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The Effects of the Volcker Rule on Corporate Bond Trading: Evidence from the Underwriting Exemption*

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Abstract

Using a novel within-dealer, within-security identification strategy, we examine intended and unintended effects of the Volcker rule on covered firms' corporate bond trading using dealer-identified regulatory data. We use the underwriting exemption to isolate the Volcker rule's effects separate from other post-crisis changes in bank regulation and broader trends in market liquidity. We find no evidence of the rule's intended reduction in the riskiness of covered firms' trading in corporate bonds. We find significant adverse liquidity effects on covered firms' corporate bond trading with 20-45 basis points higher costs for customers even for roundtrip trades of shorter duration. These effects do not appear to be transitional. The Volcker rule appears to have increased the cost of the liquidity provided by covered firms and has not decreased the liquidity risk exposure of covered firms. Finally, the Volcker rule has decreased the market share of covered firms. Customers appear to be trading more with non-bank dealers, who are exempt from the Volcker rule but also lack access to emergency liquidity support at the Fed's discount window.

JEL classification: G28, G21, G23.

Keywords: Banking regulation, Volcker rule, heightened prudential regulation, corporate bonds, market liquidity, regulatory impact analysis.

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1 Introduction

"*It's much more complicated than I would like to see*" – Paul Volcker on the proposed text of the rule that bears his name.[1]

Following the financial crisis, former Federal Reserve Chairman Paul Volcker proposed including a provision in the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank Act) restricting U.S. banks from making certain kinds of speculative investments that do not benefit their customers. Chairman Volcker argued that such speculative activity played a key role in the financial crisis. The Volcker provision of the Dodd-Frank Act is a ban on proprietary trading by commercial banks and their affiliates, although there exist exceptions to this ban for certain asset classes such as government securities and physical commodities. Since the Volcker rule took effect, many market participants have argued that the rule significantly hampers their ability to make markets, and that market liquidity has suffered as a result.[2] At the same time, policy-oriented institutions and others have argued that market liquidity is unaffected by the rule.[3]

However, empirically assessing the impact of the rule is not straightforward due to the implementation of a number of other major banking rules (including Basel III reforms, systematically important financial institution (SIFI) designation, stress testing and resolution requirements, etc.) during the same period. Existing approaches to examining the Volcker rule's impact generally choose an agnostic approach looking at market liquidity where time is divided into "pre-crisis," "crisis," "rulemaking," and "rule implementation" periods (e.g. Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018); Adrian, Boyarchenko, and Shachar (2017)), or attempt to control for other changes in bank regulations using balance sheet measures or broad stress test pass/fail results (e.g. Bao, O'Hara, and Zhou (2018)).[4]

We devise an empirical strategy exploiting specific features of the Volcker rule that allows us to better control for contemporaneous effects of other bank regulation that may otherwise confound

[1] See Financial Times, "Prospect of a deal on Volcker rule worries banks," published Nov. 11, 2013 at https://www.ft.com/content/4b5ef106-4a1b-11e3-9a21-00144feabdc0 (accessed Feb. 1, 2018).

[2] For example: https://www.thestreet.com/story/13592737/1/edicts-like-the-volcker-rule-are-draining-market-liquidity-jpmorgan-says.html, and testimony by Thomas Quaadman, U.S. Chamber of Commerce, to the U.S. House of Representatives, March 29, 2017

[3] For example, testimony by Marc Jarsulic, Center for American Progress, to the U.S. House of Representatives, March 29, 2017 https://financialservices.house.gov/uploadedfiles/hhrg-115-ba16-wstate-mjarsulic-20170329.pdf

[4] Alternatively, Trebbi and Xiao (2019) use four different estimation strategies to look for an unknown breakpoint in market liquidity and are unable to find any specific time period where market liquidity deteriorated after the crisis.

the identification of a Volcker-specific effect. We are able to use a novel difference-in-differences approach to identify the effects of the Volcker rule on covered dealer risk-taking and possible unintended effects on corporate bond market liquidity, by using the rule's underwriting exemption as an empirical lever.

The rule contains an underwriting exemption for members of the underwriting group for a bond, during the initial distribution of that bond to investors. This exemption allows dealers to justify a position using expected customer demand for the bond offering itself, in addition to any secondary market liquidity demand. Per the language of the rule, underwriting dealers can simply show "reasonable efforts are made to sell or otherwise reduce the underwriting position within a reasonable period."[5] giving dealers significantly more flexibility in their decision to take a security into inventory. In other words, even if a dealer is affiliated with a bank and therefore subject to the Volcker rule, trades of a covered dealer are exempt from the main market-making standard of the rule when two conditions jointly apply: (i) The dealer is part of the bond's underwriting group, and (ii) The bond is still being distributed, i.e. newly issued.

As other major banking reforms post-crisis do not reference underwriting, this exemption is useful for assessing the unique impact of the Volcker rule. Specifically, it creates variation in the treatment of the regulation both (i) within a covered dealer, and (ii) within a particular bond. Concerns about simultaneous changes in market liquidity or contemporaneous bank regulatory changes can be controlled for using this difference-in-differences approach.[6] Figure 1 illustrates this variation, for covered and non-covered dealers. Furthermore, if the underwriting exemption does not in fact represent (an expectation of) differential treatment under the Volcker rule, our empirical specification is biased against rejecting the null hypothesis of no difference due to the Volcker rule.

One final key to our identification strategy is a supervisory version of the TRACE dataset which fully identifies the name of each dealer along with their trading activity in U.S. corporate bonds.[7] We merge this dataset with Mergent FISD to identify which dealers are the underwriters of each bond, and when each bond is newly issued.

[5] 17 CFR §255.4 - Permitted underwriting and market making-related activities, also available at https://www.fdic.gov/news/board/2013/2013-12-10-notice-dis-a-regulatory-text.pdf

[6] This analysis is econometrically similar to Yelowitz (1995), who uses variation in Medicaid coverage extensions across states at different years in the 1980s, and covering different age groups in different states. We are simply adding a fourth dimension of differences.

[7] This is distinct from the version of TRACE available to academics, which masks individual dealers' identities.

Instead of relying on broader market measures such as price impact (Amihud, 2002) or imputed round-trip cost (IRC) as in Feldhütter (2012), we are able to calculate actual roundtrip markups earned by each dealer. We can compare these actual roundtrip markups for each dealer on bonds they underwrote versus other bonds, both before and after the Volcker rule, and during versus after the new-issue period within a bond. Additionally, we follow the intuition of Trebbi and Xiao (2019), who use the standard deviation of Amihud and IRC liquidity metrics as measures of liquidity risk, to examine the liquidity risk exposure of individual dealers affected by the Volcker rule. We do this by calculating the standard deviation of actual roundtrip markups for each dealer on each bond, each month in our sample.

We partition dealers' roundtrip trades into sub-samples based on how long each position was held.[8] This is relevant to the analysis because the Volcker rule also provides covered firms with an exemption for market making. The market making exemption of the Volcker rule could imply that a bond which a dealer purchases and then resells within the same day (i.e., a bond that is not carried in inventory overnight) qualifies more easily as a Volcker-exempt market making transaction. However, our empirical results suggest the Volcker rule affects dealers even in their short-term trading.

We focus our analysis on four questions:

1. Did the Volcker rule's ban on proprietary trading succeed in its intended objective of reducing the risk profile of bank-affiliated dealers' trading activities?

2. Did the Volcker rule have an unintended consequence of reducing covered dealers' ability to provide liquidity in the corporate bond market?

3. Are these effects restricted only to a transition period (the 15-month conformance period from April 1, 2014 to July 21, 2015[9]) or are they more lasting?

4. Does the rule's 60-day rebuttable presumption period exert an influence on covered firms' trading behavior?

With regard to intended effects, we find no statistical evidence that the Volcker rule reduced

[8] See Appendix A and Figures A.1 and A.2 for a description of roundtrip trades.

[9] https://www.occ.treas.gov/topics/capital-markets/financial-markets/trading-volcker-rule/volcker-rule-implementation-faqs.html#conformance

dealer risk-taking as measured by the standard deviation of covered dealers' corporate bond trading returns. Rather, our analysis suggests that covered firms' risk-taking has experienced an increase on short-term trades. Given the short time in inventory, some or most of these transactions could more easily qualify for the rule's market making exemption. Longer-term trading activity of covered firms, which we would expect to face more scrutiny under the rule, shows no statistically significant change in risk-taking, although the coefficients are in the direction of lower risk.

As for unintended consequences on corporate bond market liquidity, we find evidence that the rule has increased the markups Volcker-covered dealers charge their clients even on trades that we would anticipate would qualify for the rule's market making exemption. Specifically, we find that Volcker-covered firms are charging 20-45 basis points higher markups when conducting short-term trades, i.e., roundtrip trades under 15 minutes and roundtrip trades within one day. These findings are highly significant, both statistically and economically. While we would expect these transactions to be exempt, Volcker-covered dealers still appear to be charging customers a premium[10] for these trades after the Volcker rule's implementation.

When we examine dealers' market share as measured by the market value of their trading activity within a given bond and month, we find that covered dealers have decreased market share due to the rule by 6-14% in absolute terms. This appears to be a permanent effect of the rule.

This study adds to the literature a unique approach to isolate the impact of the Volcker rule while controlling for other contemporaneous changes in corporate bond market liquidity or bank regulation. An important caveat to our findings is that this study examines the impact of the Volcker rule on corporate bonds, not all markets. We cannot infer anything from this analysis about the intended effects and unintended consequences of the Volcker rule on covered dealers' trading in asset classes other than corporate bonds.

The rest of this paper is organized as follows. Section 2 presents background information on the Volcker rule and related literature on the effect of the rule on bond market liquidity. Section 3 presents the data, details on the sample construction, and summary statistics. Section 4 describes the empirical methodology. Section 5 describes the main results and Section 6 concludes.

[10] Or in other words, dealers are passing on their Volcker-related compliance costs to customers.

2 Background

Since the global financial crisis, risks faced by the financial system and individual institutions during that crisis have prompted material revisions to the prudential regulatory framework. The banking industry received particular attention in the aftermath because it received exceptional government support, although other parts of the U.S. financial sector also received official sector support. One post-crisis reform that has received particular attention is the promulgation of the Volcker rule. The rule, like many regulations put into place in the wake of the crisis, was intended to reduce the risks that could be taken on by banks and their affiliates. It restricts banks from buying certain securities for their own accounts (so-called proprietary trading), and prohibits them from investing in hedge funds or private-equity funds.

However, some market participants describe it as "one of the most vexing and resented post-crisis regulatory reforms"[11] and have pressed for its repeal. Empirically attributing changes in market liquidity and dealer behavior to the Volcker rule is difficult because many other reforms have occurred at the same time that also affect these same bank holding companies and, by extension, their dealer affiliates. The Financial Stability Oversight Council (FSOC) annual report called on FSOC member agencies to "monitor and assess the impact of rulemakings on financial institutions and markets, including market liquidity."[12] This paper is responsive to that Council recommendation.

2.1 Related Literature

This paper relates to several strands of the academic literature. First, we contribute to the small but growing literature on the effects of the Volcker rule on the corporate bond market. Trebbi and Xiao (2019) is is the first paper we are aware of to study the effects of the Volcker rule on the corporate bond market. Based on suggestion of Cochrane (2014) regarding cost-benefit analysis of financial regulation and the remarks about the potential unintended consequences of the proposed Volcker rule in Duffie (2012); Trebbi and Xiao (2019) use a wide variety of liquidity metrics across fixed-income asset classes and find no evidence of illiquidity arising from post-crisis

[11] See *American Banker*, "Volcker Rule's in crosshairs, but how much will Trump's regulators change it?" published Dec. 11, 2017 at https://www.americanbanker.com/news/volcker-rule-poised-for-revamp-with-trumps-regulators-in-place (accessed Dec. 19, 2017).

[12] Financial Stability Oversight Council (2017) Annual Report, pg 10. (accessed 12/20/2017).

financial regulation. Those authors even control for whether the bond's underwriter is one of the biggest 4 underwriters (Bank of America Merrill Lynch, JPMorgan Chase, Morgan Stanley, and Goldman Sachs). However, their sample ends on December 31, 2014 (before the Volcker rule's full implementation in July 2015), and their study does not distinguish between dealers' trading in newly issued versus seasoned bonds, and due to data limitations the authors cannot test for dealer-specific liquidity provision.

Bao, O'Hara, and Zhou (2018) focuses on how the rule has affected liquidity during times of stress, using "fallen angel" downgrades of corporate bonds (downgrades from investment grade to sub-investment grade) as an exogenous shock to customer demand for liquidity, before and after the passage of the Volcker rule. In the analysis, the authors evaluate liquidity metrics of downgraded corporate bonds in the pre- and post-Volcker period but without distinguishing between covered and non-covered dealers. They find that after the Volcker rule liquidity costs are higher during these stress events. In a subsequent phase of the analysis, they consider covered versus non-covered dealers in the pre- and post-Volcker period but use other dependent variables, such as the percentage of agency trades and dealers' willingness to commit capital as opposed to more direct corporate bond market liquidity measures. They find Volcker-covered dealers increase their usage of pre-arranged, "riskless-principal" trades to act as a broker rather than dealer in the post-Volcker period. The authors attempt to control for other concurrent changes in bank regulation through an indicator variable for whether the covered dealer's parent passed its most recent Comprehensive Capital Analysis and Review stress test or not. We add to this literature by examining both covered and non-covered dealers' liquidity provision in the corporate bond market not only in times of market stress, but also in *normal* market conditions. Further, we use the underwriting exemption and other provisions of the Volcker rule to devise a novel within security *and* within dealer strategy to identify the effects of the rule in the post-implementation period.

Our paper is also related to Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018), who study trade execution costs in the corporate bond market following the financial crisis. They find liquidity provision in corporate bonds is moving away from bank-affiliated dealers to nonbank-affiliated dealers, suggesting regulatory reforms following Basel III and the Dodd-Frank Act, including the Volcker Rule, were the primary drivers. They also find that activity moves from bank to non-bank dealers as a result of bank holding company regulation, similar to the finding in Al-

lahrakha, Cetina, and Munyan (2018) with regards to the supplementary leverage ratio. Schultz (2017) shows that after the Volcker rule date (April 2014–December 2014), dealers became more reluctant to hold positions in inventory and more likely to pre-arrange trades. Similarly, Adrian, Boyarchenko, and Shachar (2017) examine the role of financial constraints on dealers' ability to provide liquidity. They use quarterly Y-9C bank holding company regulatory filings – which naturally limits the scope of their analysis to bank-affiliated dealers – to construct a score for how constrained a dealer's parent is. They find that this score significantly predicts the price a dealer charges to provide liquidity. While the focus of these papers is on capital commitment of the dealer, our paper focuses primarily on liquidity as measured by the realized spread dealers earn from trading, i.e. the roundtrip trading profits from opening and closing a position. Additionally, we make use of the underwriting provision of the Volcker rule to identify its unique effect on corporate bond liquidity.

Our paper also contributes to the broader corporate bond liquidity literature. Bao, Pan, and Wang (2011) analyze the effect of illiquidity of corporate bonds and the asset-pricing implications of sudden and large decreases in liquidity of investment grade bonds. Harris (2015) uses a proprietary dataset of dealer price quotations matched with TRACE and finds that dealers often appear to perform "trade-throughs" in the corporate bond market, resulting in worse trade execution for customers. Dick-Nielsen and Rossi (2018) study the cost of immediacy for corporate bonds and find that dealers charge higher prices for immediacy after the crisis. Friewald, Jankowitsch, and Subrahmanyam (2012) also study corporate bond liquidity and find that liquidity is lower in times of stress, as well as for lower credit quality bonds. Our results indicate that liquidity has decreased for a subset of dealers and for certain types of transactions, shedding light on the heterogeneity of dealers and trade types.

The Securities and Exchange Commission (2017) report on access to capital and market liquidity assesses the potential impact of regulatory changes on market liquidity. The report finds "[i]n corporate bond markets, trading activity and average transaction costs have generally improved or remained flat. More corporate bond issues traded after regulatory changes than in any prior sample period. In the post-regulatory period, we estimate that transaction costs have decreased (by 31 basis points (bps), to 55.4 bps round-trip) for smaller trade sizes ($20,000) and remain low for larger trade sizes relative to the pre-crisis period (estimated at 5.7 bps round-trip for trades of $5,000,000, compared to 5.8 bps pre-crisis)."

This work does not contradict our findings. Rather, unlike our study, the SEC's analysis does not attempt to estimate the unique impact of individual regulatory reforms, including the Volcker rule, on corporate bond market liquidity. Our data similarly suggest (see Figure 2) *in aggregate* limited impact on all dealers' corporate bond markups after the Volcker rule's effective date. Thus, it is plausible that both corporate bond liquidity has improved in general post crisis – potentially in response to increased issuance, low volatility, growth of non-bank affiliated dealers, or other factors – and that the Volcker rule has had a discernible negative impact on the liquidity provision of covered dealers. The purpose of our identification strategy is to control for such confounding factors and isolate the specific effects of the Volcker rule.

Goldstein and Hotchkiss (2012) studies the market liquidity of newly issued bonds from 2002 to 2008 and characterizes the trading of dealers during that period. They find that measures of bond underpricing are due to both underwriters' decision as well as large variation in secondary market values for the bond over its first 10 days, as the bond leaves dealers and institutional investors and enters the portfolios of smaller sized retail customers. Furthermore, they find no evidence that dealers accumulate large positions in newly issued bonds to suppport its secondary market price. We take this as evidence that bonds indeed trade differently and actively during the new-issue period of a bond, giving further support to our interpretation of the underwriting exemption of the Volcker rule and motivating our difference-in-differences strategy. Finally, we note that our choice of defining the new-issue period as 40 days instead of 10 would appear to be conservative—it increases our "new-issue" sample size, but biases us against finding a significant difference between newly-issued and seasoned bonds.

While this study analyzes the impact of the Volcker rule on proprietary trading in corporate bonds and market liquidity, we do not presume to extrapolate its findings to covered firms' trading in other asset classes. Although one interpretation of our work could be that perhaps covered firms were not engaged in much proprietary trading to begin with, there is evidence of some bank holding companies and their affiliates engaging in risky proprietary trading in other asset classes. For example, the Permanent Subcommittee on Investigations (2017) report on banks' involvement with physical commodities identifies material risky trading activity by several systemically important U.S. bank holding companies in physical commodity markets – an activity still not covered by the Volcker rule or any other rule-making currently. Thus, our analysis does not preclude that some

covered firms may take excessive trading risk or that the Volcker rule could be helpful in curtailing covered firms' risk-taking in other financial markets.

2.2 The Volcker rule

The Volcker rule was proposed under the premise that the moral hazard associated with public provision of deposit insurance may incent banks to make excessively risky investments. Bank holding companies and their affiliates are covered entities under the rule. Though initially passed as section 619 of the Dodd-Frank Act in July 2010, complications in defining the extent and coverage of the rule arose. The Federal Reserve, Federal Deposit Insurance Corporation, OCC, and Securities and Exchange Commission issued a proposed rule in November 2011, followed by a separate rule by the Commodities Future Trading Commission in April 2012. Both rules were finalized in December 2013 with an effective date of April 1, 2014.[13]

The Volcker rule's main intent was to protect bank customers' deposits from risky investments the bank was making on its own behalf. The way it addressed this problem was by placing restrictions on proprietary trading by banks and their affiliates (making risky bets using their own capital) for covered asset classes and by restricting equity investments in private equity funds and hedge funds. This paper focuses on the rule's proprietary trading restrictions.

The Federal Reserve received thousands of letters and comments to the proposed rule. One interesting point raised in some of these comments was the concern that the rule's ban on proprietary trading would create a "bifurcation" between trading by Volcker-covered institutions and other entities in the market, reducing market liquidity.[14]

While this section of the paper is not intended as a tutorial on all the nuances of the Volcker rule, to understand the paper it is important to explain to the reader a few key provisions of the rule that are assessed empirically in this study. First, the rule contains a "rebuttable presumption." Specifically, any position held by a covered firm for fewer than 60 days is subject to a "rebuttable presumption" that the intent of the trade was proprietary trading. Although a trade held for greater than 60 days does not automatically enjoy a safe harbor, we examine trades of different

[13] See https://www.gpo.gov/fdsys/pkg/FR-2014-01-31/pdf/2013-31511.pdf and http://www.cftc.gov/idc/groups/public/@lrfederalregister/documents/file/2013-31476a.pdf.

[14] See, for example, comment letters by the Municipal Securities Rulemaking Board and by Darrell Duffie of Stanford University.

lengths to consider whether this 60-day demarcation in the Volcker rule appears to have any discernable impacts on market liquidity or dealer behavior. The final rule clarifies that the rebuttable presumption even extends to basis trading, where a dealer might trade in related securities (such as bonds and credit default swaps or CDS on the same reference entity).

Additionally, the Dodd-Frank Act and the final rules contain several exemptions. There are two notable Volcker rule exemptions for purposes of this paper. The first exemption applies to covered firms trading to make markets and meet reasonable expected near term customer demand (RENTD) and the exemption to facilitate trades on behalf of customers. The exemption could reduce the length of time covered dealers hold a position in inventory. For this reason, we examine roundtrip trades of different lengths to separate trades that are very short-term and would more easily qualify for the Volcker rule's market making exemption, trades that are of longer duration and thus more difficult to document as qualifying for the rule's market making exemption, and even longer-term trades that fall outside the rule's 60-day rebuttal presumption.

The second exemption in the rule applies to covered firms who are involved in the acquisition, sale, or distribution of securities in connection with underwriting activities.[15] This exemption offers an identification strategy that is central to this paper for empirically assessing the intended and unintended effects of the rule. We use the underwriting exemption as an empirical lever in this study because the exemption offers Volcker-covered institutions greater safe-harbor on their trading in the corporate bond issues that they have underwritten compared to those that they have not. Importantly, the Volcker rule's underwriting provision is unique. Other bank regulatory changes post crisis do not have provisions that affect recently underwritten securities differently.

While underwriters are exempt for securities they underwrite during the initial distribution period, the underwriting banks must still prove RENTD. Although the rule also provides clarification on who counts as an underwriter, what counts as an underwriting distribution or position, etc., it does not provide a bright line for how long the underwriting distribution period should last, or how to assess customer demand in a security distribution. Based on discussions with some market participants, we have heard that the distribution period (after which the underwriter is expected

[15] Pg. 97 of the final rule text states "To determine whether a banking entity is acting as an underwriter as part of a distribution of securities, the Agencies proposed to take into consideration the extent to which a banking entity is engaged in the following activities: ... *[t]ransacting to provide a post-issuance secondary market and to facilitate price discovery* (emphasis added)."

to have completely run off the position) is 90 days. In the analysis of the rule below, we use $\leq$ 40 days as the limit of the underwriting "new-issue" period for all the bonds in our sample, after which we consider the bond to be "seasoned." However, our findings on the effect of the Volcker rule on the cost of trading are robust to using a longer distribution period, such as 90 days or one calendar year.

3 Data and Sample Construction

The analysis in this paper makes use of three datasets to obtain information on corporate bond transactions, bond characteristics, and dealer type.

3.1 Transaction data and roundtrip trades

We use the supervisory version of the Trade Reporting and Compliance Engine (TRACE) for corporate bonds to construct trade-based measures of market liquidity and to capture dealers' trading activity. TRACE collects detailed trade information from securities brokers and dealers that are Financial Industry Regulatory Authority (FINRA) members, including the date and time at which the transaction took place, the price and quantity of the bond traded, dealer/client flags for the two parties to the transaction, and a buy/sell indicator. We clean the transaction data in keeping with the methodology described in Adrian, Boyarchenko, and Shachar (2017) and Munyan and Watugala (2019). We use data from TRACE to calculate the mean and standard deviation of dealer markups for roundtrip trades of different lengths for dealer firms both covered and not covered by the Volcker rule. Our full sample covers the 135 months from January 2006 to March 2017.

We identify round-trip trades from the data by looking within the time-stamped sequence of transactions of an individual dealer in an individual security, subject to the additional restrictions described below for the type of roundtrip trade we are searching to identify. Figures A.1 and A.2 in Appendix A illustrates how a sequence of transactions comprises a roundtrip trade. Starting from the earliest trade in the sequence, we look for a prior trade or consecutive set of trades that add up to offset the final trade's notional amount in the opposite direction (buying vs selling). We then mark all those trades as belonging to a set (so they will not be re-examined when we look

for the next roundtrip trade), and record the markup, time in inventory, total notional (one-sided) amount of the bond traded, whether the trades were retail- or institutional-sized, and the number of trades involved in the set. We then proceed to the next trade in the sequence. Once all trades have been checked to be of a given type, we re-examine the sequence from the beginning, looking for the next type of trade. The order of search is first for RPT_15M, then MM_1D, LIFO_60D, and finally, 61-90_NonRP. We proceed in this multi-stage manner (and looking backwards instead of forwards within a step) to be as conservative as possible in matching trades closer together in time. Appendix A describes the trade matching procedure in greater detail.

From the TRACE data we create four variables to measure dealers' roundtrip trades of different lengths of time. The purpose of examining roundtrip trades of different lengths is to separate trades that are very short-term and could more easily qualify for the Volcker rule's market making exemption, trades that are longer duration and that could be more difficult to justify, and trades with a duration beyond the rule's 60-day rebuttal presumption. We describe these variables below.

RPT_15M: Refers to "riskless principal" trades, where the dealer has initiated a position and then closed that position within 15 minutes. Given that corporate bonds generally trade on an infrequent basis, such a short duration trade suggests the dealer had pre-arranged a buyer before executing a trade with a customer, rather than simply trading against order flow as it arrives. Moreover, FINRA delays the public reporting of dealers' trades by 15 minutes from their execution time, so other market participants do not know some dealer has taken a position in that security until after the dealer has already exited that trade. These trades might qualify most easily as market making.

MM_1D: Refers to one-day market making, where a dealer has initiated a position and held it for at least 15 minutes, but closed that position by the end of the same trading day. This is a measure of intraday market making, where a dealer does not have to finance the position as inventory and is acting as a market-maker, but not a broker.

LIFO_60D: Refers to longer-term trades that are presumed to be subject to more substantial regulatory scrutiny under the Volcker rule. These are positions a dealer initiates and holds for longer than one trading day, but less than 60 days. We identify the set of transactions involved in this trade using the LIFO method, similar to Li and Schürhoff (2019). Given the longer time these positions are held in inventory, we find that these are also associated with longer "chains" of trades

than RPT_15M or MM_1D trades, and therefore we treat them as a separate category of trades.

61-90_NonRP: Refers to trades that extend beyond the Volcker rule's rebuttable presumption ("RP") period. In assessing the chains of trades associated with each 61-90_NonRP, we impose the condition stated in the Volcker rule that once the dealer has built up a (either long or short) position, they cannot reduce or offset that position for 60 day with a bond trade in the opposite direction. To be outside the rebuttable presumption period, the notional of the position should not be reduced for 60 days from the point of the *last* trade in the chain that increased the size of the position.

The final sample of all roundtrips trades include 1,835 dealers (unique MP_IDs), 23,438 unique bonds and 5,850 bond issuers. The average (median) dealer has roundtrip trades on 908 (79) unique bonds and 331 (59) issuers.

In Table 1 Panel A, we provide concise descriptions of the four buckets for dealers' roundtrip trades depending on trade duration. Panel B provides summary statistics on time in inventory, number of trades to roundtrip the position and par value for these same four time buckets. Our sample includes over 16.2 million corporate bond trades. Most of these transactions result in risk-less principal trades that are closed out within 15 minutes. Most roundtrip trades, regardless of time to completion, involve a single pair of buy and sell orders with the dealer. Additionally, the mean par value of trade size is much larger for MM_1D and LIFO_60D trades than RPT_15M and 61-90_NonRP trades.

Table 2 offers summary statistics on the observed markups (and their volatility) for these four different buckets of roundtrip trade lengths over the whole sample period, January 2006 to March 2017. Markups are presented at the trade level, and the volatility of markups is tabulated from individual trades at the dealer-security-month level. The data show markups are generally increasing with longer roundtrip trade types, except for 61-90_NonRP trades that have mean markup of 0.394, even lower than RPT_15M mean markups of 0.544. However, the volatility of these markups is monotonically increasing with roundtrip trade length, which makes sense given that there is the inventory risk associated with these positions.

3.2 Bond characteristics and underwriter information

Our analysis also makes use of Mergent's Fixed Income Securities Database (FISD). From Mergent FISD we draw data on a bond's underwriters and the bond's residual maturity, i.e., whether or not it is a new or seasoned corporate bond. For purposes of our analysis, we consider a bond issued in the last 40 days to be a newly issued security (i.e. underwriters of the bond can still claim the underwriting exemption). Bonds more than 40 days past issuance are considered seasoned. As explained earlier, we use this classification of newly issued versus seasoned bonds a covered dealer has underwritten as a lever to assess the unique effects of the Volcker rule.

These data are integrated with regulatory TRACE data to allow us to classify trades into those we would anticipate to be covered by the Volcker rule's underwriting exemption and those that are not. In our sample of roundtrip trades, 2,313,330 are by dealers who are also an underwriter of the traded bond. 133 dealers are underwriters at least once in our sample. In Table 3, we summarize the characteristics of these underwriters. The average underwriter is an underwriter for 226 issuers and 653 bonds. The median number of issuers and bonds per underwriter is 14 and 20, respectively. We also use information on bond characteristics, such as bond type, bankruptcy/reinstated status, notional amount outstanding, and maturity date from Mergent FISD to clean our sample consistent with Adrian, Boyarchenko, and Shachar (2017) and Munyan and Watugala (2019).

3.3 Volcker-covered status of dealers

We use data from the Federal Reserve's National Information Center (NIC) data. We hand-match the MP_ID of 2,720 dealers in supervisory TRACE to their parent institution and their RSSD-ID in the NIC dataset, to determine whether the dealer is affiliated with a bank and thus is a Volcker-covered firm. We conclude that a dealer is Volcker-covered if the dealer is affiliated with a bank holding company on or after April 1, 2014 when the Volcker rule became effective. In supervisory TRACE, we identify 736 dealers as Volcker-covered and 1,984 dealers as not covered by the Volcker rule.

4 Empirical Methodology

We estimate the effect of the Volcker rule on covered dealers' activity using a difference-in-differences analysis. We examine changes to the distribution of the markups of covered dealers' roundtrip trades in the post-Volcker period, focusing on corporate bonds the dealer helped underwrite but which are seasoned and thus no longer benefit from the Volcker rule's underwriting exemption. We also analyze differences in these changes to markup between roundtrip trades of different duration pre- and post-Volcker to explore the effects related to the market making and rebuttal presumption provisions of the rule.

We choose the Volcker rule's effective date (April 1, 2014) in our analysis as the event date for constructing pre- and post-Volcker dummies. Unlike some other banking regulations, such as capital or liquidity standards, there are minimal investor relations benefits to covered firms from achieving early compliance with the Volcker rule.[16] In our analysis, we also test if the effects of the Volcker rule are only transitional by splitting the post-Volcker period into two periods—the 16-month period 4/1/2014–7/31/2015 immediately following the rule's effective date and the later period following this 16-month window—to determine if the rule's effects persist on a longer run basis.

When a dealer is prohibited from proprietary trading under the Volcker rule, taking a position into inventory could be more costly. This is because a Volcker-covered dealer faces the rebuttable presumption that an activity is proprietary trading if it is sold in less than 60 days, meaning additional costs spent justifying a trade to supervisors or even holding the trade on balance sheet for a longer period of time. This potential increase in costs could be reflected in all three key components of a trade: price, quantity, and immediacy. We assume that quantity is wholly customer-driven, and arises as an exogenous shock from a customer's need to trade. We measure price via realized roundtrip markups charged by dealers. Immediacy is impossible to observe, since we do not know when a dealer first receives an order versus when they agree to execute that order. However, at the time of execution, we infer that riskless principal trades provide customers with less immediacy — because the dealer apparently has arranged an offsetting trade with another customer — than MM_1D, LIFO_60D, or 61-90_NonRP trades.

[16] Section 5.5 examines the choice of treatment date.

We look at these four buckets of different lengths of roundtrip trades separately because it is possible there could be less impact on dealers' very short-term trades relative to longer duration trades given the rule's market making exemption. However, to qualify for the market making exemption dealers still need to demonstrate to regulators that the inventory they hold is intended to meet RENTD.

4.1 Identification through the underwriting exemption

We consider several specific provisions of the Volcker rule to both evaluate its effects and also to distinguish the impact of the Volcker rule from other changes in bank regulation. Identification of the effect of the Volcker rule specifically is important to our study because a simple analysis of changes over time is confounded by changes in bank regulation and changes in overall market liquidity that affect all dealers. Figure 2(a) illustrates this point: if we examine average realized markups before and after the Volcker rule, sorted by the time a dealer held the position in inventory, we notice that aggregate markups generally have fallen (especially given most trades are short-term, where the drop in markups is most prominent). However, this observation tells us nothing about the effect of the Volcker rule specifically.

To implement our identification strategy, we first consider the length of dealers' roundtrip trades. We consider this because of the exemption the rule grants to covered dealers' market making and also to isolate the effects of the rule's 60-day rebuttable presumption period. We also anticipate that short-term trades of less than one day would more easily qualify for the rule's market making exemption. Additionally, the length of a dealer trade can be related to whether the bond is held in a dealer's available-for-sale or held-to-maturity portfolios. Thus, the length of a dealer trade can interact with accounting and capital treatments of the security. For these reasons, we bucket a dealer's trades by their length to explore how the rule's provisions may differ across roundtrip trades of different lengths. Importantly, the length of the trade alone is not a valid instrument for identifying Volcker effects because of the differences in accounting and capital treatments of available-for-sale and held-to-maturity securities alluded to above.

Rather, the key to our identification is the underwriting exemption to the Volcker rule. This allows us to disentangle the effects of the Volcker rule as distinct from other changes in bank regulation during this period. Specifically, we consider whether the bond involved in roundtrip

trades of different lengths is newly issued and the dealer is part of the underwriting group. When both conditions apply, the dealer is "untreated" by the Volcker rule for that particular bond, even if they are a Volcker-covered dealer and the rule is already in effect. In this manner, we can look at the impact of switching on and off the Volcker rule *within* an individual covered dealer as well as *within* a particular bond. This approach allows us to control for any other contemporaneous effects on the dealer (because the dealer is trading in bonds they underwrite as well as bonds they do not underwrite) or to the bond (because the bond is traded both by underwriters as well as non-underwriters).

4.2 Baseline specification

We estimate the following roundtrip trade level panel regression for each of the four durations of trades (RPT_15M, MM_1D, LIFO_60D, or 61-90_NonRP trades):

$$\begin{aligned} Markup_{j,d,b,t} = {} & \beta_1 PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ & + [\text{lower order interactions}] \\ & + \delta_t + \theta_i + \gamma Controls_{j,d,b,t} + \epsilon_{d,b,j,t}. \end{aligned} \tag{1}$$

where $Markup_{j,d,b,t}$ is the markup made by dealer d on roundtrip trade (RT) j initiated at time t. This regression specification is at the roundtrip trade level. $PostVolcker_t$ is 1 if t is on or after the Volcker rule's effective date of April 2014, 0 otherwise. $VolckerCovered_d$ is 1 if dealer d is a firm that is covered by the Volcker rule, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond b that is being traded in roundtrip trade j was first issued within 40 days before t, 0 otherwise. We analyze specifications with and without fixed effects. The issuer fixed effects (θ_i) control for unobservable, time-invariant characteristics at the bond issuer-level. We include monthly fixed effects (δ_t) to account for common shocks that may affect all trades within a particular month. $Controls_{d,b,j,t}$ is a vector of controls including macroeconomic shocks (in the specifications without time fixed effects), bond characteristics, and roundtrip trade characteristics (chain length, notional, and weighted time in inventory). β and γ are regression coefficients. If Volcker-exempt trades have lower cost relatively to trades subject to increased regulatory scrutiny by the Volcker rule, β_1 should be negative and significant.

We estimate the following dealer-security-month level panel regression for each of the four durations of trades (RPT_15M, MM_1D, LIFO_60D, or 61-90_NonRP trades):

$$\begin{aligned} MarkupVolatility_{d,b,t} = \beta_1 PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ + [\text{lower order interactions}] \\ + \delta_t + \theta_i + \gamma Controls_{d,b,t} + \epsilon_{d,b,j,t}. \end{aligned} \tag{2}$$

Unlike the baseline specification, which is a roundtrip trade-level regression, this specification is at a dealer-security-month aggregation. The dependent variable, $MarkupVolatility_{d,b,t}$, is the standard deviation of the markup on all roundtrip trades on bond b completed by dealer d in month t. The independent variables are as described for Eq. (1), with the bond and roundtrip trade characteristics in $Controls_{d,b,t}$ averaged across all the roundtrip trades by a dealer in a particular bond within the month. If Volcker-exempt trades have lower volatility in markups relatively to trades subject to increased regulatory scrutiny by the Volcker rule, β_1 should be negative and significant. We present the results from these regressions in section 5.

4.3 Disentangling transitory versus permanent effects

Another topic of interest in considering regulatory impacts is whether any observed intended and unintended effects associated with a regulation are transitional or more permanent in nature. In a subsequent part of the analysis, we consider this question by separating out the $PostVolcker_t$ dummy into two periods: (1) $TransitionPeriod_t$, which is 1 if the start of a roundtrip trade is between April 2014 and July 2015, 0 otherwise and (2) $LaterPeriod_t$, which is 1 if the start of the trade is in August 2015 or later, 0 otherwise. We modify the set of interaction terms in the baseline regression specifications in (1) and (2) with the two separate time dummies for the post-Volcker

period as follows,

$$\begin{aligned} Markup_{j,d,b,t} = {} & \beta_1 LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ & + \beta_2 TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ & + [\text{lower order interactions}] \\ & + \delta_t + \theta_i + \gamma Controls_{j,d,b,t} + \epsilon_{d,b,j,t}, \end{aligned} \tag{3}$$

$$\begin{aligned} MarkupVolatility_{d,b,t} = {} & \beta_1 LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ & + \beta_2 TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{d,i,t} \\ & + [\text{lower order interactions}] \\ & + \delta_t + \theta_i + \gamma Controls_{d,b,t} + \epsilon_{d,b,t}. \end{aligned} \tag{4}$$

This allows us to disentangle any differential impact from the Volcker rule during the 16-month period immediately following its implementation from its longer-run, steady state effects. If the effects on the mean markup and standard deviation of markups identified through the baseline regression specification are driven by the transitional period following the rule's effective date, β_1 will be insignificant, while β_2 will be significant. We discuss the results from these regressions in the next section.

5 Results

5.1 Effects on Liquidity / Dealer Markup

We test whether the Volcker rule had an unintended effect on corporate bond market liquidity by looking at covered dealers' realized markups on roundtrip trades of different lengths. We conduct our test at the individual roundtrip trade level. For each roundtrip trade by each dealer, we record whether the trade was initiated during the new-issue versus seasoned period of the bond, and whether it occurred before or after the Volcker rule.

As the 4-way interaction coefficients in columns (1) and (2) of Table 5 show, dealer markups have increased by 42 to 43 basis points for roundtrip trades of 15 minutes or less following the effective date of the Volcker rule. This is both highly statistically significant as well as economically quite

large. The unconditional mean realized bid-ask spread we observe for RPT_15M trades is 54 basis points. Panel A reports results using month-year fixed effects, Panel B reports the same tests using a set of macro control variables[17].

However, when we divide our time series to include a transition period 4/1/2014–7/31/2015[18] versus a post-conformance period starting 8/1/2015, as shown in columnts (1) and (2) of Table 7 Panels A and B, we find that these effects are entirely transitional. The transition period coefficient rises modestly to 44-46 bps and is significant, but declines to 14-19 bps in the later period and lose its statistical significance.

We find a sizable and persistent effect for trades concluded within more than 15 minutes but less than a day. Columns (3) and (4) of Tables 5 show that across the whole sample, markups on these trades rose 27-43bps under the Volcker rule. Those same columns in Table 7 show a 27-43bps effect in the transition period, and an 18-35bps effect that remains statistically significant in the later period.

Trades held in inventory overnight for 1-60 days do not seem to result in different realized markups for dealers affected by the Volcker rule, regardless of whether we consider the post-Volcker period in whole or with a transition period. The 4-way interaction coefficients in columns (5) and (6) of Tables 5 and 7 Panels A and B are not statistically significantly different from 0, with point estimates ranging from -7 to 35bps. On trades held longer than 60 days in inventory, are results in Table 11 are insignificant. This could be due to the difficulty in passing costs on to customers over a longer period of time versus with pre-arranged or short-term trades.

In columns (7) and (8) of Table 5 we report the results from our test of the 60-day cutoff of the Volcker rule's rebuttable presumption on proprietary trading. We find a sizable 8-14% effect from the Volcker rule on dealer's realized markups for these types of trades. In principle, this is consistent with skilled dealers conducting profitable proprietary trades and holding them past the 60-day rebuttable presumption period to avoid the Volcker rule. However, we emphasize the limitations of our identification methodology with respect to this particular question: we rely on trades held for longer than 60 days, by Volcker-covered and non-Volcker covered dealers who are underwriters and non-underwriters, both during the new-issue period of a bond and its seasoned

[17]Our macro controls are the level and change of the VIX and the 3-month Libor, the Barclays Investment Grade and High Yield index levels and returns, and the total return on the S&P 500 index.

[18]The conformance period for the Volcker rule ended that month, on 7/21/2015.

period. When we attempt to split our test on a transitional vs later period, we simply don't have enough observations to estimate the 4-way interaction for both sub-periods (which is why we do not report a column (7) or (8) in Table 7). We are therefore cautious in interpreting this result as definitive proof of continued prop trading, due to the inherent small-sample issues of this particular question.

5.2 Effects on Dealer Risk-taking / Volatility of Returns

A stated purpose of the Volcker rule is to reduce dealer risk-taking. We measure dealer risk-taking by looking at the volatility of dealer profits at the bond-month level. It is important to note that we face the same caveat in using this measure as many Value-at-Risk models of mortgage-related securities faced before the crisis—tail risks are difficult to assess in normal times, and if anything the volatility of returns can understate the severity of losses during times of market stress.

Table 6 present the results of this regression for three of the four roundtrip trade lengths (we have insufficient sample to test the monthly volatility of trades held 61-90 days). We find a significant increase in our measure of dealer trading risk attributable to the Volcker rule in roundtrip trades of 15 minutes or less, but not other types of trades. Specifically, the results suggest the standard deviation of covered dealers' markups on roundtrip trades of 15 minutes or less has increased by 0.09 to .10.

However, when we separate before and after the rule's full implementation date of July 2015 in columns (1) and(2) of Table 7 Panels C and D, we find this increase in volatility only consistently occurs during the later period (when our estimate of markup effects in Panels A and B was statistically insignificant). This suggests to us that dealers have become more varied in the pricing they offer customers on these short-term (likely pre-arranged) trades in our later sample 8/1/2015-3/31/2017, though dealers aren't charging more on average due to the Volcker rule[19].

We do note that there is a small increase of .08-.09 in dealer markup volatility for trades completed within 15 minutes when we include the full sample starting January 2006, reported in column (1) of Panels C and D of Table 7, significant at the 10% level. There is also a sizable decrease of .40 in dealer markup volatility for trades held in inventory for 1-60 days when we include

[19]Because our data identifies dealers but not individual customers, we are unable to test whether this increased volatility is due to dealers exercising greater price discrimination across different customers, or some other reason.

full sample, reported in column (3) of Panels C and D, significant at the 10% level. However, this reduction volatility is short-lived—it becomes insignificant and reverses sign during the later period.

Due to an insufficient sample size, we are unable to estimate volatility effects on trades held 15 minutes to 1 day and 60-90 days when we test a transitional versus permanent effect of the Volcker rule, which is why those coefficients are not reported in Panels C and D of Table 7.

The results in Tables 6 strike us as noteworthy. There are two possible interpretations of these findings of higher volatility on riskless principal trades and limited evidence of changes in the volatility of longer duration trades. First, that the Volcker rule may not have achieved its intended objective of reducing covered firms' risk-taking. An alternative explanation is that there was limited risky trading in corporate bonds by covered firms prior to the rule's introduction and the Volcker rule preserves the status quo in this regard. Instead, the increased costs of complying with the Volcker rule might be passed on unevenly to different customers of the dealer—some of whom now trade at a wider spread to recoup the covered dealer's higher compliance costs, while others trade at a relatively narrower spread, thereby creating higher volatility of dealer markups for some trade types.

5.3 Analysis of Duration of Round-trip Trades

It is possible that the decision to take a trade into inventory versus making a riskless principal trade is itself an endogenous response to the Volcker rule. Thus far, we have considered the effect of the Volcker rule on dealer markups separately for each trade type (RPT_15M, MM_1D, LIFO_60D, or 61-90_NonRP), because we recognize that the realized markups may be different for longer versus shorter-term or pre-arranged trades (e.g. search costs versus fundamental asset risk).

However, if dealers are pre-arranging more trades in response to the Volcker rule, it is possible that we are merely detecting an endogenous selection effect: trades which are costlier to execute and would have been held in dealer inventory before the rule are now being executed as pre-arranged trades. In other words, the cost of executing a particular trade may not have changed due to Volcker, but certain high-cost trades may have selected into shorter time-in-inventory groups (i.e. <15Min, 15Min-1Day) due to Volcker, generating an artificially higher coefficient in those subsample regressions.

Notably, Schultz (2017) finds that in the cross-section, dealers seek to pre-arrange trades more

and avoid holding positions overnight during the Volcker rule conformance period (April 2014–December 2014). Looking among bank-affiliated dealers, Bao, O'Hara, and Zhou (2018) find that the proportion of trades conducted on a riskless-principal (pre-arranged) basis has increased after the Volcker rule. Both papers attribute this change in dealers' inventory decision to the Volcker rule.

For this reason, we apply our identification approach to an analysis of a dealer's decision to hold a position in inventory. Our dependent variable is now the fraction of roundtrip trades a dealer concludes in a bond-month which are not held in inventory overnight. We test that fraction on both an equal weighted and a value-weighted basis.[20] The dependent variables in these regressions are defined as,

$$RatioNumTrades1Day_{d,b,t} = \frac{1}{N_d}\sum_{j=1}^{N_d} I^{(\text{All transactions in j within same day})}, \tag{5}$$

$$RatioDollarVolume1Day_{d,b,t} = \frac{\sum_{j=1}^{N_d} Dollar\_Volume_{j,d,b,t} \times I^{(\text{All transactions in j within same day})}}{\sum_{j=1}^{N_d} Dollar\_Volume_{j,d,b,t}}, \tag{6}$$

$$RatioAvgTradeSize1Dayy_{d,b,t} = \frac{\sum_{j=1}^{N_d} Avg\_Trade\_Size_{j,d,b,t} \times I^{(\text{All transactions in j within same day})}}{\sum_{j=1}^{N_d} Avg\_Trade\_Size_{j,d,b,t}}. \tag{7}$$

where N is all the roundtrip trades initiated by dealer d in bond b in month t. Table 8 reports our findings.

If the Volcker rule (and not other contemporaneous effects) caused affected dealers to shorten their inventory holding periods, we would expect a positive and significant coefficient on our 4-way differenced term. As we report in Panel B of Table 8, we too observe a statistically significant increase in short-term non-inventory trades in the period following the Volcker rule's effective date, consistent with Schultz (2017) and Bao, O'Hara, and Zhou (2018). However, using our specification with the underwriting lever, we find no effect of the Volcker rule on a covered dealer's decision to hold a bond position overnight in inventory, as shown by the 4-way differenced term in Table 8.

[20] Trades which are held for either less than 1 day or more than 60 days may be easier to satisfy Volcker compliance, due to either market making RENTD or the rebuttable presumption, respectively. Therefore, the time-in-inventory decision is non-monotonic and we cannot use an ordered probit model specification.

Therefore, endogenous selection of time in inventory does not seem to be driving our results.

5.4 Changes to Market Share

We further seek to understand how the corporate bond market structure has been affected by the Volcker rule. Other papers such as Bessembinder, Jacobsen, Maxwell, and Venkataraman (2018) have shown evidence that bank-affiliated dealers are committing less balance-sheet capital to supporting market liquidity, and are in fact losing market share to non-bank affiliated dealers. This is an important concern for policymakers, becaues non-bank dealers may not have access to the same emergency liquidity support as bank-affiliated dealers during a crisis.

Market share is defined as the proportion of dollar volume in a bond's trading done by dealer d in bond b during month t:

$$MktShare_{d,b,t} = \frac{\sum_{j=1}^{N_d} Dollar\_Volume_{j,d,b,t}}{\sum_{d=1}^{K}\sum_{j=1}^{N_d} Dollar\_Volume_{j,d,b,t}}, \tag{8}$$

We note that dealer-to-dealer trades can result in the denominator ($\sum_{d=1}^{K}\sum_{j=1}^{N_d} Dollar\_Volume_{j,d,b,t}$) being greater than the total dollar volume which occurs during a month. This choice of measure is intentional to focus on the market share of dealers relative to other dealers, not relative to customers. For example, if 100% of the trading in a bond occurs only between dealer A and dealer B, the denominator will equal 200% of the actual value exchanged between A and B, and dealers A and B will each have 50% market share. If 50% of the trading occurs between dealer A and dealer B, and the remaining 50% of trading occurs between dealer A and customer C, our denominator will be 150% of the actual value exchanged, and dealer A will have 66.7% market share, dealer B will have 33.3% market share.

Table 9 shows the key coefficient estimates from our 4-way differencing methodology on our measure of dealer market share.[21] In Panel A, we find a coefficient of .05 to .06, which is significant at the 10% level, meaning dealers covered by the Volcker rule experienced a *decrease* in market share due to the rule.

[21] Lower-order interaction terms are included in the regresion, but not presented for sake of brevity and will be available in an online appendix.

When we examine in Panel B the effects of the Volcker rule during the conformance period versus after the conformance period ended in July 2015, we find that the effect is entirely captured by the later period. During the transition period, our coefficient is positive but insignificant, but during the later period, our coefficient is larger than in panel A (.14 instead of .05) and now statistically significant at the 1% level. The loss of bank-affiliated dealer market share does not appear to be a temporary reaction to the rule, but instead non-bank dealers are likely to be permanently displacing covered dealers due to the Volcker rule.

5.5 Evidence Supportive of Parallel Trends Assumption/Alternative Specification: Event Study

We test the validity of our empirical approach by using half-year sub-periods to search for a trend in liquidity costs before and after the Volcker rule effective date, in an event-study framework. We find no evidence of an upward trend in liquidity costs of bank-affiliated dealer underwriters in seasoned bonds before the April 2014 treatment date, instead the trend has mixed significance across coefficients, and the trend is downward rather than upwards. We note that controlling for this pre-trend by adding a parametric time trend (as in Autor (2003)) would actually increase the size of our results.

6 Conclusion

We use the underwriting exemption of the Volcker rule combined with the regulatory TRACE dataset to identify the Volcker rule's impact on bank holding company affiliated dealers' trading in the corporate bond market. This identification strategy separates out the effects of market liquidity and other contemporaneous changes in financial regulation. Using regulatory data on secondary market transactions in corporate bonds, we classify roundtrip trades of different durations completed by all dealers, both covered by the Volcker rule and not, and those who have underwritten the bond and those who have not. If a bond has been issued more than 40 days prior we consider it "seasoned" and outside the period when the rule's underwriting exemption applies, and therefore subject to increased regulatory scrutiny. These multiple dimensions of variation allow for a difference-in-differences analysis that better identifies the intended and unintended consequences

of the Volcker rule on corporate bond trading.

A reduction of the riskiness of covered dealer trades in this market was one of the intended effects of the Volcker rule. The analysis of the volatility of trade markups suggest no evidence of such a reduction and in fact, we find an increase in volatility for riskless principal trades. We find that markups have significantly increased for trades by covered dealers, even after controlling for other contemporaneous effects. This increase in costs of 20 to 45 basis points per roundtrip trade represents a statistically and economically significant change in corporate bond market liquidity. After controlling for the 16-month transition period immediately following the implementation of the rule, we find these effects to be persistent. We further find that covered dealers are losing corporate bond market share to non-bank dealers as a result of the Volcker rule.

The duration of a roundtrip trade may influence the difficulty in demonstrating compliance with the rule's market marking exemption or whether the trade falls outside the rebuttable presumption period. However, we find no evidence that covered dealers are changing the duration of their trades as a result of the Volcker rule.

In this paper, we analyze specific aspects of the Volcker rule's impact on corporate bond trading. The rule's intended effects were particularly targeted towards bank affiliated dealer risk-taking that may affect financial stability and the need for government-funded bailouts during a crisis. This paper suggests that the rule in its current form is not reducing dealer risk-taking in corporate bonds and may be increasing the spreads charged by covered dealers. The results of this study, however, cannot be extrapolated to the effects of the rule on trading in other asset classes.

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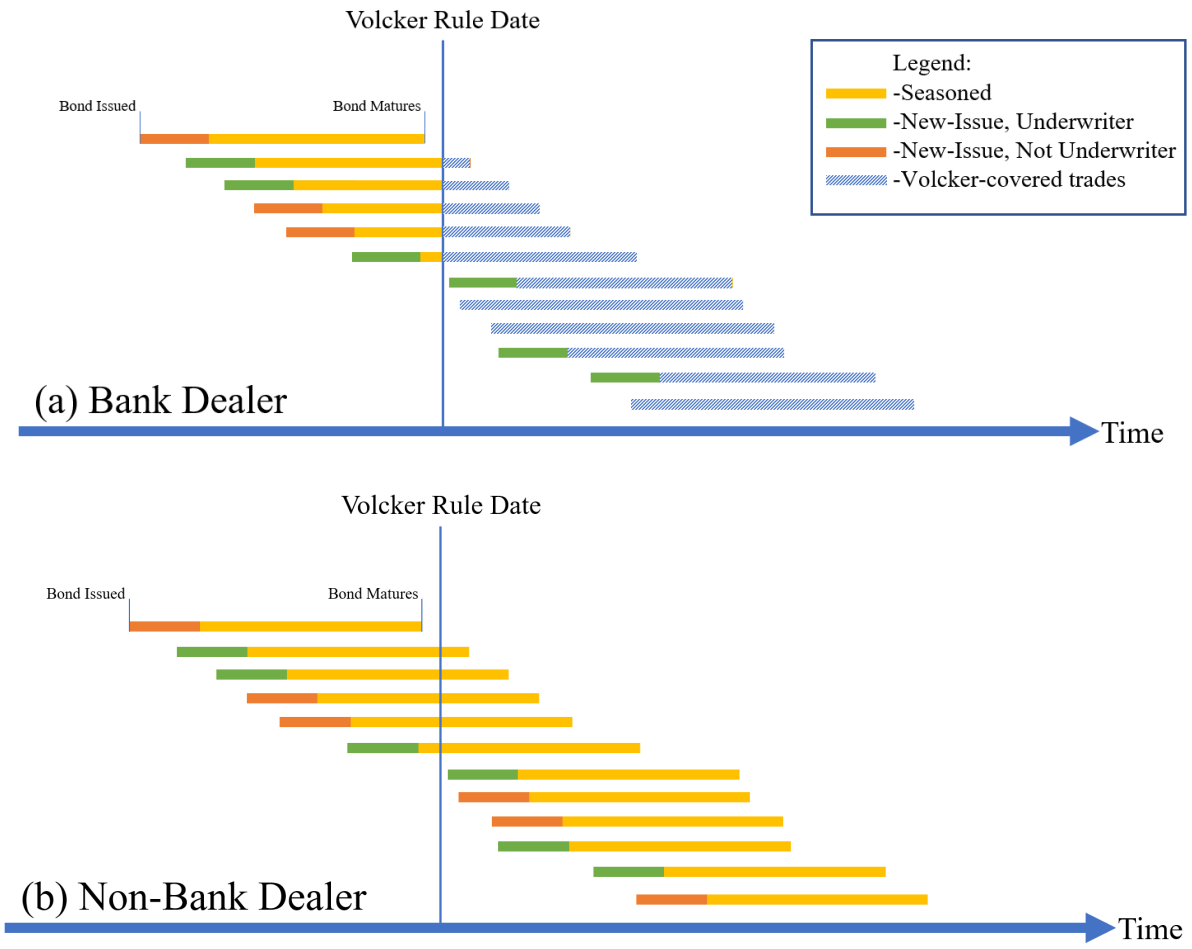
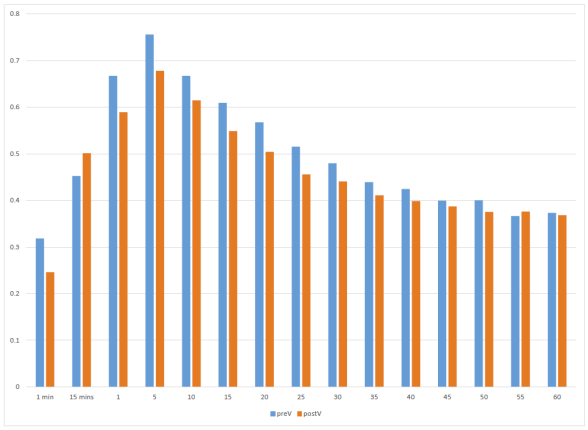
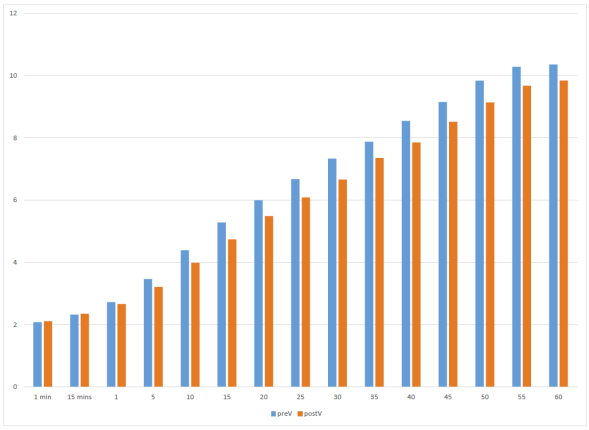


Figure 1: Identification strategy using difference-in-differences

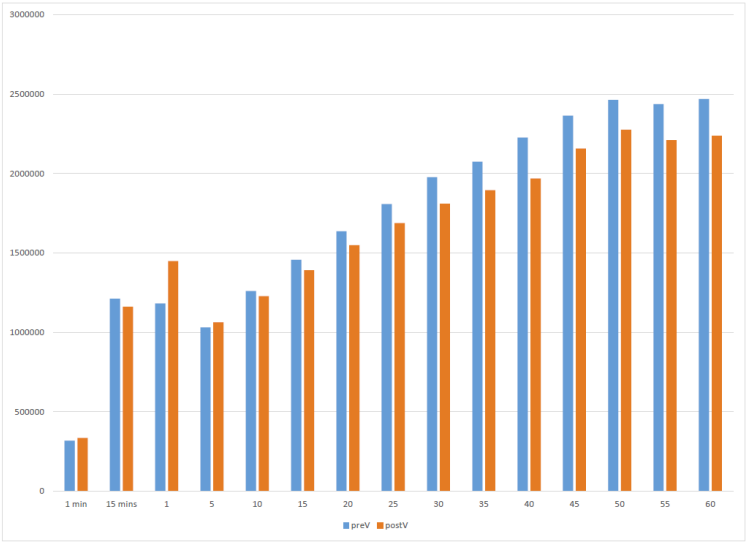
Figure (a) shows how the Volcker rule and the underwriter exemption affects an individual bank-affiliated dealer. The horizontal axis represents time. Each horizontal bar represents the life of an individual corporate bond, and bonds are ordered by their issuance date in descending order vertically. The first 40 days we call the "New-Issue" period of the bond's life, and we color that leftmost portion of the bar green or red, depending on whether that dealer was part of the underwriting group for that bond or not, respectively. The rest of the bar is colored yellow to reflect the bond's seasoned state. A vertical line denotes the Volcker rule's start date. After this date, any trade by this dealer in a bond are subject to the Volcker rule's trading restrictions (shown by the blue hash pattern). The one exception to the Volcker rule is for trades by this dealer in a newly-issued bond for which this individual dealer was part of the underwriting group (the underwriting exemption), which are denoted still in green. Figure (b) shows the same arrangement of bonds, but assuming this dealer was instead not affiliated with a bank. Coloring is the same, but now after the Volcker rule date, this dealer still does not have any trades subject to the Volcker rule's restrictions.



(a) Average markup of roundtrip trades



(b) Chain Length



(c) Par Value of Trades

Figure 2: Average markup, chain length, and par value of roundtrip trades by trade duration.

The "preV" series (blue) is for the period from January 2010 to March 2014. The "postV" series (red) is for the period from April 2014 to March 2017. The trade duration on the x-axis shows *days* in inventory, except the first two points which are for roundtrip trades completed with 1 minute and 15 minutes.
Source: TRACE, authors' calculations

Table 1: Summary of roundtrip trades

Panel A: Roundtrip trade type description

Roundtrip trade type	Duration
RPT_15M	<15 minutes
MM_1D	Between 15 minutes to 1 day
LIFO_60D	Between 1 to 60 days
61-90_NonRP	Between 61 to 90 days

Panel B: Roundtrip trade characteristics by trade type.

Roundtrip	Time in inventory (minutes)			Chain length (num. trades)			Par value (US$)		
trade type	Mean	Median	Std dev.	Mean	Median	Std dev.	Mean	Median	Std dev.
RPT_15M	1	0	2.49	2.15	2	1.71	583,386.10	31,297.00	1,901,065.00
MM_1D	104.71	64.1	102.99	2.71	2	3.47	1,284,870.89	111,679.88	3,163,314.85
LIFO_60D	19,469.26	10,176.41	21,120.25	5.15	3	8.01	1,456,922.70	110,197.30	3,986,516.76
61-90_NonRP	102,754.63	100,752.98	12,349.99	2.55	2	2.05	422,279.90	25,110.31	1,394,301.84

Panel C: Number of trades by roundtrip trade type.

Roundtrip	All Dates		Pre-Volcker		Post-Volcker	
trade type	N	% of total	N	% of total	N	% of total
RPT_15M	10,807,992	66.55%	7,952,322	66.81%	2,855,670	65.77%
MM_1D	1,798,562	11.08%	1,338,945	11.25%	459,617	10.58%
LIFO_60D	3,467,268	21.35%	2,493,267	20.96%	974,001	22.43%
61-90_NonRP	165,762	1.02%	112,846	0.95%	52,916	1.22%
All	16,239,584	100%	11,897,380	100%	4,342,204	100%

Source: TRACE, authors' calculations

Table 2: Summary statistics of roundtrip trade markups and markup volatility

Roundtrip trade type	RT Markup (price points)				RT Markup volatility (monthly by dealer and security)			
	N	Mean	Median	Std dev.	N	Mean	Median	Std dev.
RPT_15M	10,807,992	0.544	0.214	0.711	1,714,481	0.203	0.054	0.342
MM_1D	1,798,562	0.676	0.302	1.036	251,761	0.351	0.154	0.577
LIFO_60D	3,467,268	0.731	0.436	2.433	551,357	0.948	0.469	1.758
61-90_NonRP	165,762	0.394	0.27	6.618	12,807	1.345	0.591	2.715

Source: TRACE, authors' calculations

Table 3: Summary statistics of bond underwriters

	Number of underwriters	Number of issuers underwritten			Number of bonds underwritten			Bonds underwritten per issuer		
		Mean	Median	Std dev.	Mean	Median	Std dev.	Mean	Median	Std dev.
All	133	225.842	14	478.56	652.827	20	1591.836	2.891	2	3.506
Pre-Volcker	123	213.244	12	445.217	574.797	18	1348.967	2.695	2	3.039
Post-Volcker	100	156.29	12	325.077	393.78	16.5	932.066	2.52	1	2.879

Source: TRACE, Mergent, authors' calculations

Table 4: Variable Definitions

This table presents definitions of the variables used in the regressions. The first column gives the variable name. The second column includes a short description. The last column gives the source of the raw data used to construct the variable. Further descriptions of these variables are given in section 3.

Variable Name	Description	Source
$PostVolcker_t$	Indicator with value 1 on or after April 2014, 0 otherwise	See section 2.2
$VolckerCovered_d$	Indicator with value 1 if dealer d is a firm that is covered by the Volcker rule, 0 otherwise	National Information Center (NIC)
$Underwriter_{b,d}$	Indicator with value 1 if the dealer d is an underwriter of the bond b, 0 otherwise	Mergent FISD
$NewIssue_{b,t}$	Indicator with value 1 if the age of the bond b is 40 days or less, 0 otherwise	Mergent FISD
$Seasoned_{b,t}$	$-NewIssue_{b,t}$	Mergent FISD
$TransitionPeriod_t$	Indicator with value 1 between April 2014 and September 2015 inclusive, 0 otherwise	See section 4.3
$LaterPeriod_t$	Indicator with value 1 after September 2015, 0 otherwise	See section 4.3
$Chain\_Length_{j,d,b,t}$	Number of transactions in roundtrip trade j	TRACE
$Time\_in\_Inventory_{j,d,b,t}$	Time (in minutes) elapsed between the first and last trade in roundtrip trade j	TRACE
$Wgtd\_Time\_in\_Inventory_{j,d,b,t}$	Time (in minutes) elapsed weighted by the inventory remaining in the round-trip trade at each transaction step	TRACE
$Notional\_Volume_{j,d,b,t}$	Total notional (par value) of all bonds bought or sold in a round-trip trade.	TRACE
$Dollar\_Volume_{j,d,b,t}$	Half of the total traded price-weighted notional (par value) of all bonds bought and sold in a round-trip trade (in US dollar millions).	TRACE
$Pct\_Notional\_Large\_Trades_{j,d,b,t}$	Percentage of the total notional of a round-trip trade (bought and sold) which was a part of trades of par value $>$ \$100,000.	TRACE
$Avg\_Trade\_Size_{j,d,b,t}$	Total notional of a round-trip trade (bought and sold) divided by its chain length.	TRACE
$Bond\_Index\_Return_{j,t}$	Return on the Dow Jones U.S. IG Corporate Bond Index over the duration of roundtrip trade j	Haver Analytics, TRACE
$Ln(BondAge)_{b,t}$	Log of the bond's age in days	Mergent FISD
$Ln(TimeToMaturity)_{b,t}$	Log of the bond's time to maturity in days	Mergent FISD
$Ln(AmountOutstanding)_{b,t}$	Log of the bond's dollar notional amount outstanding	Mergent FISD
$HY_{b,t}$	Indicator with value 1 if a bond's rating is high yield, 0 otherwise	Mergent FISD
VIX_t	Level of the VIX Index	Haver Analytics
$LIBOR\_TBill3M_t$	TED Spread	Haver Analytics
$BarclaysIG_t$	Level of the Barclays US IG Corporate Bond Index	Haver Analytics
$BarclaysHY_t$	Level of the Barclays US HY Corporate Bond Index	Haver Analytics
$SP500\_Ret_t$	Monthly return of the S&P 500 total return index	Haver Analytics
ΔVIX_t	Change in the VIX Index	Haver Analytics
$\Delta LIBOR_t$	Change in the 3-month LIBOR rate	Haver Analytics
$BarclaysIG\_Ret_t$	Return on the Barclays US IG Corporate Bond Index	Haver Analytics
$BarclaysHY\_Ret_t$	Return on the Barclays US HY Corporate Bond Index	Haver Analytics

Table 5: Regressions on the dealer markups on roundtrip trades

This table reports the coefficient estimate and standard errors of the panel regressions with the specification in Eq. (1) where the dependent variable is the dealer markup on a roundtrip trade. The headers in first row indicate the duration of the roundtrip trades in the regression. Alternating regressions are on the entire sample period from January 2006 to March 2017 or for the post-GFC period from January 2010 to March 2017 ("$\geq$ Jan 2010"). $PostVolcker_t$ is 1 if the start of the trade is on or after April 2014, 0 otherwise. $VolckerCovered_d$ is 1 if the dealer is a firm that is bank-holding company and covered by the Volcker Rule, 0 otherwise. $Underwriter_{b,d}$ is 1 if the dealer firm is an underwriter for the bond, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond being traded was first issued less than 40 days ago, 0 if the first issue date is more than 40 days. All regressions include the necessary lower-order interactions. Panel A presents results with month fixed effects, while Panel B presents results with macroeconomic controls. All regressions include trade controls, bond controls, and issuer fixed effects. Table 4 summarizes the description of all independent variables. Standard errors are clustered by issuer and month. The significance of the coefficient estimate is indicated by * for $p < 0.10$, ** for $p < 0.05$, and *** for $p < 0.01$.

Panel A: Regressions with trade and bond controls, issuer fixed effects, and month fixed effects.

	<15 Minutes		15Min-1Day		1-60 Days		61-90 Days	
		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$VolckerCovered_d$	0.090***	0.141***	-0.062***	-0.013	0.040	0.165***	0.243***	0.401***
	(0.010)	(0.008)	(0.015)	(0.014)	(0.024)	(0.016)	(0.079)	(0.092)
$Underwriter_{b,d}$	0.500***	0.507***	0.290**	0.420**	0.061	0.224	-0.959	-1.805
	(0.138)	(0.188)	(0.119)	(0.186)	(0.125)	(0.162)	(0.891)	(1.115)
$NewIssue_{b,t}$	-0.019	-0.002	0.007	0.032*	0.085***	0.159***	0.011	0.082
	(0.012)	(0.013)	(0.020)	(0.018)	(0.031)	(0.024)	(0.260)	(0.332)
$VolckerCovered_d \times NewIssue_{b,t}$	0.004	-0.000	0.065***	0.033**	-0.008	-0.096***	-0.200	-0.317
	(0.010)	(0.012)	(0.015)	(0.014)	(0.026)	(0.019)	(0.251)	(0.302)
$VolckerCovered_d \times Underwriter_{b,d}$	-0.367***	-0.367*	-0.329***	-0.499***	-0.134	-0.365**	1.026	1.814
	(0.138)	(0.189)	(0.119)	(0.185)	(0.128)	(0.161)	(0.895)	(1.122)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.431***	-0.437***	-0.345***	-0.423**	-0.124	-0.182	-3.057	0.708
	(0.103)	(0.156)	(0.100)	(0.161)	(0.120)	(0.170)	(2.629)	(1.825)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.494***	0.502***	0.364***	0.479***	0.197	0.329*	2.925	-0.772
	(0.104)	(0.158)	(0.099)	(0.159)	(0.123)	(0.170)	(2.581)	(1.826)
$PostVolcker_t \times VolckerCovered_d$	0.010	-0.041***	0.036*	-0.018	0.129***	-0.006	-0.222	-0.358
	(0.012)	(0.011)	(0.019)	(0.017)	(0.030)	(0.022)	(0.272)	(0.271)
$PostVolcker_t \times Underwriter_{b,d}$	-0.363***	-0.372**	-0.321***	-0.461***	-0.262	-0.455**	0.857	1.677
	(0.129)	(0.175)	(0.110)	(0.170)	(0.172)	(0.198)	(1.308)	(1.494)
$PostVolcker_t \times NewIssue_{b,t}$	0.043***	-0.003	0.097***	0.023	0.247***	0.087**	-0.107	-0.200
	(0.014)	(0.011)	(0.027)	(0.021)	(0.053)	(0.038)	(0.392)	(0.441)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.332**	0.335*	0.300***	0.470***	0.214	0.454**	-0.975	-1.733
	(0.130)	(0.177)	(0.111)	(0.170)	(0.171)	(0.195)	(1.329)	(1.514)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.041***	-0.035**	-0.041**	-0.006	-0.108***	-0.024	0.299	0.365
	(0.013)	(0.014)	(0.018)	(0.017)	(0.034)	(0.029)	(0.449)	(0.500)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.337***	0.349**	0.330***	0.430***	0.089	0.181	13.317***	9.238***
	(0.114)	(0.160)	(0.105)	(0.159)	(0.193)	(0.228)	(2.782)	(1.961)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.420***	-0.434***	-0.304***	-0.436***	-0.035	-0.187	-12.854***	-8.876***
	(0.116)	(0.164)	(0.104)	(0.157)	(0.190)	(0.223)	(2.834)	(2.011)
Observations	10,564,104	7,415,770	1,762,764	1,230,896	3,398,596	2,471,581	162,386	120,587
R-squared	0.217	0.226	0.254	0.265	0.080	0.076	0.060	0.077
Month FE	Y	Y	Y	Y	Y	Y	Y	Y
Issuer FE	Y	Y	Y	Y	Y	Y	Y	Y
Macro Controls	N	N	N	N	N	N	N	N
Trade Controls	Y	Y	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Panel B: Regressions with trade and bond controls, macroeconomic controls, and issuer fixed effects.

	<15 Minutes		15Min-1Day		1-60 Days		61-90 Days	
		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$PostVolcker_t$	0.086***	0.080***	0.126***	0.108***	0.117***	0.075***	0.817**	0.955***
	(0.018)	(0.015)	(0.029)	(0.025)	(0.040)	(0.028)	(0.331)	(0.283)
$VolckerCovered_d$	0.089***	0.141***	-0.064***	-0.012	0.040	0.165***	0.266***	0.385***
	(0.009)	(0.008)	(0.015)	(0.014)	(0.024)	(0.016)	(0.079)	(0.092)
$Underwriter_{b,d}$	0.496***	0.503***	0.278**	0.420**	0.054	0.223	-1.080	-1.924*
	(0.138)	(0.189)	(0.121)	(0.185)	(0.125)	(0.160)	(0.884)	(1.120)
$NewIssue_{b,t}$	-0.006	-0.001	0.022	0.035**	0.097***	0.158***	-0.050	0.076
	(0.012)	(0.013)	(0.020)	(0.017)	(0.031)	(0.024)	(0.255)	(0.319)
$VolckerCovered_d \times Underwriter_{b,d}$	-0.361**	-0.362*	-0.318***	-0.502***	-0.124	-0.364**	1.146	1.948*
	(0.139)	(0.190)	(0.121)	(0.185)	(0.128)	(0.159)	(0.891)	(1.128)
$VolckerCovered_d \times NewIssue_{b,t}$	0.004	0.000	0.063***	0.033**	-0.010	-0.096***	-0.230	-0.320
	(0.010)	(0.012)	(0.015)	(0.014)	(0.025)	(0.019)	(0.246)	(0.293)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.439***	-0.440***	-0.336***	-0.417**	-0.121	-0.174	-3.182	0.502
	(0.103)	(0.155)	(0.102)	(0.160)	(0.120)	(0.168)	(2.584)	(1.725)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.504***	0.504***	0.355***	0.472***	0.192	0.317*	3.047	-0.539
	(0.104)	(0.157)	(0.101)	(0.159)	(0.124)	(0.168)	(2.534)	(1.721)
$PostVolcker_t \times VolckerCovered_d$	0.010	-0.041***	0.040**	-0.017	0.126***	-0.008	-0.226	-0.331
	(0.012)	(0.011)	(0.019)	(0.017)	(0.030)	(0.022)	(0.272)	(0.269)
$PostVolcker_t \times Underwriter_{b,d}$	-0.370***	-0.372**	-0.326***	-0.468***	-0.266	-0.450**	0.812	1.747
	(0.130)	(0.176)	(0.112)	(0.170)	(0.171)	(0.196)	(1.285)	(1.490)
$PostVolcker_t \times NewIssue_{b,t}$	0.015	-0.006	0.069***	0.015	0.235***	0.094**	0.035	-0.155
	(0.013)	(0.011)	(0.026)	(0.021)	(0.050)	(0.039)	(0.383)	(0.433)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.330**	0.332*	0.306***	0.481***	0.215	0.451**	-0.906	-1.811
	(0.131)	(0.177)	(0.113)	(0.170)	(0.170)	(0.192)	(1.309)	(1.510)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.040***	-0.035**	-0.035*	-0.002	-0.104***	-0.023	0.331	0.373
	(0.013)	(0.014)	(0.019)	(0.017)	(0.034)	(0.029)	(0.457)	(0.498)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.331***	0.337**	0.298***	0.396**	0.068	0.149	14.843***	10.221***
	(0.114)	(0.160)	(0.106)	(0.157)	(0.192)	(0.227)	(2.800)	(1.896)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.415***	-0.421**	-0.274**	-0.404**	-0.014	-0.154	-14.341***	-9.882***
	(0.117)	(0.164)	(0.105)	(0.156)	(0.189)	(0.223)	(2.858)	(1.944)
Observations	10,564,104	7,415,770	1,762,764	1,230,896	3,398,596	2,471,581	162,386	120,587
R-squared	0.215	0.225	0.250	0.263	0.078	0.075	0.050	0.071
Month FE	N	N	N	N	N	N	N	N
Issuer FE	Y	Y	Y	Y	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y	Y	Y	Y	Y
Trade Controls	Y	Y	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Table 6: Regressions on the volatility of dealer markups on roundtrip trades

This table reports the coefficient estimate and standard errors of the panel regressions with the specification in Eq. (2) where the dependent variable is the standard deviation of a dealer's markup on all roundtrip trades on a particular bond in a month, $MarkupVolatility_{d,b,t}$. The headers in first row indicate the duration of the roundtrip trades in the regression. Alternating regressions are on the entire sample period from January 2006 to March 2017 or for the post-GFC period from January 2010 to March 2017 ("$\geq$ Jan 2010"). $PostVolcker_t$ is 1 if the start of the trade is on or after April 2014, 0 otherwise. $VolckerCovered_d$ is 1 if the dealer is a firm that is bank-holding company and covered by the Volcker Rule, 0 otherwise. $Underwriter_{b,d}$ is 1 if the dealer firm is an underwriter for the bond, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond being traded was first issued less than 40 days ago, 0 if the first issue date is more than 40 days. All regressions include the necessary lower-order interactions. Panel A presents results with month fixed effects, while Panel B presents results with macroeconomic controls. All regressions include trade controls, bond controls, and issuer fixed effects. Table 4 summarizes the description of all independent variables. Standard errors are clustered by issuer and month. The significance of the coefficient estimate is indicated by * for $p < 0.10$, ** for $p < 0.05$, and *** for $p < 0.01$.

Panel A: Regressions with security-level controls, issuer fixed effects, and month fixed effects.

	<15 Minutes		15Min-1Day		1-60 Days	
		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$VolckerCovered_d$	0.024***	0.048***	0.086***	0.068***	0.059***	0.064***
	(0.004)	(0.002)	(0.006)	(0.007)	(0.009)	(0.010)
$Underwriter_{b,d}$	0.083**	0.101**	-0.009	-0.001	-0.246***	-0.022
	(0.034)	(0.045)	(0.031)	(0.024)	(0.087)	(0.093)
$NewIssue_{b,t}$	0.014***	0.019***	0.088***	0.071***	0.194***	0.197***
	(0.005)	(0.005)	(0.013)	(0.012)	(0.039)	(0.040)
$VolckerCovered_d \times Underwriter_{b,d}$	-0.086**	-0.095**	0.004	-0.042	0.202**	-0.054
	(0.034)	(0.045)	(0.033)	(0.026)	(0.089)	(0.093)
$VolckerCovered_d \times NewIssue_{b,t}$	-0.013***	-0.014***	-0.071***	-0.051***	-0.098***	-0.057***
	(0.003)	(0.003)	(0.009)	(0.009)	(0.024)	(0.021)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.036	-0.029	0.095*	0.091	0.125	-0.034
	(0.046)	(0.051)	(0.056)	(0.061)	(0.134)	(0.177)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.086*	0.068	-0.047	-0.016	-0.141	0.049
	(0.046)	(0.051)	(0.057)	(0.061)	(0.137)	(0.180)
$PostVolcker_t \times VolckerCovered_d$	0.052***	0.029***	-0.015*	0.002	-0.040**	-0.043**
	(0.005)	(0.004)	(0.008)	(0.008)	(0.018)	(0.019)
$PostVolcker_t \times Underwriter_{b,d}$	-0.019	-0.039	0.046	0.032	0.173	-0.000
	(0.034)	(0.043)	(0.038)	(0.030)	(0.160)	(0.177)
$PostVolcker_t \times NewIssue_{b,t}$	0.046***	0.025***	0.028*	0.008	-0.121*	-0.212***
	(0.006)	(0.005)	(0.014)	(0.013)	(0.064)	(0.058)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.048	0.058	-0.027	0.016	-0.154	0.049
	(0.035)	(0.044)	(0.041)	(0.033)	(0.158)	(0.174)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.024***	-0.023***	0.011	-0.005	0.053	0.009
	(0.005)	(0.005)	(0.011)	(0.011)	(0.034)	(0.033)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.067	0.072	-0.084	-0.064	-0.192	0.036
	(0.051)	(0.055)	(0.097)	(0.102)	(0.201)	(0.233)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.102**	-0.094*	0.059	0.017	0.211	-0.049
	(0.051)	(0.055)	(0.095)	(0.100)	(0.206)	(0.237)
Observations	1,943,460	1,403,465	248,491	168,961	546,709	389,135
R-squared	0.160	0.148	0.176	0.168	0.222	0.204
Month FE	Y	Y	Y	Y	Y	Y
Issuer FE	Y	Y	Y	Y	Y	Y
Macro Controls	N	N	N	N	N	N
Trade Controls	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Panel B: Regressions with trade and bond controls, macroeconomic controls, and issuer fixed effects.

	<15 Minutes		15Min-1Day		1-60 Days	
		≥ Jan 2010		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$PostVolcker_t$	-0.003	0.007	0.100***	0.051***	0.424***	0.232***
	(0.006)	(0.005)	(0.017)	(0.012)	(0.091)	(0.074)
$VolckerCovered_d$	0.025***	0.050***	0.085***	0.069***	0.059***	0.062***
	(0.004)	(0.002)	(0.006)	(0.007)	(0.009)	(0.010)
$Underwriter_{b,d}$	0.087**	0.105**	-0.015	0.000	-0.251***	-0.001
	(0.033)	(0.044)	(0.032)	(0.023)	(0.085)	(0.095)
$NewIssue_{b,t}$	0.020***	0.020***	0.094***	0.075***	0.204***	0.196***
	(0.005)	(0.005)	(0.014)	(0.012)	(0.041)	(0.041)
$VolckerCovered_d \times Underwriter_{b,d}$	-0.087**	-0.098**	0.009	-0.043*	0.203**	-0.078
	(0.034)	(0.044)	(0.034)	(0.025)	(0.087)	(0.094)
$VolckerCovered_d \times NewIssue_{b,t}$	-0.014***	-0.014***	-0.074***	-0.050***	-0.107***	-0.056***
	(0.003)	(0.003)	(0.009)	(0.009)	(0.025)	(0.021)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.037	-0.028	0.098*	0.096	0.150	-0.006
	(0.045)	(0.050)	(0.056)	(0.061)	(0.133)	(0.177)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.087*	0.066	-0.050	-0.022	-0.164	0.019
	(0.046)	(0.051)	(0.056)	(0.061)	(0.136)	(0.180)
$PostVolcker_t \times VolckerCovered_d$	0.049***	0.028***	-0.014	0.002	-0.046**	-0.048**
	(0.005)	(0.004)	(0.008)	(0.008)	(0.018)	(0.018)
$PostVolcker_t \times Underwriter_{b,d}$	-0.029	-0.044	0.036	0.025	0.161	-0.018
	(0.034)	(0.043)	(0.039)	(0.030)	(0.159)	(0.176)
$PostVolcker_t \times NewIssue_{b,t}$	0.028***	0.022***	0.013	0.001	-0.141**	-0.223***
	(0.007)	(0.005)	(0.015)	(0.014)	(0.058)	(0.057)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.053	0.062	-0.017	0.026	-0.134	0.079
	(0.034)	(0.043)	(0.042)	(0.033)	(0.157)	(0.174)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.021***	-0.022***	0.017	-0.002	0.088**	0.034
	(0.005)	(0.005)	(0.011)	(0.011)	(0.036)	(0.033)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.067	0.069	-0.094	-0.074	-0.269	-0.039
	(0.050)	(0.054)	(0.097)	(0.104)	(0.201)	(0.235)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.099*	-0.090*	0.070	0.027	0.258	-0.001
	(0.050)	(0.054)	(0.095)	(0.101)	(0.204)	(0.239)
Observations	1,943,460	1,403,465	248,491	168,961	546,709	389,135
R-squared	0.158	0.147	0.169	0.166	0.202	0.194
Month FE	N	N	N	N	N	N
Issuer FE	Y	Y	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y	Y	Y
Trade Controls	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Table 7: Regressions on dealer markup and markup volatility with split $PostVolcker$ period

This table reports the coefficient estimate and standard errors of the panel regressions with for dealer markup and volatility with a split $PostVolcker_t$ period. Panel A and B present results for the specification in Eq. (3) where the dependent variable is dealer markup on a roundtrip trade, while Panel C and D presents results for the specification in Eq. (4) where the dependent variable is the standard deviation of a dealer's markup on all roundtrip trades on a particular bond in a month, $MarkupVolatility_{d,b,t}$. The headers in first row indicate the duration of the roundtrip trades in the regression. Alternating regressions are on the entire sample period from January 2006 to March 2017 or for the post-GFC period from January 2010 to March 2017 ("$\geq$ Jan 2010"). $VolckerCovered_d$ is 1 if the dealer is a firm that is bank-holding company and covered by the Volcker Rule, 0 otherwise. $Underwriter_{b,d}$ is 1 if the dealer firm is an underwriter for the bond, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond being traded was first issued less than 40 days ago, 0 if the first issue date is more than 40 days. $TransitionPeriod_t$ is 1 if the start of the trade is between April 2014 and July 2015, 0 otherwise. $LaterPeriod_t$ is 1 if the start of the trade is in August 2015 or later, 0 otherwise. All regressions include the necessary lower-order interactions (coefficients not shown here for brevity). Panel A and C present results with month fixed effects, while Panel B and D present results with macroeconomic controls. All regressions include trade controls, bond controls, and issuer fixed effects. Table 4 summarizes the description of all independent variables. Standard errors are clustered by issuer and month. The significance of the coefficient estimate is indicated by * for p < 0.10, ** for p < 0.05, and *** for p < 0.01.

Panel A: Regressions on dealer markup on roundtrip trades with time fixed effects

	<15 Minutes		15Min-1Day		1-60 Days	
		$\geq$ Jan 2010		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.140	-0.161	-0.186*	-0.315*	-0.199	-0.358
	(0.139)	(0.165)	(0.110)	(0.163)	(0.431)	(0.456)
$TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.446***	-0.460***	-0.295***	-0.433***	0.075	-0.077
	(0.111)	(0.160)	(0.105)	(0.157)	(0.188)	(0.218)
Observations	10,564,104	7,415,770	1,762,764	1,230,896	3,398,596	2,471,581
R-squared	0.218	0.226	0.254	0.265	0.080	0.076
Month FE	Y	Y	Y	Y	Y	Y
Issuer FE	Y	Y	Y	Y	Y	Y
Macro Controls	N	N	N	N	N	N
Trade Controls	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y

Panel B: Regressions on dealer markup on roundtrip trades with macroeconomic controls

	<15 Minutes		15Min-1Day		1-60 Days	
		$\geq$ Jan 2010		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.187	-0.197	-0.256**	-0.352**	-0.132	-0.299
	(0.141)	(0.163)	(0.110)	(0.163)	(0.444)	(0.464)
$TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.446***	-0.455***	-0.276**	-0.416***	0.084	-0.060
	(0.112)	(0.160)	(0.106)	(0.156)	(0.188)	(0.218)
Observations	10,564,104	7,415,770	1,762,764	1,230,896	3,398,596	2,471,581
R-squared	0.215	0.225	0.251	0.264	0.078	0.075
Month FE	N	N	N	N	N	N
Issuer FE	Y	Y	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y	Y	Y
Trade Controls	Y	Y	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Panel C: Regressions on the volatility of dealer markups on roundtrip trades with time fixed effects

	<15 Minutes		1-60 Days	
		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)
$LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.125**	-0.132**	-0.053	-0.217
	(0.050)	(0.053)	(0.273)	(0.297)
$TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.091*	-0.080	0.379	0.079
	(0.051)	(0.055)	(0.242)	(0.257)
Observations	1,943,460	1,403,465	546,709	389,135
R-squared	0.160	0.149	0.202	0.196
Month FE	Y	Y	Y	Y
Issuer FE	Y	Y	Y	Y
Macro Controls	N	N	N	N
Trade Controls	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y

Panel D: Regressions on the volatility of dealer markups on roundtrip trades with macroeconomic controls

	<15 Minutes		1-60 Days	
		≥ Jan 2010		≥ Jan 2010
	(1)	(2)	(3)	(4)
$LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.137***	-0.140***	-0.175	-0.376
	(0.049)	(0.052)	(0.304)	(0.327)
$TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.086*	-0.075	0.401*	0.106
	(0.051)	(0.054)	(0.234)	(0.266)
Observations	1,943,460	1,403,465	546,709	389,135
R-squared	0.159	0.148	0.202	0.196
Month FE	N	N	N	N
Issuer FE	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y
Trade Controls	Y	Y	Y	Y
Bond Controls	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Table 8: Regressions on the fraction of roundtrip trades conducted within one day

This table reports the coefficient estimate and standard errors of the panel regressions where the dependent variable is the ratio of roundtrip trades completed within a day over all roundtrip trades initiated by a dealer in a particular bond in a month. The headers in first row indicate the dependent variable used in the regression, $RatioNumTrades1Day_{d,b,t}$, $RatioDollarTrades1Day_{d,b,t}$, and $RatioAvgTradeSize1Day_{d,b,t}$ as defined in Eqs. (5)-(7). Alternating regressions are on the entire sample period from January 2006 to March 2017 or for the post-GFC period from January 2010 to March 2017 ("$\geq$ Jan 2010"). $PostVolcker_t$ is 1 if the start of the trade is on or after April 2014, 0 otherwise. $VolckerCovered_d$ is 1 if the dealer is a firm that is bank-holding company and covered by the Volcker Rule, 0 otherwise. $Underwriter_{b,d}$ is 1 if the dealer firm is an underwriter for the bond, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond being traded was first issued less than 40 days ago, 0 if the first issue date is more than 40 days. Panel A presents results with month fixed effects, while Panel B presents results with macroeconomic controls. All regressions include the necessary lower-order interactions. All regressions include month and issuer fixed effects. Table 4 summarizes the description of all independent variables. Standard errors are clustered by issuer. The significance of the coefficient estimate is indicated by * for $p < 0.10$, ** for $p < 0.05$, and *** for $p < 0.01$.

Panel A: Regressions with security-level controls, issuer fixed effects, and month fixed effects.

	$RatioNumTrades1Day_{d,b,t}$		$RatioDollarVolume1Day_{d,b,t}$		$RatioAvgTradeSize1Day_{d,b,t}$	
		$\geq$ Jan 2010		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$VolckerCovered_d$	-0.022***	-0.023***	-0.031***	-0.032***	-0.024***	-0.026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Underwriter_{b,d}$	-0.097***	-0.099***	-0.102***	-0.099***	-0.079***	-0.077***
	(0.008)	(0.010)	(0.009)	(0.011)	(0.007)	(0.009)
$NewIssue_{b,t}$	-0.013***	-0.016***	-0.014***	-0.017***	-0.010***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$VolckerCovered_d \times Underwriter_{b,d}$	0.074***	0.081***	0.075***	0.079***	0.057***	0.060***
	(0.008)	(0.010)	(0.009)	(0.011)	(0.007)	(0.009)
$VolckerCovered_d \times NewIssue_{b,t}$	-0.013***	-0.013***	-0.017***	-0.016***	-0.014***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.071***	-0.056***	-0.101***	-0.090***	-0.076***	-0.067***
	(0.016)	(0.018)	(0.020)	(0.023)	(0.016)	(0.019)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.013	-0.031*	-0.003	-0.018	-0.008	-0.021
	(0.016)	(0.018)	(0.020)	(0.023)	(0.016)	(0.019)
$PostVolcker_t \times VolckerCovered_d$	0.003***	0.003***	0.005***	0.006***	0.003***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$PostVolcker_t \times Underwriter_{b,d}$	-0.006	-0.005	-0.008	-0.011	-0.005	-0.007
	(0.012)	(0.012)	(0.013)	(0.013)	(0.010)	(0.011)
$PostVolcker_t \times NewIssue_{b,t}$	-0.007***	-0.003**	-0.008***	-0.004***	-0.007***	-0.003***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.012	0.006	0.019	0.015	0.015	0.012
	(0.012)	(0.012)	(0.013)	(0.013)	(0.010)	(0.011)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.001	-0.002	-0.001	-0.002	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.025	-0.041	-0.004	-0.015	-0.000	-0.010
	(0.035)	(0.036)	(0.042)	(0.043)	(0.033)	(0.035)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.044	0.062*	0.019	0.035	0.017	0.030
	(0.035)	(0.036)	(0.042)	(0.044)	(0.033)	(0.035)
Observations	7,495,202	5,716,191	7,495,202	5,716,191	7,495,202	5,716,191
R-squared	0.030	0.030	0.031	0.030	0.026	0.026
Month FE	Y	Y	Y	Y	Y	Y
Issuer FE	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Panel B: Regressions with trade and bond controls, macroeconomic controls, and issuer fixed effects.

	$RatioNumTrades1Day_{d,b,t}$		$RatioDollarTrades1Day_{d,b,t}$		$RatioAvgTradeSize1Day_{d,b,t}$	
		$\geq$ Jan 2010		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)	(5)	(6)
$PostVolcker_t$	0.002***	0.001**	0.002***	0.001	0.002***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$VolckerCovered_d$	-0.023***	-0.023***	-0.032***	-0.033***	-0.025***	-0.026***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$Underwriter_{b,d}$	-0.098***	-0.099***	-0.102***	-0.100***	-0.080***	-0.078***
	(0.008)	(0.010)	(0.009)	(0.011)	(0.007)	(0.009)
$NewIssue_{b,t}$	-0.012***	-0.016***	-0.013***	-0.017***	-0.010***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$NewIssue_{b,t} \times Underwriter_{b,d}$	-0.071***	-0.055***	-0.101***	-0.090***	-0.077***	-0.066***
	(0.016)	(0.018)	(0.020)	(0.023)	(0.016)	(0.019)
$VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.013	-0.031*	-0.002	-0.019	-0.007	-0.021
	(0.016)	(0.018)	(0.020)	(0.023)	(0.016)	(0.019)
$VolckerCovered_d \times Underwriter_{b,d}$	0.075***	0.081***	0.076***	0.080***	0.057***	0.060***
	(0.008)	(0.010)	(0.009)	(0.011)	(0.007)	(0.009)
$VolckerCovered_d \times NewIssue_{b,t}$	-0.013***	-0.013***	-0.017***	-0.016***	-0.014***	-0.013***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
$PostVolcker_t \times VolckerCovered_d$	0.004***	0.004***	0.006***	0.006***	0.004***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$PostVolcker_t \times Underwriter_{b,d}$	-0.005	-0.004	-0.007	-0.011	-0.005	-0.007
	(0.012)	(0.012)	(0.013)	(0.013)	(0.010)	(0.011)
$PostVolcker_t \times NewIssue_{b,t}$	-0.005***	-0.003**	-0.005***	-0.004***	-0.005***	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$PostVolcker_t \times VolckerCovered_d \times Underwriter_{b,d}$	0.012	0.006	0.018	0.015	0.014	0.012
	(0.012)	(0.012)	(0.013)	(0.013)	(0.010)	(0.011)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t}$	-0.002	-0.002	-0.002	-0.002	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$PostVolcker_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	-0.025	-0.040	-0.003	-0.014	0.000	-0.010
	(0.035)	(0.036)	(0.042)	(0.044)	(0.033)	(0.035)
$PostVolcker_t \times VolckerCovered_t \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.044	0.062*	0.018	0.035	0.016	0.030
	(0.035)	(0.036)	(0.042)	(0.044)	(0.034)	(0.035)
Observations	7,495,202	5,716,191	7,495,202	5,716,191	7,495,202	5,716,191
R-squared	0.030	0.029	0.030	0.030	0.025	0.025
Month FE	N	N	N	N	N	N
Issuer FE	Y	Y	Y	Y	Y	Y
Macro Controls	Y	Y	Y	Y	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Table 9: Regressions on dealer-bond market share

This table reports the coefficient estimate and standard errors of the panel regressions where the dependent variable is a dealer's market share in a particular bond in a month, $MktShare_{d,b,t}$, as defined in Eq. (8). Alternating regressions are on the entire sample period from January 2006 to March 2017 or for the post-GFC period from January 2010 to March 2017 ("$\geq$ Jan 2010"). $PostVolcker_t$ is 1 if the start of the trade is on or after April 2014, 0 otherwise. $VolckerCovered_d$ is 1 if the dealer is a firm that is bank-holding company and covered by the Volcker Rule, 0 otherwise. $Underwriter_{b,d}$ is 1 if the dealer firm is an underwriter for the bond, 0 otherwise. $NewIssue_{b,t}$ is 1 if the bond being traded was first issued less than 40 days ago, 0 if the first issue date is more than 40 days. $TransitionPeriod_t$ is 1 if the start of the trade is between April 2014 and July 2015, 0 otherwise. $LaterPeriod_t$ is 1 if the start of the trade is in August 2015 or later, 0 otherwise. All regressions include the necessary lower-order interactions (coefficients not shown for brevity). All regressions include the necessary lower-order interactions. All regressions include month and issuer fixed effects. Table 4 summarizes the description of all independent variables. Standard errors are clustered by issuer. The significance of the coefficient estimate is indicated by * for p $<$ 0.10, ** for p $<$ 0.05, and *** for p $<$ 0.01.

Panel A: Regressions on market share, one post-Volcker period

		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)
$PostVolcker_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.055*	0.061*	0.054*	0.061*
	(0.031)	(0.035)	(0.031)	(0.035)
Observations	9,185,444	7,004,957	9,185,444	7,004,957
R-squared	0.214	0.222	0.213	0.222
Month FE	Y	Y	N	N
Issuer FE	Y	Y	Y	Y
Macro Controls	N	N	Y	Y

Panel B: Regressions on market share, split post-Volcker period

		$\geq$ Jan 2010		$\geq$ Jan 2010
	(1)	(2)	(3)	(4)
$LaterPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.140***	0.146***	0.140***	0.146***
	(0.050)	(0.051)	(0.050)	(0.051)
$TransitionPeriod_t \times VolckerCovered_d \times NewIssue_{b,t} \times Underwriter_{b,d}$	0.049	0.055	0.048	0.055
	(0.032)	(0.036)	(0.032)	(0.036)
Observations	9,185,444	7,004,957	9,185,444	7,004,957
R-squared	0.214	0.222	0.214	0.222
Month FE	Y	Y	N	N
Issuer FE	Y	Y	Y	Y
Macro Controls	N	N	Y	Y

Source: TRACE, NIC, Mergent, Haver Analytics, authors' calculations

Appendix A Assigning transactions to roundtrip trades

We seek to be conservative in our methodology for identifying roundtrip trading by a dealer. In particular, we bias our approach towards finding shorter, smaller chains of trades. We first seek inside the dataset for perfectly offsetting trade pairs (a buy and a sell, or a sell and a buy) occurring within one minute of each other. Then, we re-search the dataset for sequences of trades (potentially multiple buy and sell orders) that offset each other for each dealer in each bond, first for complete sequences occurring within 1 minute, then 15 minutes, then 1 calendar day, then 60 days, then up to 180 days.

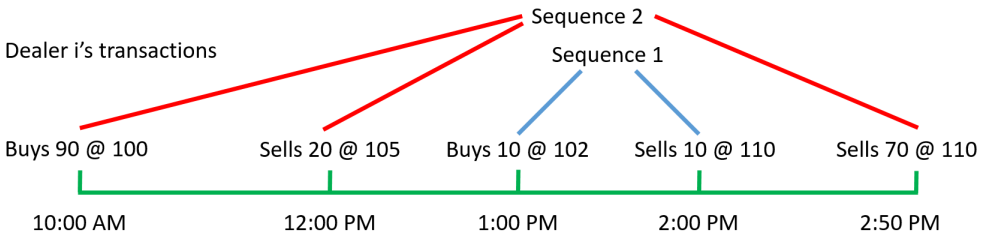
Importantly, no trade is allowed to belong to more than one sequence. If we encounter a trade already assigned to a trading sequence in an earlier step, we skip that trade and continue searching. Since we search for shorter-length and shorter-duration sequences of trades first, we are explicitly biasing our sample towards finding shorter roundtrip chains.

We search backwards from the most recent trade to the beginning of our dataset, looking for trades at the dealer-bond level. We do process the data and identify roundtrip trades as described in detail in Munyan and Watugala (2019). Because we do not know the dealer's original inventory at the inception of our dataset, we cannot adopt a FIFO approach. Instead, we use a LIFO approach to assign transactions to a roundtrip trade.

Figure A.1 illustrates a simple set of roundtrip trades by a dealer in a bond, consisting of 2 buy orders and 2 sell orders. Dealer i first buys 90 bonds from a counterparty, then sells 20, buys 10, and finally sells 80, bringing dealer i's inventory position back to where it was initially (before the 90 bond transaction).

Figure A.2 shows a slightly more complex set of trades, and how our algorithm characterizes each trade. In this case, Dealer i buys 90, then sells 20, buys 10, sells 10, and finally sells 70. In this case, our algorithm will identify two sequences of trades: [Buy 10, sell 10], and [Buy 90, sell 20, sell 70].

Figure A.1: Illustration of one roundtrip trade



Sequence 1:
Total notional volume (one-sided): 10
Dealer profits: -10*102 + 10*110 = 80
Dealer markup = 80 / 10 = 8

Sequence 2:
Total notional volume (one-sided): 90
Dealer profits: -90*100 + 20*105 + 70*110 = 800
Dealer markup = 800 / 90 = 8.8$\bar{8}$

Figure A.2: Illustration of two interspersed roundtrip trades