

# Capital Commitment and Illiquidity in Corporate Bonds\*

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## Abstract

We study trading costs and dealer behavior in U.S. corporate bond markets from 2006 to 2016. Despite a temporary spike during the financial crisis, average trade execution costs have not increased notably over time. However, alternative measures, including dealer capital commitment over various time horizons, turnover, block trade frequency, and average trade size not only decreased during the financial crisis, but continued to decline afterward. We find that these declines are attributable to bank-affiliated dealers, as non-bank dealers have increased their market commitment. The evidence shows that liquidity provision in the corporate bond markets is evolving away from the traditional commitment of bank-affiliated dealer capital to absorb customer imbalances, and supports the interpretation that post-crisis banking regulations likely contributed.

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The liquidity of the corporate bond market has attracted substantial recent attention from practitioners, regulators, and academics. The financial crisis of 2007-2009 saw the broad deterioration of liquidity in both equity (e.g., Anand, Irvine, Puckett, and Venkataraman, 2013) and corporate bond (e.g., Dick-Nielsen, Feldhutter, and Lando, 2012; Friewald, Jankowitsch, and Subrahmanyam, 2012) markets. However, while Anand et al. (2013) find that equity market liquidity recovered after the financial crisis, concerns regarding corporate bond market liquidity appear to have become more widespread in recent years. For example, Daniel Gallagher, former Commissioner of the U.S. Securities and Exchange Commission (SEC) during 2015 expressed concern that “A lack of liquidity in corporate-bond markets could pose a ‘systemic risk’ to the economy.”<sup>i</sup> A 2016 Greenwich Associates study reports that among four hundred credit investors interviewed, more than 80% indicated that reduced liquidity in corporate bonds limits their investment strategies.<sup>ii</sup>

Concerns regarding corporate bond market liquidity have been attributed by some observers to post-crisis regulatory initiatives. For example, Pacific Investment Management Company (PIMCO) asserts that “the combination of immediate-post-crisis capital and liquidity regulations and a lower return environment has made banks less able and willing to function as market makers.”<sup>iii</sup> However, not all observers are convinced that liquidity in the corporate bond markets has deteriorated. Some assert that concerns regarding bond market liquidity comprise a “myth” and arise from traditional bond dealers’ desire to maintain their “privileged market position.”<sup>iv</sup> Janet Yellen, chair of the U.S. Federal Reserve, stated “It’s not clear whether there is or is not a problem” (with liquidity), and added that “it’s a question that needs further study.”<sup>v</sup>

Our goal in this paper is to provide an analysis of liquidity and key aspects of dealer behavior in the corporate bond market over the 2006 to 2016 period. We are particularly

interested in assessing market quality in the years following the financial crisis, and in evaluating potential explanations for the changes observed. To do so, we use an enhanced version of the TRACE database of transactions in U.S. corporate bonds, made available by FINRA. In addition to the standard TRACE data, the data we study includes masked dealer identities, which allows us to directly assess activity at the dealer level, as well as unmasked trade sizes and transactions in privately-traded 144A bonds.

We document that, despite an increase during the financial crisis period, average customer trade execution costs for corporate bonds in aggregate have not increased markedly over time. We estimate that the average one-way trade execution cost during the 2014 to 2016 period averaged 0.42%, as compared to 0.40% during the 2006 to 2007 pre-crisis period.

However, average trading costs are affected by shifts in the composition of trading. Investment-grade bonds and large-issue-size bonds, which tend to be more liquid, each grew as a proportion of overall trading, as did trades that are most likely to be facilitated by electronic venues. Further, execution costs for completed trades do not capture search costs or the implicit costs associated with trades that were desired but not completed. We therefore consider a number of additional measures, including dealers' capital commitment measured at the intraday, overnight, and weekly horizons, turnover, average trade size, block trade frequency, and principal volume.

We use the term capital commitment to refer to dealers' absorbing customer order imbalances into their own inventories. Capital commitment is particularly important to the functioning of markets where buyers and sellers arrive sporadically and search costs are relatively high. Corporate bond trading largely occurs in a telephone- and instant message-oriented dealer market with limited pre-trade transparency, and days or weeks can elapse

between trades in individual bonds. However, some corporate bond trading, particularly in recently-issued bonds of larger issue sizes, is electronically facilitated. While a decline in dealer capital commitment may indicate degraded liquidity in the overall market, a decline induced by growth in electronic trading may reflect reduced search costs that imply an improvement rather than deterioration of liquidity.

We find, not surprisingly, that all measures of dealer capital commitment declined during the financial crisis. Potentially more informative, we document that most measures of dealer commitment for the overall market did not revert to pre-crisis levels and many measures continued to decline during the most recent years. All of the measures we consider point to significantly lower dealer capital commitment in the most recent 2014 to 2016 period, and many point to lower capital commitment in the recent years vs. the financial crisis period itself.

We consider possible causes for the observed decline in overall dealer capital commitment in the most recent period. Post-crisis reforms in bank regulation, including the Volcker Rule and Basel III requirements, while directly focused on banking rather than market making activities, may have affected dealers' willingness or ability to commit capital to the provision of liquidity in the corporate bond market. At the same time, the U.S. Treasury department estimates that electronic platforms (the most important of which are "request-for-quotation" systems rather than limit order books) have captured 15 % or more of customer-to-dealer market share in recent years, with the electronic share higher for investment grade than for high yield bonds. Further, corporate bond ETFs allow investors to gain exposure to corporate bond returns without directly trading in the dealer market.<sup>vi</sup> However, the market participants who create and redeem shares trade in the underlying, relatively illiquid market. Indeed, Pan and

Zheng (2017) show that corporate bond dealers manage inventory in part through the creation and redemption of ETF shares.

To assess the relative importance of these potential explanations, we compare outcomes across dealers that are affiliated with banks versus non-bank dealers, and compare outcomes for trades that are more likely to involve electronic intermediation versus those more likely to be handled through traditional methods. If regulation focused on banking affected corporate bond market making, then post-regulation outcomes should differ across bank-affiliated and non-bank dealers. In contrast, changes attributable to the emergence of corporate bond ETFs and electronically-facilitated trading potentially affect all dealers.

Our results show that the decreases in dealer capital commitment in recent years are entirely attributable to bank-affiliated dealers. Non-bank dealers increase intraday, overnight, and weekly capital commitment, turnover, block trading, and principal volume as compared to the pre-crisis period, while all of these measures were reduced in recent years for bank-affiliated dealers.

This result supports the interpretation that post-crisis regulations focused on banking have contributed to dealers' reduction in capital commitment to the corporate bond market in recent years. The results also support the prediction of Duffie (2012) that non-bank dealers will step into the void left by banks. However, non-banks dealers are significantly smaller than bank-affiliated dealers, and have not fully offset the decline in bank-affiliated dealer capital. A decline in the overall supply of market-making capital is consistent with the evidence reported by Friewald and Nagler (2016) that the relation between dealer inventory positions and risk-adjusted bond returns has strengthened in recent years.

In the segment of the market where electronically-facilitated trades are most likely to occur, we document a decrease in capital commitment relative to trading volume for both bank and non-bank dealers. This result is consistent with the interpretation that less capital is required in the portion of the market where electronic communications have reduced search costs.

It is possible that the most notable changes in the secondary market for corporate bonds do not manifest during normal trading, but emerge when the market is stressed. Further, it could be the case that non-bank dealers reduce their commitment and rely on traditional bank-affiliated dealers to provide liquidity at difficult times. To shed light on these possibilities, we study days where individual bonds are stressed by large customer block trades as well as days characterized by market-wide stress, identified based on the credit market component of the Cleveland Federal Reserve Financial Stress Index. We find that results for both bond-level and market-wide stressful days mirror those for the overall sample. In particular, non-bank dealers increased block volume, intraday, overnight, and weekly capital commitment on stressful days in recent periods relative to pre-crisis periods, while bank-affiliated dealers have reduced their stressful day market commitment.

Collectively, the evidence indicates that the roles of corporate bond dealers have changed in recent years. Bank-affiliated dealers in particular are less inclined to play the role of a traditional market maker who commits capital to absorb customer order imbalances. This shift is especially apparent in the most recent period, when banks became increasingly subject to the requirements of the Volcker Rule. At the same time, non-bank dealers have increased their market share and their willingness to commit capital, albeit from small initial pre-crisis levels. Further, electronically-facilitated trades are growing in importance, and both bank-affiliated and

non-bank dealers have decreased their capital commitment as search costs have been reduced in those segments of the market where such trading is concentrated.

The stark divergence in recent period outcomes for bank-affiliated versus non-bank dealers supports the reasoning that post-crisis regulations focused on banking have contributed to the empirically observed reductions in turnover, average trade size, block trading frequency and dealer capital commitment in the corporate bond market. It will be of interest to assess if capital commitment by non-bank dealers and/or the continued emergence of electronic quotation venues will in time fully offset the effects of decreased bank-affiliated dealer capital commitment.

This paper is organized as follows. We discuss related literature and post-crisis regulation in Section I. We describe the data, dealer sample construction, and provide aggregate market statistics in Section II. Section III presents trading cost estimates. Section IV describes how we measure dealer-level capital commitment and additional market quality variables. Section V presents the outcomes of multivariate regressions that assess the evolution of capital commitment and market quality over time, after allowing for changes in relevant control variables. In Section VI we expand the analysis to consider capital commitment and market quality outcomes separately for bank-affiliated and non-bank dealers. Section VII presents bank and non-bank dealer outcomes on days that are particularly stressful. Finally, we summarize the results and present implications of the study in Section VIII.

## **I. The Related Literature and Post-crisis Regulation**

### *A. Bond Market Liquidity Literature*

While the literature on market making and liquidity is vast, the majority of researchers' attention has focused on stock markets. Schultz (2001) was among the first to provide systematic evidence regarding corporate bond trading, showing that institutional trades in

corporate bonds incurred transactions costs that were large relative to those observed in equity markets.vii

The introduction of post trade transparency to the corporate bond market and the 2007-2009 financial crisis accelerated research focused on corporate bond trading. The phased introduction of TRACE transaction reporting during the 2002 to 2005 period triggered at least three studies, including Edwards, Harris, and Piwowar (2006), Bessembinder, Maxwell, and Venkataraman (2006) and Goldstein, Hotchkiss, and Sirri (2007), each of which concluded that TRACE led to substantial reductions in trade execution costs paid by customers. Dick-Nielsen, Feldhutter, and Lando (2012) and Friewald, Jankowitsch and Subrahmanyam (2012) document that corporate bond liquidity was substantially degraded during the 2007-2009 financial crisis.

As the corporate bond market lacks pre-trade transparency, authors have developed measures of corporate bond liquidity that do not require quotation data. Feldhutter (2012) shows that variation in trade prices across small vs. large trades is a useful measure of illiquidity for corporate bonds. Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik (2008) construct and test a measure to capture “latent” liquidity in illiquid markets.

A number of recent papers examine dealer networks and dealer behavior. Di Maggio, Kermani, and Song (2016) study the collapse of a large dealer in 2008 and find that disruption to the dealer network led to increased transaction costs. O’Hara, Wang, and Zhou (2015) document that more active insurance companies receive better transactions prices for similar trades as compared to less active insurance companies, particularly when the insurance company trades with the dominant dealer in the bond. Goldstein and Hotchkiss (2017) find that dealers’ propensity to offset trades within the same day rather than commit capital for longer periods is highest for the most risky and illiquid bonds, indicating dealers actively mitigate inventory risk

via increased search. The literature has also demonstrated that liquidity is important because it affects the valuation of corporate bonds. Chen, Lesmond, and Wei (2007) and Lin, Wang, and Wu (2011) document that illiquidity affects bonds' yield spreads, while Bao and Pan (2013) show that illiquidity contributes to the observed volatility of bond prices, and Cespa and Foucault (2014) show that a lack of liquidity can hinder efficient price discovery.

### *B. Post Crisis Regulatory Reforms*

We consider in particular the possibility that post-crisis regulatory reforms focused on banks have affected dealers' willingness to supply liquidity to the corporate bond market. A number of recent studies share this broad objective. Dick-Nielsen and Rossi (2015) study the removal of individual bonds from key indices, which is likely to generate customer selling pressure. They document that transaction costs for these bonds more than doubled in the 2010 to 2013 period as compared to the pre-crisis period. Choi and Huh (2017) document the increased use in recent years of matching (facilitating) trades, as opposed to traditional market making by bond dealers. They show that bid-ask spreads on these matched trades are significantly lower than for traditional market making trades, and they conclude that bid-ask spreads have increased in recent years for traditional market-making trades. Similarly, Schultz (2017) documents that dealers in actively traded bonds have in recent years relied more frequently on prearranged trades that are quickly offset by opposite direction trades.

The paper closest to our own is the contemporaneous study of Bao, O'Hara, and Zhou (2017). They study trades in individual bonds immediately following credit rating downgrades, when customers are likely to initiate sales, finding that trades' price impacts have increased and dealers' willingness to absorb order imbalances decreased after the Volcker Rule (discussed

further below) was implemented.<sup>viii</sup> Further, like us, they find that the reduction in market quality is concentrated in bank-affiliated dealers.

Our study is distinguished from these by the fact that we provide comprehensive evidence for the U.S. corporate bond markets, both on an overall basis and on specific days when the market is likely to be stressed, that we assess a number of additional measures of market quality, and that we assess outcomes for trades more likely to be completed with electronic intermediation. The fact that results regarding bank-affiliated vs. non-bank dealers are consistent across our broad study of the full corporate bond markets and the focused analysis of Bao, O'Hara, and Zhou (2017) is reassuring.

#### *B.1. The Dodd-Frank Act, the “Volcker Rule”, and the Basel Accords*

The Dodd-Frank act was signed into law on July 21, 2010. Several aspects of the Dodd Frank act focused specifically on banks. For example, the rule requires the Federal Reserve to conduct an annual stress test of bank holding companies with \$50 billion or more in total consolidated assets.<sup>ix</sup> Perhaps the most relevant portion of the Dodd-Frank act for the corporate bond market was the “Volcker Rule”, which was intended to prevent institutions with access to FDIC insurance or to the Federal Reserve’s discount window from engaging in risky proprietary trading. The Volcker Rule was originally scheduled to take effect on July 21, 2012. However, implementation was delayed until an effective date of April 1, 2014. Large banks were required to be fully compliant by July 21, 2015, while making good faith efforts to comply during the implementation period subsequent to April 1, 2014. In fact, a number of banks announced closures of their proprietary trading operations in advance of the implementation of the Volcker rule.<sup>x</sup>

The Volcker Rule was not intended to restrict market making activity, and specifically allows banks to conduct “riskless principal” trades that are “customer-driven.” The rule also contains a market making exemption for trading desks that “routinely stand ready to purchase and sell financial instruments.” However, Schultz (2017) observes that the Volcker Rule requires banks to report inventory turnover as well as the standard deviation of daily trading profits, with the implication that lower turnover or higher profit volatility may be deemed indicative of proprietary trading. The requirement to report inventory turnover could disincentive banks from taking positions in less-liquid bonds in particular. Duffie (2012) observes that market making is inherently a form of proprietary trading, and the Volcker Rule may have unintended consequences. He predicts that, under the Volcker Rule, “a bank that continues to offer substantial market making capacity to its clients would face a risk of regulatory sanction (and the attendant stigma) due to significant and unpredictable time variation in the proposed metrics for risk.”

In addition to the Volcker rule, dealers affiliated with banks were affected by implementation of the Basel 2.5 and Basel III banking accords, which reduce allowable bank leverage and impose more restrictive definitions regarding banks’ requisite capital holdings, in June 2012 and July 2013, respectively. A survey conducted in September 2015 by the Committee on the Global Financial Systems found that respondents considered the Basel 2.5 capital charges to have a significant impact on banks’ corporate bond trading activities.<sup>xi</sup> Basel III involved leverage ratio, liquidity coverage, and net stable funding ratio tests, each of which increase banks’ capital costs<sup>xii</sup><sup>xiii</sup>. The Basel accords impose higher capital costs for risky assets, which in turn may disincentive banks from making markets in riskier bonds in particular.

As this discussion demonstrates, it is not possible to define a single date when the effects of post-crisis regulatory initiatives became binding. As the closing of proprietary trading desks in advance of the formal effective date of the Volcker rule noted above illustrates, the effects of major new regulations can manifest themselves in advance of the formal compliance dates. We follow Bao, O’Hara, and Zhou (2017) in defining April 1, 2014 as the beginning of the “Volcker period”, while recognizing that some effects might have been manifest in the market at earlier dates.

We are able to shed light on the question of whether post-crisis banking reforms have affected liquidity provision in the corporate bond market by examining results separately for dealers that are affiliated with a bank holding company and dealers that are not so affiliated. Bank-affiliated dealers are impacted by the Volcker Rule, stress tests, and the two Basel accords. In contrast, non-bank dealers are unlikely to be directly affected by these regulatory reforms.

## **II. Data and Sample Construction**

In this section, we describe the enhanced TRACE data and the dealer samples we construct, and we report on aggregate corporate bond market statistics. Since the 2002 to 2005 TRACE phase-in period has been extensively examined by various studies that document reduced transaction costs subsequent to the introduction of transaction reporting, and to avoid having results confounded by the introduction of transparency, we omit these years and report on the January 2006 to October 2016 period.

### *A. Data Description*

We rely on an enhanced version of the TRACE data provided by FINRA that includes trade data disseminated to the public as well as (144A bond) trades not so disseminated. The data includes a dealer identification number, indication of whether the dealer is (as of 2016)

affiliated with a bank, and unmasked trade sizes. The database includes over 109,000 unique CUSIPs. However, the majority of these pertain to instruments other than corporate bonds, such as retail notes, foreign government bonds, U.S. agency debentures, pay-in-kind bonds, corporate strips, medium term notes, convertible and preferred securities, etc. We consider only the 24,648 CUSIPs identified by FISD as non-puttable U.S. Corporate Debentures and U.S. Corporate Bank Notes (bond type=CDEB or USBN) and with a reported maturity date.

The data includes 70.75 million trades completed between January 2006 and October 2016 for these CUSIPs. Table I reports the effects of additional data filters that we implement. We exclude all bonds with less than five trades during the eleven-year sample period, as well as bonds with a reported trade size that exceeds the bond's offer size, and bonds for which the TRACE implementation date is missing. We also exclude trades that are reported after the bond's amount outstanding is reported as zero in FISD, and trades with an execution date prior to January 2006. Finally, we exclude trades associated new issuances, including those indicated to be primary market transactions as well as secondary market transactions that occur immediately after the issuance.<sup>xiv</sup> With these filters imposed, the sample is comprised of 65.61 million transactions in 22,349 distinct CUSIPs.

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### *B. Dealer Samples*

We conduct a number of analyses that focus on capital commitment by individual dealers. The sample includes almost 2,700 dealers, about 2,100 of which engage in customer trades, but most of whom trade only sporadically. For tractability, we focus the dealer-level analysis on the more active dealers, defined in two ways. Each of these dealer samples excludes one relatively large dealer that, during 2014, began to report an immediately offsetting

transaction for the large majority of its principal trades. Conversations with FINRA indicated that these transactions actually represented transfers of inventory to an off-shore subsidiary.<sup>xv</sup>

First, we create a “Top 70%” sample. For each year, we select the largest dealers such that the dealers in combination have a seventy percent share of customer-dealer trading volume. The number of dealers that together comprise a 70% market share each year ranges between ten and twelve. Individual dealers may enter or depart the Top 70% sample across years, and a total of twenty unique dealers enter the Top 70% sample at some point. Second, we construct a “Constant Dealer” sample that consists of the thirty five dealers that (i) are active during all sample years, and (ii) were among the thirty most active dealers during at least one year. The “Top 70%” sample includes 28% of all trades, 68% of aggregate volume (including interdealer trading), and 71% of the customer-dealer volume. By comparison, the Constant Dealer sample includes 58% of all trades, 75% of aggregate volume, and 76% of customer-dealer volume.

The main advantage of studying the Constant Dealer sample is that any changes observed over time must reflect changes in the decisions of and outcomes to existing dealers, as opposed to the entry of new dealers or the exit of existing dealers. However, the Constant Dealer sample includes an increasing market share over time (from 69% in 2006 to 78% in 2016). The Top 70% sample in contrast focuses on dealers with a nearly constant market share. We focus on the Top 70% sample in our main tests of changing capital commitment over the sample period. However, when we consider outcomes for bank-affiliated and non-bank dealers we focus on the Constant Dealer sample, to ensure that outcomes reflect changes in the behavior of existing dealers as opposed to entry and exit of dealers.

### *C. Sub-Period Definitions*

To understand how liquidity and the willingness of dealers to commit capital to the corporate bond market have changed over time, we consider five sub-periods. We designate the January 2006 to June 2007 interval as the “Pre-Crisis” period. During this period TRACE transaction reporting was in effect for all publically-issued bonds, and the financial crisis was not yet manifest. We define this period as the benchmark in our time-series regression analyses. We follow Friewald, Jankowitsch and Subrahmanyam (2012), Dick-Nielsen, Feldhutter and Lando (2012), Bao, O’Hara and Zhou (2017) and Friewald and Nagler (2016) in defining July 2007 to April 2009 as the “Crisis” period. We designate the May 2009 to June 2010 interval as the “Post-Crisis” period. The Dodd-Frank act was signed into law on July 21, 2010, and we refer to the July 2010 to March 2014 as the “Regulation” period. Finally, following Bao, O’Hara and Zhou (2017) we designate the post April 1, 2014 period as the “Volcker” period.

#### *D. Aggregate Market Statistics*

Table II reports aggregate market statistics for the 65.61 million trades that occurred between January 2006 and October 2016, and that pass the filters described on Table I. Trading volume, including both customer-to-dealer and interdealer trades, was approximately three trillion dollars in 2006 and 2007, before declining to \$2.3 trillion during the financial crisis year of 2008. Trading activity has surged since then, to over \$3.7 trillion per year from 2010 to 2012, and between \$4.2 trillion and \$4.4 trillion per year from 2013 to 2016 (annualized). This increase in trading activity was accompanied by rapid growth in corporate bonds outstanding, from \$3.3 trillion (8,050 issues) in 2006 to over \$7.1 trillion (11,289 issues) in 2015, due to robust new issuance activity. Aggregate trading activity relative to the amount of corporate bonds outstanding has generally trended downward, from 94% in 2006 to a financial crisis low point of 63% in 2008, before recovering to over 75% in 2009 and 2010, and since declining to

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62% in 2015. Table II also reports on the volume of trading disseminated through TRACE and volume not so disseminated. The bonds whose trades were not reported through TRACE after February 2005 are private 144A bonds, many of which are high yield. All corporate bond trade prices are publicly reported through TRACE after May 2014.

### III. Trade Execution Costs

We estimate customer trade execution costs by means of indicator variable regressions, following Schultz (2001), Edwards, Harris and Piwowar (2006), and Bessembinder, Maxwell, and Venkataraman (2006). We report results for the Aggregate, Top 70%, and Constant Dealer samples, and for trade size categories, including small (less than \$100,000), medium (between \$100,000 and \$1 million), large (between \$1 million and \$10 million) and block (greater than \$10 million) trades. We also report results for investment grade and high yield bonds, and for issue size categories, defined by \$500 million and \$1 billion cutoffs. We also break out transaction costs estimates for “young” bonds, which are those that were issued within one year prior to the trade date. Finally, we report results for “clickable” bond trades, i.e. trades that are more likely to be completed through an electronic request for quotation platform. Relying on the evidence in Hendershott and Madhavan (2015), we define this category as trades of \$5 million or less in young, investment grade, large issue size bonds. “Calling” trades are all not defined as “Clickable”.

The trading cost estimates are obtained by regressions of  $\Delta P_{st}$ , the percentage change in the trade price for a given bond from an observed trade at time ‘s’ to the next observed trade at time ‘t’, on  $\Delta Q_{st} = Q_t - Q_s$ , where  $Q_s$  and  $Q_t$  are indicator variables that equal one for customer buys and negative one for customer sells at times  $s$  and  $t$ . The resulting slope coefficient estimates the effective one-way trade execution cost, and can be interpreted as half the difference

between the price at which dealers will sell a bond and the price at which they will purchase the bond.<sup>xvi</sup> The analysis includes all customer-dealer trades. To improve the precision of the trading cost estimate, we include in the regression changes in control variables that can be anticipated to also affect bond prices. Each control variable is measured as the change from the beginning of the trading day that includes trade  $s$  to the end of the trading day that includes trade  $t$ .<sup>xvii</sup>

Table III reports the resulting trading cost estimates. Focusing first on the Aggregate sample, it is noteworthy that on average (one-way) trade execution costs were nearly the same at the end of the sample as they were at the beginning, equal to 0.40% during the Pre-Crisis period and to 0.42% during the Volcker period. Average trading execution costs increased to 0.65% during the financial crisis, remained elevated at 0.63% during the post-crisis period, declined to 0.47% during the Regulation period and, as noted, 0.42% during the Volcker period. Figure 1 plots average customer trade execution costs over the sample period.<sup>xviii</sup> Average trade execution costs are notably lower for the Top 70% and Constant Dealer samples, which by construction emphasize the largest dealers in the market, as compared to the Aggregate sample. Assessing the reasons that trades with smaller dealers involve substantially higher execution costs comprises an interesting question for future research.

Table III also reports execution costs based on trade size and bond characteristics. In general, execution costs for each trade size category display similar intertemporal patterns, increasing during the financial crisis and remaining elevated immediately thereafter, before declining in the most recent Volker period to levels close to those observed during the pre-crisis benchmark period. Consistent with prior studies, small trades pay the largest percentage execution costs in corporate bonds. Small trade execution costs are approximately 0.61% during

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the pre-crisis period and the most recent Volcker period, but increased to 0.89% during the financial crisis. In contrast, trade execution costs for block trades averaged 0.16% during the first and last periods, and reached a maximum of 0.29% during the financial crisis.

Average trade execution costs were modestly greater for high yield than investment grade bonds in the initial, pre-crisis period (0.46% for high yield bonds vs. 0.36% for investment grade bonds). However, liquidity evolved differently for investment grade and high yield bonds thereafter. Transaction costs for investment grade bonds almost doubled during the financial crisis to 0.71% (from 0.36% in the pre-crisis period), before declining in the most recent Volcker period to 0.38%. In contrast, the increase in transactions costs for high-yield bonds during the financial crisis was modest, to 0.50% from 0.46% pre-crisis. Notably, transaction costs for high yield bonds did not decrease in the immediate-post-crisis period, and remain moderately higher (0.51%) in the most recent Volcker period as compared to the pre-crisis period when they averaged 0.46%. This result is consistent with the evidence reported by Goldstein and Hotchkiss (2017).

The results on Table III show that trade execution costs are lower for “young” bonds, which is broadly consistent with the well-documented “on-the-run” phenomenon by which newly issued treasury and corporate securities enjoy more liquid markets (Krishnamurthy, 2001 and Ronen and Zhou, 2013). During the January 2006 to June 2007 benchmark period, trading costs averaged 0.23% for young bonds vs. 0.44% for older bonds. Trade execution costs for young and old bonds evolved similarly during and after the financial crisis.

Finally, we consider average trade execution costs for clicking and calling trades as defined above. Clicking trades represent a small but growing (from 2% during the benchmark period to 7% during the Volcker period) share of the market. The results show that average

execution costs are lower for clickable trades in both the January 2006 to June 2007 benchmark period (0.30% vs. 0.41% for other trades) and in the most recent Volcker period (0.26% vs. 0.44%). Thus, the slight deterioration in execution costs for the overall sample is concentrated in trades that are more likely to occur through traditional telephone-based dealer trading, while execution costs for clicking trades declined modestly.

On balance, the results regarding average trade executions costs reported here do not support the notion that there has been a dramatic decline in corporate bond market liquidity in recent years. Customer trade execution costs rose during the Crisis period, but moderated thereafter, and for the full sample are only 0.02% higher during the most recent Volcker period as compared to the benchmark period.<sup>xix</sup>

However, execution costs measure only the direct cost of trades that are successfully completed. As such, they do not account for elapsed time or other search costs, or for costs associated with trades that were desired but not completed. While databases exist to allow the assessment of time-to-completion and fill rates for institutional equity orders, to our knowledge no similar data exists for bond orders. In lieu of such data we study dealers' willingness to commit capital to market making, and also report on other aspects of market quality, overall and during stressed periods.

#### **IV. Dealer-Level Measures of Market Quality**

We construct several measures relevant to the assessment of liquidity and market quality, as described below, for both the Top 70% and Constant Dealer samples. Since most individual bonds trade only sporadically, we use a portfolio approach. Each bond is assigned to one of eight portfolios, six for public bonds and two for privately issued (144A) bonds. Public bonds are allocated to portfolios based on whether the bond is of small (less than \$500 million),

medium (between \$500 million and \$1 billion), or large issue size (greater than \$1 billion), and whether the bond is rated investment grade or high yield. Private (144A) bonds are allocated to two portfolios based on whether the bond is rated investment grade or high yield.<sup>xx</sup> We report herein on results that are aggregated across dealers, while the Tables IA.II and IA.III of the Internet Appendix contain results that pertain to an average dealer portfolio.

#### *A. Measuring Dealer Capital Commitment*

The Federal Reserve Bank of New York publishes data on inventory held by primary bond dealers. However, until April 2013, the Federal Reserve reported an aggregate dealer inventory measure that included holdings in commercial paper and mortgage-backed securities along with corporate bonds.<sup>xxi</sup> Further, the Federal Reserve inventory data is aggregated across bonds and dealers, thereby precluding any cross-sectional analysis. We therefore construct our own dealer-specific measures of corporate bond capital commitment. Our intent is to measure the extent to which dealers are willing to use their own capital to absorb customer order imbalances, as opposed to simply matching customers in an agency role. In the absence of initial inventory data for each dealer in each bond, we cannot construct a dealer's total inventory. Instead, we measure the extent to which dealers allow trading to flow through to changes in inventory.

##### *A.1. Time Weighted Daily Capital Commitment*

This measure focuses on dealer capital commitment within the trading day, taking into account the elapsed time before a position is reversed. We calculate, as of the time of each completed trade, the absolute value of the difference between the dealer's accumulated (within the portfolio) principal buy volume and the dealer's accumulated principal sell volume (including both trades with customers and with other dealers), to that point in the trading day (i.e. since midnight). This measure is zero if the dealer's purchases on a principal basis are balanced

equally to its sales, and increases to the extent that that the dealer's purchases vs. sales are unbalanced, in either direction. That is, the measure captures the extent to which the dealer allows its overall inventory position to move away from the level at the beginning of the day. We then compute the average of this measure within each dealer-portfolio-day, weighting each observation by the time for which the capital is committed (i.e., until the next trade, or if no trade occurs then until midnight). We sum this measure across all dealer portfolios on a given day to obtain an aggregate (across dealers in the sample) measure of daily capital commitment. We report on both the total dollar capital commitment and the dollar figure scaled by trading volume for dealers in the sample. Note that, in contrast to the overnight measured described next, daily capital commitment would be positive even if all inventory changes were reversed before the end of the trading day. Further, the measure is larger when positions are entered earlier or exited later in the day, other things equal.

### *A.2. Overnight Capital Commitment*

This measure focuses on dealers' willingness to allow customer trades to shift their inventory away from the beginning-of-day level, without offsetting trades before the end of the day. That is, we measure the change in inventory since beginning-of-day that is also carried overnight. We quantify, for each dealer-portfolio day, the absolute value of the dealer's principal buy volume less principal sell volume. We sum this measure across dealer portfolios for each day, reporting the resulting total dollar overnight capital and also overnight capital relative to total daily trading activity for the dealers in the sample. This ratio has the simple interpretation as the percentage of daily trading activity that is carried into overnight inventory.

### *A.3. Weekly Capital Commitment*

Finally, we measure dealers' willingness to commit capital over multiple days. This measure focuses on dealers' willingness to allow customer trades to shift their inventory away

from the beginning-of-week level, without offsetting trades before the end of the week. That is, we measure the change in inventory since beginning-of-week that is carried over the weekend. In particular, we compare accumulated weekly (beginning at midnight Friday night) dealer principal buy volume for each portfolio to the accumulated principal sell volume for the week. We also sum this measure across dealer portfolios, reporting both the resulting dollar total and the total relative to the week's trading activity of the dealers in the sample. The latter can be interpreted as the percentage of weekly trading activity that is carried as inventory over the following weekend.

#### *A.4. Summary Statistics Regarding Dealer Capital Commitment*

Table IV reports summary statistics regarding dealer capital commitment, while Figure 2 displays the time series of overnight capital commitment scaled by volume for the Top 70% dealer sample. The data on Table 4 show a clear pattern by which aggregate capital commitment for the dealers in the Top 70% sample declined during the financial crisis, rebounded in dollar (but not relative to volume) terms during the post crisis period, before declining again during the regulatory period and declining further, to near-crisis levels, during the most recent Volcker period.

Top 70% dealers committed \$1.38 billion in overnight capital on average for the full sample. Overnight capital commitment decreased from an average of \$1.63 billion per night during the pre-crisis period to \$1.17 billion per night during the financial crisis, before rebounding to \$1.50 billion per night during the immediate post-crisis period. Overnight capital commitment declined to \$1.39 billion during the Regulatory period, and to \$1.31 billion per night during the most recent Volcker period. The decline in total overnight capital commitment during the financial crisis was only slightly more pronounced than the decline in trading activity as reported in Table II, as the proportion of trading carried into overnight inventory decreased

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only from 21.1% during the Pre-Crisis period to 20.5% during the financial crisis. In contrast, the decrease in overnight capital commitment in recent years occurred even as trading volumes increased, and the proportion of trading activity carried into overnight inventory declined to 16.2% during the Regulatory period and further to 13.8% during the Volcker period. These results indicate that dealers absorbed a smaller proportion of trading into inventory in recent years.

In general, the summary statistics for time-weighted daily capital and weekly capital commitment are consistent with those for overnight capital commitment. Daily capital commitment relative to volume decreased from 11.4% during the Pre-Crisis period to 8.5% during the Regulatory period and to 7.4% during the most recent Volcker period. Similarly, the proportion of weekly trading carried as inventory over the weekend declined from 10.4% during the Pre-Crisis period to 7.7% during the Regulatory period and 6.5% during the Volcker period.

Each measure of capital commitment indicates a notable decrease over time in the extent to which dealers allow their inventory to change as a consequence of trading, and decreased willingness to carry such changes overnight or over weekends. On balance, the results indicate that dealers were more likely to offset trades with opposite direction trades, thereby committing less of their own capital to absorb customer order imbalances, during the Volcker period as compared to the immediately preceding Regulatory period, and even, by most measures, relative to the financial crisis period.

## *B. Other Indicators of Market Quality Measured at the Dealer Level*

### *B.1. Trading Activity and Trade Size*

Overall trading activity is a commonly used proxy for market liquidity, with the obvious interpretation that larger volumes are indicative of a more liquid market, other things equal. In addition to trading activity relative to the amount outstanding (i.e. turnover), we consider the

average trade size. The data reported on Table IV verifies that corporate bond trading activity by the Top 70% sample relative to the amount outstanding has decreased over time, from 7.1% in the Pre-Crisis period to 4.8% during the financial crisis. Monthly turnover partially rebounded to 5.6% during the immediate pre-crisis period, before falling to 4.7% during the Regulatory period and to 4.1% during the most recent Volcker period.

Average trade size for dealers in the Top 70% sample decreased from \$2 million in the pre-crisis period to \$1.33 million during the financial crisis. The average trade size increased to \$1.49 million in the post crisis period, before falling to \$1.28 million during the Regulatory period and \$1.21 million during the Volcker period. A decrease in trade sizes could reflect that customers desire to trade in smaller increments, e.g. due to the entry of more retail customers, or could be indicative that it is difficult to locate counterparties for larger trades that are desired.

### *B.2. Principal vs. Agent Trading*

An obvious measure of dealers' willingness to commit capital to enhance liquidity is their completion of trades on a principal basis (i.e. where the dealer is the counterparty to the customer trade) rather than an agency basis (where the dealer arranges for a trade between two customers or with another dealer). TRACE reporting requires a dealer to designate a transaction as a principal trade if the dealer takes ownership of the bond, however briefly. By this standard, almost all dealer-intermediated trades are principal trades. We focus on a narrower definition of principal trades that excludes trades that are exactly offset by three or fewer opposite-direction trades by the same dealer, within one minute. Since the median bond trades only once every few months (see, for example, Edwards et al., 2007), it seems reasonable to infer that virtually all offsetting transactions that occur within one minute were in fact prearranged and that dealer capital was not meaningfully at risk.<sup>xxii</sup>

As Table IV shows, the percentage of principal trading in the Top 70% sample was 91.4% in the Pre-Crisis period, and perhaps surprisingly, increased slightly to 91.9% during the Crisis period, and then declined slightly to 91.6% of volume during the Regulatory period, before increasing notably to 94.9% of volume during the most recent Volcker period. In Section III below, we assess further which dealers, bank-affiliated or non-bank, are responsible for the increase in principal trading observed in the recent sample.

## **V. Time-Series Regressions**

The univariate means reported on Table IV indicate reductions in the most recent Volcker period relative to the Pre-Crisis period in dealers' capital commitment, as well as reductions in bond turnover and average trade size. We next report the results of time series regressions that include control variables, and that allow for formal statistical tests for equality of coefficients across time periods. Probability values are based on Newey-West standard errors, with the number of lags selected automatically based on the criterion described in Newey and West (1994).

We include in these regressions control variables for market conditions. In particular, we control for recent market-wide stock (S&P 500 index) and bond (the Barclays Capital U.S. Corporate Bond Index) returns, since Hameed, Kang, and Viswanathan (2010) and Comerton-Forde et al. (2010) show that lower returns reduce dealers' propensity to supply liquidity, via its impact on their market making profits. We control as well for changes in the CBOE stock market volatility index (VIX) and the 3-month LIBOR. We also include aggregate flows into or out of corporate bond mutual funds and ETFs, as a control for transaction demand on the part of corporate bond funds.<sup>.xxiii</sup> Finally, we include the percentage of total trading that occurs in trades of \$100,000 or less, as a control for retail trading activity.<sup>.xxiv</sup>

The key variables in this specification are indicator variables for the Crisis (July 2007-April 2009), Post-crisis (May 2009-June 2010), Regulatory (July 2010-March 2014) and Volcker (April 2014-October 2016) sub-periods. The regression intercept pertains to the Pre-Crisis (January 2006-June 2007) benchmark period, and coefficient estimates on the period indicator variables measure changes in regression intercepts relative to the benchmark period. We report  $p$ -values for each indicator variable coefficient, and indicate by use of asterisks at the bottom of Table V whether formal statistical tests reject the hypothesis that coefficients on the indicator variables are equal across sub-periods.

### *C. Capital Commitment*

In columns (1) to (6) of Table V, Panel A, we report results obtained when the dependent variable in the regression specification is alternative measures of dealer capital commitment.

The first two columns pertain to time-weighted daily capital, the second pair pertain to overnight capital, and the third pair pertain to weekly capital, with even numbered columns measuring capital commitment in dollars and odd numbered columns measuring capital commitment relative to trading volume.

When focusing on capital commitment in dollars (columns 2, 4, and 6), the results confirm an economically and statistically significant decline during the financial crisis as compared to the pre-crisis benchmark period. The decrease is \$199 million in daily capital commitment, \$330 million in overnight capital commitment, and \$574 million in weekly capital commitment. However, when measured relative to trading activity, the results indicate no significant decrease in capital commitment during the financial crisis, after allowing for variation in control variables. In particular, the coefficient estimate on the crisis period indicator variable is statistically insignificant in each of columns 1, 3, and 5.

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Coefficient estimates on the indicator variable for the post-crisis period indicate an insignificant increase in capital commitment in dollars as compared to the pre-crisis period, after allowing for variation in control variables. However, capital commitment relative to trading volume decreased by statistically significant amounts during the post-crisis period as compared to the benchmark period. Point estimates indicate a decrease of 1.6% in daily capital, 2.5% in overnight capital, and 1.7% in weekly capital.

For the Regulatory period, the results on Table V indicate decreased capital commitment relative to the pre-crisis benchmark, both in dollars and relative to trading volume. The decreases in measured dollar capital commitment during the Regulatory period are smaller (and except for weekly capital the differentials are statistically significant) than those observed during the financial crisis. However, in light of increased volumes, capital commitment as a percentage of trading activity decreased significantly during the Regulatory period as compared to both the pre-crisis benchmark and crisis periods. The decline relative to the pre-crisis benchmark is 2.1% in daily capital relative to volume, 3.6% in overnight capital relative to volume, and 2.9% in weekly capital relative to volume.

Outcomes for the Volcker period are of particular interest due to the increased restrictions on bank trading activity specified by the Volcker Rule. The results on Table V indicate decreased capital commitment during the Volcker period after allowing for variation in control variables, both in dollar capital commitment and in capital commitment relative to trading activity. Notably, capital commitment relative to trading volume during the Volcker period is not only lower than during the pre-crisis benchmark, but is also lower than during the crisis, post-crisis, and Regulatory periods, and the differential across periods is statistically significant in each case.

The decreases in dealer capital commitment during the Volcker period are economically substantial. Focusing on overnight capital commitment in dollars, the decrease during the Volcker period relative to the pre-crisis benchmark is \$239 million, which is large relative to the full sample average of \$1.38 billion, and also relative to the decline in the immediately preceding Regulatory period, which was \$140 million. Overnight capital commitment relative to trading volume decreased by 6.4% during the Volcker period as compared to the pre-crisis benchmark, which is large relative to the full sample average of 17.2%. By comparison, overnight capital commitment relative to trading volume had decreased by 3.6% during the immediately preceding Regulatory period.

To summarize, the results reported on Table V indicate economically large and statistically significant decreases in dealer capital commitment during the Volcker period as compared to preceding periods, after allowing for changes in control variables. Capital commitment in dollars during the Volcker period is equal to or less than during the financial crisis. Capital commitment relative to trading volume is substantially lower during the Volcker period as compared to the financial crisis, and also as compared to the immediately preceding Regulatory period. These results are consistent with the reasoning that the Volker rule has reduced dealers' willingness to commit capital in support of market making in corporate bonds. However, they are also consistent with the reasoning that increased competition and reduced search costs attributable to growth in electronic trading and in the holdings of corporate bond mutual funds and ETFs led to a reduced need for capital commitment by traditional dealers. We provide more specific evidence on this issue in Section VI below, where we consider outcomes separately for bank-affiliated and non-bank dealers.

#### *D. Other Market Quality Measures*

We also report in Table V results obtained when the dependent variable is trading volume relative to the amount outstanding (i.e. turnover, column 7), natural logarithm of average trade size (column 8), and principal volume as a percentage of total volume (column 9). In general, the results indicate shifts in market quality during the financial crisis as compared to the pre-crisis benchmark that were accentuated rather than reversed in the periods subsequent to the financial crisis.

Results reported in column (7) of Table V show that monthly turnover was reduced by 1.9% during the financial crisis as compared to the pre-crisis benchmark. This decline is substantial relative to the full sample average turnover (for the Top 70% sample), which is 5%. Turnover continued to decline thereafter, and during the most recent Volcker period was 2.8% less than during the benchmark period, after allowing for changes in control variables. Results reported in column (8) of Table V show a similar pattern in average log trade size, which was 0.20 lower during the financial crisis and 0.30 less during the most recent Volcker periods, as compared to the pre-crisis benchmark.

A notable exception to the overall pattern is observed for principal volume as a percentage of total volume (column 9). Principal trading was not significantly different during the financial crisis period, the post-crisis period and the Regulatory periods, but increased by a statistically significant 3.4% during the most recent Volcker period, as compared to the pre-crisis period.

On balance, the results reported in Table V suggest a changed trading environment in the recent Volcker period as compared to the January 2006 to June 2007 benchmark period. Dealers' daily, overnight, and weekly capital commitment, trading volume relative to amount outstanding, and average trade size, have all declined. Decreases in these measures during the

financial crisis period is not unanticipated. More noteworthy, these measures did not broadly recover during the Regulatory period and Volcker periods.

## **VI. Assessing Possible Explanations for Decreased Capital Commitment**

We next assess more specifically the possibility that the secondary market for corporate bonds has been affected by post-crisis regulations focused on banks. To do so, we estimate results separately for dealers that are affiliated with banks and for dealers that are not bank affiliated. We also consider the potential effects of increases in electronically-facilitated trading.

As noted, the data provided to us includes only masked dealer identifications. However, FINRA identified for us the dealers contained in our constant-dealer sample that are affiliated with banks vs. those that are not so affiliated. A recent industry report identifies Cantor Fitzgerald & Co., Daiwa Capital Markets Americas, Jefferies & Company, and Nomura Securities International as examples of prominent non-bank dealers active in the U.S. corporate bond market.<sup>xxv</sup>

It should be noted that each dealer is designated as bank-affiliated or not by FINRA based on their 2016 status. Therefore, the designation of a dealer as bank-affiliated does not evolve through time. In particular, Goldman Sachs and Morgan Stanley, which became bank holding companies during 2008, would be identified for our purposes as bank-affiliated dealers throughout the sample.<sup>xxvi</sup> This research design is appropriate because we are not primarily interested in assessing the effects of dealer shifts from non-bank to bank status in the midst of the financial crisis. Rather, our intent is to assess the effects of post-crisis banking regulations. This assessment depends on dealers' status as bank-affiliated (treated) or not bank-affiliated (non-treated) at the time the regulations become effective.

For this analysis, we shift to the Constant Dealer sample, so that the results for the bank-affiliated and non-bank samples reflect outcomes and choices of common sets of dealers, and do not reflect the entry or exit of participants. Within the Constant Dealer sample, ten dealers are non-bank, while twenty five are bank-affiliated.

*A. Summary Statistics for Bank and Non-Bank Dealers*

Table VI provides some sample statistics by sub-period for bank and non-bank dealers contained in the Constant Dealer sample. Panel A reports on market shares, average customer trade execution costs and other trading statistics, while Panel B reports on capital commitment measures.

The data on Panel A of Table VI shows that non-bank dealers' share of overall trading activity is relatively small, but has increased substantially over time. During the pre-crisis period non-bank dealers participated in 4.4% of overall trading volume, as compared to 13.5% during the Volcker period. The non-bank dealer share of customer-to-dealer volume rose more sharply, from 2.4% during the pre-crisis period to 12.5% during the Volcker period. When stated relative to the quantity outstanding, non-bank turnover increased from 0.3% per month during the pre-crisis period to 0.6% during the Volcker period, while bank-affiliated dealer turnover decreased from 6.5% during the pre-crisis period to 4.0% during the Volcker period.

Average execution costs for trades executed by non-bank dealers were slightly greater (six to seven basis points) than for trades executed by bank-affiliated dealers during both the pre-crisis benchmark and the most recent Volcker period. The higher execution costs for non-bank trades are attributable in part to the fact that their trades were smaller on average. In particular, the average trade size for non-bank dealers during the pre-crisis period was \$0.37 million, as compared to \$1.26 million for bank-affiliated dealers. Average trade sizes decreased over time,

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to \$0.31 million for non-bank dealers during the Volcker period, and more sharply (to \$0.76 million) for bank-affiliated dealers during the Volcker period.

Finally, the data on Panel A of Table VI shows that the increase in principal trading during the Volcker period is mainly attributable to non-bank dealers. In particular, the proportion of non-bank dealers' overall trading completed on a principal basis rose from 76.2% during the pre-crisis period to 90.9% during the Volcker period, while that for bank-affiliated dealers increased modestly from 92.0% to 93.6%.

Panel B of Table VI reports capital commitment measures for bank-affiliated and non-bank dealers contained in the Constant Dealer sample. Two main results are noteworthy. First, non-bank dealer capital commitment was much lower than that of bank-affiliated dealers during the pre-crisis benchmark period, for all measures of capital commitment. Focusing, for example, on overnight capital commitment, non-bank dealers' collectively carried an average of \$50 million overnight during the pre-crisis benchmark, as compared to \$1.66 billion for bank-affiliated dealers. When stated as a percentage of own daily trading volume (i.e. as the percentage of trading carried into overnight inventory) the divergence during the pre-crisis period was less stark, as non-bank dealers carried 14.8% overnight, as compared to 22.0% for bank-affiliated dealers.

Second, while both bank and non-bank reduced their capital commitment during the financial crisis, non-bank dealers have increased their capital commitment in recent years, while bank-affiliated dealers decreased their capital commitment, for all measures. Focusing again on overnight capital, non-bank dealers increased their capital commitment from \$50 million during the benchmark period to \$244 million during the most recent Volcker period. Eight of the ten individual non-bank dealers increased their capital commitment. In contrast, bank-affiliated

dealers decreased their capital commitment from \$1.66 billion during the pre-crisis period to \$1.45 billion during the Volcker period. When stated relative to trading volume, non-bank dealers' overnight capital commitment grew modestly from 14.8% during the pre-crisis period to 15.6% during the Volcker period, while bank-affiliated overnight capital commitment declined markedly from 22.0% during the pre-crisis period to 14.8% during the most recent Volcker period. Results for daily and weekly capital commitment are broadly similar to those for overnight capital commitment.

*B. Regression Outcomes for Bank and Non-Bank Capital Commitment*

In Table VII, Panel A, we report the results of implementing regressions similar to those reported on Table V, except that we include indicator variables to allow for differing time-period-specific intercepts for bank-affiliated and non-bank dealers. These results are more informative than the comparison of summary statistics contained on Table VI because the regression analysis includes the control variables as previously employed for the results reported in Table V.

The coefficient on the bank indicator variable estimates the difference in the benchmark period intercept for bank-affiliated dealers as compared to non-bank dealers. For each sub-period subsequent to the benchmark we include the product of the sub-period indicator and both bank and non-bank indicators, the coefficient estimates on which reveal the change in the intercept estimate relative to the base period for bank and non-bank dealers, respectively. While Table VII includes estimated indicator variable coefficients for each sub-period, this discussion focuses mainly on the most recent Volker sub-period.

The empirical results for all six measures of capital commitment (columns 1 to 6) are quite consistent, indicating that the decline in capital commitment during the most recent

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Volcker period as compared to the pre-crisis benchmark is entirely attributable to bank-affiliated dealers. This result strongly supports the predictions of Duffie (2012) that the Volcker Rule would likely have unintended consequences in terms of bank-affiliated dealers ability and willingness to commit capital to enhance bond market liquidity. This result is also consistent with the findings of Bao, O’Hara, and Zhou (2017), who find that bank-affiliated dealers absorb into inventory less of the order imbalances that occur in the wake of bond downgrades during the Volcker period.

The difference between indicator variable coefficient estimates obtained for bank-affiliated and non-bank dealers during the Volcker period is, in all cases, statistically significant at the .01 level. The change in capital commitment by bank-affiliated dealers during the Volcker period as compared to the benchmark period is negative and statistically significant at the .01 level for five of the six measures of capital commitment. In contrast, the change in capital commitment for non-bank dealers in the Volcker period as compared to the pre-crisis period is positive for all six measures of capital commitment, and is statistically significant for all measures but one (weekly capital commitment relative to volume).<sup>xxvii</sup>

For example, overnight capital commitment in dollars (column 4) by bank-affiliated dealers declined by \$194 million during the most recent period as compared to the pre-crisis benchmark, after allowing for changes in control variables. By comparison, overnight capital commitment by non-bank dealers increased by \$210 million from the pre-crisis benchmark to the Volcker period, after allowing for changes in control variables. When stated relative to trading activity (i.e. as the percentage of trading carried into overnight inventory) the decrease (column 3) for bank-affiliated dealers is 5.6%, while the increase for non-bank dealers is 2.4%. Results for the other measures of capital commitment are broadly similar to those for overnight capital.

It is also instructive to compare outcomes for the most recent Volcker period to the immediately preceding Regulatory period. Coefficient estimates on the Volcker period indicator are larger in absolute magnitude as compared to coefficient estimates on the Regulatory period indicator when the dependent variable is capital commitment in dollars (columns 2, 4, and 6), for both bank-and non-bank dealers. For example, the decrease in overnight capital commitment for bank affiliated dealers during the Regulatory period (as compared to the benchmark period) was \$85 million, versus \$194 million during the Volcker period. The implication is that bank-affiliated dealers sharply reduced their capital commitment after the Volcker rule became effective. In contrast, the increase in overnight capital commitment for non-bank dealers during the Regulatory period (as compared to the benchmark period) was \$152 million, compared to \$210 million during the Volcker period. The implication is that, unlike bank-affiliated dealers, non-bank dealers continued to increase their overnight capital commitment after the Volcker rule became effective.<sup>xxviii</sup>

The coefficient estimates for the bank-affiliated indicator variable reported on Table VII pertain to all twenty five bank-affiliated dealers in the Constant Dealer sample. We consider whether results are uniform for large vs. small dealers by estimating the regression specification separately for the ten largest and fifteen smaller bank-affiliated dealers, when dealer size is measured based on full sample trading volume. The results, reported in Table IA.IV of the Internet Appendix, indicate a decline in capital commitment in the Volcker period for both large and small bank-affiliated dealers. While dollar amounts are naturally greater for large dealers, dollar amounts relative to trading volume are similar. Focusing on overnight capital, for example, the decline in dollar capital commitment during the Volcker period as compared to the benchmark period is \$160 million for large dealers and \$37 million for small dealers. The

decline as a percentage of trading volume is 5.6% for large dealers and 6.2% for small dealers.

We conclude that the finding that bank-affiliated dealers have reduced capital commitment in the corporate bond markets during the Volcker period is robust across large and small dealers.

*C. Regression Outcomes for Other Market Quality Measures for Bank and Non-Bank Dealers*

In columns (7) to (9) of Table VII, Panel A, we report results for bank and non-bank dealers when the dependent variable is volume relative to amount outstanding (i.e. turnover), average trade size, and the percentage of total volume completed on a principal basis, respectively. The results indicate that the patterns observed in sample means reported on Table VI are also observed after allowing for changes in control variables, and that differences in outcomes for bank-affiliated vs. non-bank dealers during the Volker period are always statistically significant.

In particular, trading activity by non-bank dealers relative to the amount outstanding (column 7) increased by 0.3% during the Volcker period relative to the benchmark period, while trading activity by bank-affiliated dealers decreased by 2.5%, after allowing for changes in control variables. The average log trade size for bank-affiliated dealers (column 8) decreased a statistically significant \$0.40 million relative to the benchmark period after allowing for changes in control variables, while the decrease for non-bank dealers was statistically insignificant. Finally, principal trading relative to total trading (column 9) increased by a statistically significant 15.5% for non-bank dealers during the most recent period as compared to the benchmark period, while the change for bank-affiliated dealers was 2.3%.

Each of the results described in the preceding paragraphs is consistent with the reasoning that bank-affiliated dealers have reduced the extent to which they commit capital to facilitate trading during the most recent years, while non-bank dealers have increased the extent to which

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they commit capital to facilitate trading. While the lack of clearly identifiable effective dates for regulations precludes fully definitive tests, the results support the reasoning that post-crisis regulations that focus on banks, such as the Volcker Rule and the Basel Accords, have had the consequence of decreasing bank-affiliated dealers' willingness or ability to commit capital to facilitate trading in corporate bonds.

#### D. *Clicking vs. Calling Trades*

Electronic limit order books, which allow for the submission of executable orders and online transactions, have come to dominate trading in equity and futures markets. In contrast, electronic platforms for corporate bonds, while growing rapidly, account for a minority of overall trading. A 2015 survey by Greenwich Associates reports that electronic venues accounted for 8% of investment-grade corporate bond trading in 2010, growing to 20% by 2015.<sup>.xxix</sup> Further, most activity involves electronic requests for quotations, as opposed to direct executions. A 2013 Greenwich Associates industry survey concluded that “true corporate bond e-trading is a long way from becoming reality”.<sup>.xxx</sup>

Trades that utilize electronic platforms cannot be directly identified on TRACE, as each is reported by the broker-dealer involved without any specific flag. Hendershott and Madhavan (2015) study the largest electronic request for quotation platform, operated by MarketAxess, documenting that market participants are most likely to “click” rather than call a traditional dealer when conducting smaller trades in recently issued, large issue size and investment grade bonds. We next assess capital commitment and market quality for bank and non-bank dealers, for “clicking” trades, defined for our study as trades of \$5 million or less in investment grade bonds that are within one year of issuance, with an issue size of at least \$1 billion. Not all trades in

this category are executed via electronic means, but we anticipate electronic platforms to be more prevalent for these trades.

Table VII Panel B presents the results of the time series regressions identical to those in Panel A, except that results pertain to the “Click” trade subsample. Clicking trades account for a small but increasing portion of overall trading, ranging (Table 3) from two percent during the benchmark period to seven percent during the most recent Volcker period. Corresponding results for “Call” trades subsample are reported in the Internet Appendix Table IA.V. Not surprisingly, results for the call sample generally mirror those reported in Panel A of Table VIII for the full sample. We denote on Panel B of Table VIII coefficient estimates that differ significantly across the click and call samples ( $p$ -value  $< .05$ ) with bold formatting. We focus this discussion mainly on coefficient estimates for the Volcker period, to assess the evolution of outcomes over time.

The results on Panel B of Table VIII show that both bank and non-bank dealers increased their dollar capital commitment (columns 2, 4, and 6) to clicking trades over time. However, as noted, the click sample share of overall trading has grown rapidly. Relative to trading volume (columns 1, 3, and 5), the coefficient estimates on capital commitment measure during the Volcker period (as well as during the immediately preceding regulatory period) are negative for both bank and non-bank dealers, and are not statistically different from each other.

These results support the interpretation that the increased competition and reduced search costs associated with electronic request for quotation systems has reduced the demand for dealer intermediation services in the segment of the corporate bond market where electronic venues are most prevalent. Both bank and non-bank dealers have responded by committing less capital to this segment of the market, relative to volume. In contrast, in the segments of the market where

electronic venues have a less significant impact, non-bank dealers have increased their capital commitment to the overall market, even as bank-affiliated dealers withdraw.

## **VII. Stressful Day Analysis**

The results reported in the preceding sections rely on the full sample of trading days. However, it is possible that the most notable changes in bond market liquidity emerge when the market is under unusual duress. To shed light on this possibility, we examine dealer trading behavior on days when it can be reasonably be inferred that the market is stressed. To ensure robustness, we consider both stressful days identified on a bond-specific basis and stressful days identified on a market-wide basis.

The bond-specific stress measure we consider is the occurrence of a block trade of \$10 million or more, and we study the individual dealers who complete block trades. The processing of a block transaction tends to dominate a dealer's trading for the day. We calculate that, for bank-affiliated dealers, a block transaction on average accounts for 92% of the dealers' total trading in the block direction (i.e. total daily buy trading if the block is a buy, and vice versa) for the day. The corresponding figure for non-bank dealers is 94%.

A dealer who executes a block trade on a principal basis commits significant capital to bond market making. However, the extent of capital commitment depends also on how long the position remains on the dealer's books, as opposed to being offloaded through opposite direction trades to other dealers or to customers. We compute time-weighted daily capital commitment and overnight capital commitment on the days that dealers in the Constant Dealer sample complete block trades, as previously described. We also compute weekly capital commitment for the dealer in the same manner as the previously described weekly capital commitment, except that we focus on a one-week period from the date of the block trade instead of Friday in

particular. We then sum the dollar capital commitment measures across all dealers who completed block trades during the given day, and scale by the same dealers' total trading activity on the corresponding day or week.

We also rely on an indicator of market-wide stress. The Federal Reserve Bank of Cleveland constructs a Financial Stress Index. While this index has been discontinued due to a data error, we focus exclusively on its credit market component, which is a simple combination of five interest rate spreads (between UK and U.S. Treasury bills, AAA corporate bonds and U.S. Treasuries, commercial paper and Treasury bills, and 10 year U.S. Treasury notes vs. three month U.S. Treasury Bills) and the bid-ask spread in U.S. Treasury bills (Oet, Eiben, Bianco, Gramlich, and Ong, 2011).<sup>xxxix</sup> We designate individual days as stressed if the change in this index is more than 1.96 standard deviations (computed separately by sub-period) above its sub-period mean.

Table VIII reports a number of summary statistics regarding the variables used in the stressful day analyses based on the Constant Dealer sample. It can be observed that the proportion of all trading that occurs in the form of blocks greater than \$10 million has decreased for bank-affiliated dealers, but has increased for non-bank dealers, from the benchmark period through the Volcker period. Further, capital commitment on stressful days defined both on a bond-specific and a market-wide basis has decreased for bank-affiliated dealers and has increased for non-bank dealers over time.

On Table IX we report results of regression specifications similar to those on Table VII, but focusing in particular on stressful days, to assess whether these changes are observed and are statistically significant after allowing for changes in control variables. Panel A of Table IX

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Table  
VIII  
here.

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IX  
here.

pertains to stressful days identified on a bond-specific basis, while Panel B pertains to stressful days identified based on market-wide conditions.<sup>xxxii</sup>

*A. Portfolio Time Series Regressions for Bond-Specific Stressful Days*

Coefficient estimates on the bank indicator variable pertain to the difference between bank and non-bank dealers during the pre-crisis benchmark period. Estimates reported on Panel A of Table IX show that bank-affiliated dealers accommodated significantly more block trading and committed more capital during the pre-crisis period.

Turning to coefficient estimates for the bank and non-bank indicator variables during the Volcker period, which estimate changes relative to the pre-crisis benchmark period that are not accounted for by outcomes to the control variables also included in the regression, it can be observed that non-bank dealers increased both the frequency of block trading and capital commitment relative to block trading volume on stressful days for all measures, while bank-affiliated dealers decreased block trading and capital commitment on stressful days, each as compared to the pre-crisis benchmark periods. The difference in coefficient estimates across bank-affiliated and non-bank dealers is statistically significant in every instance.

These coefficient estimates are economically large, and in many ways are more striking as compared to the full-sample estimates reported on Table VII. Focusing on block volume as a percentage of total volume (column 1), the decrease for bank-affiliated dealers during the Volcker period is 3.0%, while the increase for non-bank dealers is 3.0%, each after allowing for changes in control variables. By comparison, the full sample average of this variable is 15.1%. The increase during the Volcker period in overnight capital commitment relative to block-day volume (column 3) is 9.3% for non-bank dealers who completed block trades, while the decrease

for bank-affiliated dealers who completed block trades is 20.3%. Each of these changes from the benchmark period to the Volcker period is large relative to the full sample average of 35.7%.

Results are quite uniform across measures of capital commitment, indicating that not only did non-bank dealers increase their proportion of total volume accounted for by large block trades, they committed more capital relative to block volume during the most recent period as compared to the benchmark period. In contrast, bank-affiliated dealers block trading volume and capital commitment relative to block volume declined.

### *B. Portfolio Time Series Regressions for Market-Wide Stressful Days*

In Panel B of Table IX we report the results of time series regressions that focus on aggregate capital commitment across dealers in the Constant Dealer sample on days where market wide stress is indicated. We estimate identical time series regressions for control days, which are one to seven days prior to the identified stress days. The resulting coefficient estimates are suppressed to conserve space, but we indicate by use of bold type those stressful day coefficients that differ ( $p$ -value < .05) from the corresponding coefficient on control days.<sup>xxxiii</sup> In each case where such a divergence is detected, the point estimates indicate lower capital commitment on stressful days as compared to same-period control days.

The empirical results in Panel B of Table IX are very consistent when focusing on daily time-weighted capital commitment, overnight capital commitment, or weekly capital commitment, and show that the following conclusions hold, after allowing for changes in control variables. First, bank-affiliated dealers committed much greater amounts of capital as compared to non-bank dealers on stressful days during the benchmark period. Overnight capital as a percentage of trading volumes, for example, was 8.2% higher for bank-affiliated dealers on stressful days during the benchmark period.

Second, while there was no significant change in non-bank dealers' stressful day capital commitment during the financial crisis, bank-affiliated dealers significantly reduced their stressful day capital commitment in dollars during the crisis. Further, bank-affiliated dealers' dollar capital commitment on stressful days during the crisis decreased by more than on control days, and this difference is statistically significant exception for weekly capital commitment. Bank-affiliated dealers' reduction in capital commitment on stressful days during the financial crisis was partially explained by their reduced trading volume. For example, bank-affiliated dealers overnight capital relative to trading volume (column 3) declined by 1.5% during the financial crisis. While this coefficient does not differ significantly from zero, it does differ significantly from the 2.4% increase in the corresponding measure for non-bank dealers. That is, the results support the notion that bank-affiliated dealers withdrew market making capital on the stressful days that occurred during the financial crisis to a greater extent than did non-bank dealers.

Third, when comparing results for the most recent Volcker period to the benchmark period, non-bank dealers have significantly increased their capital commitment in dollars on stressful days, while bank-affiliated dealers have significantly decreased their capital commitment. For non-bank dealers, the increase in stressful day capital commitment (e.g. \$226 million in overnight capital, column 4) is explained by a commensurate increase in stressful day trading activity as compared to the benchmark period, as the coefficient estimate on capital commitment relative to volume is not statistically significant for any of the three measures.

For bank-affiliated dealers, however, we observe a decline in capital commitment on stressful days during the Volcker period as compared to the benchmark period, whether measured in dollars or relative to trading volume. For example, bank-affiliated dealers'

overnight capital commitment on stressful days declined by \$127 million (column 4), and by 12.2% (column 3) relative to trading volume, during the Volcker period.

Further, the decrease in bank-affiliated dealers' dollar overnight capital commitment on stressful days during the Volcker period is significantly greater than their decrease on control days during the Volcker period. In contrast, non-bank dealers' capital commitment on stressful days during the Volcker period does not differ significantly from control days.<sup>xxxiv</sup>

In Section III we report that non-bank dealers have increased their market share and their capital commitment in recent years, while each decreased for bank-affiliated dealers. Here, we show that the same pattern hold on stressful days, and is more notable on days made stressful for individual dealers by block trades. Further, the data show no tendency for non-bank dealers to exit the market on stressful days, either during the financial crisis or thereafter.

## **VIII. Conclusion**

Concerns that liquidity in corporate bond markets is deteriorating are widespread. We conduct a comprehensive analysis of corporate bond trading over the 2006 to 2016 period, and obtain a number of findings relevant in evaluating these concerns. We document that, despite a temporary increase during the financial crisis, customer trade execution costs are on average nearly unchanged from 2006 to 2016. Thus the evidence for customer trade execution costs, obtained over a relatively long time series, does not indicate systematic degradation of corporate bond liquidity in recent years.

However, execution costs for completed trades do not capture the search costs that customers may have experienced in locating counterparties, or the costs associated with trades that were desired but not consummated. We conduct a broader analysis that indicates that the secondary market in corporate bonds is evolving in a manner that may indicate more difficult

trading conditions. The commitment of capital by dealers to absorb customer order imbalances is relatively important in markets, such as corporate bonds, characterized by infrequent transactions and search costs. We find that measures of dealers' capital commitment, trading volume relative to amounts outstanding, average trade size, and frequency of large block trading were not only degraded during the financial crisis, but these measures in general did not revert to pre-crisis levels in the years after the financial crisis abated.

Dealer capital commitment is potentially affected by post-crisis banking regulations such as the Volcker Rule and Basel III. To assess this possibility, we measure capital commitment and market quality separately for bank-affiliated and non-bank dealers. The results indicate that, while non-bank dealers were relatively unimportant during the pre-crisis period, they have steadily increased their market share, the proportion of their volume attributable to block trades, and their levels of capital commitment in recent years, even while bank-affiliated dealers have reduced their willingness to accommodate block trades and to commit capital to absorb customer order imbalances. Results for days subject to market-wide stress mirror those for the overall sample, and in the case of block trades are generally stronger than the full sample results.

Decreased dealer capital commitment could also result from decreased search costs associated with the growth in electronically facilitated trading, or from increased competition from corporate bond ETFs and mutual funds. We document that both banks and non-bank dealers reduced capital commitment as a percentage of volume traded in the portion of the market where electronically-facilitated trades are most likely to occur. These results support that electronic venues have reduced search costs and the need for dealer intermediation services in some segments of the corporate bond market. However, electronically-facilitated trading still represents a relatively small share of the overall market, and in the broader market where

electronic venues are less important the data shows that bank-affiliated dealers have reduced capital commitment while non-bank dealers have increased capital commitments.

On balance, these results are supportive of the Duffie (2012) prediction that bank-specific regulations enacted in the wake of the financial crisis, including the Volcker Rule and the Basel III accords, reduced the ability or willingness of bank-affiliated dealers to provide liquidity to the corporate bond markets. However, it is important to note that we have not assessed the net welfare effect of the Volcker Rule. In particular, we have not attempted to assess the net effect of the Volcker Rule on macroeconomic stability. Further, we document that non-bank dealers have partially supplanted bank-affiliated dealers, and electronically-intermediated trading, while still small, is growing in importance. It may be the case that the corporate bond market can function effectively even with reduced commitment by bank-affiliated dealers. It will be of particular interest to assess whether non-bank dealers and electronic trading sufficiently offset reductions in bank-affiliated dealer commitment in the future.

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**Table I**  
**Sample Construction**

The table below reports a description of the data. Corporate bond trade data is from TRACE (Trade Reporting and Compliance Engine) and bond descriptive data is from the Mergent Fixed Income Securities Database (FISD). The sample period is January 2006 to October 2016. The Aggregate Market sample that includes all dealers and trades includes 22,837 unique bonds and 68.2 million trades. We construct two subsamples of active dealers. The Top 70% sample includes the dealers that capture 70% of customer trading volume each year. To construct the Constant Dealer sample, we select dealers ranked in the top 30 by customer volume in any sample year then retain dealers that trade each year in the sample period.

| <u>Aggregate Market Sample</u>   | <u># Cusips</u> | <u># Trades</u> |
|--|-----------------|-----------------|
| Corporate bonds in TRACE and FISD  | 24,648          | 70,752,451      |
| Exclude bonds having less than 5 trades over the sample period   | 23,433          | 70,749,867      |
| Exclude bonds with a trade size > issue size   | 23,357          | 70,285,747      |
| Exclude primary market transactions  | 23,341          | 69,513,725      |
| Exclude trades reported after amount outstanding falls to zero   | 23,172          | 69,405,828      |
| Exclude bonds with missing TRACE dissemination date  | 23,166          | 69,404,280      |
| Exclude trades with pre-2006 execution date  | 22,837          | 68,180,930      |
| Exclude trades after offering date (if offering day <= 15, exclude issue month, otherwise exclude issue month and following month) | 22,349          | 65,611,097      |
| <br>   |                 |                 |
| <u>Top 70% Sample</u>  |                 |                 |
| % of aggregate trades  | 28%             |                 |
| % of aggregate volume  | 68%             |                 |
| % of customer volume   | 71%             |                 |
| <br>   |                 |                 |
| <u>Constant Dealer Sample</u>  |                 |                 |
| % of aggregate trades  | 58%             |                 |
| % of aggregate volume  | 75%             |                 |
| % of customer volume   | 76%             |                 |

**Table II**  
**Summary Statistics**

This table provides descriptive statistics on the size of the corporate bond market between January 2006 and October 2016. All statistics are computed using the Aggregate Market sample described in Table I.

| Year             | Corporate Bond               |                                     | # of Corporate<br>Bonds<br>Outstanding | Trading Volume                       | TRACE                            | Volume not                             |
|------------------|------------------------------|-------------------------------------|--|--------------------------------------|----------------------------------|--|
|                  | Trading Volume<br>(Billions) | Outstanding<br>Amount<br>(Billions) |  | Relative to<br>Amount<br>Outstanding | Reported<br>Volume<br>(Billions) | Disseminated on<br>TRACE<br>(Billions) |
| 2006             | 3,141                        | 3,331                               | 8,050                                  | 0.94                                 | 2,770                            | 372                                    |
| 2007             | 2,956                        | 3,577                               | 8,069                                  | 0.83                                 | 2,542                            | 414                                    |
| 2008             | 2,309                        | 3,658                               | 7,567                                  | 0.63                                 | 2,095                            | 215                                    |
| 2009             | 3,297                        | 4,327                               | 8,259                                  | 0.76                                 | 2,928                            | 369                                    |
| 2010             | 3,752                        | 4,820                               | 8,996                                  | 0.78                                 | 3,133                            | 620                                    |
| 2011             | 3,722                        | 5,171                               | 9,371                                  | 0.72                                 | 3,070                            | 652                                    |
| 2012             | 3,851                        | 5,723                               | 10,052                                 | 0.67                                 | 3,115                            | 737                                    |
| 2013             | 4,217                        | 6,199                               | 10,721                                 | 0.68                                 | 3,364                            | 853                                    |
| 2014             | 4,227                        | 6,557                               | 10,967                                 | 0.64                                 | 3,801                            | 426                                    |
| 2015             | 4,402                        | 7,147                               | 11,289                                 | 0.62                                 | 4,402                            | 1                                      |
| 2016 (10 Months) | 3,723                        | 6,726                               | 10,291                                 | 0.55                                 | 3,723                            | 0                                      |

**Table III**  
**Estimates of Transaction Costs on Customer Trades - 2006-2016**

The table reports estimated one-way trade execution costs paid by customers in customer-to-dealer principal trades for the Aggregate Market, Top 70%, and Constant Dealer samples described in Table 1. Transaction costs are estimated following the regression based model implemented by Bessembinder, Maxwell, and Venkataraman (2006). Small, medium, and large issue size are defined by \$500 million and \$1 billion cutoffs. 'Young' refers to bonds that have traded less than one year. 'Clicking' trades comprise of trades in young, investment grade, and large issue bonds that are less than or equal to \$5 million. All other trades are categorized as 'calling' trades.

|  | January 2006 -<br>June 2007 | July 2007 -<br>April 2009 | May 2009 -<br>June 2010 | July 2010 -<br>March 2014 | April 2014 -<br>Oct 2016 |
|--|-----------------------------|---------------------------|-------------------------|---------------------------|--------------------------|
|  | Pre-Crisis                  | Crisis                    | Post-Crisis             | Regulatory<br>Phase-In    | Volcker                  |
| Aggregate Market Sample                                  | 0.40%                       | 0.65%                     | 0.63%                   | 0.47%                     | 0.42%                    |
| Top 70% Sample   | 0.24%                       | 0.45%                     | 0.35%                   | 0.26%                     | 0.25%                    |
| Constant Dealer Sample                                   | 0.31%                       | 0.56%                     | 0.54%                   | 0.43%                     | 0.39%                    |
| <b>By Trade Size - Aggregate Market Sample</b>           |                             |                           |                         |                           |                          |
| Transaction Cost (%): <=\$100K                           | 0.61%                       | 0.89%                     | 0.87%                   | 0.69%                     | 0.62%                    |
| <i>% of Total Volume</i>                                 | 1%                          | 2%                        | 2%                      | 2%                        | 2%                       |
| Transaction Cost (%): >\$100K & <=\$1M                   | 0.25%                       | 0.47%                     | 0.42%                   | 0.31%                     | 0.29%                    |
| <i>% of Total Volume</i>                                 | 7%                          | 9%                        | 9%                      | 9%                        | 10%                      |
| Transaction Cost (%): >\$1M & <=\$10M                    | 0.19%                       | 0.33%                     | 0.28%                   | 0.21%                     | 0.20%                    |
| <i>% of Total Volume</i>                                 | 60%                         | 60%                       | 58%                     | 61%                       | 61%                      |
| Transaction Cost (%): > \$10M                            | 0.16%                       | 0.29%                     | 0.23%                   | 0.18%                     | 0.16%                    |
| <i>% of Total Volume</i>                                 | 32%                         | 29%                       | 31%                     | 28%                       | 27%                      |
| <b>By Bond Characteristics - Aggregate Market Sample</b> |                             |                           |                         |                           |                          |
| Transaction Cost (%): Investment Grade                   | 0.36%                       | 0.71%                     | 0.65%                   | 0.45%                     | 0.38%                    |
| <i>% of Total Volume</i>                                 | 58%                         | 64%                       | 68%                     | 63%                       | 69%                      |
| Transaction Cost (%): High Yield                         | 0.46%                       | 0.50%                     | 0.56%                   | 0.51%                     | 0.51%                    |
| <i>% of Total Volume</i>                                 | 42%                         | 36%                       | 32%                     | 37%                       | 31%                      |
| Transaction Cost (%): Large Issue Size                   | 0.36%                       | 0.68%                     | 0.57%                   | 0.38%                     | 0.33%                    |
| <i>% of Total Volume</i>                                 | 37%                         | 47%                       | 49%                     | 48%                       | 52%                      |
| Transaction Cost (%): Medium Issue Size                  | 0.38%                       | 0.64%                     | 0.67%                   | 0.48%                     | 0.45%                    |
| <i>% of Total Volume</i>                                 | 29%                         | 29%                       | 28%                     | 32%                       | 32%                      |
| Transaction Cost (%): Small Issue Size                   | 0.45%                       | 0.59%                     | 0.70%                   | 0.64%                     | 0.58%                    |
| <i>% of Total Volume</i>                                 | 34%                         | 24%                       | 23%                     | 20%                       | 16%                      |
| Transaction Cost (%): Young bonds                        | 0.23%                       | 0.50%                     | 0.39%                   | 0.31%                     | 0.27%                    |
| <i>% of Total Volume</i>                                 | 36%                         | 36%                       | 41%                     | 42%                       | 36%                      |
| Transaction Cost (%): Old bonds                          | 0.44%                       | 0.69%                     | 0.70%                   | 0.53%                     | 0.46%                    |
| <i>% of Total Volume</i>                                 | 64%                         | 64%                       | 59%                     | 58%                       | 64%                      |
| Transaction Cost (%): Clicking Trades #                  | 0.30%                       | 0.66%                     | 0.40%                   | 0.32%                     | 0.26%                    |
| <i>% of Total Volume</i>                                 | 2%                          | 5%                        | 5%                      | 5%                        | 7%                       |
| Transaction Cost (%): Calling Trades                     | 0.41%                       | 0.65%                     | 0.65%                   | 0.48%                     | 0.44%                    |
| <i>% of Total Volume</i>                                 | 98%                         | 95%                       | 95%                     | 95%                       | 93%                      |

**Table IV**  
**Capital Commitment Summary Statistics**

This table reports summary statistics on capital commitment measures. The capital commitment measures are aggregated at the daily and weekly level and all other variables are aggregated at the monthly level. Daily, weekly, and monthly averages are reported for five sub-periods and for the full January 2006 to October 2016 sample period. All variables are computed using the dealers in the Top 70% sample described in Table I. Variable definitions are provided in Appendix I

|   | Jan. 2006 -<br>Jun. 2007 | Jul. 2007 -<br>Apr. 2009 | May 2009 -<br>Jun. 2010 | Jul. 2010 -<br>Mar. 2014 | Apr. 2014 -<br>Oct. 2016 | Jan. 2006 -<br>Oct. 2016 |
|---|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|--------------------------|
|   | Pre-Crisis               | Crisis                   | Post-Crisis             | Regulatory<br>Phase-In   | Volcker                  | Full Sample              |
| Time-Weighted Daily Capital / Volume (%)  | 11.4                     | 10.6                     | 9.3                     | 8.5                      | 7.4                      | 9.1                      |
| Time-Weighted Daily Capital (\$ Millions) | 872.4                    | 604.9                    | 782.1                   | 723.1                    | 705.1                    | 725.8                    |
| Overnight Capital / Volume (%)            | 21.1                     | 20.5                     | 17.8                    | 16.2                     | 13.8                     | 17.2                     |
| Overnight Capital (\$ Millions)           | 1,625.5                  | 1,170.5                  | 1,501.2                 | 1,386.2                  | 1,313.5                  | 1,377.7                  |
| Weekend Capital / Volume (%)              | 10.4                     | 10.7                     | 8.7                     | 7.7                      | 6.5                      | 8.4                      |
| Weekend Capital (\$ Millions)             | 3,883.2                  | 2,950.5                  | 3,527.9                 | 3,174.2                  | 3,063.4                  | 3,245.9                  |
| Dollar Volume / Amount Outstanding (%)    | 7.1                      | 4.8                      | 5.6                     | 4.7                      | 4.1                      | 5.0                      |
| Average Trade Size (\$ Thousands)         | 2,004.3                  | 1,326.2                  | 1,490.2                 | 1,279.8                  | 1,212.8                  | 1,394.6                  |
| Principal Volume / Total Volume (%)       | 91.4                     | 91.9                     | 92.3                    | 91.6                     | 94.9                     | 92.5                     |

**Table V**  
**Time Series Regressions: Capital Commitment**

This table reports time series regression results over the January 2006 to October 2016 period. Each regression includes four time period indicators; the benchmark period is the January 2006 to June 2007 pre-crisis period. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. All dependent variables are computed using the dealers in the Top 70% sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between time periods are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Variable definitions are provided in Appendix I. Sample period (January 2006 to October 2016) averages of each dependent variable are shown above regression results.

|  | (1)   | (2)   | (3)                                 | (4)                                   | (5)                               | (6)                                 | (7)   | (8)  | (9)                                      |
|--|---|---|-------------------------------------|---------------------------------------|-----------------------------------|-------------------------------------|---|--|--|
|  | Time-Weighted<br>Daily Capital/<br>Volume (%) | Time-Weighted<br>Daily Capital<br>(\$ Millions) | Overnight<br>Capital/<br>Volume (%) | Overnight<br>Capital<br>(\$ Millions) | Weekend<br>Capital/<br>Volume (%) | Weekend<br>Capital<br>(\$ Millions) | Dollar Volume /<br>Amount<br>Outstanding<br>(%) | Ln Average<br>Trade Size<br>(\$ Thousands) | Principal<br>Volume / Tot.<br>Volume (%) |
| Dependent Variable Average                 | 9.1   | 725.8   | 17.2                                | 1,377.7                               | 8.4                               | 3,245.9                             | 5.0   | 7.2  | 92.5                                     |
| Crisis                                     | -0.2<br>(0.641)                               | -199.4***<br>(0.000)                            | 0.2<br>(0.818)                      | -329.9***<br>(0.000)                  | 0.2<br>(0.802)                    | -573.8***<br>(0.000)                | -1.9***<br>(0.000)                              | -0.2**<br>(0.014)                          | 0.0<br>(0.952)                           |
| Post-Crisis                                | -1.6**<br>(0.010)                             | 15.2<br>(0.701)                                 | -2.5**<br>(0.026)                   | 75.6<br>(0.322)                       | -1.7**<br>(0.012)                 | 108.3<br>(0.579)                    | -0.8***<br>(0.003)                              | 0.1<br>(0.310)                             | 0.5<br>(0.483)                           |
| Regulatory Phase-In                        | -2.1***<br>(0.000)                            | -95.5***<br>(0.010)                             | -3.6***<br>(0.001)                  | -139.8**<br>(0.044)                   | -2.9***<br>(0.000)                | -398.2*<br>(0.062)                  | -2.1***<br>(0.000)                              | -0.2**<br>(0.028)                          | -0.1<br>(0.863)                          |
| Volcker                                    | -3.5***<br>(0.000)                            | -127.8***<br>(0.000)                            | -6.4***<br>(0.000)                  | -238.5***<br>(0.000)                  | -4.1***<br>(0.000)                | -598.7***<br>(0.000)                | -2.8***<br>(0.000)                              | -0.3***<br>(0.000)                         | 3.4***<br>(0.000)                        |
| Corp Bond Index Return (t - 1)             | 2.7<br>(0.514)                                | 62.8<br>(0.796)                                 | 4.5<br>(0.578)                      | 53.8<br>(0.909)                       | 2.6<br>(0.655)                    | 985.6<br>(0.504)                    | 0.8<br>(0.563)                                  | 0.3<br>(0.276)                             | -8.2<br>(0.124)                          |
| Stock Market Index Return (t - 1)          | -4.8<br>(0.261)                               | 402.4<br>(0.111)                                | -11.3<br>(0.174)                    | 742.2<br>(0.128)                      | -8.4*<br>(0.093)                  | 1,512.2<br>(0.187)                  | 4.9***<br>(0.003)                               | 1.2***<br>(0.000)                          | -1.1<br>(0.831)                          |
| Chg. in VIX (t - 1)                        | -0.1<br>(0.242)                               | 8.1<br>(0.284)                                  | -0.2<br>(0.256)                     | 15.6<br>(0.285)                       | -0.3<br>(0.103)                   | 28.2<br>(0.483)                     | 0.1**<br>(0.042)                                | 0.0***<br>(0.001)                          | -0.1<br>(0.451)                          |
| Chg. in 3-Month Libor (t - 1)              | 0.4<br>(0.708)                                | -190.2**<br>(0.011)                             | 0.6<br>(0.743)                      | -377.1***<br>(0.007)                  | 2.0<br>(0.178)                    | -501.3*<br>(0.079)                  | -1.8***<br>(0.001)                              | -0.3***<br>(0.000)                         | -1.9<br>(0.472)                          |
| ABS (MF+ETF Flows (t-1) / Tot. Out. (t-2)) | 30.9<br>(0.360)                               | -3,333.7<br>(0.133)                             | 65.7<br>(0.289)                     | -6,481.4<br>(0.125)                   | -1.2<br>(0.976)                   | -7,753.9<br>(0.440)                 | -33.7**<br>(0.035)                              | -4.3<br>(0.154)                            | 6.6<br>(0.875)                           |
| % Retail Volume                            | -41.8*<br>(0.052)                             | -4,190.2***<br>(0.001)                          | -80.0*<br>(0.052)                   | -7,802.0***<br>(0.001)                | 9.5<br>(0.692)                    | -22,167.7***<br>(0.000)             | -26.8*<br>(0.070)                               | -17.4***<br>(0.000)                        | 24.2<br>(0.463)                          |
| Constant                                   | 11.8***<br>(0.000)                            | 963.5***<br>(0.000)                             | 22.0***<br>(0.000)                  | 1,797.5***<br>(0.000)                 | 10.3***<br>(0.000)                | 4,289.9***<br>(0.000)               | 7.8***<br>(0.000)                               | 14.8***<br>(0.000)                         | 90.9***<br>(0.000)                       |
| Observations                               | 2,716   | 2,716   | 2,716                               | 2,716                                 | 566                               | 566                                 | 130   | 130  | 130                                      |
| Adjusted R-squared                         | 0.124   | 0.167   | 0.145                               | 0.148                                 | 0.257                             | 0.167                               | 0.657   | 0.673                                      | 0.456                                    |
| Test: Crisis = Post-Crisis                 | **  | ***   | ***                                 | ***                                   | ***                               | ***                                 | ***   | ***  | ns                                       |
| Test: Crisis = Regulatory                  | ***   | ***   | ***                                 | ***                                   | ***                               | ns                                  | ns  | ns   | ns                                       |
| Test: Crisis = Volcker                     | ***   | ***   | ***                                 | **                                    | ***                               | ns                                  | ***   | ***  | ***                                      |
| Test: Post-Crisis = Regulatory             | ns  | ***   | ns                                  | ***                                   | *                                 | **                                  | ***   | ***  | ns                                       |
| Test: Post-Crisis = Volcker                | ***   | ***   | ***                                 | ***                                   | ***                               | ***                                 | ***   | ***  | **                                       |
| Test: Regulatory = Volcker                 | ***   | ns  | ***                                 | **                                    | ***                               | ns                                  | ***   | ns   | ***                                      |

**Table VI****Capital Commitment Summary Statistics: Bank vs. Non-Bank Dealers**

This table reports summary statistics for bank and non-bank dealers in the Constant Dealer sample described in Table I. Panel A reports trading statistics for the bank and non-bank samples of dealers. Panel B reports daily and weekly averages over five sub-periods of capital commitment measures for bank and non-bank dealers. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. Variable definitions are provided in Appendix I.

|   | Jan. 2006 -<br>Jun. 2007 | Jul. 2007 -<br>Apr. 2009 | May 2009 -<br>Jun. 2010 | Jul. 2010 -<br>Mar. 2014 | Apr. 2014 -<br>Oct. 2016 |
|---|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
|   | Pre-Crisis               | Crisis                   | Post-Crisis             | Regulatory<br>Phase-In   | Volcker                  |
| <b>Panel A: Trading Statistics</b>        |                          |                          |                         |                          |                          |
| Non-Bank Market Share                     | 4.4%                     | 5.1%                     | 7.0%                    | 10.2%                    | 13.5%                    |
| Non-Bank Market Share - Customer Volume   | 2.4%                     | 3.3%                     | 5.5%                    | 9.2%                     | 12.5%                    |
| <u>Bank Sample</u>                        |                          |                          |                         |                          |                          |
| Dollar Volume / Amount Outstanding (%)    | 6.5                      | 4.5                      | 5.3                     | 4.7                      | 4.0                      |
| Average Trade Size (\$ Thousands)         | 1,258.3                  | 880.9                    | 798.2                   | 817.4                    | 761.3                    |
| Principal Volume / Total Volume (%)       | 92.0                     | 90.0                     | 91.0                    | 91.3                     | 93.6                     |
| Transaction Cost (%)                      | 0.31%                    | 0.56%                    | 0.53%                   | 0.40%                    | 0.37%                    |
| <u>Non-Bank Sample</u>                    |                          |                          |                         |                          |                          |
| Dollar Volume / Amount Outstanding (%)    | 0.3                      | 0.2                      | 0.4                     | 0.5                      | 0.6                      |
| Average Trade Size (\$ Thousands)         | 373.5                    | 188.8                    | 206.1                   | 241.6                    | 305.9                    |
| Principal Volume / Total Volume (%)       | 76.2                     | 82.8                     | 77.6                    | 84.2                     | 90.9                     |
| Transaction Cost (%)                      | 0.37%                    | 0.63%                    | 0.61%                   | 0.54%                    | 0.44%                    |
| <b>Panel B: Capital Commitment</b>        |                          |                          |                         |                          |                          |
| <u>Bank Sample</u>                        |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)  | 11.8                     | 11.0                     | 9.6                     | 9.0                      | 7.9                      |
| Time-Weighted Daily Capital (\$ Millions) | 883.8                    | 611.6                    | 819.7                   | 806.1                    | 771.6                    |
| Overnight Capital / Volume (%)            | 22.0                     | 21.1                     | 18.4                    | 17.2                     | 14.8                     |
| Overnight Capital (\$ Millions)           | 1,660.1                  | 1,184.6                  | 1,577.3                 | 1,546.7                  | 1,449.2                  |
| Weekend Capital / Volume (%)              | 11.0                     | 11.3                     | 9.2                     | 8.2                      | 7.5                      |
| Weekend Capital (\$ Millions)             | 4,030.4                  | 3,057.3                  | 3,785.8                 | 3,598.6                  | 3,611.0                  |
| <u>Non-Bank Sample</u>                    |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)  | 7.9                      | 7.4                      | 8.0                     | 8.9                      | 8.2                      |
| Time-Weighted Daily Capital (\$ Millions) | 27.0                     | 21.3                     | 52.7                    | 89.9                     | 127.8                    |
| Overnight Capital / Volume (%)            | 14.8                     | 13.8                     | 15.1                    | 17.3                     | 15.6                     |
| Overnight Capital (\$ Millions)           | 50.5                     | 39.4                     | 99.6                    | 174.8                    | 244.3                    |
| Weekend Capital / Volume (%)              | 9.2                      | 8.3                      | 8.8                     | 9.7                      | 8.9                      |
| Weekend Capital (\$ Millions)             | 153.4                    | 116.0                    | 283.2                   | 482.7                    | 681.5                    |

**Table VII**

**Time Series Regressions: Bank vs. Non-Bank Dealers**

This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results. Panel A shows the results for all bonds and trades in the Constant Dealer sample. Panel B shows results for the sample of 'clicking' trades. 'Clicking' trades comprises of trades in young (age less than one year), investment grade, and large issue (issue size of at least \$1 billion) that are less than or equal to \$5 million. All other trades are categorized as 'calling' trades. Bold formatting indicates calling and clicking coefficients are statistically different at the 5% level.

| Panel A: Full Sample                              |  |   |                                |                                 |                              |                               |  |                                      |                                     |
|---|--|---|--------------------------------|---------------------------------|------------------------------|-------------------------------|--|--------------------------------------|-------------------------------------|
|   | (1)                                      | (2)                                       | (3)                            | (4)                             | (5)                          | (6)                           | (7)                                    | (8)                                  | (9)                                 |
| Dependent Variable Average                        | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital (\$ Millions) | Overnight Capital / Volume (%) | Overnight Capital (\$ Millions) | Weekend Capital / Volume (%) | Weekend Capital (\$ Millions) | Dollar Volume / Amount Outstanding (%) | Ln Average Trade Size (\$ Thousands) | Principal Volume / Total Volume (%) |
| Dependent Variable Average                        | 8.9                                      | 425.9                                     | 16.9                           | 812.2                           | 9.1                          | 1,996.2                       | 2.6                                    | 6.1                                  | 87.7                                |
| Bank  | 3.8***<br>(0.000)                        | 856.8***<br>(0.000)                       | 7.2***<br>(0.000)              | 1,609.6***<br>(0.000)           | 1.9***<br>(0.000)            | 3,877.0***<br>(0.000)         | 6.2***<br>(0.000)                      | 1.2***<br>(0.000)                    | 15.8***<br>(0.000)                  |
| Crisis x Non-Bank                                 | 0.7*<br>(0.057)                          | 21.1<br>(0.134)                           | 1.3<br>(0.149)                 | 38.5<br>(0.140)                 | 0.1<br>(0.937)               | 115.9<br>(0.142)              | 0.0<br>(0.763)                         | -0.4***<br>(0.000)                   | 7.9***<br>(0.000)                   |
| Crisis x Bank                                     | 0.4<br>(0.293)                           | -245.4***<br>(0.000)                      | 1.4*<br>(0.100)                | -426.0***<br>(0.000)            | 1.2*<br>(0.057)              | -819.8***<br>(0.000)          | -1.9***<br>(0.000)                     | -0.2*<br>(0.052)                     | -0.7*<br>(0.051)                    |
| Post-Crisis x Non-Bank                            | 1.4***<br>(0.005)                        | 70.8***<br>(0.000)                        | 2.7**<br>(0.026)               | 132.3***<br>(0.000)             | 0.7<br>(0.248)               | 277.0**<br>(0.040)            | 0.4**<br>(0.020)                       | -0.2**<br>(0.012)                    | 2.1<br>(0.278)                      |
| Post-Crisis x Bank                                | -0.9*<br>(0.053)                         | -19.0<br>(0.603)                          | -1.2<br>(0.200)                | 0.4<br>(0.995)                  | -0.8<br>(0.245)              | -97.4<br>(0.650)              | -0.9***<br>(0.000)                     | -0.1<br>(0.141)                      | -0.3<br>(0.806)                     |
| Regulatory Phase-In x Non-Bank                    | 2.3***<br>(0.000)                        | 77.9***<br>(0.000)                        | 5.0***<br>(0.000)              | 152.4***<br>(0.000)             | 1.5***<br>(0.004)            | 427.9***<br>(0.000)           | 0.2*<br>(0.075)                        | -0.2**<br>(0.035)                    | 9.1***<br>(0.000)                   |
| Regulatory Phase-In x Bank                        | -1.4***<br>(0.000)                       | -62.6**<br>(0.047)                        | -2.3***<br>(0.006)             | -85.4<br>(0.142)                | -1.9***<br>(0.001)           | -333.2*<br>(0.075)            | -1.8***<br>(0.000)                     | -0.2**<br>(0.011)                    | 0.4<br>(0.604)                      |
| Volcker x Non-Bank                                | 1.1***<br>(0.000)                        | 109.6***<br>(0.000)                       | 2.4***<br>(0.000)              | 210.3***<br>(0.000)             | 0.2<br>(0.593)               | 584.1***<br>(0.000)           | 0.3***<br>(0.001)                      | -0.0<br>(0.560)                      | 15.5***<br>(0.000)                  |
| Volcker x Bank                                    | -3.0***<br>(0.000)                       | -103.5***<br>(0.001)                      | -5.6***<br>(0.000)             | -194.4***<br>(0.000)            | -3.1***<br>(0.000)           | -363.4<br>(0.135)             | -2.5***<br>(0.000)                     | -0.4***<br>(0.000)                   | 2.3**<br>(0.011)                    |
| Observations                                      | 5,436                                    | 5,436                                     | 5,436                          | 5,436                           | 1,132                        | 1,132                         | 260                                    | 260                                  | 260                                 |
| Adjusted R-squared                                | 0.123                                    | 0.864                                     | 0.133                          | 0.862                           | 0.173                        | 0.889                         | 0.958                                  | 0.960                                | 0.784                               |
| Test: Crisis x Non-Bank = Crisis x Bank           | ns                                       | ***                                       | ns                             | ***                             | ns                           | ***                           | ***                                    | ***                                  | ***                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ***                                      | ***                                       | ***                            | **                              | **                           | **                            | ***                                    | **                                   | ns                                  |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                                    | ns                                   | ***                                 |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                                    | ***                                  | ***                                 |
| Market Controls                                   | YES                                      | YES                                       | YES                            | YES                             | YES                          | YES                           | YES                                    | YES                                  | YES                                 |

| Panel B: Clicking Trades                          |  |  |                                |  |                              |  |  |                                      |                                     |
|---|--|--|--------------------------------|--|------------------------------|--|--|--------------------------------------|-------------------------------------|
|   | (1)                                      | (2)  | (3)                            | (4)                                      | (5)                          | (6)                                    | (7)                                    | (8)                                  | (9)                                 |
| Dependent Variable Average                        | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital / Volume (\$ Millions) | Overnight Capital / Volume (%) | Overnight Capital / Volume (\$ Millions) | Weekend Capital / Volume (%) | Weekend Capital / Volume (\$ Millions) | Dollar Volume / Amount Outstanding (%) | Ln Average Trade Size (\$ Thousands) | Principal Volume / Total Volume (%) |
| Bank  | 16.2                                     | 39.1   | 31.4                           | 75.9                                     | 18.3                         | 214.3                                  | 1.9                                    | 6.0                                  | 90.8                                |
|   | <b>0.7</b>                               | <b>45.8***</b>                                     | <b>0.7</b>                     | <b>87.2***</b>                           | <b>-2.7***</b>               | <b>223.4***</b>                        | <b>3.0***</b>                          | <b>0.6***</b>                        | <b>5.5</b>                          |
|   | (0.343)                                  | (0.000)  | (0.639)                        | (0.000)                                  | (0.000)                      | (0.000)                                | (0.000)                                | (0.000)                              | (0.166)                             |
| Crisis x Non-Bank                                 | <b>-7.5***</b>                           | -1.9   | <b>-14.3***</b>                | -4.0                                     | <b>-10.2***</b>              | -9.2                                   | -0.1*                                  | <b>-0.9***</b>                       | 1.8                                 |
|   | (0.000)                                  | (0.256)  | (0.000)                        | (0.228)                                  | (0.000)                      | (0.412)                                | (0.079)                                | (0.000)                              | (0.691)                             |
| Crisis x Bank                                     | <b>-2.4***</b>                           | <b>-1.6</b>  | <b>-3.4**</b>                  | <b>-0.0</b>                              | -0.5                         | <b>27.1</b>                            | <b>-0.5***</b>                         | <b>-0.3***</b>                       | <b>-3.9***</b>                      |
|   | (0.001)                                  | (0.654)  | (0.014)                        | (0.995)                                  | (0.665)                      | (0.161)                                | (0.000)                                | (0.007)                              | (0.007)                             |
| Post-Crisis x Non-Bank                            | <b>-5.4***</b>                           | <b>4.4</b>   | <b>-10.9***</b>                | <b>7.1</b>                               | <b>-8.4***</b>               | <b>1.2</b>                             | 0.2                                    | <b>-0.7***</b>                       | -5.6                                |
|   | (0.000)                                  | (0.133)  | (0.000)                        | (0.224)                                  | (0.000)                      | (0.952)                                | (0.338)                                | (0.000)                              | (0.205)                             |
| Post-Crisis x Bank                                | <b>-7.0***</b>                           | 17.1***  | <b>-13.3***</b>                | 33.7***                                  | <b>-7.0***</b>               | 89.1***                                | <b>-0.3</b>                            | <b>-0.2***</b>                       | <b>-9.7***</b>                      |
|   | (0.000)                                  | (0.000)  | (0.000)                        | (0.000)                                  | (0.000)                      | (0.000)                                | (0.111)                                | (0.007)                              | (0.000)                             |
| Regulatory Phase-In x Non-Bank                    | <b>-5.6***</b>                           | <b>5.9***</b>                                      | <b>-10.5***</b>                | <b>11.1***</b>                           | <b>-7.0***</b>               | <b>33.2***</b>                         | 0.2*                                   | -0.4**                               | 1.9                                 |
|   | (0.000)                                  | (0.001)  | (0.000)                        | (0.002)                                  | (0.000)                      | (0.009)                                | (0.065)                                | (0.034)                              | (0.665)                             |
| Regulatory Phase-In x Bank                        | <b>-6.1***</b>                           | <b>21.2***</b>                                     | <b>-11.3***</b>                | <b>42.1***</b>                           | <b>-5.2***</b>               | <b>135.5***</b>                        | <b>0.3*</b>                            | <b>-0.3***</b>                       | <b>-6.6***</b>                      |
|   | (0.000)                                  | (0.000)  | (0.000)                        | (0.000)                                  | (0.000)                      | (0.000)                                | (0.089)                                | (0.000)                              | (0.000)                             |
| Volcker x Non-Bank                                | <b>-7.8***</b>                           | <b>11.9***</b>                                     | <b>-14.4***</b>                | <b>23.5***</b>                           | <b>-8.9***</b>               | <b>71.1***</b>                         | 0.3***                                 | -0.1                                 | <b>5.1</b>                          |
|   | (0.000)                                  | (0.000)  | (0.000)                        | (0.000)                                  | (0.000)                      | (0.000)                                | (0.000)                                | (0.261)                              | (0.230)                             |
| Volcker x Bank                                    | <b>-8.7***</b>                           | <b>35.0***</b>                                     | <b>-16.3***</b>                | <b>68.1***</b>                           | <b>-6.8***</b>               | <b>236.1***</b>                        | <b>-0.0</b>                            | <b>-0.2***</b>                       | -1.1                                |
|   | (0.000)                                  | (0.000)  | (0.000)                        | (0.000)                                  | (0.000)                      | (0.000)                                | (0.895)                                | (0.001)                              | (0.602)                             |
| Observations                                      | 5,426                                    | 5,426  | 5,426                          | 5,426                                    | 1,132                        | 1,132                                  | 260                                    | 260                                  | 260                                 |
| Adjusted R-squared                                | 0.198                                    | 0.788  | 0.188                          | 0.775                                    | 0.214                        | 0.781                                  | 0.925                                  | 0.857                                | 0.171                               |
| Test: Crisis x Non-Bank = Crisis x Bank           | ***                                      | ns   | ***                            | ns                                       | ***                          | **                                     | ***                                    | ***                                  | ns                                  |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ns                                       | ***  | ns                             | ***                                      | ns                           | ***                                    | ***                                    | ***                                  | ns                                  |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ns                                       | ***  | ns                             | ***                                      | ns                           | ***                                    | ns                                     | ns                                   | **                                  |
| Test: Volcker x Non-Bank = Volcker x Bank         | ns                                       | ***  | ns                             | ***                                      | ns                           | ***                                    | *                                      | ns                                   | ns                                  |
| Market Controls                                   | YES                                      | YES  | YES                            | YES                                      | YES                          | YES                                    | YES                                    | YES                                  | YES                                 |

**Table VIII**  
**Stressful Day Summary Statistics**

This table reports summary statistics for the stressful day analysis for bank and non-bank affiliated dealers. The capital commitment measures are aggregated at the daily and weekly level. Daily and weekly averages are reported for five sub-periods. All variables are computed using the Constant Dealer sample described in Table I. Variable definitions are provided in Appendix I. Panel A reports statistics for bond-level stress based on the occurrence of large block trades (trade size of at least \$10 million). Panel B reports statistics for days with market-wide stress based on the Federal Reserve Bank of Cleveland Stress Index. A description of the identification of "stressful days" can be found in Section VII of the paper.

| Panel A: Bond-Level Stress - Block Trading                                   |                          |                          |                         |                          |                          |
|--|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
|  | Jan. 2006 -<br>Jun. 2007 | Jul. 2007 -<br>Apr. 2009 | May 2009 -<br>Jun. 2010 | Jul. 2010 -<br>Mar. 2014 | Apr. 2014 -<br>Oct. 2016 |
|  | Pre-Crisis               | Crisis                   | Post-Crisis             | Regulatory<br>Phase-In   | Volcker                  |
| <u>Bank Sample</u>   |                          |                          |                         |                          |                          |
| Block Volume / Total Volume (%)  | 22.5                     | 19.0                     | 23.6                    | 20.6                     | 18.8                     |
| Time-Weighted Daily Capital / Volume (%)                                     | 30.8                     | 23.3                     | 25.9                    | 24.0                     | 20.8                     |
| Overnight Capital / Volume (%)   | 62.0                     | 47.3                     | 53.6                    | 48.9                     | 41.0                     |
| Weekly Capital / Volume (%)  | 42.9                     | 33.5                     | 35.4                    | 31.4                     | 25.9                     |
| <u>Non-Bank Sample</u>   |                          |                          |                         |                          |                          |
| Block Volume / Total Volume (%)  | 7.8                      | 8.2                      | 10.1                    | 10.7                     | 10.1                     |
| Time-Weighted Daily Capital / Volume (%)                                     | 9.7                      | 7.6                      | 12.0                    | 13.6                     | 12.0                     |
| Overnight Capital / Volume (%)   | 14.0                     | 9.9                      | 19.5                    | 27.1                     | 22.6                     |
| Weekly Capital / Volume (%)  | 12.5                     | 7.5                      | 13.8                    | 20.2                     | 15.8                     |
| Panel B: Market-Wide Stress - Federal Reserve Bank of Cleveland Stress Index |                          |                          |                         |                          |                          |
| # Events   | 12                       | 23                       | 4                       | 23                       | 24                       |
| <u>Bank Sample</u>   |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)                                     | 12.0                     | 9.8                      | 10.0                    | 8.5                      | 6.8                      |
| Time-Weighted Daily Capital (\$ Millions)                                    | 827.0                    | 609.7                    | 923.1                   | 788.3                    | 747.2                    |
| Overnight Capital / Volume (%)   | 22.3                     | 19.0                     | 19.8                    | 16.3                     | 12.6                     |
| Overnight Capital (\$ Millions)  | 1,534.4                  | 1,182.1                  | 1,815.6                 | 1,511.4                  | 1,387.6                  |
| Weekend Capital / Volume (%)   | 21.9                     | 18.8                     | 18.2                    | 16.1                     | 13.0                     |
| Weekend Capital (\$ Millions)  | 9,439.0                  | 7,077.2                  | 10,629.2                | 8,734.9                  | 8,305.2                  |
| <u>Non-Bank Sample</u>   |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)                                     | 7.6                      | 7.8                      | 8.8                     | 8.9                      | 7.8                      |
| Time-Weighted Daily Capital (\$ Millions)                                    | 22.4                     | 20.9                     | 60.0                    | 95.2                     | 130.3                    |
| Overnight Capital / Volume (%)   | 14.1                     | 14.6                     | 16.8                    | 17.2                     | 14.9                     |
| Overnight Capital (\$ Millions)  | 40.4                     | 38.8                     | 116.1                   | 183.9                    | 246.3                    |
| Weekend Capital / Volume (%)   | 15.1                     | 13.0                     | 15.0                    | 16.9                     | 14.8                     |
| Weekend Capital (\$ Millions)  | 299.1                    | 227.0                    | 677.8                   | 1,088.8                  | 1,431.1                  |

**Table IX**  
**Time Series Regressions: Stressful Days**

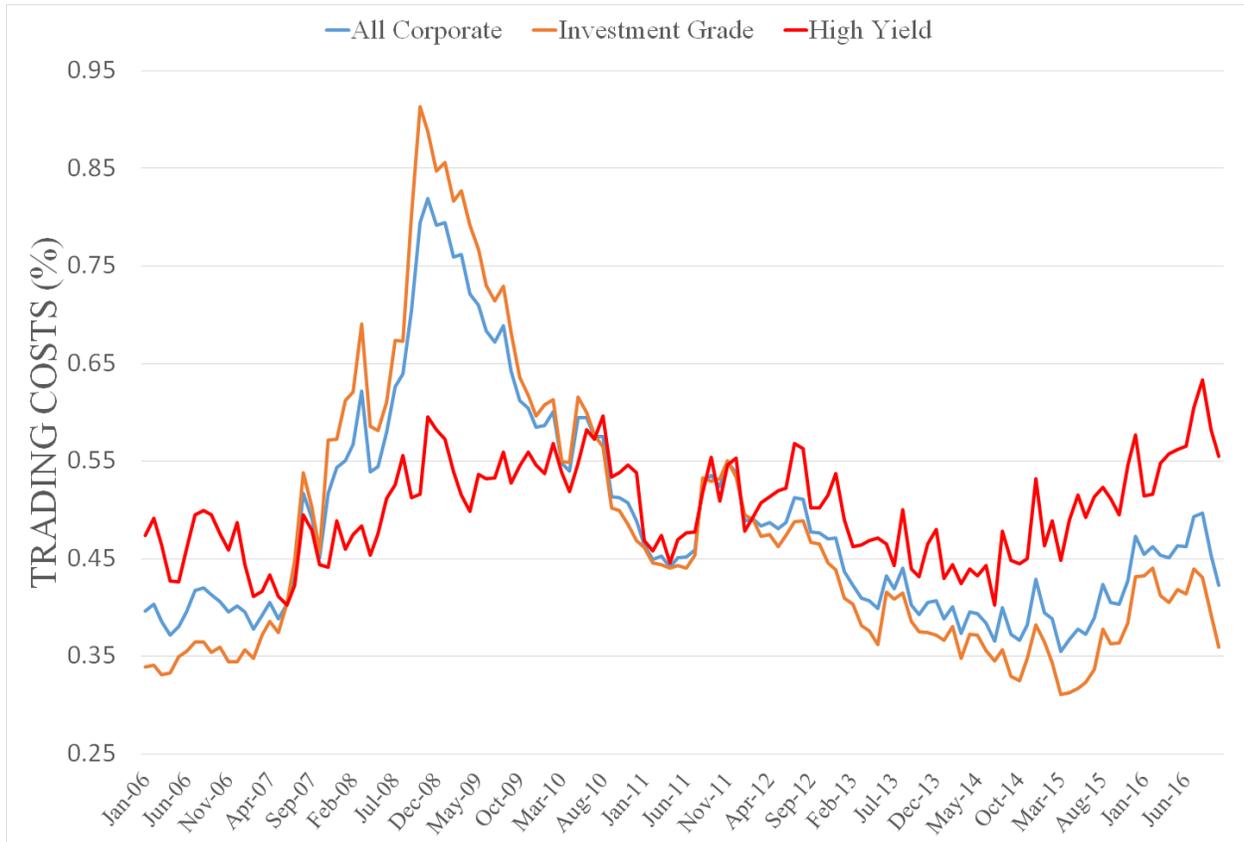
This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers on stressful days. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results. Panel A reports statistics for bond-level stress based on the occurrence of large block trades (trade size of at least \$10 million). Panel B reports statistics for days with market-wide stress based on the Federal Reserve Bank of Cleveland Credit Market Index. A description of the identification of "stressful days" can be found in Section IV of the paper. In Panel B, bold indicates coefficients are statistically different (at least 5%) from control days [-7,-1] prior to the stressful day.

| Panel A: Bond-Level Stress - Block Trading        |  |  |                                      |                                   |
|---|--|--|--------------------------------------|-----------------------------------|
|   | (1)                                      | (2)  | (3)                                  | (4)                               |
|   | Block<br>Volume /<br>Total Volume<br>(%) | Time-<br>Weighted<br>Daily Capital<br>/ Volume (%) | Overnight<br>Capital /<br>Volume (%) | Weekly<br>Capital /<br>Volume (%) |
| Dependent Variable Average                        | 15.1                                     | 18.2   | 35.7                                 | 24.4                              |
| Bank  | 14.7***<br>(0.000)                       | 21.1***<br>(0.000)                                 | 47.9***<br>(0.000)                   | 30.4***<br>(0.000)                |
| Crisis x Non-Bank                                 | 1.4<br>(0.104)                           | -1.4<br>(0.412)                                    | -2.2<br>(0.463)                      | -3.2<br>(0.192)                   |
| Crisis x Bank                                     | -2.5***<br>(0.000)                       | -6.8***<br>(0.000)                                 | -12.7***<br>(0.000)                  | -7.7***<br>(0.000)                |
| Post-Crisis x Non-Bank                            | 2.8***<br>(0.001)                        | 4.3**<br>(0.010)                                   | 9.7***<br>(0.003)                    | 5.1**<br>(0.033)                  |
| Post-Crisis x Bank                                | 1.5*<br>(0.062)                          | -2.9***<br>(0.004)                                 | -4.2**<br>(0.022)                    | -3.7**<br>(0.024)                 |
| Regulatory Phase-In x Non-Bank                    | 3.7***<br>(0.000)                        | 4.5***<br>(0.004)                                  | 14.7***<br>(0.000)                   | 9.3***<br>(0.000)                 |
| Regulatory Phase-In x Bank                        | -1.2<br>(0.170)                          | -6.2***<br>(0.000)                                 | -11.4***<br>(0.000)                  | -9.8***<br>(0.000)                |
| Volcker x Non-Bank                                | 3.0***<br>(0.000)                        | 2.4<br>(0.100)                                     | 9.3***<br>(0.001)                    | 3.9*<br>(0.090)                   |
| Volcker x Bank                                    | -3.0***<br>(0.000)                       | -9.8***<br>(0.000)                                 | -20.3***<br>(0.000)                  | -16.3***<br>(0.000)               |
| Observations                                      | 5,430                                    | 5,190  | 5,190                                | 5,190                             |
| Adjusted R-squared                                | 0.590                                    | 0.442  | 0.504                                | 0.362                             |
| Test: Crisis x Non-Bank = Crisis x Bank           | ***                                      | ***  | ***                                  | *                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ns                                       | ***  | ***                                  | ***                               |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***  | ***                                  | ***                               |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***  | ***                                  | ***                               |
| Market Controls                                   | YES                                      | YES  | YES                                  | YES                               |

| Panel B: Market-Wide Stress - Federal Reserve Bank of Cleveland Credit Market Index |   |   |   |                                       |                                       |                                     |
|---|---|---|---|---------------------------------------|---------------------------------------|-------------------------------------|
|   | (1)   | (2)   | (3)                                     | (4)                                   | (5)                                   | (6)                                 |
|   | Time-<br>Weighted<br>Daily<br>Capital /<br>Volume (%) | Time-<br>Weighted<br>Daily Capital<br>(\$ Millions) | Overnight<br>Capital /<br>Volume<br>(%) | Overnight<br>Capital<br>(\$ Millions) | Weekend<br>Capital /<br>Volume<br>(%) | Weekend<br>Capital<br>(\$ Millions) |
| Dependent Variable Average  | 8.5   | 407.0   | 16.2                                    | 772.7                                 | 15.9                                  | 4,591.3                             |
| Bank  | 4.4***<br>(0.000)                                     | 804.6***<br>(0.000)                                 | 8.2***<br>(0.000)                       | 1,494.0***<br>(0.000)                 | 6.8***<br>(0.000)                     | 9,139.8***<br>(0.000)               |
| Crisis x Non-Bank   | 1.3<br>(0.155)  | <b>-29.8</b><br>(0.335)                             | 2.4<br>(0.198)                          | <b>-69.6</b><br>(0.256)               | 1.1<br>(0.344)                        | -235.0<br>(0.429)                   |
| Crisis x Bank   | -1.2<br>(0.109)                                       | <b>-245.6***</b><br>(0.000)                         | -1.5<br>(0.275)                         | <b>-420.3***</b><br>(0.000)           | 0.1<br>(0.907)                        | <b>-2,524.7***</b><br>(0.000)       |
| Post-Crisis x Non-Bank  | 3.5**<br>(0.027)                                      | 47.1<br>(0.235)                                     | 7.5**<br>(0.026)                        | 94.1<br>(0.231)                       | 3.9**<br>(0.026)                      | 846.1*<br>(0.051)                   |
| Post-Crisis x Bank  | 0.4<br>(0.685)  | 105.6<br>(0.310)                                    | 2.3<br>(0.302)                          | 299.5<br>(0.114)                      | 0.2<br>(0.872)                        | 1,657.6***<br>(0.004)               |
| Regulatory Phase-In x Non-Bank  | 2.0**<br>(0.045)                                      | 37.8<br>(0.328)                                     | 4.1**<br>(0.049)                        | 62.1<br>(0.418)                       | 4.7***<br>(0.000)                     | 429.0<br>(0.336)                    |
| Regulatory Phase-In x Bank  | -2.8***<br>(0.007)                                    | <b>-73.6</b><br>(0.392)                             | <b>-5.0***</b><br>(0.008)               | <b>-104.3</b><br>(0.531)              | <b>-2.9**</b><br>(0.024)              | <b>-1,064.9</b><br>(0.299)          |
| Volcker x Non-Bank  | -0.8<br>(0.286)                                       | 124.1***<br>(0.000)                                 | -1.7<br>(0.273)                         | 226.1***<br>(0.000)                   | 0.2<br>(0.885)                        | 1,078.3***<br>(0.003)               |
| Volcker x Bank  | <b>-6.3***</b><br>(0.000)                             | <b>-63.5</b><br>(0.327)                             | <b>-12.2***</b><br>(0.000)              | <b>-126.7</b><br>(0.294)              | <b>-8.4***</b><br>(0.000)             | <b>-1,187.5**</b><br>(0.044)        |
| Observations  | 172   | 172   | 172                                     | 172                                   | 172                                   | 172                                 |
| Adjusted R-squared  | 0.342   | 0.904   | 0.320                                   | 0.896                                 | 0.615                                 | 0.934                               |
| Test: Crisis x Non-Bank = Crisis x Bank   | ***   | ***   | **                                      | ***                                   | ns                                    | ***                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank                                   | *   | ns  | ns                                      | ns                                    | **                                    | *                                   |
| Test: Regulatory x Non-Bank = Regulatory x Bank                                     | ***   | ns  | ***                                     | ns                                    | ***                                   | **                                  |
| Test: Volcker x Non-Bank = Volcker x Bank   | ***   | ***   | ***                                     | ***                                   | ***                                   | ***                                 |
| Market Controls   | YES   | YES   | YES                                     | YES                                   | YES                                   | YES                                 |

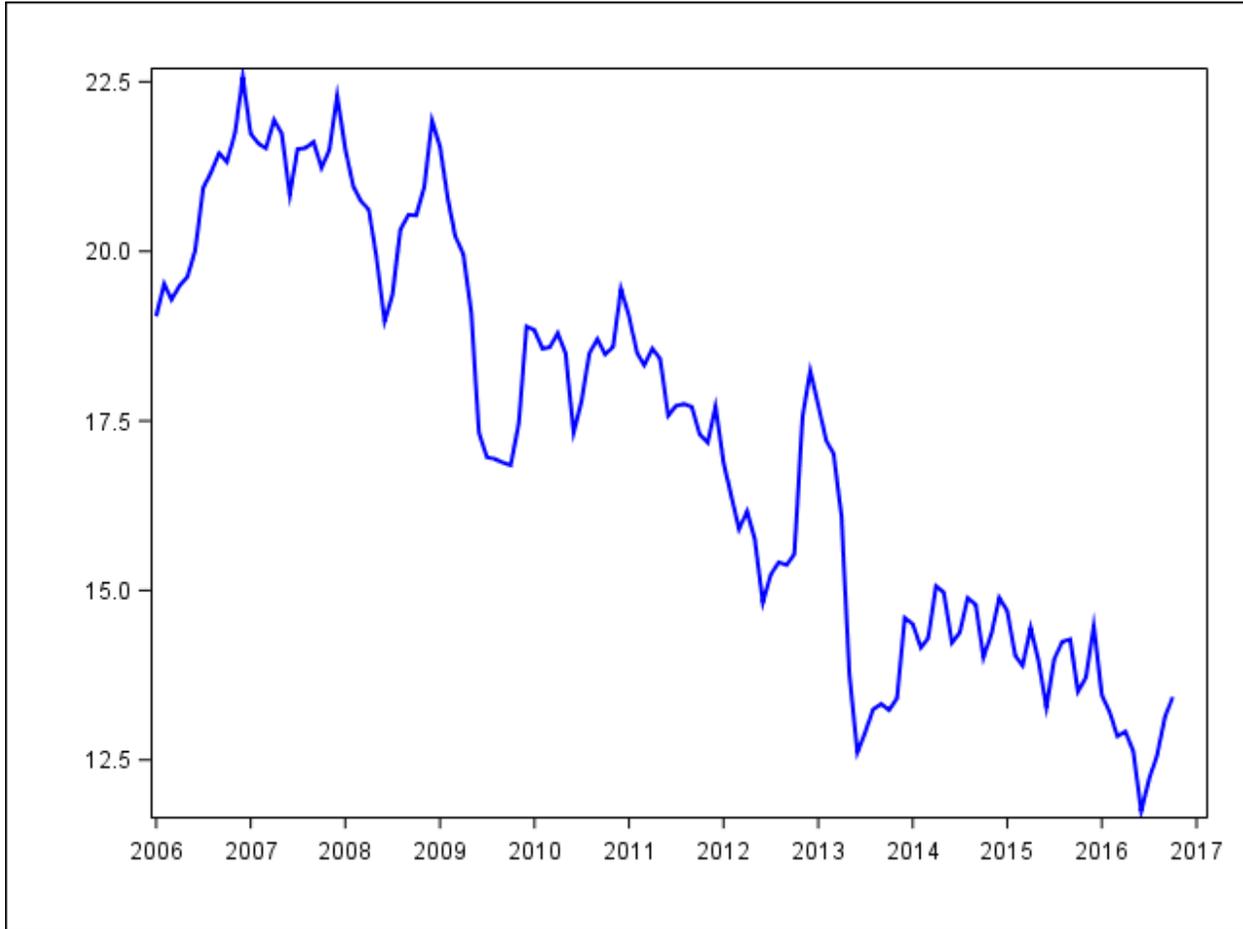
**Figure 1: Monthly corporate bond trading costs on customer trades with dealers, 2006-2016**

The figure reports estimated trade execution costs paid by customers in customer-to-dealer principal trades for the Aggregate Market sample described in Table I. Transaction costs are estimated following the regression based model implemented by Bessembinder, Maxwell, and Venkataraman (2006).



**Figure 2: Overnight Capital / Volume (%) in corporate bonds, 2006-2016**

This figure shows the six-month moving average aggregate overnight capital scaled by volume for the Top 70% dealers over the January 2006 to October 2016 period. Daily observations are averaged over each month.



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i <http://www.bloomberg.com/news/articles/2015-03-02/corporate-bond-market-poses-systemic-risk-sec-s-gallagher-says>.

ii <https://www.greenwich.com/press-release/2017-liquidity-starved-bond-investors-could-get-relief-block-trading-solutions-and>

iii <http://www.barrons.com/articles/a-look-at-bond-market-liquidity-1440103954>.

iv “Overlooking the Other Sources of Liquidity”, Wall Street Journal, July 26, 2015, available at <http://www.wsj.com/articles/overlooking-the-other-sources-of-liquidity-1437950015>.

v <http://blogs.wsj.com/economics/2015/07/15/fed-chairwoman-janet-yellens-report-to-congress-live-blog/>.

vi Though bond ETFs have grown rapidly from 0.2% (net asset value to bonds outstanding) to 4.1% over our sample period, they remain substantially smaller than equity market ETFs. Bond ETF information is available to academics from ICI.org.

vii Researchers have also studied closely related markets. Asquith, Au, and Covert (2013) examine the market for borrowing corporate bonds (which facilitates the ability to take short positions), reporting a reduction in borrowing costs over time. Das, Kalimipalli, and Nayak (2014) argue that the advent of CDS trading has made bond markets less efficient and has not improved market liquidity. Loon and Zong (2014) find that post-trade transparency in the CDS market surrounding the advent of a central clearing led to improvements in liquidity and trading activity.

viii However, Anderson and Stulz (2017) argue that, while liquidity has indeed been degraded around systematic stress events, the degradation of liquidity after bond-specific events is actually less pronounced in the recent data as compared to pre-crisis years.

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ix <https://www.federalreserve.gov/newsevents/pressreleases/files/bcreg20160623a1.pdf>.

x “JPMorgan shifting its proprietary trading desk,” 9/27/2010, NY Times; “Goldman to close prop-trading unit,” 9/4/2010, Wall Street Journal; “Morgan Stanley to spin off prop trading unit,” 1/10/2011, Reuters; “Bank of America is shutting down Merrill’s bond prop trading desk,” 6/10/2011, Business Insider; “Citigroup exits proprietary trading, says most staff leave,” 1/27/2012, Bloomberg; “RBC exits half it prop-trading strategies as Volker Rule looms,” 12/3/2014, Bloomberg.

xi Committee on the Global Financial System, 2016, Fixed Income Market Liquidity, #55, p20.

xii Committee on the Global Financial System, 2014, Market-making and Proprietary Trading: Industry Trends, Drivers and Policy Implications, #52, p.28.

xiii In addition, European banks with large corporate bond trading desks also face regulatory changes associated with the Basel Accords that potentially affect their capital commitments to U.S. trading desks. In February 2009, UBS announced that it is focusing on wealth management and other core businesses and making significant reductions in fixed income trading. In November of 2011, Credit-Suisse announced that it would accelerate previously announced plans to reduce their risk-weighted assets in fixed income by 50%. Barclays, as part of a strategic review in May of 2014 announced that that it is reducing its investment banking workforce by 25%. “Preparing UBS for the new market environment,” 2/10/2009, UBS Investor Release. “Barclays strategic review,” 2/12/2013, Barclays Investor Release. “Press release,” 7/28/2011, Credit Suisse Media Release. “Deutsche Bank cuts prop trading, cautious about 2010,” 2/4/2010, Reuters.

xiv The intent is to avoid the possibility that results obtained here could be attributable to the growth in new bond issues and associated trades. If the offering day is on or before the 15<sup>th</sup> of

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the month we exclude the remainder of the issue month, otherwise we exclude the issue month and the following month.

<sup>xv</sup> Since November 2015 FINRA has required dealers to specifically flag such offshore affiliate transactions. See <http://www.finra.org/industry/notices/15-14>. Since the affiliate flag was not available for the majority of our sample period we could not reliably identify which trades involved genuine capital commitment by this bank. Nevertheless, our key conclusions continue to hold when this bank is not excluded from the sample.

<sup>xvi</sup> Estimation is based on the pooled sample using the Generalized Method of Moments. Each trade is weighted by the inverse of the square root of the elapsed time since the prior trade for the bond. Estimates for subsets of bonds are identified by use of an indicator variable to identify the time  $t$  trade that meets the corresponding definitional criteria.

<sup>xvii</sup> The control variables include the percentage change in the Barclay's Capital U.S. 7-10 Year Treasury Bond Index, the percentage change in the S&P 500 Index, the percentage change in the Barclays Capital U.S. Corporate Bond Index, the percentage change in 7-10 Year Treasury Index in excess of the percentage change in the 3-month Treasury Index, and the percentage change in the Barclay's Capital U.S. High Yield Bond Index in excess of the percentage change in the Barclay's Capital U.S. Corporate Bond Index.

<sup>xviii</sup> The slight uptick in average trade execution costs during the most recent period can be explained in part by the commensurate decline in average trades size, reflecting the fact that execution costs in corporate bonds are typically larger (in percentage terms) for smaller trades.

<sup>xix</sup> These findings are consistent with two recent working papers that present coarser estimates of trading costs. Trebbi and Xiao (2016) examine U.S. data, Auilina and Suntheim (2016) examine U.K. data, each reporting that execution costs are not higher in recent years.

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xx Sample sizes for 144A bonds were too small to allow for assignment to issue size portfolios.

xxi The data can be downloaded from the MarketAxess website,

[http://www.marketaxess.com/research/market-insights/dealer\\_net\\_positions.php](http://www.marketaxess.com/research/market-insights/dealer_net_positions.php). The

disaggregated data made available after April 2013 indicates that mortgage backed securities account for over 50% of the dealers' holdings.

xxii Other studies, including Zitzewitz (2011) and Ederington, Guan, and Yadav (2015), also use a one-minute window, and refer to these trades as “riskless principal” transactions.

xxiii The variable is standardized by the prior month total net asset value. Data on fund flows is obtained from the Investment Company Institute.

xxiv While the coefficients estimated on these control variables are not our main focus, it can be observed that dealer capital commitment in dollars is positively associated with recent stock market returns. Increases in VIX are associated with decreased capital commitment relative to trading volume, but perhaps surprisingly, with greater capital commitment in dollars. Increases in LIBOR are associated with decreased capital commitment relative to volume, as are increased gross flows to or from bond mutual funds and ETFs. Finally, increased retail trading is associated with smaller capital commitment.

xxv The report is available at [http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/archive/2012/Oliver\\_Wyman\\_The\\_Volcker\\_Rule\\_Restrictions\\_on\\_Proprietary\\_Trading.pdf](http://www.oliverwyman.com/content/dam/oliver-wyman/global/en/files/archive/2012/Oliver_Wyman_The_Volcker_Rule_Restrictions_on_Proprietary_Trading.pdf).

xxvi See <http://www.nytimes.com/2008/09/22/business/22bank.html>.

xxvii Increased competition for traditional dealers has emerged in the form of corporate bond ETFs, particularly for investment grade bond indices. In the Internet Appendix [Table IA.VI] we report regression coefficients that correspond to those in Table VII Panel A, except that the

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subsamples are defined for investment grade and high yield bonds. In each of these subsamples we find, in line with the overall sample, that bank-affiliated dealers have reduced their capital commitment while non-bank dealers have increased capital commitments during the Regulatory and the Volcker periods, relative to the pre-crisis benchmark period. These results support that our central conclusions are robust to increased competition from bond ETFs.

xxviii Note, though, that the increase in overnight capital commitment during the Volcker period vs. the preceding Regulatory period for non-bank dealers was less than proportionate to their increase in trading volume, as evidenced by a smaller coefficient estimate during the Volcker period in column (3).

xxix See Greenwich Associates, “The Continuing Corporate Bond Evolution”, Q4 2015.

xxx Corporate Bond E-Trading: Same Game, New Playing Field, McKinsey& Company-Greenwich Associates, p. 5.

xxxi For general description see: <https://www.clevelandfed.org/newsroom-and-events/publications/economic-commentary/2012-economic-commentaries/ec-201204-the-cleveland-financial-stress-index-a-tool-for-monitoring-financial-stability.aspx>. Daily observations on the credit spread component are downloaded from <https://fred.stlouisfed.org/series/CMRKTSD678FRBCLE>. The metric was discontinued May 5, 2016, so this analysis ends at that date.

xxxii We continue to assess statistical significance while relying on Newey-West standard errors. However, since stressful days are irregularly spaced in the data we do not implement the Newey and West (1994) method to select the lag length. Results reported on Table IX are based on two lags. We verified that inference was wholly unaffected by longer lag length specifications.

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xxxiii Cross-equation tests are conducted by estimating the system by the Generalized Method of Moments.

xxxiv For robustness, we study two additional measures of stressful days, and present the results in the Internet Appendix Tables IA.VII & IA.VIII. First, we focus on days in which customer trading volume in a particular bond is unusually high. Second, we construct a composite stress index, separately for high yield and investment grade bonds, by combining information from the Cleveland Fed Credit Stress Index with measures of bond market returns, the VIX equity volatility index, and returns to the Wilshire 5000 stock index. Each of these analyses confirms the conclusions reached here.

**Internet Appendix for**  
**“Capital Commitment and Illiquidity in Corporate Bonds\*”**

**Summary**

This Internet Appendix includes the following tables. Table IA.I provides detailed variable definitions. Tables IA.II and IA.III shows our capital commitment results are robust to an individual portfolio-dealer regression methodology. Table IA.IV shows declines in capital commitment for both large and small bank-affiliated dealers. Table IA.V reports results of times series capital commitment regressions for the sample of ‘calling’ rather than ‘clicking’ trades. ‘Clicking’ trades comprises of trades in young (age less than one year), investment grade, and large issue (issue size of at least \$1 billion) that are less than or equal to \$5 million. All other trades are categorized as ‘calling’ trades. Table IA.VI reports results of times series capital commitment regressions for both investment grade and high yield bonds. Tables IA.VII and IA.VIII show stressful day results are robust to alternate definitions of stress. For bond-level stressful days, we examine bond-days when customer-dealer trading volume exceeds the average customer-dealer volume for the same bond over the prior six months by two standard deviations. On each of those days, we focus on the single most active dealer and restrict the analysis to bond-days when the most active dealer's activity is economically substantial by requiring that active dealer volume with

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\* Citation format: Bessembinder, Hank, Jacobsen, Stacey, Maxwell, William and Kumar Venkataraman, Internet Appendix for “Capital Commitment and Illiquidity in Corporate Bonds,” *Journal of Finance* [DOI STRING]. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article.

customers exceeds \$1 million. For market-wide stress, we construct a composite stress index, separately for high yield and investment grade bonds, by combining information from the Federal Reserve Bank of Cleveland Financial Stress Index with measures of bond market returns, the VIX equity volatility index, and returns to the Wilshire 5000 stock index.

**Table IA.I**  
**Variable Definitions**

| Panel A: Dependent Variables               |  |
|--|--|
| Time-Weighted Daily Capital                | 'Daily Time-Weighted Capital' refers to aggregate daily unsigned, time-weighted changes in capital for each dealer in a portfolio. Capital commitment is measured at the time of each completed trade in a portfolio as the absolute value of the difference between the dealer's accumulated principal buy volume and the dealer's accumulated principal sell volume to that point in the day. The measure is aggregated over each dealer-portfolio-day by weighting each observation by the time for which the capital is committed (i.e., until the next trade, or if no trade occurs then until the end of the day). We sum this measure across all dealer portfolios on a given day to obtain an aggregate measure of daily capital commitment. This measure is reported both unscaled and scaled by volume across all dealers and bonds in the sample. |
| Overnight Capital                          | 'Overnight capital' is aggregate volume completed on a principal basis that is not offset by the end of the trading day, i.e., that is absorbed as a change in overnight inventory. This measure is based on end-of-day capital for each dealer in a portfolio, where capital is accumulated throughout the day for each portfolio as the absolute value of the difference between the dealer's accumulated principal buy volume and the dealer's accumulated principal sell volume. We sum this measure across all dealer portfolios on a given day to obtain an aggregate measure of daily capital commitment. This measure is reported both unscaled and scaled by volume across all dealers and bonds in the sample.   |
| Weekend Capital                            | 'Weekend Capital' is aggregate volume completed on a principal basis that is not offset by the end of the trading week, i.e., that is absorbed as a change in weekend inventory. This measure is based on end-of-week capital for each dealer in a portfolio, where capital is accumulated throughout the week (beginning and ending at midnight Friday night) for each portfolio as the absolute value of the difference between the dealer's accumulated principal buy volume and the dealer's accumulated principal sell volume. We sum this measure across all dealer portfolios on a given week to obtain an aggregate measure of weekend capital commitment. This measure is reported both unscaled and scaled by volume across all dealers and bonds in the sample.   |
| Dollar Volume / Amount Out.                | Aggregate dollar volume scaled by total amount outstanding for each month.   |
| Average Trade Size                         | Average dollar trade size over each month.   |
| Principal Volume / Total Volume            | Trades are classified as 'principal' if not reported as 'Agency' by FINRA or 'reversed' within one minute. Trades are classified as 'reversed' when an exact offsetting quantity (either a customer or interdealer trade) occurs or a combination of 2-3 trades offsets the customer trade within 60 seconds prior or subsequent to the trade. Principal volume is aggregated then scaled by total volume each month.  |
| Transaction Costs %                        | Transaction costs are estimated following the regression based model implemented by Bessembinder, Maxwell, and Venkataraman (2006). Estimation details are provided in Section III of the paper.   |
| Block Volume / Total Volume                | 'Block' refers to a single large trade by a dealer of at least \$10 million. Block volume is aggregated then scaled by total volume each month.  |
| Panel B: Control Variables                 |  |
| Corp Bond Index Return (t - 1)             | The return to the Barclays Capital U.S. Corporate Bond Index in the previous month.  |
| Stock Market Index Return (t - 1)          | The return to the S&P 500 index in the previous month.   |
| Chg. in VIX (t - 1)                        | The change in the CBOE stock market volatility index (VIX) in the previous month.  |
| Chg. in 3-Month Libor (t - 1)              | The change in 3-month LIBOR in the previous month.   |
| ABS (MF+ETF Flows (t-1) / Tot. Out. (t-2)) | The absolute value of the aggregate flows into or out of investment grade corporate bond mutual funds and ETFs scaled by the prior month total net asset value. The data is obtained from the Investment Company Institute (ICI).  |
| % Retail Volume                            | The percentage of total volume that occurs in trades of less than \$100,000. This measure is computed using the Aggregate Market sample described in Table I.  |

**Table IA.II**  
**Individual Portfolio-Dealer Regressions: Capital Commitment**

This table reports time series regression results over the January 2006 to October 2016 period using an individual portfolio-dealer approach. Bonds are placed in eight portfolios based on investment grade and high yield, small, medium, and large issue size, and public and private (144A) status. Each regression includes four time period indicators; the benchmark period is the January 2006 to June 2007 pre-crisis period. The capital commitment measures are computed at the portfolio-dealer-day and portfolio-dealer-week level and all other variables are computed at the portfolio-dealer-month level. All dependent variables are computed using the dealers in the Top 70% sample described in Table I. All regressions include portfolio-dealer fixed effects and portfolio bond characteristics and market controls and report standard errors clustered at the portfolio-dealer level. Tests for statistical differences between time periods are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Variable definitions are provided in Appendix I. Sample period (January 2006 to October 2016) averages of each dependent variable are shown above regression results.

|  | (1)                                      | (2)   | (3)                            | (4)                               | (5)                          | (6)                             | (7)                                    | (8)                                  | (9)                                |
|--|--|---|--------------------------------|-----------------------------------|------------------------------|---------------------------------|--|--------------------------------------|------------------------------------|
| Dependent Variable Average                 | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital / (\$ Millions) | Overnight Capital / Volume (%) | Overnight Capital / (\$ Millions) | Weekend Capital / Volume (%) | Weekend Capital / (\$ Millions) | Dollar Volume / Amount Outstanding (%) | Ln Average Trade Size (\$ Thousands) | Principal Volume / Tot. Volume (%) |
| Dependent Variable Average                 | 11.2                                     | 8.1   | 21.4                           | 15.4                              | 10.3                         | 36.4                            | 0.4                                    | 13.6                                 | 90.9                               |
| Crisis                                     | 0.2<br>(0.472)                           | -3.4***<br>(0.000)                          | 1.3**<br>(0.048)               | -6.0***<br>(0.000)                | 1.5***<br>(0.000)            | -12.4***<br>(0.000)             | -0.3***<br>(0.000)                     | -0.2***<br>(0.000)                   | -4.1***<br>(0.000)                 |
| Post-Crisis                                | -1.9***<br>(0.000)                       | -0.9**<br>(0.030)                           | -3.2***<br>(0.001)             | -1.4*<br>(0.086)                  | -1.5***<br>(0.007)           | -4.3**<br>(0.042)               | -0.2***<br>(0.000)                     | -0.2***<br>(0.000)                   | -1.7***<br>(0.002)                 |
| Regulatory Phase-In                        | -3.1***<br>(0.000)                       | -1.4***<br>(0.000)                          | -5.4***<br>(0.000)             | -2.2***<br>(0.001)                | -3.0***<br>(0.000)           | -7.1***<br>(0.000)              | -0.3***<br>(0.000)                     | -0.4***<br>(0.000)                   | -2.5***<br>(0.000)                 |
| Volcker                                    | -4.2***<br>(0.000)                       | -1.6***<br>(0.000)                          | -7.9***<br>(0.000)             | -3.0***<br>(0.000)                | -4.2***<br>(0.000)           | -8.5***<br>(0.000)              | -0.3***<br>(0.000)                     | -0.4***<br>(0.000)                   | 0<br>(0.953)                       |
| Ln (Average Issue Size)                    | -2.0***<br>(0.000)                       | 1.9***<br>(0.000)                           | -4.7***<br>(0.000)             | 3.4***<br>(0.000)                 | -3.6***<br>(0.000)           | 8.3***<br>(0.000)               | 0.1**<br>(0.024)                       | 0.1<br>(0.470)                       | 1.9<br>(0.282)                     |
| Ln (Average Bond Age)                      | -0.2<br>(0.307)                          | 0.1<br>(0.203)                              | -0.5<br>(0.333)                | 0.3*<br>(0.067)                   | 1.8***<br>(0.000)            | 0<br>(0.966)                    | -0.1***<br>(0.005)                     | -0.3***<br>(0.001)                   | -2.2**<br>(0.039)                  |
| Corp Bond Index Return (t - 1)             | 0.6<br>(0.481)                           | 2.0**<br>(0.033)                            | 2<br>(0.216)                   | 3.0*<br>(0.076)                   | 2<br>(0.375)                 | 14.9*<br>(0.093)                | 0.2***<br>(0.000)                      | 0.4***<br>(0.002)                    | -8.2<br>(0.102)                    |
| Stock Market Index Return (t - 1)          | -1.4<br>(0.258)                          | 5.3***<br>(0.000)                           | -3.4<br>(0.163)                | 10.1***<br>(0.000)                | -13.5***<br>(0.000)          | 25.6***<br>(0.002)              | 0.6***<br>(0.000)                      | 1.4***<br>(0.000)                    | 16.5***<br>(0.009)                 |
| Chg. in VIX (t - 1)                        | -0.1***<br>(0.002)                       | 0.1***<br>(0.009)                           | -0.2***<br>(0.004)             | 0.1***<br>(0.006)                 | -0.4***<br>(0.000)           | 0.3<br>(0.166)                  | 0.0***<br>(0.000)                      | 0.0***<br>(0.000)                    | 0.1<br>(0.462)                     |
| Chg. in 3-Month Libor (t - 1)              | 1.0***<br>(0.000)                        | -1.1***<br>(0.000)                          | 2.3***<br>(0.000)              | -2.2***<br>(0.000)                | 2.4***<br>(0.000)            | -2.4<br>(0.231)                 | -0.0***<br>(0.000)                     | -0.2***<br>(0.000)                   | -1.8<br>(0.111)                    |
| ABS (MF+ETF Flows (t-1) / Tot. Out. (t-2)) | -11.7*<br>(0.058)                        | -0.7<br>(0.880)                             | -15.8<br>(0.191)               | 3.5<br>(0.701)                    | -6.8<br>(0.389)              | -1.0<br>(0.968)                 | -1.4***<br>(0.000)                     | 0.6<br>(0.289)                       | -44.1**<br>(0.011)                 |
| % Retail Volume                            | -16.0<br>(0.237)                         | -45.3***<br>(0.008)                         | -16.5<br>(0.561)               | -73.4**<br>(0.031)                | 16.2<br>(0.414)              | -166.3<br>(0.100)               | -0.2<br>(0.839)                        | -6.3***<br>(0.001)                   | -20.9<br>(0.496)                   |
| Constant                                   | 42.4***<br>(0.000)                       | -15.8***<br>(0.000)                         | 90.8***<br>(0.000)             | -27.9***<br>(0.000)               | 55.1***<br>(0.000)           | -65.1**<br>(0.026)              | -0.9<br>(0.270)                        | 14.7***<br>(0.000)                   | 76.0***<br>(0.002)                 |
| Observations                               | 242,124                                  | 242,124                                     | 242,124                        | 242,124                           | 50,497                       | 50,497                          | 11,606                                 | 11,606                               | 11,600                             |
| Adjusted R-squared                         | 0.155                                    | 0.265                                       | 0.147                          | 0.222                             | 0.143                        | 0.251                           | 0.739                                  | 0.767                                | 0.583                              |
| Test: Crisis = Post-Crisis                 | ***                                      | ***   | ***                            | ***                               | ***                          | ***                             | ***                                    | ns                                   | ***                                |
| Test: Crisis = Regulatory                  | ***                                      | ***   | ***                            | ***                               | ***                          | *                               | ns                                     | ***                                  | ***                                |
| Test: Crisis = Volcker                     | ***                                      | ***   | ***                            | ***                               | ***                          | ns                              | ***                                    | ***                                  | ***                                |
| Test: Post-Crisis = Regulatory             | ***                                      | ns  | ***                            | ns                                | *                            | ***                             | ***                                    | ***                                  | ns                                 |
| Test: Post-Crisis = Volcker                | ***                                      | *   | ***                            | ns                                | ***                          | ***                             | ***                                    | ***                                  | ***                                |
| Test: Regulatory = Volcker                 | ***                                      | ns  | ***                            | ns                                | ***                          | **                              | ***                                    | ns                                   | ***                                |

**Table IA.III**  
**Individual Portfolio-Dealer Regressions: Bank vs. Non-Bank Dealers**

This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers using an individual portfolio-dealer approach. Bonds are placed in eight portfolios based on investment grade and high yield, small, medium, and large issue size, and public and private (144A) status. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the portfolio-dealer-day and portfolio-dealer-week level and all other variables are computed at the portfolio-dealer-month level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions include portfolio fixed effects and portfolio bond characteristics and market controls and report robust standard errors. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results.

|   | (1)                                      | (2)                                       | (3)                            | (4)                             | (5)                          | (6)                           | (7)                             | (8)                                  | (9)                                 |
|---|--|---|--------------------------------|---------------------------------|------------------------------|-------------------------------|---------------------------------|--------------------------------------|-------------------------------------|
| Dependent Variable Average                        | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital (\$ Millions) | Overnight Capital / Volume (%) | Overnight Capital (\$ Millions) | Weekend Capital / Volume (%) | Weekend Capital (\$ Millions) | Dollar Volume / Amount Out. (%) | Ln Average Trade Size (\$ Thousands) | Principal Volume / Total Volume (%) |
| Dependent Variable Average                        | 10.9                                     | 3.1                                       | 21.7                           | 5.9                             | 15.5                         | 14.4                          | 0.1                             | 13.5                                 | 85.7                                |
| Bank  | 4.2***<br>(0.000)                        | 4.3***<br>(0.000)                         | 8.1***<br>(0.000)              | 23.1***<br>(0.000)              | -0.6<br>(0.154)              | 19.3***<br>(0.000)            | 0.2***<br>(0.000)               | 0.8***<br>(0.000)                    | 3.6***<br>(0.000)                   |
| Crisis x Non-Bank                                 | -1.9***<br>(0.000)                       | 0.1***<br>(0.003)                         | -3.9***<br>(0.000)             | -6.0***<br>(0.003)              | -4.6***<br>(0.000)           | 0.2<br>(0.411)                | -0.0***<br>(0.005)              | 0.1<br>(0.274)                       | 1.9*<br>(0.093)                     |
| Crisis x Bank                                     | -1.1***<br>(0.000)                       | -1.5***<br>(0.000)                        | -1.9***<br>(0.000)             | -5.8***<br>(0.000)              | -1.2***<br>(0.000)           | -5.4***<br>(0.000)            | -0.1***<br>(0.000)              | -0.2***<br>(0.000)                   | -1.5**<br>(0.024)                   |
| Post-Crisis x Non-Bank                            | -0.4***<br>(0.003)                       | 0.4***<br>(0.000)                         | -0.9***<br>(0.001)             | -0.3<br>(0.872)                 | 1.1***<br>(0.006)            | -2.5***<br>(0.000)            | -0.0***<br>(0.002)              | -0.1**<br>(0.023)                    | -6.4***<br>(0.000)                  |
| Post-Crisis x Bank                                | -2.3***<br>(0.000)                       | -0.5***<br>(0.000)                        | -4.5***<br>(0.000)             | -3.2*<br>(0.072)                | -0.6**<br>(0.020)            | 1.0***<br>(0.005)             | 0.0***<br>(0.000)               | 0.1**<br>(0.044)                     | -3.9***<br>(0.000)                  |
| Regulatory Phase-In x Non-Bank                    | 0.8***<br>(0.000)                        | 0.9***<br>(0.000)                         | 1.7***<br>(0.000)              | 0.9<br>(0.540)                  | -4.9***<br>(0.000)           | 4.3***<br>(0.000)             | 0.0*<br>(0.069)                 | 0.3***<br>(0.000)                    | 5.4***<br>(0.000)                   |
| Regulatory Phase-In x Bank                        | -1.0***<br>(0.000)                       | -0.6***<br>(0.000)                        | -2.0***<br>(0.000)             | -5.3***<br>(0.001)              | -1.9***<br>(0.000)           | -3.4***<br>(0.000)            | -0.1***<br>(0.000)              | -0.3***<br>(0.000)                   | 5.6***<br>(0.000)                   |
| Volcker x Non-Bank                                | 0.3***<br>(0.001)                        | 1.3***<br>(0.000)                         | 0.4*<br>(0.057)                | 3.9***<br>(0.001)               | -6.5***<br>(0.000)           | 6.3***<br>(0.000)             | 0.0***<br>(0.000)               | 0.2***<br>(0.000)                    | 8.3***<br>(0.000)                   |
| Volcker x Bank                                    | -1.5***<br>(0.000)                       | -0.9***<br>(0.000)                        | -3.0***<br>(0.000)             | -8.7***<br>(0.000)              | -2.9***<br>(0.000)           | -3.7***<br>(0.000)            | -0.1***<br>(0.000)              | -0.3***<br>(0.000)                   | 7.2***<br>(0.000)                   |
| Observations                                      | 750,799                                  | 750,799                                   | 750,799                        | 596,337                         | 156,582                      | 156,582                       | 35,991                          | 34,770                               | 33,479                              |
| Adjusted R-squared                                | 0.025                                    | 0.117                                     | 0.023                          | 0.078                           | 0.024                        | 0.117                         | 0.154                           | 0.238                                | 0.044                               |
| Test: Crisis x Non-Bank = Crisis x Bank           | ***                                      | ***                                       | ***                            | ns                              | ***                          | ***                           | ***                             | ***                                  | ***                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ***                                      | ***                                       | ***                            | *                               | ***                          | ***                           | ***                             | ***                                  | **                                  |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                             | ***                                  | ns                                  |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                             | ***                                  | ns                                  |
| Market Controls                                   | YES                                      | YES                                       | YES                            | YES                             | YES                          | YES                           | YES                             | YES                                  | YES                                 |

**Table IA.IV**  
**Time Series Regressions: Large Bank vs. Small Bank Dealers**

This table reports time series regression results over the January 2006 to October 2016 period for large bank and small bank-affiliated dealers relative to all non-bank dealers. The ten largest dealers by volume over the full 2006 to 2016 sample period are classified as 'large', all other dealers are classified as 'small'. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results. Bold formatting indicates 'large' and 'small' coefficients are statistically different at the 5% level.

|   | (1)                                      | (2)           | (3)                                       | (4)             | (5)                            | (6)            | (7)                             | (8)             | (9)                          | (10)          | (11)                          | (12)             | (13)                                   | (14)           | (15)                                 | (16)           | (17)                                | (18)           |
|---|--|---------------|---|-----------------|--------------------------------|----------------|---------------------------------|-----------------|------------------------------|---------------|-------------------------------|------------------|--|----------------|--------------------------------------|----------------|-------------------------------------|----------------|
|   | Time-Weighted Daily Capital / Volume (%) |               | Time-Weighted Daily Capital (\$ Millions) |                 | Overnight Capital / Volume (%) |                | Overnight Capital (\$ Millions) |                 | Weekend Capital / Volume (%) |               | Weekend Capital (\$ Millions) |                  | Dollar Volume / Amount Outstanding (%) |                | Ln Average Trade Size (\$ Thousands) |                | Principal Volume / Total Volume (%) |                |
| Dependent Variable Average                        | 9.1                                      | 9.9           | 609.3                                     | 121.3           | 17.2                           | 18.9           | 1,157.7                         | 233.4           | 8.5                          | 10.5          | 2,754.0                       | 619.2            | 4.0                                    | 0.6            | 7.2                                  | 5.6            | 92.1                                | 86.7           |
|   | Large                                    | Small         | Large                                     | Small           | Large                          | Small          | Large                           | Small           | Large                        | Small         | Large                         | Small            | Large                                  | Small          | Large                                | Small          | Large                               | Small          |
| Bank  | <b>3.4***</b>                            | <b>5.7***</b> | <b>668.2***</b>                           | <b>161.6***</b> | <b>6.2***</b>                  | <b>11.6***</b> | <b>1,243.9***</b>               | <b>315.2***</b> | <b>1.2***</b>                | <b>5.0***</b> | <b>2,933.8***</b>             | <b>789.8***</b>  | <b>5.1***</b>                          | <b>0.9***</b>  | <b>1.5***</b>                        | <b>0.3***</b>  | <b>16.7***</b>                      | <b>11.5***</b> |
|   | (0.000)                                  | (0.000)       | (0.000)                                   | (0.000)         | (0.000)                        | (0.000)        | (0.000)                         | (0.000)         | (0.006)                      | (0.000)       | (0.000)                       | (0.000)          | (0.000)                                | (0.000)        | (0.000)                              | (0.000)        | (0.000)                             | (0.000)        |
| Crisis x Non-Bank                                 | 0.7                                      | 0.9**         | 12.3                                      | 4.4             | 1.1                            | 1.7**          | 21.1                            | 9.2             | -0.1                         | 0.5           | 66.3                          | 31.9             | 0.0                                    | -0.0           | -0.5***                              | -0.4***        | 8.0***                              | 7.5***         |
|   | (0.174)                                  | (0.033)       | (0.264)                                   | (0.361)         | (0.261)                        | (0.046)        | (0.296)                         | (0.321)         | (0.945)                      | (0.493)       | (0.230)                       | (0.330)          | (0.947)                                | (0.323)        | (0.000)                              | (0.000)        | (0.000)                             | (0.000)        |
| Crisis x Bank                                     | 0.5                                      | 0.2           | <b>-204.7***</b>                          | <b>-39.5***</b> | 1.6                            | 0.4            | <b>-347.8***</b>                | <b>-75.4***</b> | 1.4*                         | 0.1           | <b>-624.5***</b>              | <b>-175.7***</b> | <b>-1.7***</b>                         | <b>-0.3***</b> | -0.1**                               | -0.1           | <b>-1.2***</b>                      | <b>1.6***</b>  |
|   | (0.375)                                  | (0.674)       | (0.000)                                   | (0.000)         | (0.107)                        | (0.597)        | (0.000)                         | (0.000)         | (0.052)                      | (0.940)       | (0.000)                       | (0.000)          | (0.000)                                | (0.000)        | (0.028)                              | (0.241)        | (0.008)                             | (0.009)        |
| Post-Crisis x Non-Bank                            | 1.3**                                    | 1.7***        | 63.3***                                   | 37.4***         | 2.6*                           | 3.5***         | 116.5***                        | 74.4***         | 0.6                          | 1.2*          | 266.6***                      | 167.7**          | 0.3**                                  | 0.1**          | -0.3***                              | -0.2           | 2.2                                 | 1.5            |
|   | (0.050)                                  | (0.007)       | (0.000)                                   | (0.000)         | (0.056)                        | (0.006)        | (0.000)                         | (0.000)         | (0.363)                      | (0.100)       | (0.004)                       | (0.018)          | (0.011)                                | (0.028)        | (0.000)                              | (0.121)        | (0.252)                             | (0.471)        |
| Post-Crisis x Bank                                | -0.8                                     | -0.8*         | 4.8                                       | -19.6**         | -0.9                           | -1.3           | 43.9                            | -34.1**         | -0.6                         | -0.9          | 50.1                          | -120.1*          | -0.6***                                | -0.3***        | <b>0.1**</b>                         | <b>-0.5***</b> | -0.6                                | 0.2            |
|   | (0.181)                                  | (0.071)       | (0.875)                                   | (0.026)         | (0.388)                        | (0.130)        | (0.449)                         | (0.049)         | (0.365)                      | (0.262)       | (0.765)                       | (0.056)          | (0.001)                                | (0.000)        | (0.011)                              | (0.000)        | (0.624)                             | (0.881)        |
| Regulatory Phase-In x Non-Bank                    | 2.3***                                   | 2.3***        | 72.9***                                   | 67.9***         | 5.0***                         | 5.1***         | 142.3***                        | 134.6***        | 1.4***                       | 1.8***        | 396.6***                      | 375.7***         | 0.2*                                   | 0.2***         | -0.2***                              | -0.1           | 9.3***                              | 8.6***         |
|   | (0.000)                                  | (0.000)       | (0.000)                                   | (0.000)         | (0.000)                        | (0.000)        | (0.000)                         | (0.000)         | (0.007)                      | (0.000)       | (0.000)                       | (0.000)          | (0.000)                                | (0.056)        | (0.000)                              | (0.005)        | (0.213)                             | (0.000)        |
| Regulatory Phase-In x Bank                        | -1.5***                                  | -0.9**        | -53.3**                                   | -9.4            | -2.4***                        | -1.7**         | -66.8                           | -18.3           | -1.9***                      | -1.7**        | -247.7                        | -70.3            | <b>-1.5***</b>                         | <b>-0.4***</b> | <b>-0.1*</b>                         | <b>-0.4***</b> | <b>-0.6</b>                         | <b>5.5***</b>  |
|   | (0.003)                                  | (0.042)       | (0.045)                                   | (0.183)         | (0.010)                        | (0.044)        | (0.170)                         | (0.181)         | (0.001)                      | (0.011)       | (0.102)                       | (0.119)          | (0.000)                                | (0.000)        | (0.088)                              | (0.000)        | (0.470)                             | (0.000)        |
| Volcker x Non-Bank                                | 1.1***                                   | 1.1***        | 106.1***                                  | 103.1***        | 2.3***                         | 2.3***         | 203.6***                        | 198.5***        | 0.1                          | 0.4           | 562.6***                      | 554.3***         | 0.3***                                 | 0.3***         | -0.1                                 | -0.0           | 15.6***                             | 15.0***        |
|   | (0.000)                                  | (0.000)       | (0.000)                                   | (0.000)         | (0.000)                        | (0.000)        | (0.000)                         | (0.000)         | (0.762)                      | (0.350)       | (0.000)                       | (0.000)          | (0.000)                                | (0.000)        | (0.328)                              | (0.964)        | (0.000)                             | (0.000)        |
| Volcker x Bank                                    | -3.1***                                  | -3.0***       | <b>-90.1***</b>                           | <b>-14.5</b>    | -5.6***                        | -6.2***        | <b>-159.9***</b>                | <b>-36.6*</b>   | -3.1***                      | -2.8***       | -350.7***                     | -8.1             | <b>-2.1***</b>                         | <b>-0.5***</b> | <b>-0.3***</b>                       | <b>-0.5***</b> | 2.4***                              | 1.0            |
|   | (0.000)                                  | (0.000)       | (0.000)                                   | (0.186)         | (0.000)                        | (0.000)        | (0.000)                         | (0.086)         | (0.000)                      | (0.002)       | (0.009)                       | (0.946)          | (0.000)                                | (0.000)        | (0.000)                              | (0.000)        | (0.010)                             | (0.410)        |
| Observations                                      | 5,436                                    | 5,436         | 5,436                                     | 5,436           | 5,436                          | 5,436          | 5,436                           | 5,436           | 1,132                        | 1,132         | 1,132                         | 1,132            | 260                                    | 260            | 260                                  | 260            | 260                                 | 260            |
| Adjusted R-squared                                | 0.108                                    | 0.264         | 0.838                                     | 0.642           | 0.116                          | 0.278          | 0.838                           | 0.617           | 0.180                        | 0.277         | 0.868                         | 0.654            | 0.953                                  | 0.866          | 0.978                                | 0.773          | 0.789                               | 0.722          |
| Test: Crisis x Non-Bank = Crisis x Bank           | ns                                       | ns            | ***                                       | ***             | ns                             | ns             | ***                             | ***             | *                            | ns            | ***                           | ***              | ***                                    | ***            | ***                                  | ***            | ***                                 | ***            |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ***                                      | ***           | **  | ***             | **                             | ***            | ns                              | ***             | *                            | ***           | ns                            | ***              | ***                                    | ***            | ***                                  | ***            | *                                   | ns             |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***           | ***                                       | ***             | ***                            | ***            | ***                             | ***             | ***                          | ***           | ***                           | ***              | ***                                    | ***            | ns                                   | ***            | ***                                 | *              |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***           | ***                                       | ***             | ***                            | ***            | ***                             | ***             | ***                          | ***           | ***                           | ***              | ***                                    | ***            | ***                                  | ***            | ***                                 | ***            |
| Market Controls                                   | YES                                      | YES           | YES                                       | YES             | YES                            | YES            | YES                             | YES             | YES                          | YES           | YES                           | YES              | YES                                    | YES            | YES                                  | YES            | YES                                 | YES            |

**Table IA.V**  
**Time Series Regressions: Calling Trades**

This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers for 'calling' trades. 'Clicking' trades comprises of trades in young (age less than one year), investment grade, and large issue (issue size of at least \$1 billion) that are less than or equal to \$5 million. All other trades are categorized as 'calling' trades. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results. Bold formatting indicates 'calling' and 'clicking' coefficients are statistically different at the 5% level.

|   | (1)                                      | (2)                                       | (3)                            | (4)                             | (5)                          | (6)                           | (7)                             | (8)                                  | (9)                                 |
|---|--|---|--------------------------------|---------------------------------|------------------------------|-------------------------------|---------------------------------|--------------------------------------|-------------------------------------|
| Dependent Variable Average                        | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital (\$ Millions) | Overnight Capital / Volume (%) | Overnight Capital (\$ Millions) | Weekend Capital / Volume (%) | Weekend Capital (\$ Millions) | Dollar Volume / Amount Out. (%) | Ln Average Trade Size (\$ Thousands) | Principal Volume / Total Volume (%) |
| Bank  | <b>4.0***</b><br>(0.000)                 | <b>846.4***</b><br>(0.000)                | <b>7.4***</b><br>(0.000)       | <b>1,591.3***</b><br>(0.000)    | <b>1.9***</b><br>(0.000)     | <b>3,853.4***</b><br>(0.000)  | <b>6.1***</b><br>(0.000)        | <b>1.2***</b><br>(0.000)             | <b>16.0***</b><br>(0.000)           |
| Crisis x Non-Bank                                 | <b>0.9*</b><br>(0.056)                   | 22.4<br>(0.113)                           | <b>1.5</b><br>(0.104)          | 40.9<br>(0.118)                 | <b>0.3</b><br>(0.745)        | 117.7<br>(0.150)              | 0.1<br>(0.702)                  | <b>-0.4***</b><br>(0.000)            | 7.9***<br>(0.000)                   |
| Crisis x Bank                                     | <b>0.5</b><br>(0.287)                    | <b>-245.9***</b><br>(0.000)               | <b>1.6*</b><br>(0.084)         | <b>-427.4***</b><br>(0.000)     | 1.3**<br>(0.035)             | <b>-835.1***</b><br>(0.000)   | <b>-1.9***</b><br>(0.000)       | -0.1*<br>(0.072)                     | <b>-0.6</b><br>(0.109)              |
| Post-Crisis x Non-Bank                            | <b>1.6**</b><br>(0.022)                  | <b>71.2***</b><br>(0.000)                 | <b>3.0**</b><br>(0.025)        | <b>133.4***</b><br>(0.000)      | <b>0.9</b><br>(0.143)        | <b>297.6**</b><br>(0.021)     | 0.3**<br>(0.027)                | <b>-0.2**</b><br>(0.020)             | 2.2<br>(0.253)                      |
| Post-Crisis x Bank                                | <b>-0.7</b><br>(0.211)                   | -20.6<br>(0.573)                          | <b>-0.8</b><br>(0.420)         | -1.7<br>(0.981)                 | <b>-0.6</b><br>(0.364)       | -98.4<br>(0.640)              | <b>-1.0***</b><br>(0.000)       | -0.1<br>(0.239)                      | <b>0.0</b><br>(0.986)               |
| Regulatory Phase-In x Non-Bank                    | <b>2.6***</b><br>(0.000)                 | <b>77.4***</b><br>(0.000)                 | <b>5.6***</b><br>(0.000)       | <b>151.7***</b><br>(0.000)      | <b>1.7***</b><br>(0.002)     | <b>421.3***</b><br>(0.000)    | 0.2*<br>(0.095)                 | -0.2**<br>(0.030)                    | 9.2***<br>(0.000)                   |
| Regulatory Phase-In x Bank                        | <b>-1.3***</b><br>(0.007)                | <b>-66.2**</b><br>(0.035)                 | <b>-2.1**</b><br>(0.018)       | <b>-91.3</b><br>(0.117)         | <b>-1.9***</b><br>(0.002)    | <b>-358.1*</b><br>(0.058)     | <b>-1.9***</b><br>(0.000)       | -0.2**<br>(0.019)                    | <b>0.6</b><br>(0.408)               |
| Volcker x Non-Bank                                | <b>1.3***</b><br>(0.000)                 | <b>105.5***</b><br>(0.000)                | <b>2.7***</b><br>(0.000)       | <b>202.1***</b><br>(0.000)      | <b>0.2</b><br>(0.600)        | <b>554.9***</b><br>(0.000)    | 0.3***<br>(0.002)               | -0.1<br>(0.503)                      | <b>15.6***</b><br>(0.000)           |
| Volcker x Bank                                    | <b>-2.9***</b><br>(0.000)                | <b>-112.1***</b><br>(0.000)               | <b>-5.3***</b><br>(0.000)      | <b>-208.3***</b><br>(0.000)     | <b>-3.0***</b><br>(0.000)    | <b>-435.4**</b><br>(0.037)    | <b>-2.6***</b><br>(0.000)       | <b>-0.4***</b><br>(0.000)            | 2.4***<br>(0.007)                   |
| Observations                                      | 5,436                                    | 5,436                                     | 5,436                          | 5,436                           | 1,132                        | 1,132                         | 260                             | 260                                  | 260                                 |
| Adjusted R-squared                                | 0.120                                    | 0.862                                     | 0.132                          | 0.860                           | 0.171                        | 0.890                         | 0.956                           | 0.959                                | 0.791                               |
| Test: Crisis x Non-Bank = Crisis x Bank           | ns                                       | ***                                       | ns                             | ***                             | ns                           | ***                           | ***                             | ***                                  | ***                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ***                                      | ***                                       | ***                            | **                              | **                           | **                            | ***                             | **                                   | ns                                  |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                             | ns                                   | ***                                 |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***                                       | ***                            | ***                             | ***                          | ***                           | ***                             | ***                                  | ***                                 |
| Market Controls                                   | YES                                      | YES                                       | YES                            | YES                             | YES                          | YES                           | YES                             | YES                                  | YES                                 |

**Table IA.VI**  
**Time Series Regressions: Investment Grade vs. High Yield**

This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers and for investment grade and high yield bonds. Each regression includes four time period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level and all other variables are computed at the monthly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Bold formatting indicates investment grade and high yield coefficients are statistically different at the 5% level. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results.

|   | (1)                                      | (2)                                      | (3)                                      | (4)                            | (5)                            | (6)                            | (7)                            | (8)                            | (9)                          | (10)                         | (11)                         | (12)                         | (13)                                   | (14)                                   | (15)                              | (16)                              | (17)                                | (18)                                |
|---|--|--|--|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|--|--|-----------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|
| Dependent Variable Average                        | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital / Volume (%) | Time-Weighted Daily Capital / Volume (%) | Overnight Capital / Volume (%) | Weekend Capital / Volume (%) | Dollar Volume / Amount Outstanding (%) | Dollar Volume / Amount Outstanding (%) | Average Trade Size (\$ Thousands) | Average Trade Size (\$ Thousands) | Principal Volume / Total Volume (%) | Principal Volume / Total Volume (%) |
|   | 9.4                                      | 8.2                                      | 295.3                                    | 130.8                          | 18.0                           | 15.5                           | 561.8                          | 250.7                          | 9.5                          | 8.5                          | 1369.2                       | 627.0                        | 2.3                                    | 3.6                                    | 13.0                              | 13.2                              | 90.7                                | 83.9                                |
|   | IG                                       | HY                                       | IG                                       | HY                             | IG                             | HY                             | IG                             | HY                             | IG                           | HY                           | IG                           | HY                           | IG                                     | HY                                     | IG                                | HY                                | IG                                  | HY                                  |
| Bank  | 2.9***                                   | 4.0***                                   | <b>579.3***</b>                          | <b>277.5***</b>                | 5.6***                         | 7.3***                         | <b>1,094.5***</b>              | <b>515.1***</b>                | 1.0**                        | 2.4***                       | <b>2,601.4***</b>            | <b>1,275.6***</b>            | <b>5.3***</b>                          | <b>8.4***</b>                          | <b>1.1***</b>                     | <b>1.4***</b>                     | <b>8.1***</b>                       | <b>21.5***</b>                      |
|   | (0.000)                                  | (0.000)                                  | (0.000)                                  | (0.000)                        | (0.000)                        | (0.000)                        | (0.000)                        | (0.000)                        | (0.013)                      | (0.000)                      | (0.000)                      | (0.000)                      | (0.000)                                | (0.000)                                | (0.000)                           | (0.000)                           | (0.000)                             | (0.000)                             |
| Crisis x Non-Bank                                 | <b>-1.8***</b>                           | <b>3.9***</b>                            | 1.6                                      | 19.7**                         | <b>-3.4***</b>                 | <b>7.3***</b>                  | 2.7                            | 36.1**                         | <b>-2.5***</b>               | <b>4.5***</b>                | 6.2                          | 109.8**                      | -0.1                                   | 0.4                                    | -0.5***                           | -0.4***                           | <b>1.6</b>                          | <b>10.6***</b>                      |
|   | (0.001)                                  | (0.000)                                  | (0.844)                                  | (0.011)                        | (0.000)                        | (0.000)                        | (0.863)                        | (0.011)                        | (0.007)                      | (0.002)                      | (0.870)                      | (0.046)                      | (0.313)                                | (0.000)                                | (0.000)                           | (0.000)                           | (0.347)                             | (0.000)                             |
| Crisis x Bank                                     | 0.1                                      | 1.2**                                    | <b>-177.7***</b>                         | <b>-67.5***</b>                | 0.9                            | 2.5**                          | <b>-310.8***</b>               | <b>-114.8***</b>               | 1.2                          | 1.5**                        | <b>-590.9***</b>             | <b>-228.9***</b>             | -1.8***                                | -1.9***                                | <b>-0.2***</b>                    | <b>0.0</b>                        | -1.4***                             | 0.3                                 |
|   | (0.854)                                  | (0.045)                                  | (0.000)                                  | (0.000)                        | (0.293)                        | (0.013)                        | (0.000)                        | (0.000)                        | (0.146)                      | (0.043)                      | (0.000)                      | (0.002)                      | (0.000)                                | (0.002)                                | (0.002)                           | (0.449)                           | (0.007)                             | (0.654)                             |
| Post-Crisis x Non-Bank                            | 0.2                                      | 2.2***                                   | 27.1*                                    | 43.5***                        | 0.7                            | 4.0***                         | 50.1*                          | 82.0***                        | <b>-0.7</b>                  | <b>2.1**</b>                 | 61.0                         | 216.0***                     | <b>0.1</b>                             | <b>1.1***</b>                          | -0.3***                           | -0.2***                           | -1.2                                | 3.3                                 |
|   | (0.748)                                  | (0.008)                                  | (0.051)                                  | (0.000)                        | (0.587)                        | (0.003)                        | (0.061)                        | (0.000)                        | (0.351)                      | (0.038)                      | (0.531)                      | (0.000)                      | (0.487)                                | (0.003)                                | (0.001)                           | (0.010)                           | (0.546)                             | (0.185)                             |
| Post-Crisis x Bank                                | <b>-1.6***</b>                           | <b>0.5</b>                               | -3.1                                     | -16.1                          | <b>-2.6***</b>                 | <b>1.7</b>                     | 10.4                           | -10.2                          | <b>-1.5**</b>                | <b>0.8</b>                   | -78.4                        | -19.1                        | -0.6***                                | -1.4***                                | <b>-0.2***</b>                    | <b>0.1</b>                        | -1.6*                               | 1.8                                 |
|   | (0.002)                                  | (0.427)                                  | (0.894)                                  | (0.317)                        | (0.002)                        | (0.168)                        | (0.815)                        | (0.737)                        | (0.030)                      | (0.335)                      | (0.606)                      | (0.810)                      | (0.002)                                | (0.005)                                | (0.007)                           | (0.488)                           | (0.086)                             | (0.354)                             |
| Regulatory Phase-In x Non-Bank                    | <b>0.7</b>                               | <b>3.9***</b>                            | 37.4***                                  | 40.7***                        | <b>2.1***</b>                  | <b>7.6***</b>                  | 76.1***                        | 76.7***                        | <b>0.2</b>                   | <b>2.9***</b>                | 209.3***                     | 218.5***                     | <b>0.0</b>                             | <b>0.8***</b>                          | -0.3***                           | -0.2**                            | <b>5.4***</b>                       | <b>10.7***</b>                      |
|   | (0.140)                                  | (0.000)                                  | (0.000)                                  | (0.000)                        | (0.009)                        | (0.000)                        | (0.000)                        | (0.000)                        | (0.788)                      | (0.000)                      | (0.000)                      | (0.000)                      | (0.676)                                | (0.005)                                | (0.002)                           | (0.049)                           | (0.003)                             | (0.000)                             |
| Regulatory Phase-In x Bank                        | <b>-2.1***</b>                           | <b>-0.3</b>                              | -32.6                                    | -29.9**                        | <b>-3.7***</b>                 | <b>-0.2</b>                    | -48.3                          | -36.7                          | -2.4***                      | -1.1                         | -202.7                       | -130.5*                      | -1.6***                                | -2.0***                                | -0.3***                           | -0.2*                             | -0.6                                | 1.7**                               |
|   | (0.000)                                  | (0.609)                                  | (0.122)                                  | (0.015)                        | (0.000)                        | (0.836)                        | (0.219)                        | (0.107)                        | (0.000)                      | (0.106)                      | (0.118)                      | (0.051)                      | (0.000)                                | (0.000)                                | (0.001)                           | (0.052)                           | (0.567)                             | (0.030)                             |
| Volcker x Non-Bank                                | <b>-0.7**</b>                            | <b>2.9***</b>                            | <b>64.5***</b>                           | <b>45.5***</b>                 | <b>-0.9</b>                    | <b>5.4***</b>                  | <b>126.3***</b>                | <b>84.8***</b>                 | <b>-1.4***</b>               | <b>1.8***</b>                | <b>343.7***</b>              | <b>240.4***</b>              | <b>0.2***</b>                          | <b>0.8***</b>                          | -0.2**                            | 0.0                               | <b>9.3***</b>                       | <b>18.7***</b>                      |
|   | (0.046)                                  | (0.000)                                  | (0.000)                                  | (0.000)                        | (0.195)                        | (0.000)                        | (0.000)                        | (0.000)                        | (0.006)                      | (0.009)                      | (0.000)                      | (0.000)                      | (0.006)                                | (0.000)                                | (0.048)                           | (0.681)                           | (0.000)                             | (0.000)                             |
| Volcker x Bank                                    | <b>-4.0***</b>                           | <b>-1.6***</b>                           | -56.7***                                 | -45.5***                       | <b>-7.5***</b>                 | <b>-2.7***</b>                 | -120.6***                      | -71.3***                       | <b>-3.8***</b>               | <b>-1.9***</b>               | -179.0                       | -184.5***                    | <b>-2.1***</b>                         | <b>-3.0***</b>                         | -0.3***                           | -0.5***                           | 1.3                                 | 3.3***                              |
|   | (0.000)                                  | (0.001)                                  | (0.007)                                  | (0.000)                        | (0.000)                        | (0.001)                        | (0.001)                        | (0.001)                        | (0.000)                      | (0.001)                      | (0.371)                      | (0.002)                      | (0.000)                                | (0.000)                                | (0.000)                           | (0.000)                           | (0.168)                             | (0.000)                             |
| Observations                                      | 5,436                                    | 5,430                                    | 5,436                                    | 5,430                          | 5,436                          | 5,430                          | 5,436                          | 5,430                          | 1,132                        | 1,132                        | 1,132                        | 1,132                        | 260                                    | 260                                    | 260                               | 260                               | 260                                 | 260                                 |
| Adjusted R-squared                                | 0.154                                    | 0.082                                    | 0.853                                    | 0.813                          | 0.163                          | 0.083                          | 0.847                          | 0.799                          | 0.211                        | 0.135                        | 0.869                        | 0.836                        | 0.963                                  | 0.933                                  | 0.954                             | 0.950                             | 0.521                               | 0.817                               |
| Test: Crisis x Non-Bank = Crisis x Bank           | ***                                      | ***                                      | ***                                      | ***                            | ***                            | ***                            | ***                            | ***                            | ***                          | **                           | ***                          | ***                          | ***                                    | ***                                    | ***                               | ***                               | *                                   | ***                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | **                                       | **                                       | ns                                       | ***                            | **                             | *                              | ns                             | ***                            | ns                           | ns                           | ns                           | ***                          | ***                                    | ***                                    | **                                | ***                               | ns                                  | ns                                  |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***                                      | ***                                      | ***                                      | ***                            | ***                            | ***                            | ***                            | ***                            | ***                          | ***                          | ***                          | ***                          | ***                                    | ***                                    | ns                                | ns                                | ***                                 | ***                                 |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***                                      | ***                                      | ***                                      | ***                            | ***                            | ***                            | ***                            | ***                            | ***                          | ***                          | ***                          | ***                          | ***                                    | ***                                    | **                                | ***                               | ***                                 | ***                                 |
| Market Controls                                   | YES                                      | YES                                      | YES                                      | YES                            | YES                            | YES                            | YES                            | YES                            | YES                          | YES                          | YES                          | YES                          | YES                                    | YES                                    | YES                               | YES                               | YES                                 | YES                                 |

**Table IA.VII**  
**Stressful Day Summary Statistics for Alternate Stress Events**

This table reports summary statistics for the stressful day analysis for bank and non-bank affiliated dealers. The capital commitment measures are aggregated at the daily and weekly level. Daily and weekly averages are reported for five sub-periods. All variables are computed using the Constant Dealer sample described in Table I. Variable definitions are provided in Appendix I. Panel A reports statistics for bond-level stress based on abnormal selling at the bond level. Panel B reports statistics for days with market-wide stress based on the Composite Stress Index. A description of the identification of "stressful days" can be found in the Appendix Summary.

| Panel A: Bond-Level Stress - Abnormal Sell Volume    |                          |                          |                         |                          |                          |
|--|--------------------------|--------------------------|-------------------------|--------------------------|--------------------------|
|  | Jan. 2006 -<br>Jun. 2007 | Jul. 2007 -<br>Apr. 2009 | May 2009 -<br>Jun. 2010 | Jul. 2010 -<br>Mar. 2014 | Apr. 2014 -<br>Oct. 2016 |
|  | Pre-Crisis               | Crisis                   | Post-Crisis             | Regulatory<br>Phase-In   | Volcker                  |
| <u>Bank Sample</u>                                   |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)             | 28.8                     | 23.2                     | 24.9                    | 23.5                     | 21.0                     |
| Overnight Capital / Volume (%)                       | 61.6                     | 49.2                     | 53.7                    | 50.4                     | 43.9                     |
| Weekly Capital / Volume (%)                          | 39.2                     | 31.3                     | 31.3                    | 29.3                     | 25.1                     |
| <u>Non-Bank Sample</u>                               |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)             | 13.7                     | 11.6                     | 13.7                    | 16.7                     | 18.2                     |
| Overnight Capital / Volume (%)                       | 26.3                     | 22.1                     | 26.6                    | 36.5                     | 37.3                     |
| Weekly Capital / Volume (%)                          | 18.6                     | 13.1                     | 16.0                    | 23.3                     | 22.8                     |
| Panel B: Market-Wide Stress - Composite Stress Index |                          |                          |                         |                          |                          |
| # Events   | 20                       | 17                       | 15                      | 76                       | 36                       |
| <u>Bank Sample</u>                                   |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)             | 11.8                     | 9.8                      | 8.6                     | 9.0                      | 6.6                      |
| Overnight Capital / Volume (%)                       | 21.4                     | 18.9                     | 16.5                    | 17.2                     | 12.4                     |
| Weekend Capital / Volume (%)                         | 20.3                     | 18.0                     | 16.9                    | 16.4                     | 12.7                     |
| <u>Non-Bank Sample</u>                               |                          |                          |                         |                          |                          |
| Time-Weighted Daily Capital / Volume (%)             | 7.9                      | 5.4                      | 7.3                     | 9.4                      | 8.5                      |
| Overnight Capital / Volume (%)                       | 14.9                     | 9.8                      | 13.8                    | 18.3                     | 16.7                     |
| Weekend Capital / Volume (%)                         | 13.3                     | 10.5                     | 13.8                    | 16.7                     | 15.1                     |

**Table IA.VIII**  
**Time Series Regressions: Alternate Stressful Days**

This table reports time series regression results over the January 2006 to October 2016 period for bank and non-bank affiliated dealers on stressful days. Each regression includes four period indicators; the benchmark period is January 2006 to June 2007. The capital commitment measures are computed at the daily and weekly level. All dependent variables are computed using the Constant Dealer sample described in Table I. All regressions report Newey-West standard errors and include market controls. Tests for statistical differences between changes (relative to the benchmark period) in bank dealer and non-bank dealer activity each period are included below regression results. \*\*\*, \*\*, and \* stand for statistical significance at the 1%, 5%, and 10% level, respectively. Dependent variable sample period (January 2006 to October 2016) averages are shown above regression results. Panel A reports statistics for bond-level stress based on abnormal selling at the bond level. Panel B reports statistics for days with market-wide stress based on the Composite Stress Index. Bold formatting indicates stressful day coefficients are statistically different at the 5% level from control days [-7,-1] prior to the event. A description of the identification of "stressful days" can be found in the Appendix Summary.

| Panel A: Bond-Level Stress - Abnormal Sell Volume |   |                                   |                                |
|---|---|-----------------------------------|--------------------------------|
|   | (1)   | (2)                               | (3)                            |
|   | Time-Weighted Daily<br>Capital / Volume (%) | Overnight Capital /<br>Volume (%) | Weekly Capital /<br>Volume (%) |
| Dependent Variable Average                        | 20.2  | 42.6                              | 25.9                           |
| Bank  | 15.1***<br>(0.000)                          | 35.3***<br>(0.000)                | 20.6***<br>(0.000)             |
| Crisis x Non-Bank                                 | 0.1<br>(0.950)                              | 0.5<br>(0.890)                    | -1.3<br>(0.616)                |
| Crisis x Bank                                     | -3.8***<br>(0.000)                          | -8.5***<br>(0.000)                | -4.3***<br>(0.000)             |
| Post-Crisis x Non-Bank                            | 2.4<br>(0.110)                              | 6.2*<br>(0.051)                   | 2.0<br>(0.439)                 |
| Post-Crisis x Bank                                | -1.5**<br>(0.049)                           | -1.9<br>(0.210)                   | -3.3**<br>(0.014)              |
| Regulatory Phase-In x Non-Bank                    | 4.8***<br>(0.000)                           | 14.2***<br>(0.000)                | 8.4***<br>(0.000)              |
| Regulatory Phase-In x Bank                        | -3.5***<br>(0.000)                          | -7.1***<br>(0.000)                | -6.2***<br>(0.000)             |
| Volcker x Non-Bank                                | 5.8***<br>(0.000)                           | 13.9***<br>(0.000)                | 6.5***<br>(0.001)              |
| Volcker x Bank                                    | -6.4***<br>(0.000)                          | -14.8***<br>(0.000)               | -11.7***<br>(0.000)            |
| Observations                                      | 4,916                                       | 4,916                             | 4,916                          |
| Adjusted R-squared                                | 0.194                                       | 0.218                             | 0.137                          |
| Test: Crisis x Non-Bank = Crisis x Bank           | **  | ***                               | ns                             |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank | ***   | ***                               | **                             |
| Test: Regulatory x Non-Bank = Regulatory x Bank   | ***   | ***                               | ***                            |
| Test: Volcker x Non-Bank = Volcker x Bank         | ***   | ***                               | ***                            |
| Market Controls                                   | YES   | YES                               | YES                            |

| Panel B: Market-Wide Stress - Composite Stress Index |  |                                      |                                    |
|--|--|--------------------------------------|------------------------------------|
|  | (1)  | (2)                                  | (3)                                |
|  | Time-Weighted<br>Daily Capital /<br>Volume (%) | Overnight<br>Capital /<br>Volume (%) | Weekend<br>Capital /<br>Volume (%) |
| Dependent Variable Average                           | 8.6  | 16.5                                 | 15.7                               |
| Bank   | 3.9***<br>(0.005)                              | 6.5***<br>(0.001)                    | 7.0***<br>(0.000)                  |
| Crisis x Non-Bank                                    | -0.7<br>(0.677)                                | -1.5<br>(0.598)                      | -0.1<br>(0.948)                    |
| Crisis x Bank  | -0.2<br>(0.928)                                | 1.1<br>(0.738)                       | 0.4<br>(0.789)                     |
| Post-Crisis x Non-Bank                               | 0.3<br>(0.836)                                 | 0.5<br>(0.863)                       | 1.0<br>(0.504)                     |
| Post-Crisis x Bank                                   | -2.3*<br>(0.068)                               | -3.3<br>(0.108)                      | -2.9**<br>(0.016)                  |
| Regulatory Phase-In x Non-Bank                       | 2.3*<br>(0.074)                                | 4.9**<br>(0.029)                     | 4.3***<br>(0.000)                  |
| Regulatory Phase-In x Bank                           | -1.9<br>(0.258)                                | -2.7<br>(0.222)                      | -3.0**<br>(0.011)                  |
| Volcker x Non-Bank                                   | 1.1<br>(0.358)                                 | 2.8<br>(0.185)                       | 2.8**<br>(0.019)                   |
| Volcker x Bank                                       | -4.7***<br>(0.006)                             | -8.1***<br>(0.000)                   | -6.5***<br>(0.000)                 |
| Observations   | 328  | 328                                  | 328                                |
| Adjusted R-squared                                   | 0.179  | 0.191                                | 0.430                              |
| Test: Crisis x Non-Bank = Crisis x Bank              | ns   | ns                                   | ns                                 |
| Test: Post-Crisis x Non-Bank = Post-Crisis x Bank    | *  | ns                                   | ***                                |
| Test: Regulatory x Non-Bank = Regulatory x Bank      | ***  | ***                                  | ***                                |
| Test: Volcker x Non-Bank = Volcker x Bank            | ***  | ***                                  | ***                                |
| Market Controls                                      | YES  | YES                                  | YES                                |