the quantity of bonds held through funds. Conversely, an increase in bond market liquidity, which would reduce the cost of transacting in bond markets directly, could lead investors to decrease the quantity of bonds held through funds.[229] If the Dodd-Frank Act or the Volcker Rule affected

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[227] Accredited investors can also gain exposure to corporate debt and treasuries via private funds, but for simplicity we focus our analysis on investment companies registered under the Investment Company Act of 1940 because they hold significantly more assets, are accessible to a broader base of investors, and data on their holdings is more readily available.

[228] We refer to OEFs, CEFs, and ETFs, collectively, as "funds".

[229] There are structural and operational differences between mutual funds, CEFs, and ETFs that result in differences in how investors gain access to each fund type. However, all of these fund types provide alternative means of achieving exposure to bond markets. We therefore assume that while the magnitude of any effects might differ [Footnote continued on next page]

bond market liquidity, and to the extent that bond funds may involve cost efficiencies or liquidity transformation, we might expect to observe a change in the relative quantities of bonds held directly and bonds held through funds.

In this section, we examine data from January 1977 through June concerning aggregate trends in two bond market measures: (1) the share of fund assets invested in debt securities such as Treasury and corporate bonds, and (2) the share of outstanding debt that is owned by funds in aggregate. Although we find some significant changes in the participation of investment companies in the bond markets, for reasons discussed in Part B.VI.C below, these trends are likely influenced by a range of factors that confound our ability to reach conclusions regarding the effect of changes in bond market liquidity that may have occurred during the period relevant to the Dodd-Frank Act and the Volcker Rule.

Figure 51 shows that the combined holdings of OEFs, ETFs, and CEFs grew from $50 billion in the late 1970s to roughly $15.7 trillion in 2016.[230] We note that holdings of corporate and foreign bonds increased from $692 billion in 2009 to $2.2 trillion in 2016. Figure 52 shows the share of total fund assets invested in different types of debt. From 2009 through 2016, the percentage of fund assets held in corporate bonds increased from 11.3% to 13.9%.

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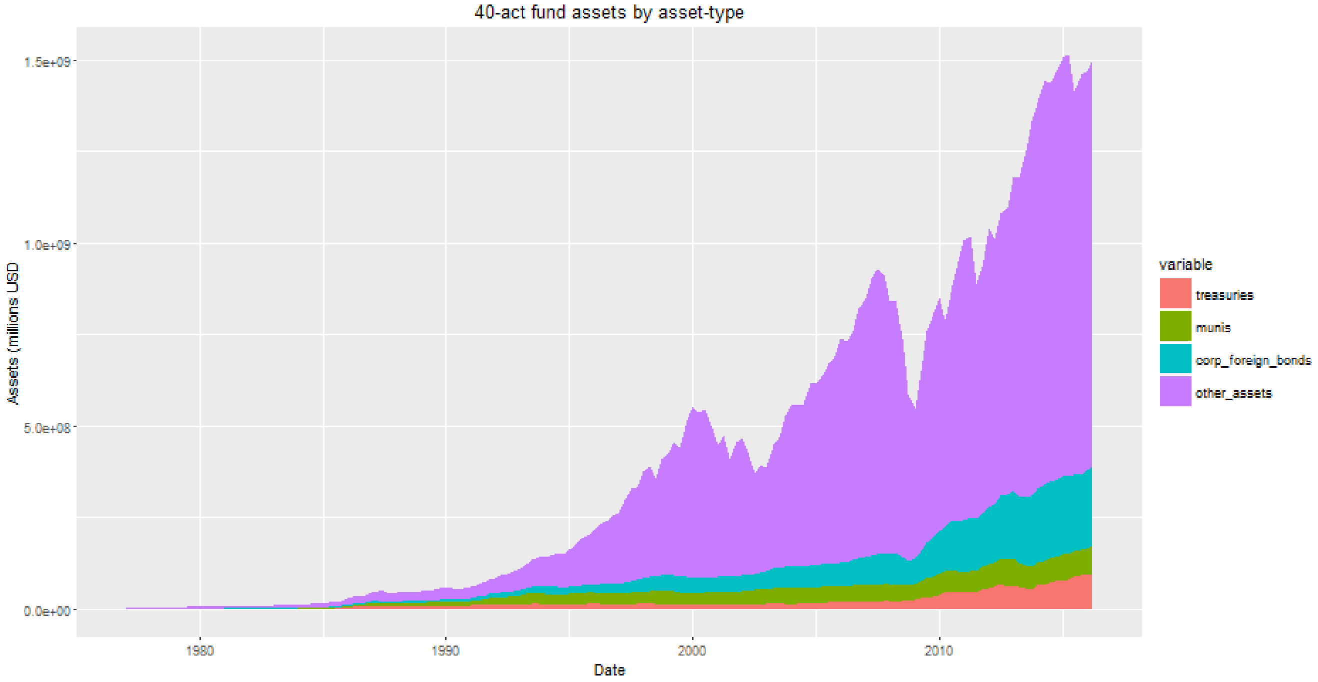
across these fund types, any effects associated with a change in underlying bond market liquidity would be in the same direction. For example, a decrease in the liquidity of the underlying bond market would make substituting to any of these fund types relatively more attractive.

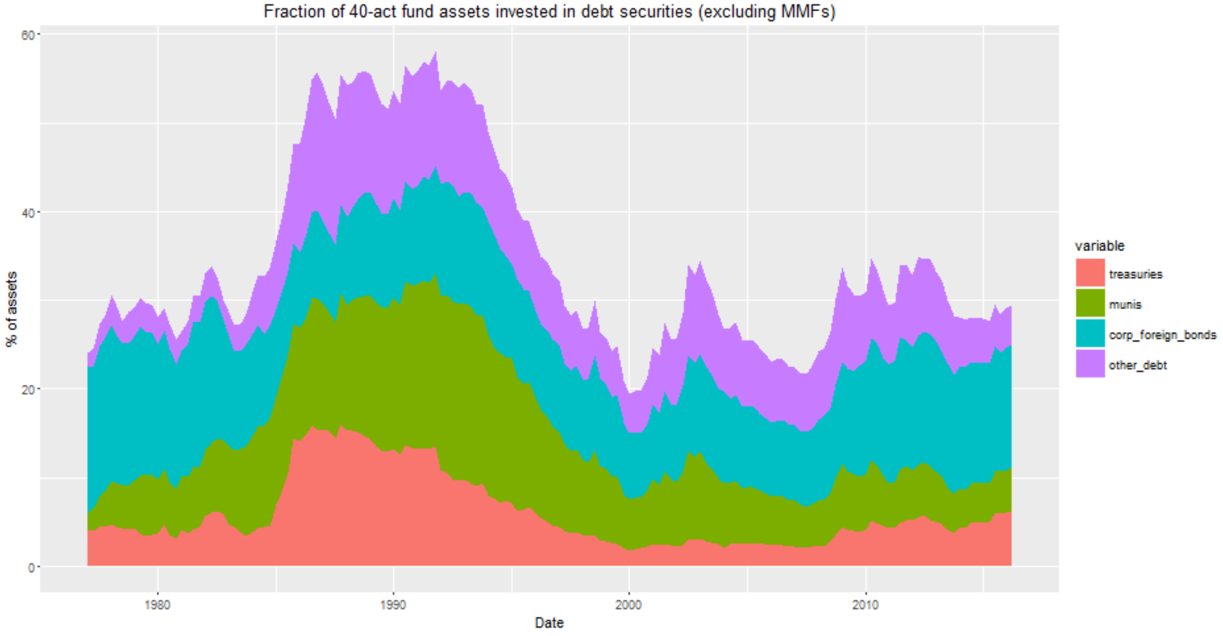
[230] All statistics and figures in this section are derived from Federal Reserve Flow of Funds data. *See* http://www.federalreserve.gov/releases/z1/current/default.htm

Figure 51. 1940 Act fund assets by asset type. Other assets include equities.



Source: DERA analysis.

Figure 52. 1940 Act Fund allocations to debt securities. "other_debt" includes agency bonds, syndicated loans, repo, and other forms of lending.



Source: DERA analysis.

To the extent that bond market participants change their relative quantities of bonds held directly and through funds as a function of liquidity in the underlying bond markets, the above could be interpreted as evidence of a decrease in bond market liquidity from 2009 to 2016; however there are several important issues with that interpretation. First, it is not clear when the regulatory action that is the subject of the Report might have started to affect market liquidity. While some of the increase in both holdings of bonds by funds and the percentage of fund holdings invested in bonds since 2009 may be attributable to regulatory effects, these increases may simply be the continuation of a longer-term trend. Second, the dollar value of fund holdings and the percentage of fund holdings in bonds are also affected by the relative market values of bonds and other securities. That means some or all of the changes in fund allocation to bonds from 2009 to 2016 might instead be attributable to changes in the values of bonds and other securities. We note similar fluctuations in fund allocations vis-à-vis underlying valuations over the entire sample period (1977 to 2016). Finally, any change in the relative quantities of bonds held directly and through funds may be due to factors other than the liquidity of the underlying bond market, such as changes in demand composition (i.e., the relative demand for bonds by different types of investors who are more or less likely to achieve bond ownership through funds), changes in investor appetite for diversification, evolving investor expectations about relative bond and bond fund costs and performance, and potential changes to the costs of launching an ETF and their availability to investors, among others.[231]

Figures 53-55 provide a more detailed examination of fund debt holdings. In particular, they show investment in debt by fund type. Overall, the patterns within fund types are consistent with holdings across fund types. In particular, the percentage of assets held in corporate and

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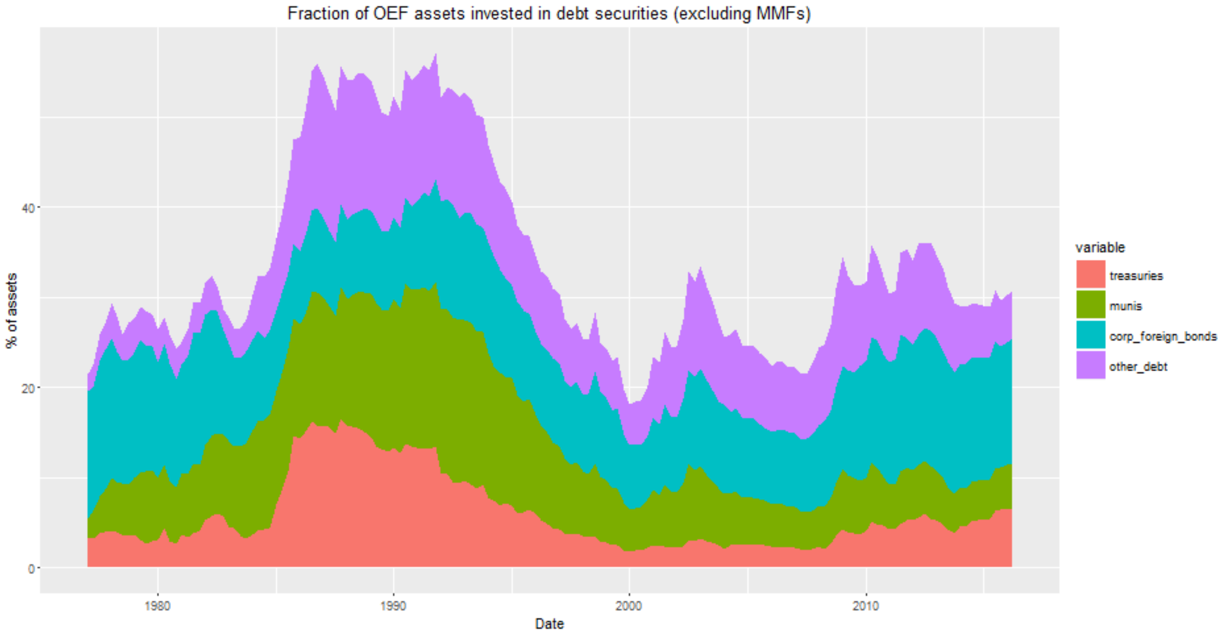
[231] For example, investors in defined contribution retirement plans may be more likely to gain exposure to various asset classes by investing in mutual funds rather than directly in the underlying securities markets.

foreign bonds increases from 2009 to 2016 for OEFs, ETFs, and CEFs.[232] However, the same caveats that applied across all fund holdings apply within fund types, so these increases cannot be directly attributed to changes in bond market liquidity or regulatory actions.

Figure 53. OEF allocations to debt securities. "other_debt" includes agency bonds, syndicated loans, repo, and other forms of lending.



Source: DERA analysis.

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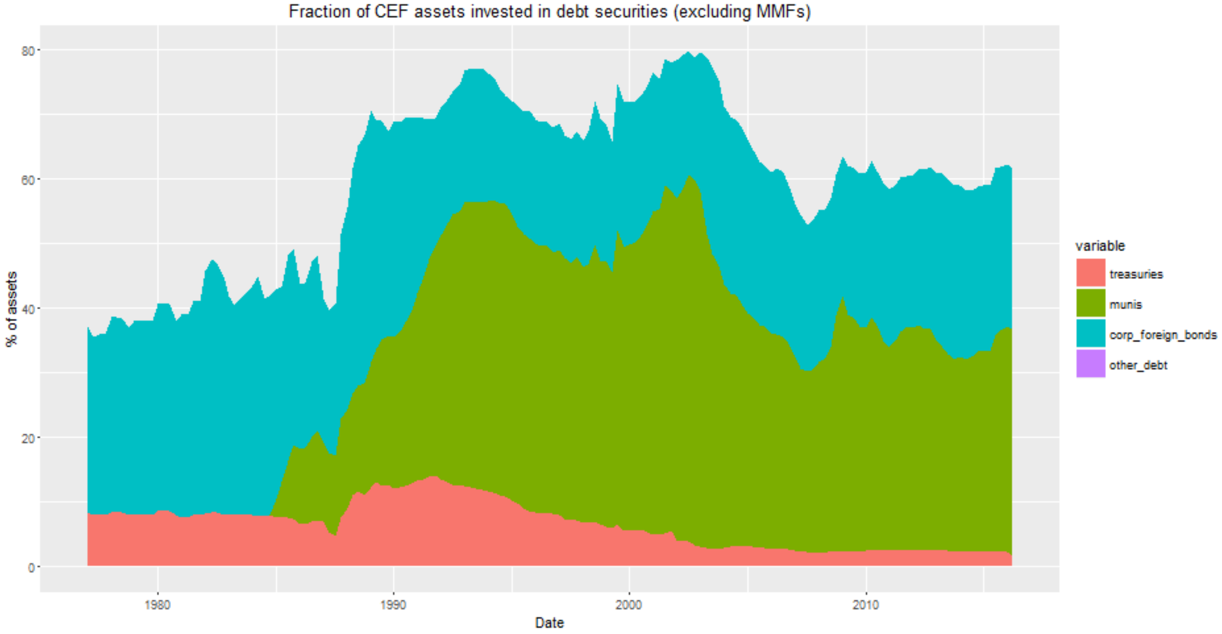
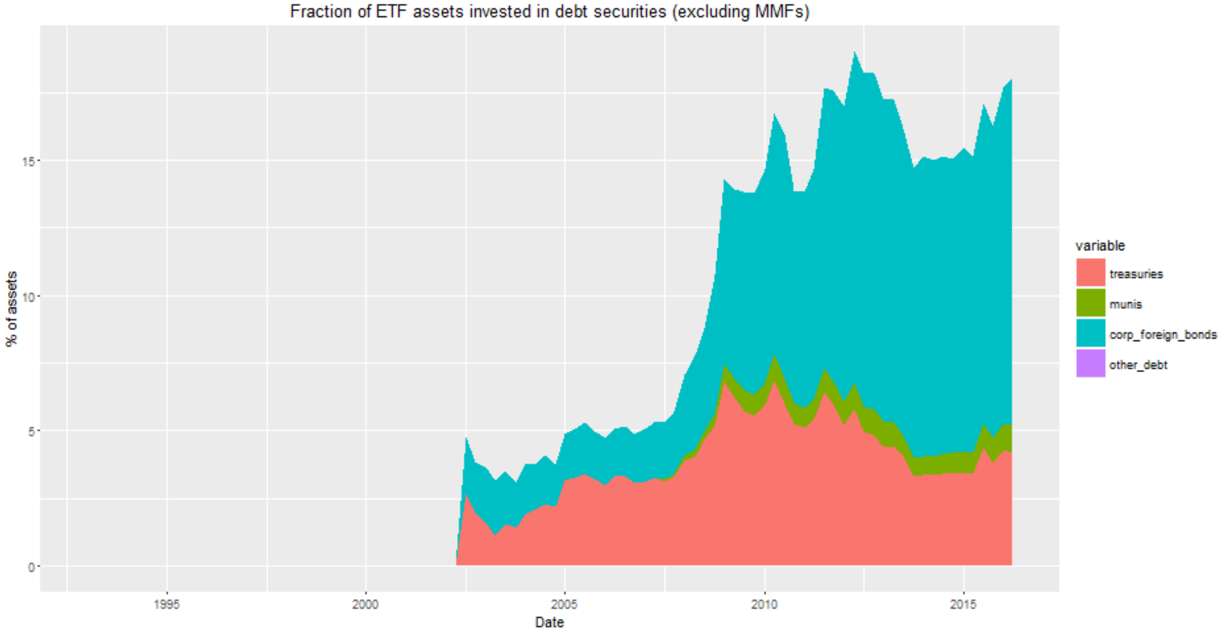
[232] Ownership by CEFs from 2012 to 2016 remained relatively stable.

Figure 54. CEF allocations to debt securities. "other_debt" includes agency bonds, syndicated loans, repo, and other forms of lending.



Source: DERA analysis.

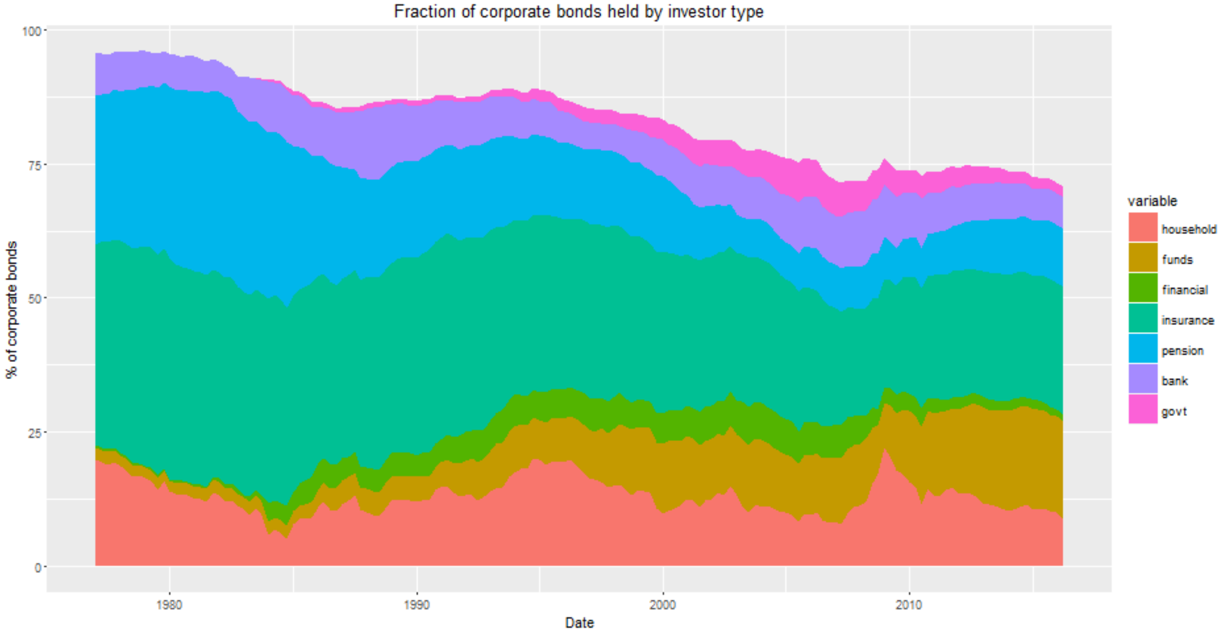
Figure 55. ETF allocations to debt securities. "other_debt" includes agency bonds, syndicated loans, repo, and other forms of lending.



Source: DERA analysis.

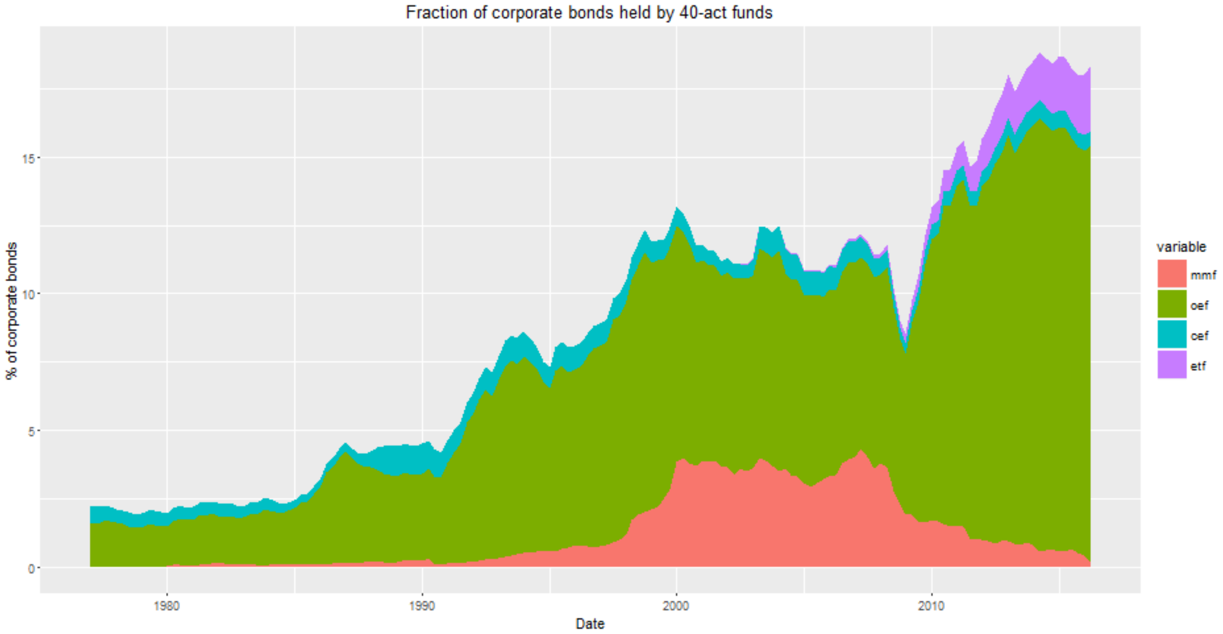
Figures 56-57 show ownership of corporate bonds by owner and fund type. From 2009 to 2016 the percentage of corporate and foreign bonds held by households decreased from 22.0% to 8.6%, while the percentage of corporate and foreign bonds held by funds increased from 8.5% to 18.3%. These results would seem to be consistent with households allocating away from holding underlying bonds directly towards holding them through funds, potentially as a result of a decrease in underlying bond market liquidity. As was the case earlier, however, that interpretation is subject to several meaningful caveats. The largest changes to household and fund allocations occurred during the financial crisis of 2008-2009, a historically anomalous time period. Because we cannot isolate when any regulatory actions would have taken effect in the bond market, this shift in ownership may instead be the continuation of a trend that began with the financial crisis. Importantly, viewed over the entire sample period, household ownership appears to have returned to a level consistent with much of the previous two decades. In addition, over the same period, the percentage of equities held by households increased from 36% to 40%, so some of the decreased household share of outstanding corporate and foreign bonds may also reflect a reallocation of exposure towards equities rather than towards indirect bond holdings through funds.

Figure 56. Share of corporate/foreign debt by owner type



Source: DERA analysis.

Figure 57. Share of corporate/foreign debt by fund type



Source: DERA analysis.

C. Limitations in Interpreting the Data

The above analysis could be interpreted as consistent with a decrease in bond market liquidity from 2009 to 2016, however, these results cannot necessarily be attributed to changes in bond market liquidity or any regulatory actions during that period. In this section, we describe additional considerations that limit our ability to interpret the results from 2009 to 2016.

First, in equilibrium, fund behavior and bond market liquidity are likely to be jointly determined by multiple factors including macroeconomic conditions, regulatory constraints, and investor preferences. The above discussion takes fund behavior as a given and considers potential changes in investor behavior as a result of contemplated changes in bond market liquidity. It is the case, however, that changes in the economic environment may drive changes in fund behavior, which in turn, could affect bond market liquidity. For example, it could be the case that funds trade more actively than the individual investors who make up their client base. If a change in the economy causes these investors to shift some of their assets from direct bond ownership towards funds, the increased trading presence of funds could induce greater liquidity in the bond market. Thus, decreases in direct bond investment and increasing investment in bonds through funds could imply an increase in bond market liquidity rather than a decrease.[233]

The more general point, however, is that when funds trade assets, their buying or selling activity can affect the underlying market for these assets. For example, Coval and Stafford (2007) provide evidence supporting the hypothesis that when mutual funds collectively sell large quantities of a stock, the stock's price can be pushed away from its fundamental value for a

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[233] This conclusion is sensitive to the assumption that funds trade more actively than individuals. Alternatively, if funds tend to trade less than households—for example, because they aggregate demand across all fund investors before trading—an increase in allocation to bond funds could lead to a decrease in underlying bond market liquidity.

period of months, followed by a reversion back towards fundamental value.[234] Several more recent studies look for a similar effect in corporate bond markets and find mixed evidence. Cai et al. (2016) find that institutional investors, including mutual funds, exhibit herding behavior when they sell corporate bonds and that this herding pushes prices temporarily away from their fundamental value. A primary reason funds choose to sell bonds is to accommodate redemptions. Choi and Shin (2016) find some evidence that bond funds experiencing outflows during periods of market stress such as the Taper Tantrum exert pressure on bond prices, but not under normal circumstances. Hoseinzade (2016) finds no evidence supporting the hypothesis that fund outflows lead to price pressure in underlying corporate bond markets. Both Hoseinzade (2016) and Choi and Shin (2016) point out that bond fund managers do not necessarily meet redemptions by selling corporate bonds, but may use more liquid assets to meet redemptions instead. This could explain the lack of a clear outflow effect on bond prices. Chernenko and Sunderam (2016) find evidence supporting this explanation. The authors show that mutual funds hold substantially more cash to engage in "liquidity transformation" when they hold less liquid assets, during periods of lower overall market liquidity, and when they face more volatile fund flows. Finally, both Bhattacharya and O'Hara (2016) and Israeli, Lee, and Sridharan (2016) show that if price discovery migrates from underlying stocks or bonds to ETFs that invest in those assets, some measures of liquidity in the underlying market can deteriorate.

To the extent that the above studies provide evidence that fund activity affects the underlying bond market, they should be viewed as a potential confounding factor in any analysis of bond market liquidity with respect to the regulatory reforms that are the subject of the Report.

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[234] Temporary price deviations from an asset's "efficient" or fundamental value are generally considered to be indicators of illiquidity and cause deteriorations in some measures of market liquidity. *See* Hasbrouck (2007) for a more detailed discussion.

For example, if a given regulatory action took effect at the same time funds experienced outflows for an unrelated reason—for example, if it coincided with an aggregate reduction in investor demand for bonds—fire-sale effects associated with those outflows could show up in measures of bond market liquidity despite being unrelated to the regulatory action.[235] On balance, the evidence on price effects suggests that, if they exist at all, they are more prominent during periods of market stress, so the risk of a confounding effect may be highest for regulatory events that occur during such periods.

D. Summary

Changes in bond market liquidity could lead to changes in investor allocation between direct investment in bonds and investment in bonds through funds. That observation suggests that an analysis of changes in fund holdings could provide indirect evidence on bond market liquidity. To the extent that the increased ownership of corporate bonds by funds demonstrated above is due to a reallocation by investors from the underlying bond market, funds could also be viewed as a substitute for any deterioration in the liquidity of the underlying market. If funds are able to provide liquidity transformation—accommodating subscriptions and redemptions in a more liquid manner than the underlying assets they invest in—this type of shift could partially offset increased illiquidity in the underlying bond market. However, it is important to note that we cannot isolate the cause of the increased share of fund ownership in bonds. It is possible that the shift is due to other factors, like a reallocation of investors from other asset classes into corporate bonds to, for example, gain exposure to higher yields during a low interest rate environment on less risky debt securities. To the extent that increased fund ownership of bonds

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[235] If, on the other hand, price movements due to increased fund trading activity were exclusively associated with the incorporation of new fundamental information, typical measures of liquidity would not decrease.

is driven by factors such as the latter, funds cannot be interpreted as providing a substitute for any deterioration in underlying bond markets. Furthermore, the trading activity of funds that participate in the bond market may affect bond market liquidity in ways that confound our ability to identify the impacts of regulatory action on bond market liquidity.

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107. Rel. No. 33-9497, Proposed Rule Amendments for Small and Additional Issues Exemptions Under Section 3(b) of the Securities Act, (December 18, 2013), 79 FR 3925.

108. Rel. No. 34-72472, Application of “Security-Based Swap Dealer” and “Major Security-Based Swap Participant” Definitions to Cross-Border Security-Based Swap Activities (Jun. 25, 2014) 79 FR 47277, n.139 (Cross-Border Adopting Release);

109. Rel. No. 33-9638, Asset-Backed Securities Disclosure and Registration (Sept. 4, 2014) 79 FR at 57192 (Regulation AB2 Adopting Release)

110. Rel. No. 34-73407, Credit Risk Retention (Oct. 22, 2014), 79 FR 77602 (Credit Risk Retention Adopting Release).

111. Rel. No. 34-74244, Regulation SBSR—Reporting and Dissemination of Security-Based Swap Information (Feb. 11, 2015) 80 FR at 14699-14700 (Regulation SBSR Adopting Release)

112. Rel. No. 33-9741, Amendments to Regulation A (Mar. 25, 2015) 80 FR 21805 (Regulation A+ Adopting Release)

113. Rel. No. 34-75611, Registration Process for Security-Based Swap Dealers and Major Security-Based Swap Participants (Aug. 5, 2015) 80 FR at 49003 (Registration Adopting Release).

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115. Rel. No. 34-77617, Business Conduct Standards for Security-Based Swap Dealers and Major Security-Based Swap Participants (Apr. 14, 2016) 81 FR 29960

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Appendices

Appendix A. Regulatory Reform Timeline

- February 13, 2008: Economic Stimulus Act of 2008 signed into law.
- March 16, 2008: Bear Stearns sold to JP Morgan.
- September 15, 2008: Lehman Bros files for bankruptcy.
- October 3, 2008: Emergency Economic Stabilization Act of 2008 (including TARP) signed into law.
- January 21, 2010: President Obama announces support for Volcker Rule-type restrictions on proprietary trading by banking entities.
- April 7, 2010: Proposed amendments to Regulation AB issued by Commission.
- May 18-20, 2010: Amendment to include a version of the Volcker Rule in Dodd-Frank is introduced in the Senate, but is not approved.
- June 29, 2010: Dodd-Frank Act conference report filed; contains Volcker Rule.
- June 30, 2010: Dodd-Frank Act conference report passes House.
- July 15, 2010: Dodd-Frank Act conference report passes Senate.
- July 21, 2010: Dodd-Frank Act signed into law (including Volcker).
- December 2010: Basel III capital framework finalized by BCBS.
- January 18, 2011: FSOC issues a study and recommendations on implementing the Volcker Rule.
- March 2011: Treasury Department panel discussion on IPO problem; gives rise to IPO Task Force.
- March 30, 2011: Proposed interagency rule on credit risk retention issued by the SEC.
- July 26, 2011: Reproposal of amendments to Regulation AB in light of Dodd-Frank requirements.
- October 5, 2011: Proposed draft implementing Volcker rules published in *American Banker.*
- October 11, 2011: Implementing rules for Volcker first proposed.

- October 20, 2011: Rebuilding the IPO On-Ramp proposal released by Treasury IPO Task Force.

- November 2011: Series of bills advancing IPO Task Force proposals passed House.

- March 8, 2012: JOBS Act (rolling up several of the House bills) passed House.

- March 22, 2012: Senate passes JOBS Act with amendments to crowdfunding.

- March 27, 2012: House passes Senate's version of JOBS Act.

- April 5, 2012: JOBS Act signed into law; Titles I, V, and VI take effect.

- June 2012: FRB, FDIC, and OCC propose Basel III rules (Three NPRs: (1) Regulatory Capital Rules: Regulatory Capital, Implementation of Basel III, Minimum Regulatory Capital Ratios, Capital Adequacy, and Transition Provisions; (2) Regulatory Capital Rules: Standardized Approach for Risk-Weighted Assets; Market Discipline and Disclosure Requirements; and (3) Regulatory Capital Rules: Advanced Approaches Risk-based Capital Rule; Market Risk Capital Rule). [FR published Aug 30, 2012.]

- August 29, 2012: SEC proposed amendments to Regulation D to implement Title II of JOBS Act, lifting ban on general solicitation.

- January 1, 2013: BCBS phase-in begins: Minimum common equity capital ratio (initially 3.5%), minimum common equity plus capital conservation buffer (initially 3.5%), minimum Tier 1 capital (initially 4.5%).

- July 2, 2013: Basel III final rule adopted by FRB, and OCC and FDIC shortly thereafter (July 9). [OCC and Fed rule published in FR Oct 11, 2013]. FDIC adopted as interim final rule; went final in April 2014.

- July 10, 2013: SEC adopted amendments to Regulation D to implement Title II of JOBS Act, lifting ban on general solicitation; SEC adopted amendments to disqualify certain "bad actors" from Rule 506 of Regulation D to implement requirements of the Dodd-Frank Act; SEC proposes additional conditions for Regulation D offerings.

- July 2013: FRB, FDIC, and OCC propose leverage ratio rule.

- August 28, 2013: Credit risk retention rules re-proposed.

- September 23, 2013: Regulation D amendments take effect.

- October 23, 2013: SEC proposes rules implementing Title III of the JOBS Act (Crowdfunding).

- October 2013: FRB, FDIC, and OCC publish proposed Liquidity Coverage Ratio rule (diverges from Basel III).

- December 10, 2013: Final Volcker rules adopted.

- December 18, 2013: SEC proposes rules implementing Title IV of the JOBS Act (Regulation A+).

- January 1, 2014: BCBS phase-in continues: Minimum common equity capital ratio increases to 4%, minimum common equity plus capital conservation buffer increases to 4%, and minimum Tier 1 capital increases to 5.5%; phase-in of deductions from CET1 set at 20%, minimum total capital set at 8%, and minimum total capital plus conservation buffer set at 8%.

- January 1, 2014: Effective date for most of OCC and Fed final rule on regulatory capital; compliance date for all banks that are not S&Ls.

- February 25, 2014: Reopening of comment period for revised approach to Regulation AB amendments.

- April 1, 2014: Effective date (but not compliance date) for Volcker Rule.

- April 8, 2014: FRB, FDIC, and OCC adopt final leverage ratio rule; issued proposed rule to modify the calculation for supplementary leverage ratio per recent BCBS changes thereto.

- July 21, 2014: Original end of Volcker Rule conformance period; extended to July 21, 2015.

- August 27, 2014: SEC adopts revisions to Regulation AB.

- September 3, 2014: FRB, FDIC, and OCC adopt final rule modifying definition of Supplementary Leverage Ratio to conform to Basel III changes. Adopt final Liquidity Coverage Ratio rule for large banks and a modified LCR rule for smaller banks [published Oct. 2014].

- September 4, 2014: SEC issues the Regulation AB revisions.

- October 22, 2014: Final interagency credit risk retention rules adopted by SEC.

- January 1, 2015: BCBS phase-in continues: Minimum common equity capital ratio increases to 4.5%, minimum common equity plus capital conservation buffer increases to 4.5%, phase-in of deductions from CET1 increases to 40%, and minimum tier 1 capital increases to 6%. Liquidity coverage ratio minimum implemented at 60%.

- January 1, 2015: effective date for most of remaining OCC and Fed final rule implementing regulatory capital and LCR final rule (although compliance with LCR phased in thru 1/1/17); compliance date with regulatory capital rule for remaining banks.

- March 25, 2015: SEC adopts final rules implementing Title IV of the JOBS Act (Regulation A+).

- June 19, 2015: Regulation A+ final rules take effect.

- July 21, 2015: End of general Volcker Rule conformance period—deadline for conforming to the Volcker Rule's prohibition on proprietary trading and on ownership of covered funds not owned before December 31, 2013.

- October 30, 2015: SEC adopts final rules implementing Title III of the JOBS Act (Crowdfunding).

- January 1, 2016: BCBS phase-in continues: New capital conservation buffer at 0.625%. Minimum common equity plus capital conservation buffer increases to 5.125%. Deduction from CET1 phase-in increases to 60%. Minimum total capital plus conservation buffer increases to 8.625%. LCR increases to 70%.

- May 3, 2016: FRB, OCC, and FDIC propose net stable funding ratio rule.

- May 16, 2016: Crowdfunding final rules take effect.

- July 21, 2017: Deadline for conforming to the Volcker Rule's prohibition on ownership of covered funds owned by banks on or before December 31, 2013.

Appendix B. Regulatory Reform Timeline: Security-Based Swap Markets

Date	Type	Rule
Oct. 14, 2010	Proposed	Ownership Limitations and Governance Requirements for Security-Based Swap Clearing Agencies, Security-Based Swap Execution Facilities, and National Securities Exchanges with Respect to Security-Based Swaps under Regulation MC
Nov. 3, 2010	Proposed	Prohibition Against Fraud, Manipulation, and Deception in Connection with Security-Based Swaps
Nov. 19, 2010	Proposed	Regulation SBSR - Reporting and Dissemination of Security-Based Swap Information
Nov. 19, 2010	Proposed	Security-Based Swap Data Repository Registration, Duties, and Core Principles
Dec. 7, 2010	Proposed	Further Definition of "Swap Dealer," "Security-Based Swap Dealer," "Major Swap Participant," "Major Security-Based Swap Participant" and "Eligible Contract Participant"(Proposed Interpretations)
Dec. 15, 2010	Proposed	End-User Exception to Mandatory Clearing of Security-Based Swaps
Dec. 15, 2010	Proposed	Process for Submissions for Review of Security-Based Swaps for Mandatory Clearing and Notice Filing Requirements for Clearing Agencies; Technical Amendments to Rule 19b-4 and Form 19b-4 Applicable to All Self-Regulatory Organizations
Jan. 14, 2011	Proposed	Trade Acknowledgment and Verification of Security-Based Swap Transactions
Feb. 2, 2011	Proposed	Registration and Regulation of Security-Based Swap Execution Facilities (Proposed Interpretation)
Mar. 17, 2011	Proposed	Beneficial Ownership Reporting Requirements and Security-Based Swaps
Apr. 29, 2011	Proposed	Further Definition of “Swap,” “Security-Based Swap,” and “Security-Based Swap Agreement”; Mixed Swaps; Security-Based Swap Agreement Recordkeeping (Proposed Interpretations)
Jun. 1, 2011	Proposed	Further Definition of "Swap," "Security-Based Swap," and "Security-Based Swap Agreement"; Mixed Swaps; Security-Based Swap Agreement Recordkeeping (Joint Proposed Rules; Proposed Interpretation)
Jun. 8, 2011	Adopted	Beneficial Ownership Reporting Requirements and Security-Based Swaps (Confirmation)
Jun. 9, 2011	Proposed	Exemptions for Security-Based Swaps Issued by Certain Clearing Agencies
Jun. 29, 2011	Proposed	Business Conduct Standards for Security-Based Swap Dealers and Major Security-Based Swap Participants
Oct. 12, 2011	Proposed	Registration of Security-Based Swap Dealers and Major Security-Based Swap Participants
Mar. 30, 2012	Adopted	Exemptions for Security-Based Swaps Issued by Certain Clearing Agencies

Apr. 27, 2012	Adopted	Further Definition of “Swap Dealer,” “Security-Based Swap Dealer,” “Major Swap Participant,” “Major Security-Based Swap Participant” and “Eligible Contract Participant” (Joint Final Rule; Joint Interim Final Rule; Interpretation)
Jun. 28, 2012	Adopted	Process for Submissions for Review of Security-Based Swaps for Mandatory Clearing and Notice Filing Requirements for Clearing Agencies; Technical Amendments to Rule 19b-4 and Form 19b-4 Applicable to All Self-Regulatory Organizations
Jul. 18, 2012	Adopted	Further Definition of “Swap,” “Security-Based Swap,” and “Security-Based Swap Agreement”; Mixed Swaps; Security-Based Swap Agreement Recordkeeping
Oct. 18, 2012	Proposed	Capital, Margin, and Segregation Requirements for Security-Based Swap Dealers and Major Security-Based Swap Participants and Capital Requirements for Broker-Dealers
May 1, 2013	Proposed	Cross-Border Security-Based Swap Activities; Re-Proposal of Regulation SBSR and Certain Rules and Forms Relating to the Registration of Security-Based Swap Dealers and Major Security-Based Swap Participants
Apr. 17, 2014	Proposed	Recordkeeping and Reporting Requirements for Security-Based Swap Dealers, Major Security-Based Swap Participants, and Broker-Dealers; Capital Rule for Certain Security-Based Swap Dealers
Jun. 25, 2014	Adopted	Application of "Security-Based Swap Dealer" and "Major Security-Based Swap Participant" Definitions to Cross-Border Security-Based Swap Activities
Sep. 8, 2014	Proposed	Treatment of Certain Communications Involving Security-Based Swaps That May Be Purchased Only By Eligible Contract Participant
Feb. 11, 2015	Proposed	Regulation SBSR—Reporting and Dissemination of Security-Based Swap Information
Feb. 11, 2015	Adopted	Regulation SBSR-Reporting and Dissemination of Security-Based Swap Information
Feb. 11, 2015	Adopted	Security-Based Swap Data Repository Registration, Duties, and Core Principles
Apr. 29, 2015	Proposed	Application of Certain Title VII Requirements to Security-Based Swap Transactions Connected with a Non-U.S. Person's Dealing Activity That Are Arranged, Negotiated, or Executed By Personnel Located in a U.S. Branch or Office or in a U.S. Branch or Office of an Agent
Aug. 5, 2015	Proposed	Applications by Security-Based Swap Dealers or Major Security-Based Swap Participants for Statutorily Disqualified Associated Persons to Effect or Be Involved in Effecting Security-Based Swaps
Aug. 5, 2015	Adopted	Registration Process for Security-Based Swap Dealers and Major Security-Based Swap Participants
Sep. 4, 2015	Proposed	Access to Data Obtained by Security-Based Swap Data Repositories and Exemption from Indemnification Requirement

Dec. 11, 2015	Proposed	Establishing the Form and Manner with which Security-Based Swap Data Repositories Must Make Security-Based Swap Data Available to the Commission
Feb. 10, 2016	Adopted	Security-Based Swap Transactions Connected with a Non-U.S. Person's Dealing Activity That Are Arranged, Negotiated, or Executed By Personnel Located in a U.S. Branch or Office or in a U.S. Branch or Office of an Agent; Security-Based Swap Dealer De Minimis Exception
Apr. 14, 2016	Adopted	Business Conduct Standards for Security-Based Swap Dealers and Major Security-Based Swap Participants
Jun. 8, 2016	Adopted	Trade Acknowledgment and Verification of Security-Based Swap Transactions
Jul. 14, 2016	Adopted	Regulation SBSR—Reporting and Dissemination of Security-Based Swap Information
Aug. 29, 2016	Adopted	Access to Data Obtained by Security-Based Swap Data Repositories

Appendix C. Appendix to Access to Capital Analysis

This appendix describes the procedures used to collect the Regulation D sample and the data on the other offerings. One of the original purposes of Form D, first adopted in 1982, was to collect and analyze data on issuers using Regulation D.[236] However, until 2008, issuers filed Form D on paper, making the extraction of information for large-scale statistical analysis cumbersome. In February 2008, the SEC adopted amendments to Form D that required issuers to submit their Form D filings electronically, in a structured data format.[237] As a result of those requirements, which were phased in from September 2008 through March 2009, Form D filings are now machine-readable. Using basic text parsing tools, DERA staff was able to extract the reported elements and place them in a database enabling the large-scale statistical analysis reported here.

Regulation D Sample

1. We collected all Form D filings (new filings and amendments) on EDGAR starting in January 2009 through December 2014. We extracted all fields from each filing and applied the following treatments to arrive at our final sample.
2. Subsequent amendments to a new filing are treated as incremental fundraising and recorded in the calendar year in which the amendment is filed. For offerings initiated prior to 2009 and continuing into future years, an issuer would have filed only Form D amendments in an electronic (machine readable) form required for this analysis. If these

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[236] Rel. No. 33-6389 *Revision of Certain Exemptions From Registration for Transactions Involving Limited Offers and Sales* (Mar. 8, 1982); 47 FR 11251 (1982) (adopting Form D as a replacement for Forms 4(6), 146, 240 and 242).

[237] Rel. No. 33-8891 *Electronic Filing and Revision of Form D* (Feb. 27, 2008) 70 FR 10592 (2008).

amendments reference a post-2008 sale date, the first filed amendment is treated as an original Form D filing, as we do not have access to Form D data prior to 2009.

3. The incremental amount sold between two successive filings of the same issuer is determined by taking the difference between the "total amounts sold" reported in each such filing. We estimate the incremental amount of capital raised and reported in amended filings for which there is no original filing in electronic form. This occurs only in 2009. The estimated incremental capital raised in these instances is based on a "haircut" of the total amount sold reported in the latest filed amendment. This percentage is the average incremental amount sold in all amendments for which there is an original filing in electronic form, calculated separately for funds and non-funds. This resulted in haircut percentages of 11% and 27%, respectively. This treatment is unnecessary for offerings starting in 2010.
4. We separate amendments filed into two categories. The first category is comprised of amendments that are filed in the same year when the offering was initiated, while the second category consists of amendments filed in the year subsequent to the year of initial offering. "Same year" is defined as 12 months from the initial date of filing. A number of pooled investment funds appear to report, in their annual amendments, net asset values for the total amount sold under the offering. Net asset values could reflect fund performance as well as new investment into, and redemptions from, the fund. Since it is not possible to distinguish between the two impacts, we present the second category of amendments (filed for offerings initiated prior to 2014) separate from the total amount raised in initial offerings. However, it is plausible that amendments filed within the same year when offerings are initiated, would reflect updates to capital raising efforts of the

issuers. Therefore, we use the incremental amounts in the first set of amendments in calculating the total amount raised in initial offerings.

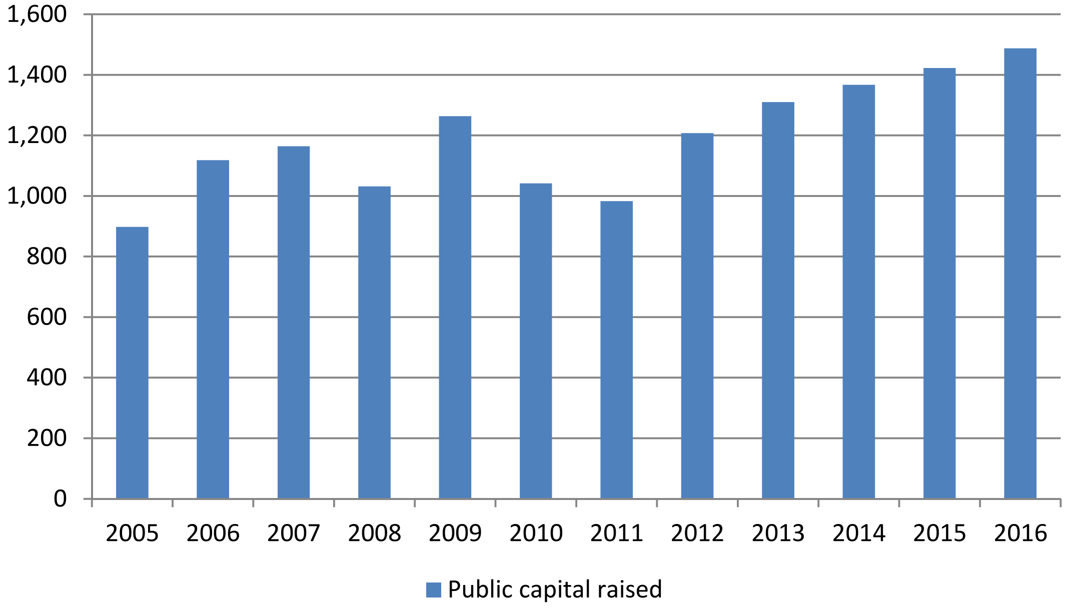
5. Foreign issuers are determined based on the information on Issuer State that they provide.
6. When an issuer checks the box to claim more than one offering exemption (Rule 504, 505, or 506), for the purpose of this analysis, we assume that any issuer that checks the box for Rule 506 is in fact relying on Rule 506.

Other Offerings

1. Data on IPOs, equity offerings by seasoned issuers (EOSIs), convertible debt offerings, public debt offerings, and private offerings are taken from Securities Data Corporation's New Issues database (Thomson Financial). Data on non-ABS Rule 144A offerings are taken from Securities Data Corporation's New Issues database and Mergent database.
2. Data on ABS offerings are taken from the Asset-Backed Alert and Commercial Mortgage Alert publications. We use non-U.S. collateral backed deals to proxy for deals done by foreign issuers.
3. Public debt offerings by government, state, municipal, and quasi-governmental issuers (e.g., Fannie Mae, Freddie Mac) are excluded from the public debt sample.

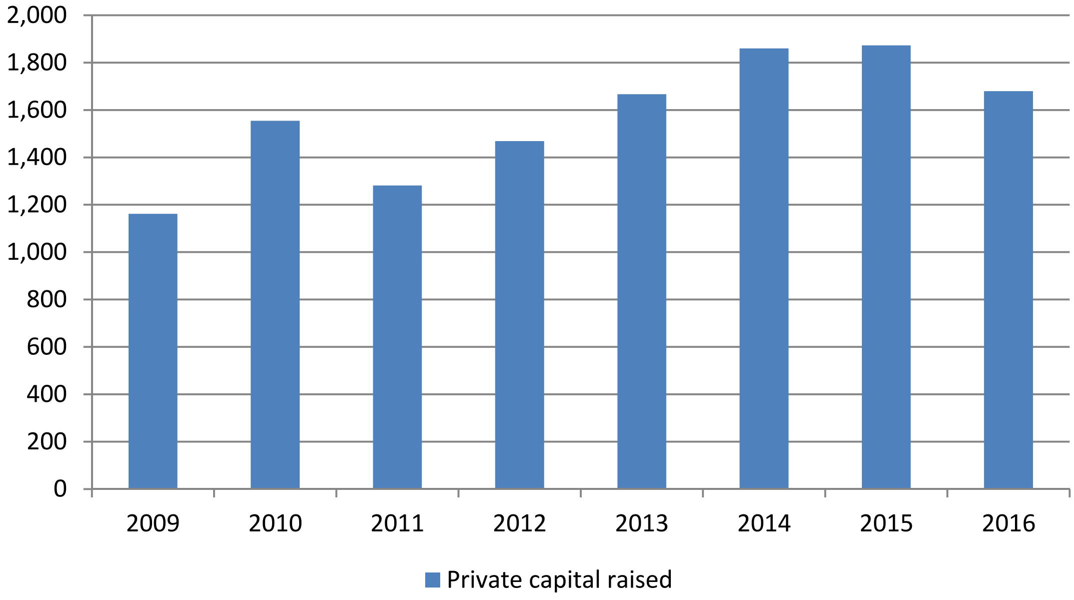
Total Capital Raised In Registered and Unregistered Offerings

Figure C.1. Capital raising through registered offerings (in $ billions), 2005-2016



Source: DERA analysis

Figure C.2. Capital raising through unregistered offerings (in $ billions), 2009-2016



Source: DERA analysis

Appendix D. Appendix to Market Liquidity Analysis: Corporate Bonds

Data Filters and Estimation

1. TRACE Data

As discussed in Part B.IV.C, we collect corporate bond transaction data from the regulatory version of TRACE and merge it with bond characteristics from the Mergent Fixed Income Securities Database (FISD). The FISD database includes issuance date, issue size, original maturity date, and instrument complexity features (i.e., variable rate, non-standard interest payment frequencies, pay-in-kind, redeemable, convertible, unconventional day count basis for accrued interests, and sinking fund). Our sample period spans January 2, 2003, through September 19, 2016.

We construct our corporate bond transaction data sample using the trade reporting filters and the discretionary filters below:

- Trade reporting filters

(1) Remove all corporate bond trade reports that are missing the security identifier, CUSIP.

(2) Remove corporate bond trade reports that were subsequently corrected or canceled.

(3) Remove duplicate interdealer trade reports.[238]

- Discretionary filters

(1) Remove all primary market corporate bond trades ("P1" trades).

(2) Remove all trades for Rule 144A corporate securities.

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[238] The regulatory version of TRACE includes two trade reports for each interdealer trade reported by respective dealers.

(3) Remove corporate bond trade reports that are missing any of the following information: executing dealer identifier, contra-party identifier, buy or sell indicator, dealer capacity code, trade execution date, trade execution time, price, and par volume.

(4) Remove corporate bond trade reports with zero or negative price.

(5) Remove corporate bond trade reports with zero, negative, or non-integer par volume.

(6) Remove corporate bond trades executed on holidays and weekends.

(7) Remove all corporate bonds that are not covered by the FISD database and corporate bonds with missing issue size[239] in the FISD database.

(8) Remove corporate bond trade reports for which the trade execution date is prior to the issuance date of the bond.

(9) Remove corporate bond trade reports for which the trade execution date falls after the original maturity date of the bond.

(10) Remove corporate bond trade reports with par volume greater than one-half of its issue size.

Table D.1 reports the sample composition for each sub-period after applying filters listed under the trade reporting filters and discretionary filters. From Table D.1, we note that the sample reduction from applying the discretionary filters is larger for the "Post-crisis," the "Regulatory," and the "Post-regulatory" sub-period than earlier sub-periods. This larger reduction in our sample for the later sub-periods is primarily driven by our filters based on the FISD database: the portion of TRACE-eligible bond issues covered by the FISD database

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[239] Issue size is one of the data items with the fewer number of missing observations in the FISD database. We use issue size to gauge the availability of data on various bond characteristics and instrument complexity features (e.g., issuance date, issue size, original maturity date, variable rate, non-standard interest payment frequencies, pay-in-kind, redeemable, convertible, unconventional day count basis for accrued interests, and sinking fund) in the FISD database.

appears to have dropped for the “Post-crisis,” the “Regulatory,” and the “Post-regulatory” sub-period compared to earlier sub-periods. The sample composition change due to the changes in the FISD database coverage could result in a bias in our liquidity analysis. For example, if the reduction in the FISD database coverage is primarily on the bonds that trade infrequently, then eliminating TRACE-eligible bond issues that are not covered in the FISD database from our liquidity analysis could leave us with a sample of bonds that are more liquid and bias the results towards finding better liquidity in the corporate bond market than there actually is.

To the extent that the changes in the FISD database coverage of bonds could influence our findings on corporate bond market liquidity, we examine trading activities of TRACE-eligible bond issues that are not covered by the FISD database (hence excluded from our liquidity study) for each sub-period. Specifically, in Table D.2 Panel A, for TRACE-eligible bonds that are not covered by the FISD database, we report average daily statistics for the portion of bonds with trades, the number of trades, and par volume across sub-periods. From Table D.2 Panel A, we note that the average daily portion of bonds with trades is substantially larger during the “Post-crisis,” the “Regulatory,” and the “Post-regulatory” sub-period than earlier sub-periods. During the “TRACE Phase-in,” the “Pre-crisis,” and “Crisis” sub-period, the average daily portion of bonds with trade is at most 0.3% whereas the average daily portion of bonds with trades is at least 2.2% and as large as 8.4% during the “Post-crisis” and the “Regulatory” subperiod, respectively. Furthermore, we observe substantially larger average daily trade count and par volume for TRACE-eligible bonds with no coverage in the FISD database during the “Post-crisis,” the “Regulatory,” and the “Post-regulatory” sub-period than earlier sub-periods. Based on our comparative analysis on trading activity statistics for TRACE-eligible bonds with no coverage in the FISD database across sub-periods, the exclusion of

TRACE-eligible bonds that are not covered by the FISD database from our liquidity analysis is less likely to bias our results towards finding better liquidity in the corporate bond market for the later sub-periods, the “Post-crisis,” the “Regulatory,” and the “Post-regulatory” sub-period.

Finally, Table D.2 Panel B reports the portion (in percentage) of final sample observations with missing bond characteristics (i.e., issue size, credit quality, age (time since issuance), original maturity, and complexity features) after applying the data filters discussed above by each sub-period. From Panel B of Table D.2, we note that the portion of our final sample observations with missing bond characteristics is small for each sub-period; hence, it minimally influences distributional statistics reported throughout the sections in Part B.IV.C.

2. Transaction Cost Estimation

We closely follow the empirical design of the corporate bond transaction cost estimation method (EHP regression model) presented in Edwards, Harris, and Piwowar (2007). The EHP regression-based transaction cost estimation method controls for bond pricing factors: corporate bond market returns, duration risk, and credit risk, in estimating round-trip transaction costs for customer trades. Identification of the EHP regression model requires at least eight observations (eight trades for each corporate bond (CUSIP)). In addition, the EHP cost regression model requires at least one of each customer buy and sell trade for identification.

For EHP transaction cost estimation, in addition to all filters listed under the trade reporting error and the discretionary filters in Table D.1, we apply the following price-based filters that include criteria to remove trade reports that appear to be incorrectly reported:

- Price-based filters

(1) Remove corporate bonds trades that executed at special price using special price flag in the regulatory version of TRACE.

(2) Remove corporate bond trades executed at prices at least ten percent above or below the previous trade price in the same day.

(3) Remove corporate bond trades executed at prices at least ten percent above or below the daily median trade price.

(4) Remove corporate bond trades executed at prices at least ten percent above or below the 9-day centered median trade price.

Table D.1 reports the effects of applying the price-based filters and applying EHP transaction cost regression on our sample for each sub-period. Furthermore, in Table D.4 Panel A through Panel F, we report EHP transaction cost estimation results that include the following statistics: average transaction costs, median transaction costs, and the confidence interval for average transaction cost estimates for each sub-period.

3. FOCUS Data

FOCUS consists of Part I and Part II. We use quarterly data obtained from Part II of FOCUS reports to analyze changes in dealer inventory, dealer risk-taking, and dealer profitability over time. Our sample period spans from the first quarter of 2003 to the third quarter of 2016 (55 quarters). We use the following filters to construct our FOCUS data set:

(1) Remove observations with unknown designated examining authorities;

(2) Remove SEC identification exclusions;

(3) Remove missing dealer identifications (i.e., missing “ID8”);

(4) Remove legacy exclusions;

(5) Remove additional dealer firm-quarter observations submitted by multiple designated examining authorities; and

(6) remove duplicate observations.

Finally, we exclude dealer firms using the Alternative Net Capital (ANC) computation for at least one quarter during the sample period because such filers do not report data items that are comparable to the data items reported by other dealer firms for the duration of our sample. The dealer firms using the ANC computation also all filed FOCUS Form Part II for some quarters in our sample period prior to using the ANC computation. To mitigate the effects on data trend from discontinuing filing FOCUS Form Part II, we identify those unique dealer firms (i.e., unique variable "ID8") using the ANC computation (8 dealer firms: Goldman, Sachs & Co., Merrill Lynch, Pierce, Fenner & Smith Inc., Citigroup Global Markets Inc., Lehman Brothers Inc., Morgan Stanley & Co. LLC, J.P. Morgan Securities LLC (formerly Bear, Stearns & Co. Inc), J.P. Morgan Securities Inc., and Barclays Capital Inc.) and remove them for the duration of the sample period. Applying the above filters results in a total of 999 dealer firms and 29,027 observations (dealer firm-quarter pairs) for our final sample.

Part II of FOCUS reports includes the following sections: Statement of Financial Condition, Computation of Net Capital, and Statement of Income. For corporate obligations inventory, we use Line Item 400 (securities and spot commodities owned, at market value: corporate obligations) in the Statement of Financial Condition section. To normalize corporate obligations inventory, we divide corporate obligations inventory by total capital and allowable subordinated liabilities (Line Item 3530 in the Computation of Net Capital section). For haircuts, we use Line Item 3710 (haircuts on securities: corporate obligations) in the Computation of Net Capital section. To normalize haircuts, we divide haircuts by total securities and spot commodities owned at market value (Line Item 850 in the Statement of Financial Condition section). For gains or losses from trading in debt securities, we use Line Item 3944 (gains or losses on firm securities trading accounts from trading in debt securities) in the Statement of Income section.

Sample Composition

Table D.1. Data filters and sample composition by sub-period

			TRACE eligible bond issues with trades (count)	Number of trades (count)	Par volume (in $billion)
"TRACE Phase-in" period	Sub-period 1	Initial	34,909	24,862,674	27,832
		Trade reporting filters	34,374	18,221,833	14,975
		Discretionary filters	27,993	16,987,387	12,258
		Price-based filters	24,063	16,866,073	12,109
		After applying EHP regression	23,065	16,843,209	11,997
"Pre-crisis" period	Sub-period 2	Initial	29,048	11,036,180	12,391
		Trade reporting filters	28,438	7,898,921	7,298
		Discretionary filters	23,735	7,424,664	5,958
		Price-based filters	20,294	7,393,163	5,897
		After applying EHP regression	19,765	7,377,770	5,851
"Crisis" period	Sub-period 3	Initial	30,126	17,279,585	13,662
		Trade reporting filters	29,484	12,290,780	7,832
		Discretionary filters	25,203	11,901,803	6,713
		Price-based filters	21,342	11,632,492	6,499
		After applying EHP regression	20,569	11,608,541	6,470
"Post-crisis" period	Sub-period 4	Initial	54,348	48,749,042	39,896
		Trade reporting filters	53,759	34,592,369	21,865
		Discretionary filters	32,062	30,606,643	14,192
		Price-based filters	26,934	30,442,782	14,093
		After applying EHP regression	25,217	30,373,438	14,074
"Regulatory" period	Sub-period 5	Initial	43,973	32,031,283	29,892
		Trade reporting filters	43,360	22,707,533	16,494
		Discretionary filters	26,564	18,653,183	8,813
		Price-based filters	22,125	18,611,287	8,782
		After applying EHP regression	20,190	18,546,003	8,772
"Post-regulatory" period	Sub-period 6	Initial	49,956	37,084,671	37,205
		Trade reporting filters	49,325	26,551,653	22,221
		Discretionary filters	27,364	21,207,304	11,066
		Price-based filters	21,695	21,113,617	11,005
		After applying EHP regression	20,146	21,061,943	10,994

Source: DERA analysis

Table D.2. Panel A. Trading activity for TRACE-eligible bonds with no coverage in the FISD database

		Number of TRACE eligible bond issues (CUSIPs)	TRACE eligible bond issues with trades (%)	Number of trades (counts)	Par volume (in $billion)
"TRACE Phase-in" period	Sub-period 1	21,022	0.3	176	0.1
"Pre-crisis" period	Sub-period 2	28,740	0.1	108	0.1
"Crisis" period	Sub-period 3	8,099	0.3	81	0.1
"Post-crisis" period	Sub-period 4	16,513	2.2	1,449	0.9
"Regulatory" period	Sub-period 5	7,212	8.4	3,435	2.6
"Post-regulatory" period	Sub-period 6	11,349	7.4	4,202	3.7

Table D.2. Panel B. Observations in the final sample with missing bond characteristics

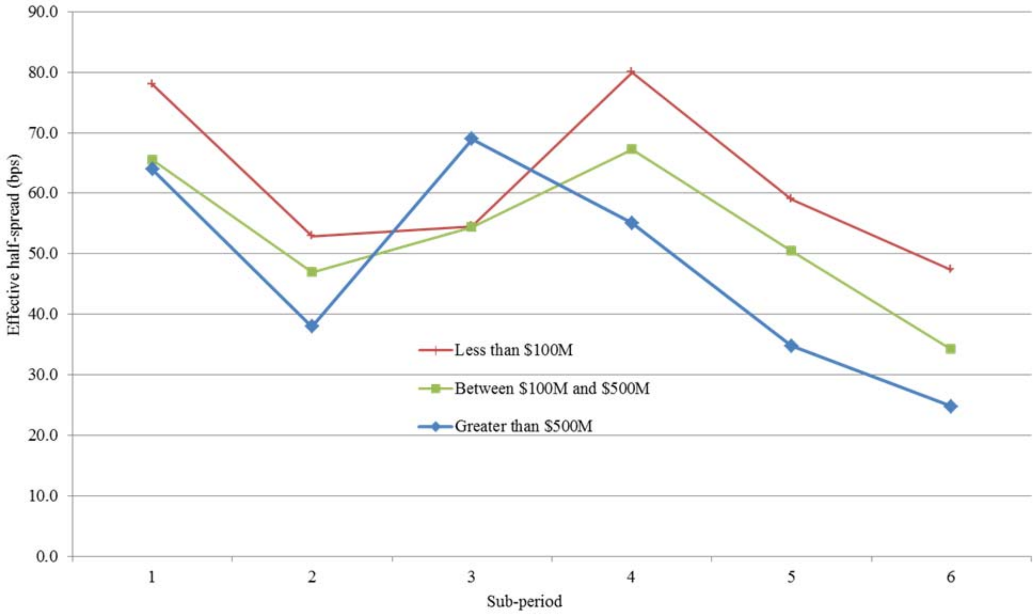
		Obervations with missing bond characteristics (%)						
		After dropping Rule 144A issues and issues with no FISD coverage	After applying the trade reporting and the discretionary filters			After applying the trade reporting, the discretionary, and the price-based filters		
		TRACE eligible bond issues	TRACE eligible bond issues with trades	Trades	Par volume	TRACE eligible bond issues with trades	Trades	Par volume
"TRACE Phase-in" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	6.1	0.2	0.0	0.1	0.1	0.0	0.1
	Age	0.5	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	0.5	0.0	0.0	0.0	0.0	0.0	0.0
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
"Pre-crisis" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	5.3	0.0	0.0	0.0	0.0	0.0	0.0
	Age	2.3	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	2.3	0.0	0.0	0.1	0.0	0.0	0.1
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
"Crisis" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Age	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
"Post-crisis" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Age	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	0.1	0.0	0.0	0.1	0.0	0.0	0.1
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
"Regulatory" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Age	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0
"Post-regulatory" period	Issue size	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Credit quality	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Age	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Maturity	0.1	0.1	0.1	0.3	0.1	0.1	0.3
	Complexity	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: DERA analysis

Transaction Costs

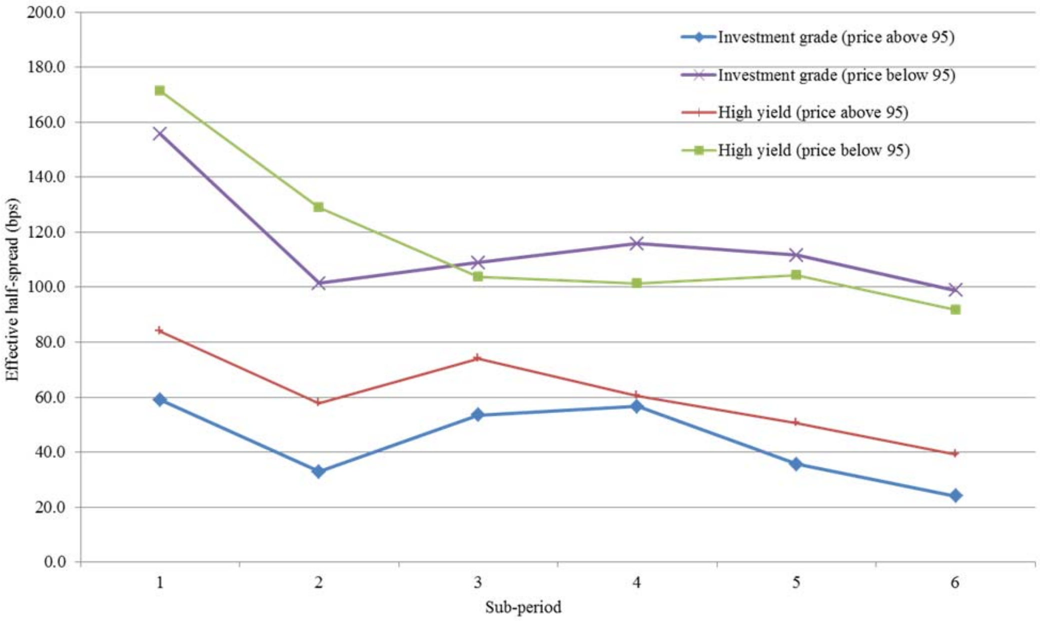
Figure D.1. Cross-sectional EHP average transaction costs

Panel A. By issue size ($20,000 trade size)



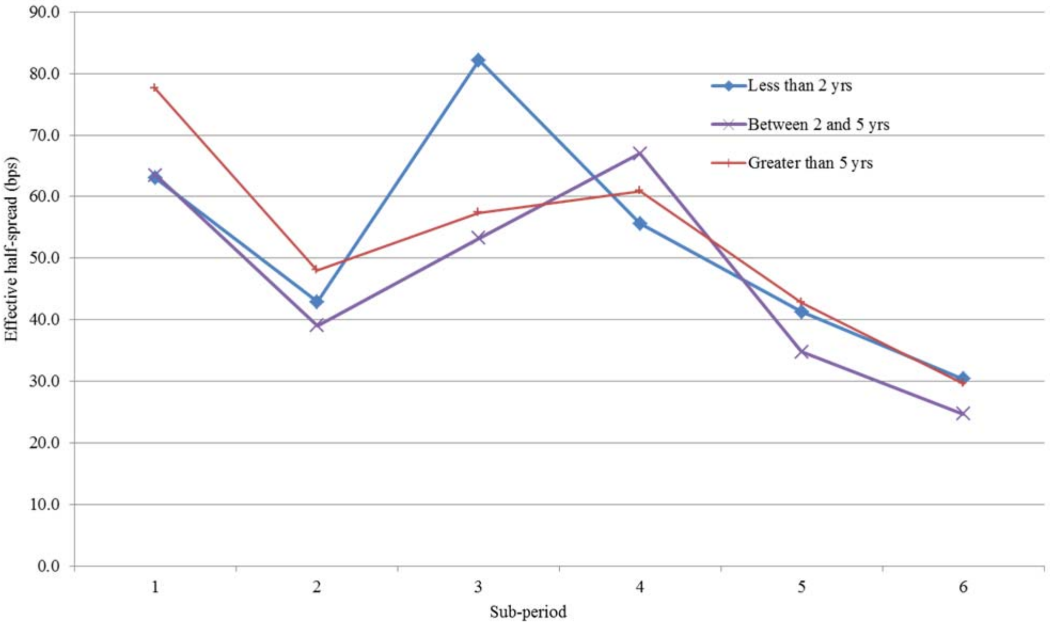
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel B. By credit quality ($20,000 trade size)



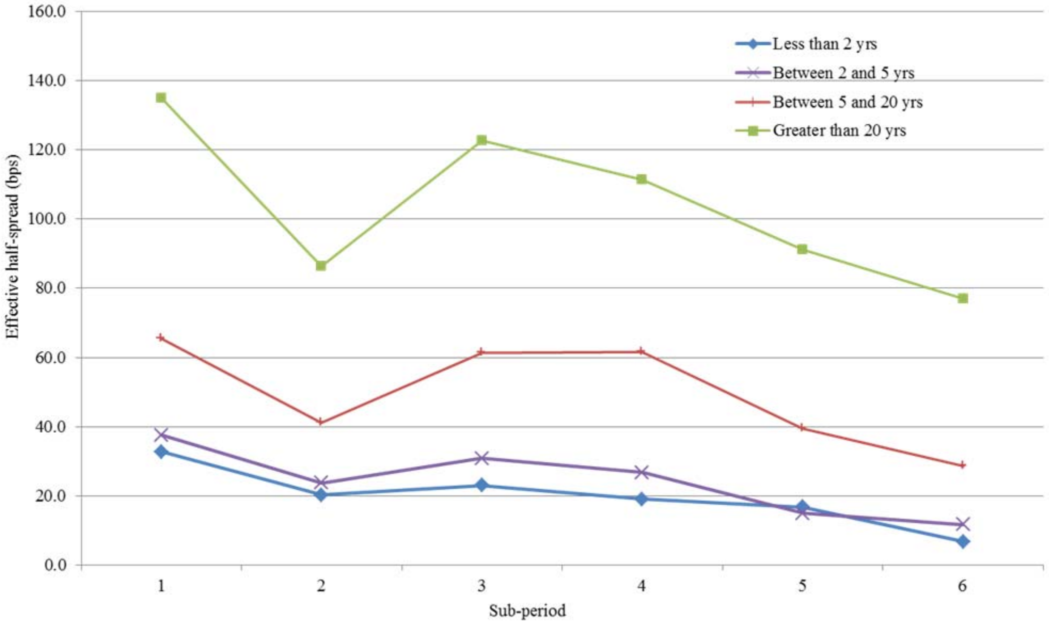
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel C. By age ($20,000 trade size)



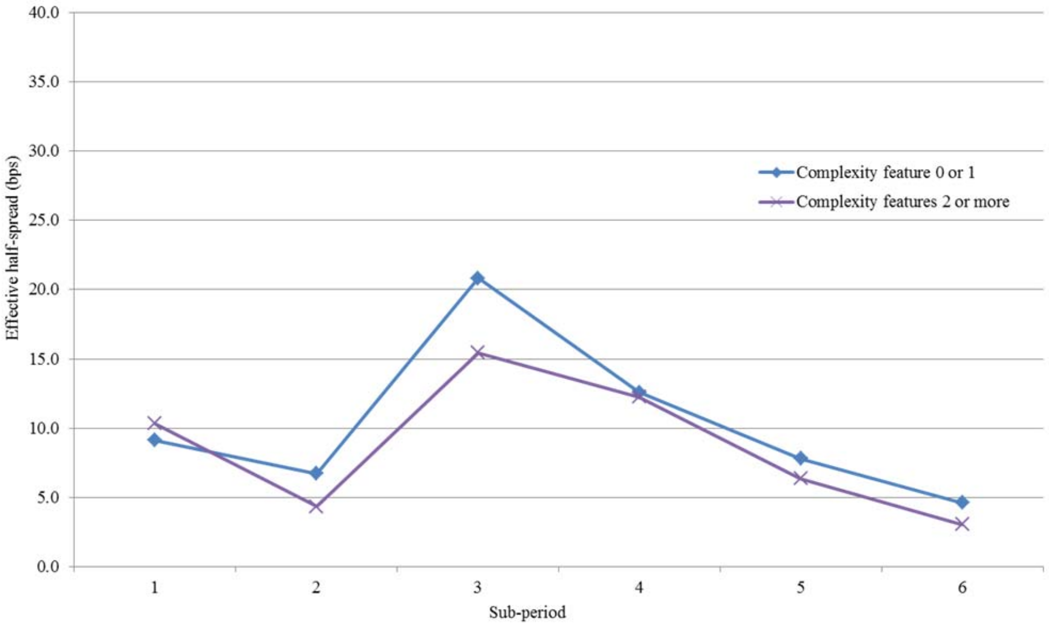
Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Panel D. By maturity ($20,000 trade size)



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Figure D.2. Cross-sectional EHP average transaction costs. By complexity ($1,000,000 trade size)



Note: Sub-period 1 – “TRACE Phase-in”; Sub-period 2 – “Pre-Crisis”; Sub-period 3 – “Crisis”; Sub-period 4 – “Post-crisis”; Sub-period 5 – “Regulatory”; Sub-period 6 – “Post-regulatory”

Source: DERA analysis

Table D.3. Zero commission vs. non-zero commission customer agency trades

			Dealer capacity	
			Agency	
			zero commission	non-zero commission
"TRACE Phase-in" period	Sub-period 1	Customer trade count	1,297	324
		Portion (%) of total customer trades	8.0	2.0
		Trade size	(%)	(%)
		<$100,000	83.8	88.8
		$100,000 - $1,000,000	11.1	9.2
		$1,000,000 - $5,000,000	3.5	1.7
		>$5,000,000	1.6	0.2
"Pre-crisis" period	Sub-period 2	Customer trade count	1,301	313
		Portion (%) of total customer trades	10.0	2.4
		Trade size	(%)	(%)
		<$100,000	87.3	88.3
		$100,000 - $1,000,000	9.8	9.4
		$1,000,000 - $5,000,000	1.8	2.0
		>$5,000,000	1.0	0.2
"Crisis" period	Sub-period 3	Customer trade count	1,969	526
		Portion (%) of total customer trades	12.1	3.2
		Trade size	(%)	(%)
		<$100,000	93.1	89.7
		$100,000 - $1,000,000	5.5	8.8
		$1,000,000 - $5,000,000	0.8	1.4
		>$5,000,000	0.6	0.1
"Post-crisis" period	Sub-period 4	Customer trade count	2,697	708
		Portion (%) of total customer trades	12.1	3.2
		Trade size	(%)	(%)
		<$100,000	93.2	89.7
		$100,000 - $1,000,000	5.7	8.5
		$1,000,000 - $5,000,000	0.9	1.6
		>$5,000,000	0.2	0.2
"Regulatory" period	Sub-period 5	Customer trade count	3,412	708
		Portion (%) of total customer trades	15.3	3.2
		Trade size	(%)	(%)
		<$100,000	90.7	88.9
		$100,000 - $1,000,000	7.3	9.3
		$1,000,000 - $5,000,000	1.5	1.6
		>$5,000,000	0.5	0.2
"Post-regulatory" period	Sub-period 6	Customer trade count	3,725	742
		Portion (%) of total customer trades	16.6	3.3
		Trade size	(%)	(%)
		<$100,000	89.2	86.6
		$100,000 - $1,000,000	8.2	10.9
		$1,000,000 - $5,000,000	2.0	2.2
		>$5,000,000	0.6	0.3

Source: DERA analysis

Table D.4. Panel A. EHP transaction costs. “TRACE Phase-in” sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	82.8	67.8	82.1	83.5
10	76.5	61.5	76.1	77.0
20	66.2	52.0	65.8	66.5
50	48.3	36.5	47.9	48.6
100	35.4	25.3	35.1	35.8
200	25.2	17.5	24.8	25.6
500	14.9	10.3	14.4	15.4
1000	9.2	6.2	8.7	9.8
2000	5.6	3.5	5.0	6.2
5000	3.2	1.4	2.2	4.2
10000	5.3	2.7	2.9	7.6

Table D.4. Panel B. EHP transaction costs. “Pre-crisis” sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	58.3	44.0	57.5	59.0
10	52.5	39.0	52.1	53.0
20	43.2	31.2	42.8	43.5
50	30.2	21.2	29.9	30.5
100	22.8	16.0	22.4	23.1
200	16.7	11.7	16.3	17.0
500	10.2	7.0	9.7	10.6
1000	6.4	4.2	5.9	6.9
2000	4.1	2.6	3.6	4.7
5000	2.9	1.7	2.1	3.8
10000	4.0	2.2	2.1	5.9

Table D.4. Panel C. EHP transaction costs. “Crisis” sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	77.8	69.4	76.8	78.7
10	70.4	61.5	69.8	71.0
20	62.4	55.1	62.0	62.9
50	51.2	44.7	50.7	51.6
100	42.6	36.1	42.0	43.1
200	34.8	28.9	34.1	35.5
500	25.7	20.8	24.8	26.5
1000	19.9	16.2	19.0	20.9
2000	15.5	12.8	14.5	16.6
5000	12.1	9.7	10.2	13.9
10000	11.3	7.6	7.4	15.2

Table D.4. Panel D. EHP transaction costs. “Post-crisis” sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	67.8	60.9	67.6	68.1
10	65.5	58.2	65.4	65.7
20	60.4	52.6	60.3	60.6
50	47.3	39.9	47.2	47.4
100	36.2	29.5	36.1	36.4
200	27.0	21.7	26.9	27.2
500	17.9	14.0	17.7	18.1
1000	12.6	9.7	12.3	12.8
2000	8.4	6.4	8.1	8.7
5000	5.8	4.5	5.3	6.2
10000	6.3	4.5	5.2	7.5

Table D.4. Panel E. EHP transaction costs. "Regulatory" sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	43.5	33.7	43.2	43.7
10	43.0	30.9	42.8	43.1
20	39.8	27.1	39.7	39.9
50	30.5	19.7	30.4	30.6
100	22.8	14.8	22.7	22.9
200	16.7	11.3	16.6	16.8
500	11.0	7.9	10.8	11.1
1000	7.7	5.8	7.6	7.9
2000	5.3	4.3	5.2	5.5
5000	4.4	3.5	4.1	4.8
10000	5.9	4.0	5.1	6.8

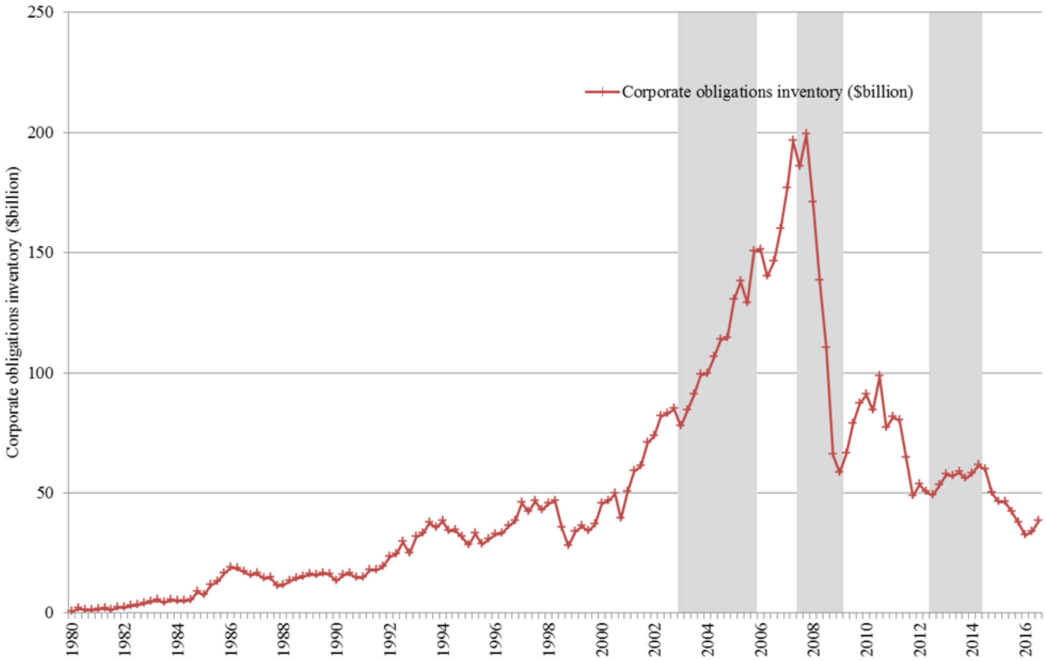
Table D.4. Panel F. EHP transaction Costs. "Post-regulatory" sub-period

Trade size (in thousand)	Effective half-spread Weighted average cost (bps)	Effective half-spread Median cost (bps)	Weighted lower confidence limit of weighted average	Weighted upper confidence limit of weighted average
5	31.0	22.1	30.9	31.1
10	30.5	20.3	30.4	30.6
20	27.7	17.7	27.6	27.7
50	21.0	13.3	20.9	21.0
100	15.4	9.6	15.4	15.5
200	11.0	6.9	10.9	11.0
500	6.8	4.4	6.7	6.8
1000	4.5	3.1	4.4	4.6
2000	3.0	2.2	2.9	3.1
5000	2.8	1.9	2.7	3.0
10000	4.3	2.2	3.9	4.7

Source: DERA analysis

Dealer Activity

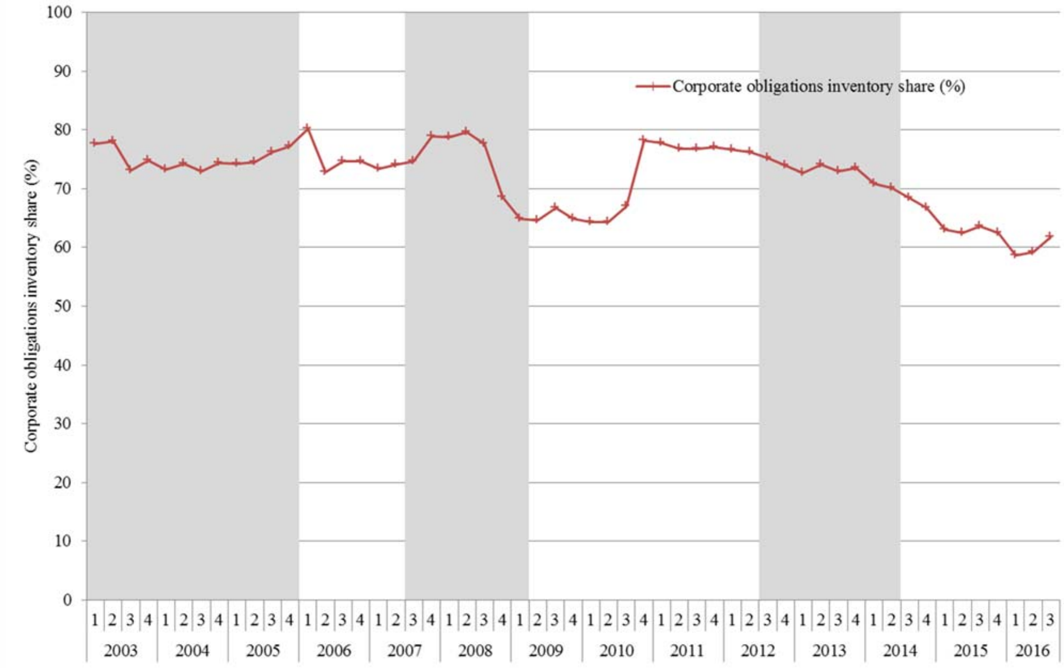
Figure D.3. Corporate obligations inventory, excluding ANC filers



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"

Source: DERA analysis

Figure D.4. Share of aggregate (non-ANC sample) corporate obligations inventory. Top 25 constant dealer sample



Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations – for the Top 25 Constant Dealer Sample relative to the Non-ANC Sample. 1Q 2003 – 4Q 2005 (shaded) – "TRACE Phase-in"; 1Q 2006 – 2Q 2007 (non-shaded) – "Pre-crisis"; 3Q 2007 – 1Q 2009 (shaded) – "Crisis"; 2Q 2009 – 2Q 2012 (non-shaded) – "Post-crisis"; 3Q 2012 – 2Q 2014 (shaded) – "Regulatory"; 3Q 2014 – 3Q 2016 (non-shaded) – "Post-regulatory"

Source: DERA analysis

Table D.5. Panel A. Corporate obligations inventory, excluding ANC filers

			Distributions, by sub-periods ($million)							
	Number of dealer firms	Number of observations	Mean	1st percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	99th percentile
"TRACE Phase-in" period	715	7,071	188.6	0.0	0.0	0.0	0.0	0.0	14.8	3,219
"Pre-crisis" period	621	3,393	285.9	0.0	0.0	0.0	0.0	0.0	20.2	8,116
"Crisis" period	600	3,826	242.8	0.0	0.0	0.0	0.0	0.0	11.3	5,000
"Post-crisis" period	620	6,689	143.8	0.0	0.0	0.0	0.0	0.0	28.9	4,668
"Regulatory" period	533	3,829	117.6	0.0	0.0	0.0	0.0	0.0	50.1	3,569
"Post-regulatory" period	524	4,219	91.4	0.0	0.0	0.0	0.0	0.0	42.1	2,621

Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. "TRACE Phase-in" period – 1Q 2003 – 4Q 2005; "Pre-crisis" period – 1Q 2006 – 2Q 2007; "Crisis" period – 3Q 2007 – 1Q 2009; "Post-crisis" period – 2Q 2009 – 2Q 2012; "Regulatory" period – 3Q 2012 – 2Q 2014; "Post-regulatory" period – 3Q 2014 – 3Q 2016

Table D.5. Panel B. Corporate obligations inventory by affiliation. Top 25 constant dealer sample

					Distributions, by sub-periods ($million)					
		Affiliation	Number of dealer firms	Number of observations	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile
"TRACE Phase-in" period	Top 25	Non-BHC	18	216	117.8	0.0	0.7	13.0	83.5	280.1
		BHC	30	360	2,708	0.0	0.0	43.4	445.4	6,978
	Non-Top 25		667	6,495	51.3	0.0	0.0	0.0	0.0	2.2
"Pre-crisis" period	Top 25	Non-BHC	18	108	198.7	0.0	0.0	28.0	72.5	789.5
		BHC	30	180	3,920	0.0	0.0	20.5	738.0	16,954
	Non-Top 25		573	3,105	78.3	0.0	0.0	0.0	0.0	2.2
"Crisis" period	Top 25	Non-BHC	18	126	109.2	0.0	0.4	12.2	49.5	103.7
		BHC	30	210	3,314	0.0	0.7	43.9	382.0	8,925
	Non-Top 25		552	3,490	62.8	0.0	0.0	0.0	0.0	0.7
"Post-crisis" period	Top 25	Non-BHC	18	234	425.1	0.0	10.2	48.0	247.5	1,993
		BHC	30	390	1,495	0.0	4.9	93.4	560.3	6,331
	Non-Top 25		572	6,065	46.0	0.0	0.0	0.0	0.0	2.9
"Regulatory" period	Top 25	Non-BHC	18	144	438.5	0.0	1.5	46.6	125.3	2,326
		BHC	30	240	1,104	0.0	9.5	180.5	860.1	3,544
	Non-Top 25		485	3,445	35.5	0.0	0.0	0.0	0.0	3.9
"Post-regulatory" period	Top 25	Non-BHC	18	162	344.2	0.0	0.0	21.6	148.7	984
		BHC	30	270	700.4	0.0	14.1	105.5	759.5	1,398
	Non-Top 25		476	3,787	37.2	0.0	0.0	0.0	0.0	2.3

Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 400 – securities and spot commodities owned, at market value: corporate obligations. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. "TRACE Phase-in" period – 1Q 2003 – 4Q 2005; "Pre-crisis" period – 1Q 2006 – 2Q 2007; "Crisis" period – 3Q 2007 – 1Q 2009; "Post-crisis" period – 2Q 2009 – 2Q 2012; "Regulatory" period – 3Q 2012 – 2Q 2014; "Post-regulatory" period – 3Q 2014 – 3Q 2016

Source: DERA analysis

Table D.6. Panel A. Haircuts, excluding ANC filers

			Distributions, by sub-periods ($million)							
	Number of dealer firms	Number of observations	Mean	1st percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	99th percentile
"TRACE Phase-in" period	715	7,071	13.6	0.0	0.0	0.0	0.0	0.0	1.6	211.6
"Pre-crisis" period	621	3,393	19.7	0.0	0.0	0.0	0.0	0.0	1.9	316.2
"Crisis" period	600	3,826	18.9	0.0	0.0	0.0	0.0	0.0	1.2	408.3
"Post-crisis" period	620	6,689	12.0	0.0	0.0	0.0	0.0	0.0	3.1	374.7
"Regulatory" period	533	3,829	9.8	0.0	0.0	0.0	0.0	0.0	4.3	303.6
"Post-regulatory" period	524	4,219	8.9	0.0	0.0	0.0	0.0	0.0	4.7	284.5

Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3710 – haircuts on securities: corporate obligations. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. "TRACE Phase-in" period – 1Q 2003 – 4Q 2005; "Pre-crisis" period – 1Q 2006 – 2Q 2007; "Crisis" period – 3Q 2007 – 1Q 2009; "Post-crisis" period – 2Q 2009 – 2Q 2012; "Regulatory" period – 3Q 2012 – 2Q 2014; "Post-regulatory" period – 3Q 2014 – 3Q 2016

Table D.6. Panel B. Haircuts by affiliation. Top 25 constant dealer sample

					Distributions, by sub-periods ($million)					
		Affiliation	Number of dealer firms	Number of observations	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile
"TRACE Phase-in" period	Top 25	Non-BHC	18	216	7.9	0.0	0.1	1.6	7.5	25.4
		BHC	30	360	188.8	0.0	0.0	3.5	48.2	393.8
	Non-Top 25		667	6,495	4.1	0.0	0.0	0.0	0.0	0.3
"Pre-crisis" period	Top 25	Non-BHC	18	108	9.7	0.0	0.0	2.7	7.8	30.5
		BHC	30	180	263.3	0.0	0.0	1.7	57.4	763.5
	Non-Top 25		573	3,105	6.0	0.0	0.0	0.0	0.0	0.2
"Crisis" period	Top 25	Non-BHC	18	126	6.0	0.0	0.0	1.0	4.8	10.8
		BHC	30	210	254.6	0.0	0.2	5.8	39.7	410.1
	Non-Top 25		552	3,490	5.2	0.0	0.0	0.0	0.0	0.1
"Post-crisis" period	Top 25	Non-BHC	18	234	32.6	0.0	0.7	4.5	22.9	131.5
		BHC	30	390	121.6	0.0	0.5	9.7	41.0	398.4
	Non-Top 25		572	6,065	4.2	0.0	0.0	0.0	0.0	0.3
"Regulatory" period	Top 25	Non-BHC	18	144	35.1	0.0	0.1	4.1	17.0	152.4
		BHC	30	240	86.0	0.0	0.7	13.9	67.2	266.6
	Non-Top 25		485	3,445	3.4	0.0	0.0	0.0	0.0	0.4
"Post-regulatory" period	Top 25	Non-BHC	18	162	33.2	0.0	0.0	2.7	11.0	160.3
		BHC	30	270	71.3	0.0	1.3	15.7	64.8	211.7
	Non-Top 25		476	3,787	3.5	0.0	0.0	0.0	0.0	0.3

Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3710 – haircuts on securities: corporate obligations. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. "TRACE Phase-in" period – 1Q 2003 – 4Q 2005; "Pre-crisis" period – 1Q 2006 – 2Q 2007; "Crisis" period – 3Q 2007 – 1Q 2009; "Post-crisis" period – 2Q 2009 – 2Q 2012; "Regulatory" period – 3Q 2012 – 2Q 2014; "Post-regulatory" period – 3Q 2014 – 3Q 2016

Source: DERA analysis

Table D.7. Panel A. Gains or losses from trading in debt securities, excluding ANC filers

			Distributions, by sub-periods ($million)							
	Number of dealer firms	Number of observations	Mean	1st percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	99th percentile
"TRACE Phase-in" period	715	7,071	2.5	-8.0	0.0	0.0	0.0	0.0	3.3	70.2
"Pre-crisis" period	621	3,393	2.6	-5.0	0.0	0.0	0.0	0.0	3.0	81.3
"Crisis" period	600	3,826	-13.0	-170.5	0.0	0.0	0.0	0.0	3.0	63.1
"Post-crisis" period	620	6,689	2.1	-22.8	0.0	0.0	0.0	0.0	4.5	95.6
"Regulatory" period	533	3,829	0.8	-34.7	0.0	0.0	0.0	0.1	3.7	69.4
"Post-regulatory" period	524	4,219	0.4	-31.3	0.0	0.0	0.0	0.0	3.4	39.7

Note: Data represent quarterly broker-dealers' responses to FOCUS Form Part II, Line Item 3944 – gains or losses on firm securities trading accounts from trading in debt securities. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. "TRACE Phase-in" period – 1Q 2003 – 4Q 2005; "Pre-crisis" period – 1Q 2006 – 2Q 2007; "Crisis" period – 3Q 2007 – 1Q 2009; "Post-crisis" period – 2Q 2009 – 2Q 2012; "Regulatory" period – 3Q 2012 – 2Q 2014; "Post-regulatory" period – 3Q 2014 – 3Q 2016

Table D.7. Panel B. Gains or losses from trading in debt securities by affiliation. Top 25 constant dealer sample

					Distributions, by sub-periods ($million)					
		Affiliation	Number of dealer firms	Number of observations	Mean	10th percentile	25th percentile	Median	75th percentile	90th percentile
"TRACE Phase-in" period	Top 25	Non-BHC	18	216	2.2	0.0	0.0	1.6	10.3	16.1
		BHC	30	360	26.8	-0.5	0.0	0.9	11.5	87.2
	Non-Top 25		667	6,495	1.2	0.0	0.0	0.0	0.0	1.6
"Pre-crisis" period	Top 25	Non-BHC	18	108	4.5	0.0	0.0	1.5	8.8	15.9
		BHC	30	180	16.8	-1.4	0.0	0.9	9.3	77.5
	Non-Top 25		573	3,105	1.7	0.0	0.0	0.0	0.0	1.4
"Crisis" period	Top 25	Non-BHC	18	126	6.4	0.0	0.0	0.7	5.2	24.3
		BHC	30	210	-231.0	-334.7	0.0	0.1	8.4	49.3
	Non-Top 25		552	3,490	-0.6	0.0	0.0	0.0	0.0	1.5
"Post-crisis" period	Top 25	Non-BHC	18	234	0.5	0.0	0.0	2.3	9.4	33.3
		BHC	30	390	6.4	-7.4	0.0	0.7	16.0	111.9
	Non-Top 25		572	6,065	1.9	0.0	0.0	0.0	0.0	2.1
"Regulatory" period	Top 25	Non-BHC	18	144	-2.2	-11.9	0.0	0.2	5.9	25.5
		BHC	30	240	-0.2	-18.5	0.0	0.5	13.2	88.8
	Non-Top 25		485	3,445	1.0	0.0	0.0	0.0	0.0	2.1
"Post-regulatory" period	Top 25	Non-BHC	18	162	-7.9	-10.1	0.0	0.4	5.1	23.1
		BHC	30	270	0.3	-8.8	-0.7	0.0	12.3	37.2
	Non-Top 25		476	3,787	0.8	0.0	0.0	0.0	0.0	1.8

Note: Data represent quarterly broker-dealers’ responses to FOCUS Form Part II, Line Item 3944 – gains or losses on firm securities trading accounts from trading in debt securities. The number of observations corresponds to the number of dealer firm-quarter pairs in each sub-period. “TRACE Phase-in” period – 1Q 2003 – 4Q 2005; “Pre-crisis” period – 1Q 2006 – 2Q 2007; “Crisis” period – 3Q 2007 – 1Q 2009; “Post-crisis” period – 2Q 2009 – 2Q 2012; “Regulatory” period – 3Q 2012 – 2Q 2014; “Post-regulatory” period – 3Q 2014 – 3Q 2016

Source: DERA analysis

Table D.8. Panel A. Trade size by issue size

	Average daily trade count & par volume					
	Less than $100M		Between $100M and $500M		Greater than $500M	
	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)
"TRACE Phase-in" period	2,336	0.2	6,176	5.2	5,988	6.9
Portion (%)	16.1	1.3	42.6	42.3	41.3	56.4
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	93.2	26.9	59.3	1.6	60.5	1.3
$100,000 - $1,000,000	5.5	17.4	17.5	6.8	17.9	4.8
$1,000,000 - $5,000,000	1.1	27.9	18.4	42.2	13.7	24.5
>$5,000,000	0.3	27.8	4.8	49.4	8.0	69.4
"Pre-crisis" period	2,072	0.1	4,637	5.0	4,709	6.7
Portion (%)	18.1	1.0	40.6	42.1	41.2	56.9
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	93.6	31.2	54.8	1.2	56.8	1.0
$100,000 - $1,000,000	5.3	19.0	17.6	5.4	19.5	4.3
$1,000,000 - $5,000,000	0.9	27.1	21.1	40.2	13.8	20.8
>$5,000,000	0.2	22.6	6.5	53.2	9.9	73.9
"Crisis" period	1,612	0.1	4,276	3.7	7,848	7.4
Portion (%)	14.1	0.9	37.4	32.9	68.7	66.2
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	93.3	31.5	61.1	1.7	63.6	1.7
$100,000 - $1,000,000	5.7	20.6	16.2	6.1	17.4	5.4
$1,000,000 - $5,000,000	0.9	26.2	17.4	39.8	11.7	24.2
>$5,000,000	0.2	21.7	5.4	52.4	7.3	68.8
"Post-crisis" period	2,421	0.1	6,192	3.8	10,313	9.3
Portion (%)	12.8	1.0	32.7	28.5	54.5	70.6
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	93.3	35.0	67.3	2.6	61.0	1.7
$100,000 - $1,000,000	5.8	23.5	16.9	9.0	21.4	7.4
$1,000,000 - $5,000,000	0.7	23.1	12.3	41.2	11.8	27.5
>$5,000,000	0.1	18.4	3.5	47.2	5.8	63.4
"Regulatory" period	1,575	0.1	5,950	3.5	10,688	9.8
Portion (%)	8.6	0.7	32.7	26.4	58.7	72.9
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	90.8	32.3	64.9	2.7	56.2	1.7
$100,000 - $1,000,000	8.2	27.3	19.7	10.8	24.9	9.0
$1,000,000 - $5,000,000	0.9	23.8	12.2	41.8	13.2	30.6
>$5,000,000	0.2	16.6	3.2	44.7	5.6	58.8
"Post-regulatory" period	1,043	0.1	5,353	3.5	11,529	11.1
Portion (%)	5.8	0.6	29.9	23.7	64.3	75.7
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	89.5	24.7	62.1	2.4	53.4	1.5
$100,000 - $1,000,000	9.0	24.4	21.4	10.8	26.5	9.0
$1,000,000 - $5,000,000	1.2	26.7	13.0	40.8	14.2	31.3
>$5,000,000	0.3	24.3	3.5	46.0	6.0	58.2

Table D.8. Panel B. Trade size by credit quality

	Average daily trade count & par volume			
	Investment grade		High yield	
	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)
"TRACE Phase-in" period	10,683	8.4	3,810	3.9
Portion (%)	73.7	68.2	26.3	31.8
Trade size	(%)	(%)	(%)	(%)
<$100,000	71.6	2.1	47.9	1.1
$100,000 - $1,000,000	15.0	5.7	17.5	6.0
$1,000,000 - $5,000,000	7.9	21.3	29.6	55.3
>$5,000,000	5.5	71.0	5.0	37.6
"Pre-crisis" period	7,093	7.4	4,325	4.5
Portion (%)	62.1	62.4	37.9	37.6
Trade size	(%)	(%)	(%)	(%)
<$100,000	67.0	1.5	55.2	1.3
$100,000 - $1,000,000	17.0	5.0	14.8	4.9
$1,000,000 - $5,000,000	8.8	18.3	23.7	46.9
>$5,000,000	7.2	75.2	6.3	46.9
"Crisis" period	10,749	7.3	2,988	3.9
Portion (%)	78.3	64.9	21.8	35.1
Trade size	(%)	(%)	(%)	(%)
<$100,000	72.2	2.5	48.3	0.9
$100,000 - $1,000,000	15.5	6.4	16.1	4.4
$1,000,000 - $5,000,000	7.3	21.5	27.5	43.7
>$5,000,000	5.0	69.5	8.1	51.0
"Post-crisis" period	13,916	9.0	5,010	4.3
Portion (%)	73.5	67.8	26.5	32.2
Trade size	(%)	(%)	(%)	(%)
<$100,000	69.4	2.6	60.8	1.7
$100,000 - $1,000,000	18.6	8.7	16.3	6.4
$1,000,000 - $5,000,000	8.0	25.7	17.8	43.3
>$5,000,000	4.0	63.0	5.1	48.6
"Regulatory" period	12,982	9.5	5,231	3.9
Portion (%)	71.3	70.8	28.7	29.2
Trade size	(%)	(%)	(%)	(%)
<$100,000	62.8	2.3	60.3	2.1
$100,000 - $1,000,000	22.6	9.9	19.8	8.9
$1,000,000 - $5,000,000	10.2	29.3	15.8	43.8
>$5,000,000	4.5	58.5	4.1	45.2
"Post-regulatory" period	12,516	10.2	5,408	4.5
Portion (%)	69.8	69.6	30.2	30.4
Trade size	(%)	(%)	(%)	(%)
<$100,000	59.0	2.0	55.9	1.8
$100,000 - $1,000,000	24.9	9.9	21.7	8.7
$1,000,000 - $5,000,000	11.1	28.7	17.8	44.5
>$5,000,000	5.1	59.5	4.6	45.0

Table D.8. Panel C. Trade size by age

	Average daily trade count & par volume					
	Less than 2 years		Between 2 years and 5 years		Greater than 5 years	
	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)
"TRACE Phase-in" period	5,912	6.2	5,240	4.5	3,348	1.7
Portion (%)	40.8	50.0	36.1	36.3	23.1	13.7
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	62.2	1.4	63.5	1.7	73.1	3.3
$100,000 - $1,000,000	15.9	4.8	16.6	6.2	14.0	8.4
$1,000,000 - $5,000,000	15.1	29.0	14.5	33.9	10.0	39.1
>$5,000,000	6.8	64.8	5.4	58.1	2.9	49.2
"Pre-crisis" period	3,428	5.9	5,157	4.0	2,833	2.0
Portion (%)	30.0	49.9	45.2	33.5	24.8	16.6
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	49.3	0.7	67.6	2.0	69.8	2.4
$100,000 - $1,000,000	18.1	3.5	15.7	6.3	14.8	6.5
$1,000,000 - $5,000,000	20.9	25.7	12.0	32.3	11.0	33.2
>$5,000,000	11.8	70.1	4.8	59.4	4.4	57.9
"Crisis" period	4,942	5.8	4,687	3.4	4,108	2.0
Portion (%)	36.0	51.5	34.1	30.7	29.9	17.8
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	58.6	1.2	67.8	2.3	75.0	3.6
$100,000 - $1,000,000	16.5	4.5	15.9	6.6	14.0	8.1
$1,000,000 - $5,000,000	16.1	27.0	11.8	33.2	7.6	30.7
>$5,000,000	8.9	67.3	4.5	58.0	3.4	57.5
"Post-crisis" period	6,823	6.6	6,252	4.4	5,850	2.3
Portion (%)	36.1	49.7	33.0	33.1	30.9	17.2
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	58.1	1.6	66.9	2.2	77.9	4.4
$100,000 - $1,000,000	21.5	7.2	18.2	8.0	13.8	10.3
$1,000,000 - $5,000,000	14.2	30.5	10.8	32.2	6.1	32.5
>$5,000,000	6.3	60.7	4.1	57.6	2.2	52.8
"Regulatory" period	7,509	7.3	5,735	3.8	4,970	2.3
Portion (%)	41.2	54.3	31.5	28.7	27.3	17.0
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	54.0	1.6	63.2	2.4	72.8	3.7
$100,000 - $1,000,000	24.4	8.5	22.1	10.6	17.5	11.6
$1,000,000 - $5,000,000	15.5	33.6	11.0	34.1	7.2	32.6
>$5,000,000	6.1	56.3	3.7	52.9	2.6	52.1
"Post-regulatory" period	6,761	7.5	6,853	5.0	4,309	2.2
Portion (%)	37.7	51.2	38.2	33.8	24.0	15.0
Trade size	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	49.3	1.3	60.2	2.2	68.6	3.2
$100,000 - $1,000,000	26.6	8.2	23.5	10.4	20.4	12.2
$1,000,000 - $5,000,000	16.9	32.4	12.3	35.3	8.2	33.4
>$5,000,000	7.1	58.1	4.0	52.1	2.8	51.2

Table D.8. Panel D. Trade size by maturity

	Average daily trade count & par volume							
	Less than 2 yrs		Between 2 yrs and 5 yrs		Between 5 yrs and 20 yrs		Greater than 20 yrs	
	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)
"TRACE Phase-in" period	46	0.1	1,084	1.5	10,601	8.3	2,768	2.4
Portion (%)	0.3	0.7	7.5	12.5	73.1	67.5	19.1	19.3
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	77.9	8.4	62.1	1.1	64.2	1.9	71.2	1.8
$100,000 - $1,000,000	9.7	8.3	17.2	3.9	16.8	6.7	11.0	4.1
$1,000,000 - $5,000,000	5.1	15.4	13.4	20.5	14.2	35.9	11.3	28.3
>$5,000,000	7.4	68.0	7.3	74.5	4.8	55.4	6.6	65.8
"Pre-crisis" period	23	0.1	692	1.6	8,344	7.7	2,355	2.5
Portion (%)	0.2	0.5	6.1	13.4	73.1	64.7	20.6	21.3
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	65.9	5.2	54.5	0.6	61.8	1.7	67.7	1.3
$100,000 - $1,000,000	13.6	8.2	18.7	2.8	17.4	5.9	11.0	3.4
$1,000,000 - $5,000,000	8.7	17.4	15.0	14.9	14.9	33.4	12.6	25.9
>$5,000,000	11.7	69.3	11.8	81.6	5.8	59.0	8.8	69.4
"Crisis" period	35	0.1	735	1.4	10,349	7.6	2,613	2.2
Portion (%)	0.3	0.6	5.3	12.5	75.3	67.5	19.0	19.3
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	62.7	5.7	52.0	0.8	66.1	2.3	72.8	1.8
$100,000 - $1,000,000	15.5	9.9	18.5	3.3	16.7	6.7	10.3	4.4
$1,000,000 - $5,000,000	11.8	26.4	17.9	20.9	12.2	32.2	10.5	27.5
>$5,000,000	10.0	58.0	11.6	75.0	5.0	58.9	6.5	66.3
"Post-crisis" period	50	0.1	1,191	1.8	13,839	9.3	3,840	2.1
Portion (%)	0.3	0.4	6.3	13.6	73.1	70.1	20.3	15.9
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	65.1	5.8	52.2	1.0	66.5	2.4	74.3	2.8
$100,000 - $1,000,000	20.5	14.9	24.1	5.6	18.7	8.5	13.3	8.1
$1,000,000 - $5,000,000	9.0	29.2	16.3	23.9	10.6	32.7	8.7	33.2
>$5,000,000	5.4	50.1	7.4	69.6	4.2	56.4	3.7	55.9
"Regulatory" period	47	0.0	1,149	1.5	13,225	9.6	3,788	2.3
Portion (%)	0.3	0.3	6.3	11.2	72.6	71.5	20.8	17.0
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	66.2	6.3	44.1	1.0	61.8	2.3	68.3	2.9
$100,000 - $1,000,000	20.4	15.6	29.3	8.2	22.2	9.8	18.2	10.0
$1,000,000 - $5,000,000	9.2	33.7	19.8	32.1	11.8	33.9	9.6	33.7
>$5,000,000	4.2	44.5	6.9	58.8	4.3	54.0	4.0	53.4
"Post-regulatory" period	44	0.0	1,275	1.7	13,150	10.2	3,435	2.7
Portion (%)	0.2	0.3	7.1	11.5	73.4	69.6	19.2	18.4
Trade size	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
<$100,000	61.6	5.5	41.7	0.9	59.2	2.0	60.6	2.0
$100,000 - $1,000,000	24.5	17.6	30.2	8.2	23.6	9.8	22.7	9.5
$1,000,000 - $5,000,000	9.2	30.7	21.1	33.2	12.7	34.4	11.3	30.9
>$5,000,000	4.7	46.2	7.0	57.7	4.6	53.7	5.4	57.6

Table D.8. Panel E. Trade size by complexity

	Average daily trade count & par volume			
	Complexity feature 0 or 1		Complexity features 2 or more	
	Trade (count)	Par volume (in $billion)	Trade (count)	Par volume (in $billion)
"TRACE Phase-in" period	12,473	9.3	2,027	3.0
Portion (%)	86	75.4	14	24.6
Trade size	(%)	(%)	(%)	(%)
<$100,000	66.1	2.1	61.7	0.9
$100,000 - $1,000,000	16.3	6.9	11.5	2.6
$1,000,000 - $5,000,000	12.8	34.4	18.0	25.4
>$5,000,000	4.8	56.6	8.8	71.1
"Pre-crisis" period	9,524	8.5	1,895	3.3
Portion (%)	83	72.1	17	27.9
Trade size	(%)	(%)	(%)	(%)
<$100,000	63.2	1.7	59.7	0.7
$100,000 - $1,000,000	17.1	6.0	11.6	2.3
$1,000,000 - $5,000,000	13.6	31.5	18.2	22.9
>$5,000,000	6.1	60.7	10.5	74.1
"Crisis" period	12,172	8.7	1,565	2.5
Portion (%)	89	78.0	11	22.0
Trade size	(%)	(%)	(%)	(%)
<$100,000	67.8	2.2	59.3	0.9
$100,000 - $1,000,000	16.0	6.5	12.3	2.9
$1,000,000 - $5,000,000	11.2	30.5	18.6	26.4
>$5,000,000	5.1	60.7	9.9	69.8
"Post-crisis" period	16,582	11.5	2,344	1.7
Portion (%)	88	86.9	12	13.1
Trade size	(%)	(%)	(%)	(%)
<$100,000	66.3	2.3	73.3	2.5
$100,000 - $1,000,000	18.8	8.4	12.1	5.4
$1,000,000 - $5,000,000	10.6	31.6	10.4	29.9
>$5,000,000	4.3	57.7	4.2	62.3
"Regulatory" period	16,589	12.4	1,624	1.0
Portion (%)	91	92.4	9	7.6
Trade size	(%)	(%)	(%)	(%)
<$100,000	61.3	2.1	70.0	3.0
$100,000 - $1,000,000	22.3	9.8	16.3	8.0
$1,000,000 - $5,000,000	11.9	33.5	10.4	33.9
>$5,000,000	4.5	54.6	3.3	55.1
"Post-regulatory" period	16,846	13.7	1,078	1.0
Portion (%)	94	93.4	6	6.6
Trade size	(%)	(%)	(%)	(%)
<$100,000	57.9	1.9	61.4	1.8
$100,000 - $1,000,000	24.2	9.7	19.8	7.2
$1,000,000 - $5,000,000	13.0	33.7	14.1	32.6
>$5,000,000	4.9	54.8	4.8	58.3

Source: DERA analysis

Table D.9. Amount of pre-trade information: Quote standing for at least 2 seconds

		Distribution								
		Number of Trades	Mean	5th percentile	10th percentile	25th percentile	Median	75th percentile	90th percentile	95th percentile
Issue size	Without quote	85,557	408.5	1.5	3.0	20.0	250	500	1,000	1,500
(in $million)	With quote	1,569,160	1,050.4	63.2	250	450	750	1,320	2,250	2,750
Credit quality	Without quote	85,554	NM	HY	HY	HY	HY	IG	IG	IG
	With quote	1,569,148	NM	HY	HY	HY	IG	IG	IG	IG
Age	Without quote	85,544	1.8	0.0	0.0	0.1	0.9	2.1	4.4	7.4
(in years)	With quote	1,569,130	3.8	0.2	0.4	1.3	2.6	4.8	8.1	11.4
Maturity	Without quote	85,037	10.0	1.5	3.0	4.0	7.0	10.6	21.1	30.0
(in years)	With quote	1,567,913	12.1	4.4	5.0	6.6	10.0	10.2	30.0	30.1
Complexity	Without quote	85,557	NM	0	0	0	0	1	1	1
	With quote	1,569,160	NM	0	0	0	0	0	0	1

NM – not meaningful
HY – high yield
IG – investment grade

Note: The value 0 for the complexity variable indicates that a corporate bond issue has zero or one complexity feature and the value 1 for the complexity variable indicates that a corporate bond issue has two or more complexity features.

Source: DERA analysis