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THE EFFECTS OF MANDATORY TRANSPARENCY IN FINANCIAL MARKET DESIGN: EVIDENCE FROM THE CORPORATE BOND MARKET

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ABSTRACT

Many financial markets have recently become subject to new regulations requiring transparency. This paper studies how mandatory transparency affects trading in the corporate bond market. In July 2002, TRACE began requiring the public dissemination of post-trade price and volume information for corporate bonds. Dissemination took place in Phases, with actively traded, investment grade bonds becoming transparent before thinly traded, high-yield bonds. Using new data and a differences-in-differences research design, we find that transparency causes a significant decrease in price dispersion for all bonds and a significant decrease in trading activity for some categories of bonds. The largest decrease in daily price standard deviation, 24.7%, and the largest decrease in trading activity, 41.3%, occurs for bonds in the final Phase, which consisted primarily of high-yield bonds. These results indicate that mandated transparency may help some investors and dealers through a decline in price dispersion, while harming others through a reduction in trading activity.

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I. Introduction

Trading in many financial securities takes place in environments with a great deal of transparency. For instance, nearly all U.S. stocks trade on exchanges with real-time reporting of pre-trade bid and ask quotes and post-trade transaction prices and volume. On the other hand, some securities, such as credit default swaps and collateralized debt obligations, have historically traded over-the-counter without even post-trade information about previous transactions. This paper studies the effects of a dramatic increase in transparency in the corporate bond market. We find that transparency significantly reduces price dispersion for all bonds and significantly reduces trading activity for some categories of bonds.

Corporate bonds were largely exchange-traded in the 1930s, which meant that post-trade prices and volume were publicly available (Bias and Green 2007). After World War II, however, trading in this market migrated to over-the-counter, with private bilateral negotiations and no public reporting of transaction details. If investors wanted information on a bond's market price, they had a limited set of options: they could contact corporate bond dealers and ask for quotes or they could consult a vendor that provides estimated prices (widely known as "matrix prices").

The corporate bond market underwent a significant change in July 2002 when information on the prices and volume of completed transactions were once again publicly disclosed. FINRA (then the NASD) mandated transparency in the corporate bond market through the Trade Reporting and Compliance Engine (TRACE) program. FINRA required that all transactions in U.S. corporate bonds by regulated market participants be reported on a timely basis to TRACE. Corporate bonds are one of the world's largest over-the-counter markets with average transactions of $4.2 trillion a year over this period (SIFMA 2013). FINRA then made this information transparent by publicly releasing (in their words "disseminating") the prices and volume completed bond trades. Bond trade dissemination was Phased-in on four separate dates over a three-and-a-half year period. The increase in information available to market participants was so significant that it has been compared to the early 20th century introduction of stock market tickers and electronic screens for Treasuries (Vames 2003).

Studies of changes in market design for opaque markets are usually limited because, although data sometimes exists after the new design is implemented, there is rarely comprehensive information on market behavior beforehand. Prior to 2010, FINRA did not release any information regarding a bond's trades until after the dissemination Phase for that bond began. In 2010, however, FINRA released transactions data on all bonds, disseminated and not disseminated, since the start of TRACE. With this newly released dataset, it now possible to observe changes in the trading behavior of corporate bonds using data from periods before and after their trades are disseminated. Moreover, this comprehensive record of transactions makes it is possible to provide a definitive account of the effect of TRACE across all categories of bonds.[3]

Even before FINRA released this historical transaction-level data, TRACE had become a template for how financial market reform and regulation should proceed. Difficulties evaluating the trading and value of over-the-counter instruments during the 2008 financial crisis motivated some to propose reforms inspired by TRACE. See, for example, Acharya, Engle, et al. (2009) or the recommendations of the Squam Lake Group (French et. al., 2010) which state:

> *Regulators should promote greater transparency in the CDS market for the more liquid and standardized index and single-name contracts. Consideration should be given to the introduction of a trade reporting system for these contracts similar to the TRACE system.*

Furthermore, TRACE was expanded in March 2010 to include Agency-Backed Securities and in May 2011 to include Asset-Backed Securities. In April 2013, the FINRA board approved a proposal, currently awaiting SEC approval, to publicly disseminate 144A transactions. There are also on-going efforts to mimic TRACE for European corporate bonds (Learner 2011). Finally, Title VII of the Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) requires that swaps (including credit default swaps, interest rate swaps, collateralized debt obligations, and other derivatives) be traded and cleared centrally on exchanges. Dodd-Frank follows TRACE's definition of transparency by requiring public dissemination of post-trade transaction information regarding price and volume.

Proponents of TRACE argue that transparency makes the corporate bond market accessible to retail clients, enhances market integrity and stability, and provides regulators greater ability to monitor the market. They reason that with the introduction of transparency, price discovery and the bargaining power of previously uninformed participants should improve (NASD 2005). This in turn should be reflected in a decrease in bond price dispersion and, if more stable prices attract additional participants, an increase in trading activity (Levitt 1999).

Opponents of TRACE object to mandatory transparency, saying that is unnecessary and potentially harmful. They argue that "transparency would add little or no value" to highly liquid and investment grade bonds since these issues often trade based on widely known US Treasury benchmarks (NASD 2006). They further argue that if additional information about trades was indeed valuable, then third-party participants would already collect and provide it, a view that dates back to Stigler (1963). Opponents also forecast adverse consequences for investors since, if price transparency reduces dealer margins, dealers would be less willing to commit capital to hold certain securities in inventory making it more difficult to trade in these securities. The Bond Market Association argued that the adverse effects of transparency may be exacerbated for lower-rated and less frequently traded bonds (Mullen 2004).

[3] Because of data limitations, earlier studies of TRACE focused on part of TRACE's implementation and, therefore, on particular subsets of bonds. For instance, Bessembinder, Maxwell, and Venkataram (2006) primarily study the effect of Phase 1 of TRACE on using data from the National Association of Insurance Commissioners. Edwards, Harris, and Piwowar (2007) and Hotchkiss, Goldstein, and Sirri (2007) study the effect of Phase 2 on different samples of bonds.

Lastly, opponents saw TRACE as imposing heavy compliance costs, particularly for small firms who do not self-clear (Jamieson 2006). Thus, opponents argue that market transparency reduces overall trading activity and the depth of the market. Not surprisingly, similar arguments for and against transparency have resurfaced in response to the recent introduction of the Dodd-Frank's post-trade transparency requirements for swaps (Economist 2011).

The implementation of TRACE and the release of the new database provide a unique opportunity to study the impacts of mandated transparency on market behavior. TRACE's dissemination of price and volume data was not implemented on all bonds simultaneously. In July 2002, FINRA began collecting price and volume information for all corporate bond trades. On the same day, FINRA began dissemination of this information for just a subset of bonds. There were three other major "Phase-ins," Phase 2, 3A, and 3B, expanding the set of bonds covered. Bonds were assigned to Phases using bond issue size, credit quality, and previous levels of trading activity. By February 2005, the price and volume of every corporate bond trade was publicly disseminated shortly after the trade's execution. Thus, between 2002 and 2005, corporate bond market participants went from having little knowledge of trading activity to having post-trade knowledge similar to equity market participants.

Our empirical strategy exploits these Phases to construct a before-and-after comparison between bonds subject to a change in transparency and bonds that are not. This difference-in-difference research design gives us the chance to avoid confounding the effects of transparency with unobserved shocks to the corporate bond market. Although our approach does not cover the first Phase of TRACE (where there is no TRACE data beforehand), it covers the remaining Phases, which represent 98% of bonds in the Phases.

The new database and our research design allow us to ask questions previous researchers were unable to investigate. Previous work on TRACE focused on imputed transaction costs. In this paper, we focus on TRACE's impact on market behavior, in particular its effect on trading activity and price dispersion. Earlier work also focused only on Phase 1 and/or Phase 2. This paper covers the entire TRACE implementation period, which is important because the types of bonds covered by TRACE in later Phases differ from that of earlier Phases by design. In particular, bonds covered in earlier Phases had large issue sizes and investment grade ratings, while bonds covered in later Phases of TRACE were bonds with smaller issue sizes and lower credit quality. These latter bonds are exactly the ones that opponents of TRACE warned would have the most adverse consequences.

We find that post-trade transparency of price and volume leads to a significant reduction in trading activity and price dispersion. Using our main measure of trading activity, trading volume/issue size, and our preferred differences-in-differences specification, we find a significant 15.2% reduction in trading activity in the 90 days after TRACE's introduction for the pooled sample across Phases 2, 3A, and 3B, i.e., the Phases where we can observe trading before and after dissemination. This result is driven primarily by Phase 3B bonds, which experience a significant 41.3% reduction in volume/issue size. Phase 3B bonds are largely bonds with credit ratings below investment grade that trade infrequently. Event studies show that the reduction in trading activity for Phase 3B bonds occurs immediately upon dissemination. In addition, these results are robust to alternative differences-in-differences specifications that vary time trends and control groups. The reduction in trading activity caused by TRACE is also seen using several other measures of trading activity such as volume, number of trades, and average trade size.

Transparency also causes a significant reduction in price dispersion. We find a significant 8.5% reduction in within-day price standard deviation in the 90 days after TRACE's introduction for the pooled sample, and significant reductions for Phases 2, 3A, and 3B when examined individually. The largest reduction is for Phase 3B bonds, which is a significant 24.7%. The reduction for Phases 2 and 3A are also both significant at 7.3% and 6.5%, respectively. Event studies show that price dispersion falls immediately upon dissemination for all three Phases. In addition, these results are robust to trends and alternative assumptions about control groups. The reduction is also evident using other measures of price dispersion such as the difference between the maximum and minimum price on a given day and price standard deviation measures computed over longer time windows.

FINRA implemented TRACE in Phases because of concerns about the possible negative impact of transparency on thinly traded, small issue and low-credit rated bonds. Examining issue size across all Phases, we find that trading activity decreases more for large issue size bonds, but that the reduction in price dispersion is uncorrelated with issue size. Credit ratings, however, matter for both trading activity and price dispersion. High-yield bonds experience a large and significant reduction in trading activity, while the results are mixed for investment grade bonds. High-yield bonds also experience the largest decrease in price dispersion, but price dispersion significantly falls across all credit qualities. Therefore, the introduction of transparency in the corporate bond market has heterogeneous effects across sizes and rating classes.

Lastly, we report on a complementary analysis using transactions data from the National Association of Insurance Commissioners (NAIC) in an attempt to investigate the effect of TRACE on Phase 1 bonds. This analysis is inconclusive. However, since NAIC data reports the identity of the security dealer doing each trade, we analyze that data and show that TRACE causes a reduction in dealer volume and number of trades for the largest dealers for all Phases.

The rest of this paper is organized as follows. Section 2 presents additional background on TRACE and reviews the related literature. Section 3 describes the historical TRACE database and presents descriptive statistics. Section 4 describes our research design and the main results. Section 5 examines the robustness of our findings and reports on TRACE's effect on alternative measures of trading activity and price dispersion. In Section 6, we further explore heterogeneity in our findings based on ratings and issue size. Section 7 reports on an investigation of corporate bond trading using the NAIC database. The last section states our conclusions and discusses the implications of our findings.

II. TRACE and the Corporate Bond Market

II.A History and Implementation of TRACE

The Trade Reporting and Compliance Engine (TRACE) was launched in July 2002, but it has its origins in the late 1990s when the Securities and Exchange Commission (SEC) reviewed issues related to price transparency in U.S. debt markets. After this review, the SEC asked the National Association of Security Dealers (NASD) to take three steps to enhance the transparency and the integrity of the corporate debt market: 1) adopt rules to report all transactions in U.S. corporate bonds to NASD and develop systems to receive and distribute transaction prices on an immediate basis; 2) create a database of transactions in corporate bonds to enable NASD and other regulators to take a proactive role in supervising the corporate debt market; and 3) create a surveillance program to better detect misconduct and foster investor confidence in the corporate debt market. The NASD changed its name to the Financial Industry Regulatory Agency (FINRA) in 2007.[4]

By January 2001, the SEC approved rules requiring NASD members to report all over-the-counter (OTC) market transactions in eligible fixed income securities to the NASD and mandating that certain market transactions be disseminated. NASD developed a platform, TRACE, to facilitate this mandatory reporting. The rules, referred to as the "TRACE Rules," are contained in the new Rule 6200 Series that replaced the old Rule 6200 Series, which governed the Fixed Income Pricing System (FIPS). FIPS started in April 1994 with reported transactions information on approximately 50 high-yield bonds at any point in time.

NASD's stated rationale for the introduction of TRACE was to bring transparency to the corporate bond market. Advocates of transparency anticipated that almost everyone would benefit because of increased market participation. For instance, SEC commissioner Arthur Levitt (1999) remarked, "This participation means more trading, more market liquidity, and perhaps even new business for bond dealers." Doug Shulman, NASD's President of Markets, Services and Information stated as much (NASD 2005): "By disseminating accurate and timely trading information, TRACE enhances the integrity of the corporate bond market and creates a level playing field for all investors." The 2005 TRACE Fact Book adds (p. 2): "From a regulatory standpoint, such levels of transparency better enable regulators to monitor the market, pricing and execution quality."

Critics were concerned about how disclosure would impact the incentives of dealers and traders (see e.g., Bravo 2003, Decker 2007) and in turn the operation of the corporate bond market. The Bond Market Association warned of "serious concerns about the potential harm to liquidity resulting from rapid transaction data on lower rated, less frequently traded issues" (Mullen 2004). In particular, there was a concern that dealers may be less likely to commit capital to hold inventory in illiquid securities when information about their transactions was made public. If bid-ask spreads subsidize dealers inventory holding costs and if TRACE reduces these spreads, it may become too costly for dealers to hold some less actively traded securities.

[4] http://www.finra.org/Industry/Compliance/MarketTransparency/TRACE/FAQ/P085430, Last accessed: July 14, 2012.

Another concern was that making trades public, particularly large trades, would disadvantage dealers. If large dealers buy in quantity and then provide liquidity to the market, having the price and quantity they buy at known may cap the resale price they can charge. Thus, as Duffie (2012) states, censoring trade information allows dealers to "have the chance to reduce inventory imbalances stemming from large trades with less concern that the size of a trade or their reservation price will be used to the bargaining advantage of their next counterparties." These concerns ultimately motivated the NASD to censor trade size reports at $1,000,000 for high-yield bonds and $5,000,000 for investment grade bonds (Vames 2003).

On July 1, 2002, FINRA implemented TRACE, requiring dealers to report all bond transactions on TRACE-eligible securities within 75 minutes. As described in Table 1, FINRA began disseminating price and volume data for trades in selected investment-grade bonds with initial issue of $1 billion or greater (i.e., Phase 1 bonds). FINRA's dissemination occurred immediately upon reporting for these bonds. A "TRACE-eligible security" is any US dollar-denominated debt security that is depository-eligible and registered by the SEC, or issued pursuant to Section 4(2) of the Securities Act of 1933 and purchased or sold pursuant to Rule 144a.[5] Additionally, the 50 high-yield securities disseminated under FIPS were transferred to TRACE, which now disseminated their trades.[6] We denote these bonds the FINRA50. About 520 securities had their information disseminated by the end of 2002.

At the start of Phase 1, it was not certain when and to what extent TRACE would be expanded. After all, the FIPS program had existed without expansion for eight years. Initially, a bond transactions reporting committee comprised of NASD and the Bond Market Association members was established to study TRACE's impact. Their mandate was to focus not on the largest, highest quality credit and actively traded issues, but rather on the rest of the market (Vames 2003). Their recommendation was to expand TRACE's coverage. The NASD approved the expansion of TRACE on November 21, 2002 and by the SEC on February 28, 2003.

Phase 2 of TRACE was implemented on March 3, 2003, and it expanded dissemination to include smaller investment grade issues. The new dissemination requirements included securities with at least $100 million par value or greater and ratings of A- or higher. In addition, dissemination began on April 14, 2003 for a group of 120 Investment-Grade securities rated BBB. We denote these BBB bonds as the FINRA120.[7] After Phase 2 was implemented, the number of disseminated bonds increased to approximately 4,650 bonds. Meanwhile, the FINRA50 subset did not remain constant over our time

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[5] The list of eligible security types is: (1) Investment-grade debt, including Rule 144A/DTCC eligible securities, (2) High-yield and unrated debt of U.S. companies and foreign private companies, (3) Medium-term notes, (4) Convertible debt and other equity-linked corporate debt not listed on a national securities exchange, (5) Capital trust securities, (6) Equipment trust securities, (7) Floating rate notes, (8) Global bonds issued by U.S. companies and foreign private companies, and (9) Risk-linked debt securities (e.g., "catastrophe bonds"). TRACE-eligible securities exclude debt that is not depository-eligible, sovereign debt, development bank debt, mortgage- and asset-backed securities, collateralized mortgage obligations, and money market instruments.
[6] Alexander, Edwards, and Ferri (2000) examine the liquidity of the bonds in the FIPS dataset.
[7] The FINRA120 sample was selected by FINRA to study the impact of dissemination on market behavior and has been studied by Goldstein, Hotchkiss, and Sirri (2007).

period. On July 13, 2003, the FINRA50 list was updated, and the list was then updated quarterly for the next 5 quarters.[8]

Finally, on April 22, 2004, after TRACE had been in effect for some bonds for almost two years, the NASD approved the expansion of TRACE to almost all bonds. The last Phase came in two parts, which FINRA designates as Phase 3A and Phase 3B. The distinction between Phase 3A and 3B is that Phase 3B bonds are eligible for delayed dissemination. Dissemination is delayed if a transaction is over $1 million and occurs in a bond that trades infrequently and is rated BB or below. In addition, dissemination is delayed for trades immediately following the offering of TRACE-eligible securities rated BBB or below. In Phase 3A, effective on October 1, 2004, 9,558 new bonds started having their information about trades disseminated. In Phase 3B, effective on February 7, 2005, an additional 3,016 bonds started dissemination, though sometimes with delay.[9] According to the NASD at that point, there was "real-time dissemination of transaction and price data for 99 percent of corporate bond trades" (NASD 2005).

In an effort parallel to increasing the number of bonds with disseminated trade information, FINRA reduced the time delay for reporting a transaction from 75 minutes on July 1, 2002, to 45 minutes on October 1, 2003, to 30 minutes on October 1, 2004, and to 15 minutes on July 1, 2005. On January 9, 2006, the time delay for dissemination was eliminated. Since most bond trades infrequently, our trading analysis uses one day as the basic unit of time. In our sample the average number of trades per day for a bond is 0.68. Therefore, we do not focus on changes in time to dissemination, but instead on new dissemination.

II.B Related Literature

There are three main studies of TRACE, each of which focuses on either Phase 1 or Phase 2. Bessembinder, Maxwell, and Venkataram (2006) study 439 bonds in Phase 1 using transaction data from the National Association of Insurance Commissioners. They formulate and estimate a structural model of transaction costs and report a 4.9-7.9 basis point reduction in transaction costs for Phase 1 bonds in a before-and-after comparison. They also find that after Phase 1, there is a decline in the concentration ratio for the 12 largest dealers.

Two other studies examine transaction costs for Phase 2 bonds. Using a then proprietary database of all bond trades (which is now publicly available), Edwards, Harris, and Piwowar (2007) also

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[8] The FINRA50 list was updated on July 13, 2003, October 15, 2003, January 15, 2004, April 14, 2004, and July 14, 2004.

[9] Rule 6250(b)(2)(A) states: "Transactions that are greater than $1 million (par value) in BB-rated TRACE-eligible securities that trade an average of less than one time per day will be disseminated two business days from the time of execution." Rule 6250(b)(2)(B) states: "Transactions that are greater than $1 million (par value) in TRACE-eligible securities rated B or lower that trade an average of less than one time per day will be disseminated four business days from the time of execution." On January 9, 2006, this exception changed and there was immediate dissemination of all trades.

examine imputed transaction costs. They find that transparent bonds have lower transaction costs. Since this result may be due to bond characteristics rather than the effect of transparency, they also report on a difference-in-difference analysis, which compares the transactions costs of bonds which are newly disseminated to three distinct control groups of bonds that do not change dissemination status. The transactions costs of newly disseminated bonds decrease relative to each control group across the entire range of trade sizes.

Hotchkiss, Goldstein and Sirri (2007) report on a controlled experiment, commissioned by the NASD, of 120 BBB Phase 2 bonds, 90 of which are actively traded and 30 of which are relatively inactive. Through cooperation with the NASD, the authors construct a matched sample of the 90 actively traded bonds based on industry, average trades per day, bond age, and time to maturity. When the 90 actively traded bonds were disseminated on April 14, 2003, the matched bond was not. To increase power, they also compare the disseminated sample to a larger portfolio of non-disseminated bonds. For the 90 actively traded bonds, they find declines in transaction costs for all but the group with the smallest trade size. There is no evidence of a reduction in transaction costs for inactively traded bonds. In subsequent work, Hotchkiss and Goldstein (2012) study new issues of corporate bonds, and find a secular decline in price dispersion from July 2002 through February 2007 for newly issued bonds.

While these studies provide evidence that TRACE reduces transaction costs for Phase 1 and Phase 2 bonds, there is little evidence about TRACE's effect on trading activity. For their sample of 120 BBB bonds, Hotchkiss, Goldstein, and Sirri (2007) report that TRACE did not cause an increase in daily trading volume and the number of transactions per day. Despite this small sample size and time period, Duffie (2012) concludes "the empirical evidence does not generally support prior concerns by dealers that the introduction of TRACE would reduce market liquidity." Others, including the SEC, saw the evidence as inconclusive, stating that concerns about liquidity were also not rejected.[10]

The absence of any trading activity results is surprising in light of the negative reaction to TRACE from many market participants. For instance, Bessembinder and Maxwell (2008) report that the near universal perception among bond dealers is that trading became more difficult after TRACE. (See also Jamieson 2006 and Decker 2007). Bessembinder and Maxwell (2008) are skeptical of these claims given that there was an upward trend in aggregate corporate bond trading from 2002-2007. This increase in aggregate bond trading does not imply TRACE increased trading activity, however, since there was also an upward trend in the amount of corporate debt outstanding due to new issues. When we hold the number of bonds constant by examining bonds covered in TRACE's four Phases, there is a strong downward trend in average daily volume (see Figure 1). In addition, we believe another the reason that previous work did not detect significant adverse effects on trading activity is that it did not examine the later Phases of TRACE, where the decline in trading activity is strongest.

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[10] The SEC's Director of Market Regulation Nazareth (2004) stated "the NASD commissioned two studies to address this issue [the impact of TRACE on liquidity]. Neither study provided significant evidence that transparency harms liquidity. However, neither study was extensive enough to address all concerns raised by dealers and other market participants." The industry group, the Bond Market Association, described these studies as largely inconclusive (Mullen 2004).

Also relevant is a set of studies on municipal bonds. Green, Hollifield, and Schurhoff (2007a) find significant price dispersion in new issues of municipal bonds, which they attribute to the decentralized and opaque market design. Green, Hollified, and Schurhoff (2007b) analyze broker-dealer and customer trades, and report that dealers exercise substantial market power. On January 31, 2005 the Municipal Securities Rulemaking Board started requiring that information about trades in municipal bonds be reported within 15 minutes, similar to TRACE. Schultz (2012) compares price dispersion at offering date for municipal bonds before and after this change and finds that it falls sharply. He does not, however, study post-offer trading activity.

There is also empirical research on the effects of transparency in settings other than the bond market. Greenstone, Oyer, and Vissing-Jorgensen (2006) study the mandatory disclosure requirements of the 1964 Securities Act Amendment. These requirements required OTC firms to register with the SEC, provide regular updates on financial positions, issue proxy statements, and report on insider holdings and trades. They find that these newly registered OTC firms experience positive abnormal returns post-disclosure. Further afield, Jensen (2007) investigates the impact of increased information on price dispersion among fishermen in southern India. After mobile phones became available, he finds a sharp reduction in price dispersion and a reduction of waste due to excess fish.

Finally, the theoretical work on the impact of dissemination highlights various mechanisms through which dissemination can impact trading behavior. (See Biais, Glosten, and Spatt (2005) for a review of the literature on the impact of transparency on financial markets). Madhavan (1995) demonstrates that dealers may prefer not to disclose trades because they benefit from the reduction in price competition. Pagano and Roell (1996) argue that well-informed dealers may be able to extract rents from less well-informed customers in an opaque market, and that transparency may result in more uninformed traders entering the market. Bloomfield and O'Hara (1999) show that transparency can reduce market makers incentives to supply liquidity, if the market maker has more difficulty unwinding inventory following large trades. On the other hand, Naik, Neuberger, and Viswanathan (1999) show how transparency can improve dealers' ability to share risks, which decreases their inventory costs and therefore customers' costs of trading.

III. Data and Descriptive Statistics

III.A Historical TRACE data and Phase identification

Beginning in July 2002, TRACE publicly provided price and volume data for disseminated trades for Phase 1 bonds.[11] This and later publicly disseminated trade data constitutes the "Public" TRACE database available to market participants at the time. Simultaneously, FINRA also collected non-disseminated trade data. This non-disseminated data represents all trades on corporate bonds in the period before public dissemination. In March 2010, FINRA released a "Historical" TRACE dataset, which

[11] FINRA censored reported trading volume at $1 million for high-yield bonds and $5 million for investment-grade bonds. That is, for trades greater than this amount, the actual trading volume was not reported and TRACE only reported that the trade size exceeded the cap.

includes both disseminated and non-disseminated transaction records, starting from TRACE's initiation in July 2002. We use the Historical TRACE database to examine the period from July 1, 2002 through December 31, 2006. Since Phase 3B, the last major Phase of TRACE, concluded in February 2005, our time period covers all four TRACE Phases.

The information in the FINRA databases (both Public and Historical) is self-reported by bond dealers who are FINRA members. Dealers are required to report the bond's CUSIP, the trade's execution time and date, the transaction price ($100 = par), and the volume traded (in dollars of par). In addition, dealers are required to indicate whether they were the buyer or the seller, and whether the counterparty to the trade was a dealer or a customer. Unlike the Public TRACE database, the Historical TRACE database does not censor volume at $1 million or $5 million. Finally, dealers are required to correct errors in previously reported trades with flags corresponding to trade cancels, modifies, or reversals.

There are a number of steps required to process this raw data into the analysis dataset that we use. These steps and their rationale are described in detail in the Data Appendix and outlined in Table A1. Two of the major steps are to eliminate all bonds not contained in the Mergent Fixed Income Securities Database (FISD), and to drop all bonds with an equity-like component since partial price information may be available from the stock market. Next we eliminate some of the trading records for the remaining bonds. There are three main reasons. First, there are records for trades that do not actually take place since they are cancelled, modified, or reversed. Second, there are records corresponding to trades that are reported more than once. Third, there are records with issues concerning their price, size, or timing. Table A1 enumerates the number of bonds and trade records affected by each step.[12] After applying the filters described in Table A1, there are 21,149,525 trades, corresponding to 30,643 CUSIPs, remaining in the Cleaned Historical TRACE database.

Phase Identification

FINRA's criterion for a bond's dissemination Phase is presented in Table 1. The main criteria are the initial issue size and the credit rating. FINRA does not indicate a bond's Phase designation in either the Historical or Public FINRA dataset. As a result, we contacted FINRA and obtained their listings of the bonds included at the start of Phases 2, 3A, and 3B. We obtained the list of bonds that are in the FINRA50 or FINRA120 directly from the FINRA website.[13]

FINRA did not provide us a list of bonds in Phase 1. To construct the Phase 1 list, we require a bond to have an initial issue size of $1 billion or more, be investment grade (following the criteria FINRA

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[12] We do not exclude bonds trades that occurred on the NYSE's Automated Bond System. Even though they take place on an exchange and therefore are transparent, they constitute a tiny fraction of the market. For instance, Hotchkiss, Goldstein, and Sirri (2007) state that 99.9% of corporate bond trading in 2004 takes place over-the-counter.

[13] The list is available at http://www.finra.org/Industry/Compliance/MarketTransparency/TRACE/Announcements/P117685, last accessed January 28, 2013.

used as outlined in Table 1), and have a publicly disseminated trade before the start of Phase 2.[14] Bonds which are simultaneously classified in a Phase and in either the FINRA50 or FINRA120 are excluded from our Phase lists. The Data Appendix and Table A2 further describe the steps involved in matching the Phase lists to the Cleaned Historical TRACE database.

Table A2 shows that after cleaning, there are 343 Phase 1 bonds, 2,538 Phase 2 bonds, 11,087 Phase 3A bonds, and 2,853 Phase 3B bonds. We designate these 16,825 bonds and 14,210,328 trades as the Cleaned Phase Sample. The remaining bonds in the Cleaned Historical TRACE database are not associated with any Phase. 7,669 bonds are always disseminated (they were issued after the beginning of their Phases and always disseminated) and 1,708 bonds are never disseminated (they matured before the start of what would have been their Phase). Finally, 671 bonds are not disseminated consistent with FINRA's guidelines. They either have some non-disseminated trades after a bond's Phase began or some disseminated trades before the Phase's start date.

Although the number of bonds disseminated in Phase 1 and Phase 2 is lower than the number in Phases 3A and 3B, bonds in the earlier Phases account for a larger number of trades per bond. For instance, bonds in Phase 1 are heavily traded with a total of 10,208 trades per bond over our sample period. In contrast, bonds in Phase 3B have only 351 trades per bond.

III.B Bond Characteristics

Table 2 shows the distribution of issue size, credit rating, coupon rate, and maturity for our sample of bonds by Phases. As mentioned above, when assigning bonds to Phases, FINRA uses issue size and rating as criteria. Table 2 shows the mean bond issue size decreases from Phase 1 to Phase 3A, consistent with the rules set by FINRA outlined in Table 1. Phase 1 bonds have by far the largest issue size with a mean of $1.466 billion and Phase 3A bonds are the smallest with mean issue sizes of $82 million. Phase 3B bonds have a larger mean issue size of $181 million.

We also report the quartiles of the issue size distribution as well as the 10th and 90th percentiles. These quantiles show that there is overlap in issue size between Phases 2, 3A, and 3B. For example, the median of Phase 3B bonds equals the 25th percentile of Phase 2 bonds and the 75th percentile of Phase 3A bonds is close to the 25th percentile of Phase 3B bonds. These overlapping intervals allow us to compare bonds with similar issue sizes across Phases 2, 3A, and 3B.

Data on credit ratings comes from two sources. We first use ratings information from S&P RatingsXpress if it is available. This covers 74.5% of bonds for the four Phases. If ratings are not available in S&P RatingsXpress, we use ratings from FISD.[15,16] FISD includes ratings from S&P, Moody's, Fitch and Duff and Phelps. To assign a FISD rating, we first use the S&P value if it exists, otherwise the

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[14] This approach will not capture bonds that are classified by FINRA as Phase 1, but do not trade before Phase 2.
[15] Akins (2012) states that the S&P RatingsXpress database is more complete than FISD's S&P ratings database.
[16] FINRA does not rely exclusively on S&P ratings. It also uses ratings from other nationally recognized statistical rating organizations. If a bond is unrated or split rated, FINRA has specific rules determining the bond's rating for the purposes of Phase classification.

Moody's value, otherwise the Fitch value, and otherwise the Duff and Phelps value. If FISD does not have a rating from any of the four, we classify the bond as unrated. Using both sources, there are ratings for 99.2% of bonds, and 127 bonds are classified as unrated.

Table 2 shows the distribution of credit ratings at the start of each Phase. The average rating at the beginning of the Phase is similar between Phases 1, 2, and 3A. Bonds in Phase 3B have significantly lower credit ratings. While there is overlap between the ratings in Phases 1, 2, and 3A, there is little or no overlap in ratings between Phase 3B and the other Phases. The 10th percentile rating in Phase 3B is a BB+, while the 90th percentile rating in Phase 1, 2, and 3A are BBB, A-, and BBB-, respectively.

Table 2 also describes bond characteristics not used by FINRA when assigning Phases. For example, most bonds have fixed coupon rates. The only Phase with less than 90% fixed coupons is Phase 2 and even these bonds have fixed coupons 84.9% of the time. Consistent with ratings, the highest coupon rates are for Phase 3B. In addition, Phase 1 bonds have the lowest maturity at issue with a mean of 8.98 years and a median of 5.10 years. All three of the other Phases have a mean maturity greater than 11.8 years and a median maturity greater than 9.7 years.

III.C Measuring Trading Activity and Price Dispersion

Trading Activity

We measure trading activity in several ways. Our first measure is trading volume, which we define as the number of bonds traded times their par value. Figure 1 plots the daily trading volume averaged by week for the bonds in Phases 2, 3A, and 3B from July 2002 through December 2006.[17] The three vertical lines correspond to the starting date for each of the three Phases.[18] For all three Phases, the average daily trading volume fell by about a half over the entire period July 2002 to December 2006. While this volume drop may be due to TRACE, we cannot, at this point, exclude the possibility that there is a pre-existing downward trend in volume independent of TRACE.

To focus on changes in the immediate time period surrounding dissemination, the first section of Table 3 reports the mean and quartiles of daily volume for the period 90-days before and 90-days after the beginning of each Phase.[19] Table 3 shows the mean trading volume is lower in the 90-day period after the start of each Phase than in the 90-day period before each Phase. The declines in Phases 2 and 3A are not as large as that for Phase 3B, where the average 90-day trading volume falls 41.9%. For Phase 2 and 3A, the percentage declines are 4.9% and 5.5%, respectively.

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[17] Figure 1 does not include trading days that SIFMA recommends that bond dealers take off or operate for less than a full day. Additionally, Figure 1 does not include the two weeks spanning Christmas and New Year's Day due to significantly reduced volume.

[18] Bonds in Phase 1 are not plotted in Figure 1 because of scaling. Phase 1 bonds have an average daily volume of 7,513,772 for the sample period.

[19] Since bonds trade infrequently, we use a 90-day window to capture changes in trading behavior. In Table 4, we also look at 30- and 60-day windows.

Table 3 also shows how skewed the distribution of trading volume is across our sample. The mean trading volume in Phases 3A and 3B is roughly 100 times greater than the medians in the period before dissemination. In addition, more than half of the Phase 3B bonds do not trade in the 90 days after dissemination. Moreover, the average trading volume for Phase 1 bonds is more than 50 times greater than the average trading volume for Phase 3B bonds for the post 90-day period. Taken together, these facts suggest substantial heterogeneity in trading volume within and across our bond samples.

These differences in trading volume across Phases may be due to difference in bond issue sizes. A larger bond issue may generate more after-market trading simply because there are more bonds to trade. As shown in Table 2, the mean issue size of Phase 1 bonds is almost six times greater than those in Phase 2. Phase 2 bonds' mean issue size is three times those of bonds in Phase 3A. Comparing median issue sizes in Table 2 across Phases sometimes leads to even larger differences. For example, the median issue size in Phase 2 is $200 million, while the median issue size in Phase 3A is $12 million.

To address the issue of whether the difference in volume across Phases is driven by differences in issue size, we next examine volume divided by issue size. Figure 2 plots volume divided by issue size for each of the four Phases. While the time-series of volume/issue size in Figure 2 follows the time-series for volume in Figure 1, dividing volume by issue size makes the plots of trading activity for Phases 2, 3A, and 3B closer to one another than volume alone. In addition, the second section of Table 3, which reports statistics on volume/issue size by Phase, reinforces this conclusion.[20] Normalizing by issue size reduces the skewness in comparisons both within and across Phases. Comparing within Phases, the mean of volume/issue size in Phases 3A and 3B is four and 18 times the median respectively. This compares to a ratio of about 100 for volume as discussed above. Comparing across Phases, the mean of volume/issue size in Phase 1 is eight times that in Phase 3B in the 90 days after dissemination. This compares to 50 times when using volume. Consequently, the remainder of the paper reports volume/issue size as our primary measure of trading activity. We also conduct the entire analysis using volume alone, but to save space we only report those results when discussing alternative measures of trading in Table 6.

Table 3 also reports a within-bond metric, by computing the fraction of bonds for which trading volume increases, decreases or remains the same in the 90 days before and after the Phase initiation date. Since the comparison is before vs. after for a given bond, the numbers are identical whether using volume or volume/issue size. Phase 3B bonds show a pronounced decline in trading activity in the within-bond comparisons. 45.1% of Phase 3B bonds have more trading volume before dissemination, while 15.2% of Phase 3B bonds have more trading volume afterwards. A large percentage of Phase 3B bonds, 39.7%, do not trade in the 90-days before or after the beginning of the Phase. The within-bond results for Phase 2 bonds also show a decline but not as much, from 51.4% to 43.7%. The results for

[20] An alternative normalization would be log volume. As seen in Table 3, this is infeasible since volume is equal to zero for many bonds in the 90 days surrounding the Phase starts.

Phase 3A are mixed. The fraction of bonds with higher volume post dissemination is slightly greater than for before dissemination, however, the mean volume declines from the period before to after.

Price Dispersion

We also examine the impact of transparency on price dispersion. We begin by focusing on the daily price standard deviation, defined for bond i on day t as

$$\sigma_{it} = (\sum_j (p_{ijt} - p_{it})^2)^{½}, \tag{1}$$

where p_{ijt} is the price of bond i for trade j on day t and p_{it} is the average price of bond i on day t. We focus on price standard deviation because it does not depend on assumptions about the relationship between transaction prices and order flow. We examine other measures of price dispersion in Section 6. All measures of daily price standard deviation are in units of dollars.

To compute a daily price standard deviation, it is necessary to observe at least two bond trades in a day. Given the lack of trading in many bonds, we often do not observe two trades.[21] Further, to measure the effects of dissemination on price dispersion, we require that there is at least one daily price standard deviation observation both in the 90 days before and in the 90 days after the bond's change in dissemination. As a result, the number of bonds used in our price standard deviation analysis is substantially smaller than the number used in the volume analysis. This can be seen in Table 3's sample counts for each Phase. For example, only 57.0% of Phase 3A and 40.0% of Phase 3B bonds in the volume sample are also in the price standard deviation sample. Although not shown, the bonds for which we can compute price standard deviation tend to have a larger size at issue and higher rating than the volume sample.

There is a potential bias in our price standard deviation measure since the sample is defined based on trading behavior both before and after changes in dissemination. If dissemination causes an increase or decrease in bond trading, this may change the number of bonds for which we can compute price standard deviation. Thus, if the bonds that would have traded without dissemination substantially differ from the bonds that do trade with dissemination, then it may be difficult to interpret changes in price standard deviation.[22] This appears to not to be an issue for our sample.[23] To further investigate

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[21] Measures of transaction costs such as direct round trip or imputed transaction costs also present difficulties for less actively traded bonds since they require observing multiple trades within a short time horizon. For instance, Edwards, Harris, and Piwowar (2007)'s method requires that a bond trades at least nine times.

[22] This problem does not affect our volume calculations because when a bond does not trade, it counts as having zero trading volume.

[23] The probability that any of the Phase 2, 3A, or 3B bonds trade at least twice on a day in the 90 days before dissemination is 12.5%. To test whether this probability changes after TRACE, we estimate the effect of TRACE on the probability that a bond trades twice or more on a given day. The estimates come from a difference-in-difference regression similar to those estimated in Table 6, where the dependent variable is an indicator for whether a bond trades two or more times in a day. (The next section introduces our difference-in-difference

the robustness of our price standard deviation findings, in Section 6 we construct a matched sample of bonds holding constant the observable characteristics of bonds before and after dissemination.

Figure 3 plots the daily price standard deviation averaged by week from July 2002 through December 2006.[24] Just as with trading volume, there is a reduction in price standard deviation over the entire time period. In fact, the price standard deviation falls by over a half from July 2002 to December 2006. However, unlike trading volume, the decline in price standard deviation seems to initiate at TRACE's launch, and continues through 2005. Another pattern in Figure 3 is that price standard deviation, over the entire period, is usually highest for Phase 3A bonds, and is lowest for Phase 1. Furthermore, standard deviation for Phase 1 bonds is lower than for Phase 2 and Phase 3A in the early part of the sample period, but converges by the end of our sample period.

Table 3 also reports on price standard deviation in the 90-day window around when a bond changes its dissemination status. There is a reduction in price standard deviation, measured in dollars, for bonds in all three Phases. The average Phase 2 bond's price standard deviation falls from $0.83 to $0.76, a 8.4% reduction, while the median Phase 2 bond's price standard deviation falls from $0.67 to $0.65. The percentage of bonds with higher standard deviation before the start of Phase 2 is 56.6%. The drop in price standard deviation is even greater for Phase 3A and 3B bonds. The average Phase 3A bond's price standard deviation falls by $0.10, which is a 13.1% decrease, while the average Phase 3B falls by $0.20, which is a 30.8% decrease. The median bond's price standard deviation drops by $0.08 and $0.10, respectively. Column (5) of Table 3 shows that the number of bonds for whom the price standard deviation is greater beforehand is 59.6% and 63.5% for Phases 3A and 3B, respectively.

Thus, Figures 1, 2, and 3 and Table 3 show that TRACE coincides with a decrease in trading volume for Phase 3B bonds. Moreover, there are sharp reductions in price standard deviation in each of the three Phases within a short 90-day window surrounding dissemination. However, changes in either volume or price standard deviation are contemporaneous with an overall downward trend in trading

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methodology.) There is a statistically significant 0.37% reduction in the probability of trading for treated bonds across all three Phases.

Assuming that the likelihood of trading is independent across days, this implies that TRACE causes a negligible reduction in the probability that a bond's price standard deviation can be measured across 90 calendar days. The estimated probability that a bond is no longer in the price standard deviation sample due to TRACE is less than 0.01%. This is calculated as follows: the probability that in any day among the 90 calendar days before there are at least two trades on the same day and that in any day among the 90 calendar days after dissemination there at least two trades on the same day is equal (1-(1-Pr(at least two trades on day))^64) * (1-(1-Pr(at least two trades on day))^64), where 64 is the average number of trading days among 90 calendar days. The 0.37% reduction in the probability of at least two trades on a day from estimated probability of at least two trades before TRACE of 12.5% yields a 0.01% reduction in the probability that a bond will be in price standard deviation sample due to TRACE.

[24] Following Figure 1, Figure 2 does not include trading days that SIFMA recommends that bond dealers take off or operate for less than a full day and does not include the two weeks spanning Christmas and New Year's Day.

activity and in price standard deviation during our sample period. As a result, we cannot immediately conclude that any changes or lack of changes are the result of TRACE alone. Our next task is to adjust for market trends.

IV. Research Design and Main Results

IV.A Differences in Differences Framework

Although the before-and-after comparisons in Table 3 show that price standard deviation falls for bonds in all Phases and trading volume declines for Phase 3B bonds, a before-and-after comparison is not sufficient to attribute the changes to dissemination alone. We adjust for market trends by comparing the changes in the treated sample to those in a control group by estimating differences-in-differences models of the form:

$$y_{it} = \alpha + \gamma_0 \text{ Disseminate}_i + \gamma_1 \text{ Post}_t + \lambda \text{ Disseminate}_i \times \text{Post}_t + \varepsilon_{it,} \quad (2)$$

where y_{it} is bond i's outcome (i.e., measures of trading activity or price dispersion) on day t, Disseminate_i is an indicator for whether the bond changes dissemination status (i.e., is in the treated group) and Post_t is an indicator for the trade outcomes on days after the dissemination period. Since there are repeated observations per bond, in all estimates, the standard errors are clustered by bond.

In equation (2), any pre-existing difference between bonds that change dissemination status and those that do not are captured by γ_0. Any effects of dissemination that accrue to all bonds – that is, effects that are not limited to only bonds that change their dissemination status in the Phase – are absorbed by time effects γ_1. The coefficient of interest is λ, which estimates the direct effect of transparency on a bond's trading outcome. The coefficient λ reflects the change in trading outcomes for bonds that change dissemination status compared to the change in trading outcomes for bonds that do not change dissemination status. Estimates of λ, therefore, net out aggregate changes in bond trading outcomes.

It is possible that changes in dissemination will also affect bonds that do not change dissemination if the market impounds that information into all trading activity. Indeed, the overall downward trend in trading activity and price standard deviation in Figures 1 and 2 may be the consequence of TRACE's introduction in July 2002. However, we cannot assert that TRACE caused this decrease because we do not observe trading activity before Phase 1. The overall downward trend could instead be due to macroeconomic factors affecting the corporate bond market. For example, the Federal Reserve Bank raised interest rates 17 times from June 2004 through June 2006 (NASD 2006). In our regression equation, the time effects incorporate all of these potential factors, and therefore we cannot interpret the estimates of γ_1 as a causal effect of dissemination.

For λ to provide unbiased estimates of the causal effect of transparency there are several important necessary assumptions. First, transparency and its consequences must not have been fully anticipated by market participants; to the degree that impacts were foreseen by traders and dealers, the impacts on trading activity and price dispersion would appear before the actual change in dissemination status. If all trade outcomes responded immediately at Phase 1, our TRACE results for Phases 2, 3A, and 3B would only measure the incremental impact of later Phases of TRACE. Bessembinder, Maxwell, and Venkataraman (2006) first emphasized this point when they argued that TRACE's initiation affected all bonds, not only those in Phase 1. In this case, our estimates understate the true impact of TRACE. (In Section VII, we investigate Phase 1 using a separate data set from the National Association of Insurance Commissioners.)

It seems unlikely that the effects of TRACE occurred in their entirety at the beginning of Phase 1. Even though TRACE started collecting information on trade activity for all bonds from July 1, 2002, the schedule of when transaction data would be disseminated remained uncertain. The timing of the expansions was not initially known and took place incrementally, depending on both FINRA and SEC approval. For example, FINRA, then NASD, approved Phase 2 on November 21, 2002, but the SEC did not approve it until February 28, 2003. Phase 2 was implemented on March 3, 2003. Thus, participants knew in advance that dissemination would expand, but they did not exact timing until shortly before it occurred.

The second assumption for λ to be a causal estimate is that there are no other changes simultaneous with the Phase start date that affects the trading activity for those bonds changing dissemination status. That is, in equation (2), the interaction between Disseminate and Post is uncorrelated with other unmeasured factors that affect trade activity that change at the same time as the change in dissemination status (but are not caused by the change in dissemination status). There are trends in the bond market trading during our time period, but we are unaware of any changes to bond market trading that coincide with the Phase start dates.

Finally, a third assumption is that we can measure the counterfactual difference in bond trading with the bonds that do not change dissemination status. That is, we assume that the change over time in control bonds' behavior reveals what would have occurred to treated bonds if there had been no change in their dissemination status. Note this assumption does not mean that control bonds must have the same characteristics as treated bonds, but rather that the change in their behavior captures the counterfactual time path. This is important because our treated bonds have different attributes than our control bonds by definition. FINRA selected bonds for Phases based on characteristics such as ratings and issue size. For instance, Phase 2 bonds are investment grade and have an original issue size of at least $100 million. Hence, our third assumption will be violated if the bond trading activity varies substantially over time due to different bond characteristics. We examine the sensitivity of our results to these three assumptions in the next section.

To estimate equation (2), there are two implementation decisions. First, it is necessary to specify the estimation window. Since bonds trade infrequently, a longer time window may be needed to observe changes in trading activity. A longer time window, however, may lead us to misattribute the effect of a change in dissemination to underlying market trends. For these reasons, we report estimates of equation (2) for three different estimation windows covering 30, 60, and 90 days surrounding the Phase start dates.

The second implementation decision is how to define the control bonds for any Phase for these regressions. Because of the four distinct TRACE Phases, there are several possibilities for defining control bonds. Control bonds can be defined as bonds that were already disseminated before the Phase begins. For example, to measure the impact of transparency on Phase 2 bonds, we can compare the trading behavior of Phase 2 bonds with the trading behavior of Phase 1 bonds. Alternatively, a control group can be defined as bonds that are disseminated in a later Phase. For example, for Phase 2 bonds, the control group could be Phase 3A and Phase 3B bonds.

We defined our control group several ways, both including Phase 1 bonds that were already disseminated and also excluding Phase 1 and only including bonds from later Phases that were not disseminated. We find that including or excluding Phase 1 bonds does not change our results in any meaningful way. With the exception of our robustness tests in Table 6, our Tables all use Phase 1 bonds in the control groups.

Another issue with control groups that we must confront is that Phase 3A and Phase 3B occur just over four months apart, on October 1, 2004 and February 7, 2005, respectively. If we use a 90-day window before and after a Phase to capture the effects of dissemination, the post-dissemination trading of Phase 3A overlaps with the pre-dissemination trading of Phase 3B. Therefore, we do not use Phase 3B bonds as controls for Phase 3A bonds, and vice versa. When we present the analysis below, we use the bonds in Phases 1, 3A, and 3B as control bonds for Phase 2, and we use the bonds in Phases 1 and 2 as control bonds for Phases 3A and 3B.

IV.B Estimates

Table 4 reports estimates of equation (2) for 30, 60, and 90-day windows for bonds in Phases 2, 3A, and 3B, separately. It also reports pooled estimates, based on equation (2), with data stacked across the three Phases. That is, there are separate intercepts α for each Phase and γ_0 and γ_1 is also allowed to differ by Phase, while λ does not differ by Phase.

The estimate of the effect of TRACE on trading volume/issue size, pooled across all three Phases, is negative and significant for all three estimation windows. Across all Phases, volume/issue size (in percent, i.e., multiplied by 100) drops by 0.027 in the 90-day window around dissemination, which is significant at the 1% level. This is a 15.2% reduction from 0.178, the average level before dissemination. Across Phases, the only statistically significant reduction in volume/issue size for all estimation windows is for Phase 3B, which is significant at the 1% level.

In the 90-day window, TRACE reduces the average volume/issue size (in percent) for Phase 3B bonds by 0.074. This represents a 41.3% drop from the average level before dissemination. These findings reinforce the within-bond comparisons reported in column (9) of Table 3, which shows that three times as many bonds in Phase 3B have lower volume after dissemination than before.

Price standard deviation, reported in columns (6), (7) and (8), drops significantly (at the 1% level) after dissemination for all estimation windows, and for both the pooled sample and each Phase separately. In the 90-day window the pooled estimate of the reduction in price standard deviation is 7.7 cents and is highly significant. Across the Phases, the smallest 90-day drop is for Phase 3A bonds. These bonds experience a significant reduction of 5.9 cents in their daily price standard deviation, which represents a 6.5% decrease relative to before the start of the Phase 3A. The largest drop is for bonds in Phase 3B. These bonds experience a significant reduction by 16.8 cents, which corresponds to a 24.7% reduction from the previous level. This pattern mirrors those the price standard deviation results in the within-bond comparisons reported in Table 3.[25]

In summary, the estimates in Table 4 suggest that transparency causes a significant reduction in volume/issue size for Phase 3B bonds. In addition, daily price standard deviation falls significantly across all Phases. Since for each Phase our results are more precisely estimated at the 90-day window than at the 30 or 60-day window in subsequent tables, we report estimates from the 90-day estimation windows.

V. Timing, Robustness, and Other Measures of Trading Activity and Price Dispersion

In this section, we revisit the assumptions underlying the differences-in-differences estimates above and report estimates for other measures of trading activity and price dispersion.

V.A Event Study and Time Windows

Table 4 does not tell us how long it takes for the market to react to a change in dissemination. Changes may be immediate if market participants anticipate the effects of dissemination in advance of Phase start dates. On the other hand, changes due to dissemination may occur with delay because of adjustment costs, such as rebalancing inventories, faced by market participants. Delays may also occur if participants require time to utilize the newly available data. Moreover, the relative infrequency of bond trading may make it difficult to detect the effects of dissemination in short estimation periods.

To examine when the effects of dissemination begin, we estimate an "event-study" version of the regression model that allows the effects to differ by one-week intervals:

$$y_{it} = \alpha + \gamma_0 \text{ Disseminate}_i + \gamma_w \, x \text{ One-Week Interval}_t + \lambda_w \text{ Disseminate}_i \, x \text{ One-Week Interval}_t + \varepsilon_{it,} \qquad (3)$$

[25] The mean daily price standard deviation in column (5) of Table 4 is not identical to the mean daily price standard deviation in column (1) of Table 3. In Table 3, we compute the average daily price standard deviation, equally weighted by bond. In Table 4, we compute the average daily price standard deviation without weighting by bond, and cluster by bond in the regression. Since we require at least two trades on a day to calculate daily price standard deviation, unlike volume, we do not observe price standard deviation for each day and, hence, the calculated daily price standard deviation differs between Table 3 and 4 due to weighting. The measured daily price standard deviation in Tables 3 and 4 are close, and the relative sizes by Phase are similar.

where the One-Week $Interval_t$ is an indicator of whether day t is in week w. Equation (3) is estimated for each Phase separately. γ_0 captures any pre-existing difference between disseminated and non-disseminated bonds, while γ_w captures the overall trend in trading outcome in week w.

The estimate of λ_w is the amount by which the average newly disseminated bond deviates in trading outcome (either volume/issue size or price standard deviation) from control bonds during the one-week interval w. If there is a trend in the market that only affects bonds that change dissemination status, it should be reflected in the relative levels of λ_w. For example, if volume in newly disseminated bonds is trending down in the time period before a change in dissemination, the λ_w's will be higher before than after. Since the estimates of λ_w are based on one-week contrasts, they will be estimated less precisely than models which impose a common effect for the period before and a separate common effect for the period after as in equation (2).

Figure 4 plots values of λ_w for trading volume/issue size for each week by Phase. We adopt the convention that week 0 includes the dissemination date and the six calendar days following it. We normalize λ_w to be zero in the week before the change in dissemination (i.e., week -1) and we add a vertical line to the plot for that week.[26] The patterns in Figure 4 for Phase 2 and 3A are consistent with the results in Tables 3 and 4. Volume/issue size is not affected by transparency for bonds since there is no shift in the level of coefficient estimates after dissemination in the Figure.

The Phase 3B plot in Figure 4 shows a sharp and significant drop in volume/issue size from the week immediately preceding dissemination to the first week after it. This suggests that the negative volume/issue size results for Phase 3B in Tables 3 and 4 are caused by dissemination and occur shortly after Phase 3B starts. In addition, for Phase 3B, the level of trading activity remains lower for the 12 weeks after dissemination begins. This persistent reduction is consistent with the Table 4 Phase 3B differences-in-differences estimates for 30, 60, and 90-days being similar.

For price standard deviation, the event study plots in Figure 5 show a clear drop at dissemination for all three Phases. The coefficients for each Phase are at or above zero before dissemination, and are clearly below zero after dissemination. Importantly, there is a pronounced drop in price standard deviation between week -1 and the first week of dissemination in each of the three Phases. The absence of visual evidence of trends provides support for a causal interpretation of TRACE's effect on price standard deviation.

In summary, the event-study plots in Figure 4 show a volume effect only for Phase 3B bonds, while Figure 5 shows a decline in price standard deviation for all three Phases. Furthermore, there is no pre-trend in price standard deviation for newly disseminated bonds. This fact provides support for our identification assumptions of incomplete anticipation and no simultaneous non-dissemination related changes in the bond market. Moreover, a large percentage of the overall effect for price standard deviation occurs immediately after dissemination.

[26] Since the event study includes the period from 90 days before and 90 days after day 0, there is one fewer calendar day in week -13.

V.B Time Trends

Another assumption underlying the differences-in-differences estimates is common parallel trends. That is, we assume that if treated bonds had not changed their dissemination status, their trading behavior would follow the same trajectory as the control group bonds. However, it is possible that trading outcomes for treated bonds follow different trajectories than control bonds. As discussed above in Section IV, one reason for this possibility is that the control bonds have different characteristics than treated bonds, particularly since FINRA uses size and credit ratings to determine Phase classifications.

To relax the common trends assumption, in Table 5, we estimate specifications allowing the trade outcomes for bonds to evolve over time depending on whether they are investment-grade or not. Specifically, we estimate models with linear and quadratic time trends by including Phase-specific quadratic functions of time in equation (2) as follows:

$$y_{it} = \alpha + \gamma_0 \text{ Disseminate}_i + \gamma_{01i} \text{ Investment Grade}_i \, t + \gamma_{02i} \text{ Investment Grade}_i \, t^2 + \gamma_1 \text{ Post}_t + \lambda \text{ Disseminate}_i \times \text{Post}_t + \varepsilon_{it,} \quad (4)$$

where Investment Grade_i is an indicator for bond ratings of BBB- and above. For each Phase, the variable t starts at zero at the beginning of the time window. For the pooled estimate, we estimate separate Phase-specific trends.

Since equation (4) adds more flexible time trends to our differences-in-differences regression, we anticipate a reduction in the precision of the estimates in Table 5 compared to Table 4. The precision of each significant estimate in Table 5 column (2) is lower than that in Table 4 (which is repeated for convenience as column (1)). The pooled estimate of volume/issue size although smaller is still significant at the 5% level. The estimate for Phase 2 volume/issue size becomes insignificant with trends. Importantly, the estimate for Phase 3B remains significant at the 1% level.

When estimating equation (4) for price standard deviation, Table 5 column (6) shows that the results are robust to the addition of trends. For each Phase separately, as well as pooled, the estimates remain negative and significant at the 1% level.

V.C Control Groups

We also address the robustness of the Table 4 results by considering two variations on the control group. First, we eliminate Phase 1 bonds from the control group. As discussed above, Phase 1 bonds are larger and more actively traded than bonds in any other Phase. It is therefore possible that the change in trading behavior of Phase 1 bonds does not provide an adequate counterfactual for bonds that change their dissemination status. In columns (3) and (7) of Table 5, we report estimates for volume/issue size and price standard deviation where Phase 1 bonds are not used as controls. This means that for Phase 2, the control bonds are from Phase 3A and 3B. For Phase 3A and 3B, the control bonds are from Phase 2. The estimates reported in columns (3) and (7) are nearly identical to our base results in columns (1) and (5), respectively.

Second, we construct a matched sample, restricting the treated sample to bonds for which there is a suitable control bond with similar pre-treatment characteristics. The pre-treatment bond characteristics we use to construct the matched sample are issue size, credit rating at Phase start, time to maturity at Phase start, and years since issue at Phase start.[27] To construct the matched sample, we divide the sample (which includes Phase 1 bonds) by issue size into four quartiles. For the other three characteristics, we divide in two groups: investment grade and high-yield, above and below the median time to maturity, and above and below the median years since issue. This results in 32 potential cells for each Phase. We exclude a cell if there are either fewer than 5 treated bonds or fewer than 5 control bonds. When we define the matched sample using our four bond characteristics, we cover 99.6% of Phase 2 bonds in our volume sample, but for Phases 3A and 3B the treated sample is only 41.1% and 28.3%, respectively for volume/issue size. For price standard deviation, we cover 99.9% of Phase 2 bonds in our price standard deviation sample, 47.7% of Phase 3A bonds, and 28.8% of Phase 3B bonds.

The estimates for the matched-sample differences-in-differences regression are in columns (4) and (8) of Table 5. To control for bond attributes, we add a dummy variable for each cell to equation (2), and interact the cell dummy with Post and treated. Their inclusion means that our estimates are a weighted average of the within-cell differences-and-differences estimates. For the matched sample, the volume/issue size estimates in column (4) for the pooled sample and Phase 3B remain negative and significant. Thus, the negative and significant effect of dissemination on volume/issue size documented in Table 4 for Phase 3B and the pooled sample is robust to the alternative specifications in columns (2)-(4).

The price standard deviation results for the matched sample in column (8) are similar to those in columns (5)-(7) for the both the pooled and Phase samples. The only difference worth highlighting is that for Phase 3B, the effect on price standard deviation is no longer significant. This reduction in significance may be due to the small sample size of only 325 treated and 1,582 control bonds. Thus, examining columns (5)-(8) of Table 5 shows that the negative and significant effect of dissemination documented in Table 4 is robust across all alternative specifications for the pooled sample, and Phases 2 and 3A. The results are also robust for two of the three alternative specifications for Phase 3B.

V.D Alternative Measures of Trading Activity and Price Dispersion

Trading Activity

So far, we've focused our investigation on volume/issue size and price standard deviation as the measures of TRACE's impact on bond trading. Next, we consider some alternative measures of trading activity and price dispersion in Table 6 and 7, respectively. Both Tables report estimates from the

[27] We eliminate bonds that are unrated from the matched sample.

differences-in-differences regressions with 90-day windows used in Tables 4, but with different outcomes.

As described above, TRACE proponents expected that transparency would increase trading activity, expand market participation, and attract greater retail interest. [28] In Table 6, we consider volume (not normalized by issue size), the probability of trade, the probability of a large trade, the number of trades, and the average trade size. The probability of trade is the percentage of days a bond trades during our sample period. The odd-numbered columns of Table 6 report the average value of the dependent variable for treated bonds in the 90 days before dissemination. The even numbered columns report the differences-in-differences estimate for each of the outcomes.

Before turning to the effects of dissemination on alternative measures of trading activity, we note some important differences in trading activity across Phases in means reported in the odd-numbered columns in Table 6. Trade sizes for Phase 3B bonds are quite large, but Phase 3B bonds trade infrequently. For instance, the average trade size for Phase 3B bonds is 1,205,940, which is much larger than Phase 2 bonds and more than twice the average size of Phase 3A bonds. Despite this larger trade size, volume for Phase 3B bonds is much smaller than Phase 2 bonds, and approximately the same size as Phase 3A bonds. This is explained by the much lower probability of trading for Phase 3B bonds.

Dissemination causes a significant reduction in volume for the pooled sample and for Phases 3A and 3B separately as seen in column (2). For the pooled sample, there is 17.2% percent reduction in volume / issue after dissemination, significant at the 1% level. For Phase 3A bonds, the reduction is 28.7%, while for Phase 3B bonds, the reduction is 26.8%, both significant at the 5% level. The percentage reduction volume for in Phase 3B is not as large as the percentage reduction in volume/issue size in Table 4 and the significance level is lower. This difference may be due to greater skewness for trading volume, caused by idiosyncratic large trades, compared to volume/issue size when Phase 1 are included in the controls. Although not shown in the Table, when we eliminate Phase 1 bonds from our differences-in-differences regression on volume, only the Phase 3B and pooled estimates are negative and both are significant at the 1% level.[29]

In the next two columns of Table 6, we fit models of the probability of any trade and the probability of a trade over $1 million in size. In the Public TRACE dataset, TRACE censored the reporting of trades greater than $1 million (for high-yield) and $5 million (for investment grade). This was due to objections from dealers and certain institutional market participants who claimed that it would be possible to infer their trading positions from the release of large trade sizes and therefore place them at a competitive disadvantage.

Our estimates for the probability of any trade indicate that in the pooled sample, TRACE reduces trading. However, there are significant opposite patterns by Phase. The probability of trade for Phase 2

[28] FINRA defines retail trades as $100,000 or less (Ketchum 2012).

[29] The estimate for Phase 3B volume without Phase 1 as a control is -96,507.7, similar to our estimate of -98,343.6 in Table 6, but the standard error is 19,386.6, much below the standard error in Table 6 of 45,222.4.

bonds decreases significantly at the 1% level, the probability of trade for Phase 3A bonds increases significantly at the 1% level, and the probability of trade in Phase 3B decreases significantly at the 10% level. When we measure of probability of trades over $1 million in size, the effect for Phase 3A is no longer significantly positive, but the effect for Phase 2 and 3B remain significantly negative. For Phase 3B, the reduction in the probability of a large trade is -0.012, which is a 23.1% reduction from the mean level of 0.052. Thus, these two findings suggest that TRACE's influence on participation, as measured by probability of trade, is not positive as proponents anticipated.

The results for the number of trades are also similar to that for volume/issue size. In column (8), the change in the number of trades for the pooled sample and Phase 3B is negative and significant at the 1% level. Interestingly, the 0.49 reduction in the number of trades in Phase 3B of is greater than the mean number of trades, 0.30, prior to dissemination. The reason for this is that the number of trades for Phase 3B bonds which trade most frequently experience a greater reduction than the number of trades for Phase 3B bonds which trade infrequently.[30]

We also examine average trade size in columns (9) and (10). Those results repeat the pattern of a significant decline for the pooled result and for Phase 3B. It's worth noting that trade sizes are larger for Phase 3B than in any other Phase. The reduction in trade sizes occurs even though certain infrequently traded Phase 3B bonds were subject to delayed dissemination if their transaction size was $1 million or greater.[31] These results imply that the decline of large trades in Phase 3B play a large role in our overall volume findings.

Finally, in unreported tabulations, we also find that TRACE does not increase the likelihood of retail size trades. For instance, the pooled estimate for the probability of a trade less than $100,000 is 0.000 with standard error 0.00128. In Phase 2, the estimate is significantly negative, -0.0127 with standard error 0.00218. Hence, TRACE did not increase the likelihood of retail size trades.

In summary, the results in Table 6 show that volume, probability of a large trade, number of trades, and trade size follow the same pattern as volume/issue size. Thus, TRACE does not appear to have increased market participation even from retail investors.

Price Dispersion

A weakness of our daily price dispersion measure is that since we require at least two trades in a day, it cannot be computed for all bonds. It is possible that TRACE also affects price dispersion for bonds that do not trade at least twice a day. To examine this possibility, in Table 7, we consider three

[30] In an unreported analysis, we further investigated the reduction in the number of trades. There is a gradient in the percentage reduction in the probability that a bond trades multiple times a day. The percentage reduction in the likelihood of trading at least 20 times a day is greater than the percentage reduction at least 10 times a day, which in turn is greater than the percentage reduction in the probability of trading at least 5 times a day.

[31] An infrequently traded bond is one that does not average one or more trades per day over last 20 business days of a 90-day period determined each quarter by NASD.

additional measures of price dispersion: the intra-day absolute spread (max price minus min price)[32], the price standard deviation of all trades in 10-day windows, and the price standard deviation of all trades in 30-day windows. Using the 10-day and 30-day price standard deviation increases our sample sizes slightly. For instance, with the 30-day measure our coverage of Phase 3A bonds is 63.0% and Phase 3B bonds is 42.1% compared to 57.0% and 40.0% respectively with the intraday measure.

The results on other measures of price dispersion in Table 7 confirm the price standard deviation results in Tables 4 and 5. Every measure for the pooled sample and for each Phase is negative and significant. As with daily price standard deviation, the largest effect of dissemination occurs in Phase 3B for all three measures of dispersion. For the absolute spread, a reduction of 39.7 cents represents 28.6% of the average spread pre-transparency. This percentage reduction is similar to the 24.7% reduction for daily price standard deviation. Thus, transparency reduces price dispersion for four different metrics for all Phases.

VI. Heterogeneity in Credit Rating and Issue Size

While the price dispersion results are consistent across all Phases, the results on trading activity differ for Phase 3B. What is different about the bonds in Phase 3B? FINRA selects the bonds in each Phase using credit rating, issue size, and trading activity. Examining credit rating and issue size in Table 2 shows that Phase 3B differs from the other Phases because it is the only Phase with a majority of high-yield bonds. However, there is some overlap of credit rating and issue size between Phases, making it possible to identify whether credit rating or size is the main determinants of the Phase 3B results.

In Table 8, we pool the Phases, and split the treated sample by credit rating and issue size. We split credit ratings into investment grade, BBB- or above, and high-yield, BB+ or below. We split issue size into bonds with issue size less than or greater than or equal to $100 million. These criteria follow FINRA's breakpoints for Phase 2 classification. The control bonds remain the same across columns. The overlap between Phases on credit quality and issue size is shown in Table 8. For the 3,164 high-yield bonds in our sample, 634 are from Phase 3A, while the remainder is in Phase 3B. For 9,087 bonds with issue size less than $100 million, 677 are from Phase 3B, while 8,410 are from Phase 3A and 10 are from Phase 2. Thus, pooling the high-yield sample amounts to combining most of Phase 3B with a portion of Phase 3A, while pooling the small issue size sample amounts to combining most of Phase 3A with a portion of Phase 3B.

The effect of dissemination on volume/issue size on high-yield bonds is a highly significant -0.057, while it is a smaller and less significant -0.013 for investment grade bonds, as shown in columns (1) and (2) of Table 8. This 4.4 ratio of effects represents a statistically significant difference as shown by the p-value from the Chi-square test reported below the estimates. Turning to issue size, the effect of dissemination on volume/issue size is primarily driven by bonds with issue size ≥ $100 million. The estimate for bonds with issue size < $100 million is not statistically significant and close to zero. This is

[32] Using equity data from TAQ, Corwin and Schultz (2012) demonstrate that intraday absolute spread is highly correlated with bid ask spreads and show that it also outperforms other low-frequency spread measures.

consistent with the results in Table 4, which show that Phase 3A bonds do not experience a reduction in trading activity. These bonds by definition primarily have issue size less than $100 million. Thus, the volume/issue size findings appear to be driven by low credit bonds or bonds with issue size ≥ $100 million.

To examine which feature is more responsible for driving the volume/issue size results, we next report a two-way split of the sample. In column (5) and (6), we split the investment grade sample into small and large issue size bonds. In column (7) and (8), we split the high-yield sample into small and large issue size bonds. The estimate for small investment grade bonds is not significant, but the estimate for large investment grade bonds is negative and significant. This estimate, however, is smaller than either estimate for high-yield bonds, which are both negative and similar in size for both small and large issue size bonds. Therefore, it appears that the results for volume/issue are affected more by credit ratings than issue size.

The second panel of Table 8 reports on price standard deviation split by ratings and issue size. Each of the estimates is negative and highly significant for all subgroups, but the reduction in price standard deviation is significantly larger for high-yield bonds than for investment grade bonds throughout. When examining issue size, the reduction in price dispersion is only slightly larger for bonds with issue size ≥ $100 million.

Thus, the reason the results on Phase 3B are different than the other Phases is largely because of the high proportion of high-yield bonds in that Phase. Although not shown, the other measures of trading activity in Table 6 and the measures of price dispersion in Table 7 decrease more for high-yield bonds than for investment grade bonds. Therefore, our initial question in this subsection of why the bonds in Phase 3B behave differently needs to be recast to ask why do high-yield bonds behave differently?

The fact that investment grade and high-yield bonds behave differently is not a surprise. Investment grade bonds trade near par except for price fluctuations due to market interest rate movements. This means that they can be treated as substitutes with one another within credit rating categories. High-yield bonds, even within the same rating category, are not as close as substitutes since they are subject to idiosyncratic, firm-specific risks.[33] Moreover, some market participants such as pension and mutual funds have rules restricting ownership of high-yield bonds. Furthermore, since investment grade bonds trade more frequently than high-yield, they are also less opaque. For instance, the probability of a trade on any given day (pre-TRACE) is more than three times higher for the investment-grade sample in Phase 2 compared to the mostly high-yield sample in Phase 3B. Given these differences, TRACE probably provided more incremental information on trading activity for high-yield bonds than for investment grade bonds.

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[33] Asquith, Au, Covert, and Pathak (2013) document significant differences between investment grade and high-yield bonds in the market for borrowing bonds.

In addition, the bond market is a dealer market, so dealer inventory will affect trading levels and the potential impacts of TRACE. Dealers only hold inventory in those bonds with sufficient trading activity to cover their carry cost. Thinly traded bonds may require dealers to have higher spreads to cover their holding costs. Since TRACE reduces price dispersion significantly, the benefit of holding bonds in inventory decreases. TRACE reduces price dispersion the most for high-yield bonds, so the incentive to reduce inventory is strongest for those bonds. Thus, lower trading activity in high-yield bonds post-TRACE may be the result of a supply-side response of dealers.

VII. NAIC

The evidence so far leaves open the question of TRACE's impact on Phase 1 bonds. TRACE data does not exist before July 2, 2002 when Phase 1 begins; therefore, our analysis of the effects of transparency using trades both before and after dissemination in TRACE is limited to Phases 2, 3A, and 3B. Phase 1 is important because, as discussed above in Section IV, dissemination of Phase 1 bonds may affect the corporate bond market behavior more broadly if transparency in part of the market influences trading in the rest of the market. As described in Section II, Bessembinder, Maxwell, and Venkataraman (2006) examine trading costs in Phase 1 using data from the National Association of Insurance Companies (NAIC). While the NAIC database is not as complete as TRACE because it only contains transaction data for insurance companies, the NAIC data begins in 1994.

In this section, we describe the NAIC data and use that database from January 1, 2000 through December 31, 2006 to examine the effects of Phase 1 of TRACE as well as to verify our results for Phases 2, 3A, and 3B. The NAIC database also contains information about dealer activity not available in TRACE, which we use to examine how TRACE affected dealer market share.

Before using the NAIC data, we first compare it to the TRACE data both for coverage and to determine whether insurance companies trade differently than the rest of the corporate bond market. According to the Federal Reserve's Flow of Funds statement, insurance companies own 24.6% of outstanding corporate bonds in 2002Q3-2006Q4.[34] While several other papers, notably Bessembinder, Maxwell, and Venkataraman (2006) and Campbell and Taksler (2003), have previously used NAIC data, to our knowledge we provide the first direct comparison of the two databases.[35]

The NAIC Data Appendix and Tables B1 and B2 describe the NAIC data and how it compares to the TRACE database. Importantly, in the process of making this comparison, we discovered a systematic error in how NAIC's trades are reported. Many NAIC trades are disaggregated and reported as multiple transactions in the NAIC database. Since previous research on the NAIC database (e.g. Bessembinder, Maxwell, and Venkataraman (2006)) do not mention this problem of disaggregation, we assume that

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[34] Campbell and Taksler (2003) estimate that insurance companies hold between one-third and 40% of corporate bonds.

[35] Bessembinder, Maxwell, and Venkataraman (2006) do divide the NAIC database into TRACE and non-TRACE samples, but do not compare trading by NAIC members to trading by non-NAIC members.

they treated these multiple transactions as multiple trades, when they are not. This leads to an over-reporting in the number of trades and an under-reporting of the true price dispersion.[36]

NAIC's reporting requirements require many individual trades to be split into separate records for reporting purposes. For example, insurance companies must separately report bonds purchased and sold in the same calendar year from bonds purchased and held through the end of the year. This means if an insurance company purchases $1 million par of a bond on January 1, 2001 and sells $500,000 of this before December 31, 2001 and the remaining $500,000 in the following year, under NAIC reporting guidelines, this single purchase would be split into two separate purchases of $500,000 each. If this is treated as two trades, volume is unaffected, but the number of trades is overstated and price standard deviation is understated. A more complete discussion of the misreporting of trades is explained in the NAIC Appendix.

Table B1 reports the steps we took to process the raw NAIC file into our cleaned NAIC database. We only use those bonds from the NAIC database that are also in the Cleaned Historical TRACE database for our analysis.[37] Because of the misreporting issue discussed above, Table B1 reports the total number of transactions from the NAIC database in the column labeled "Ungrouped Trades." It also reports an estimate of the true number of trades by grouping transactions with identical CUSIP, date, price, and counterparty into a single record with volume summed for the grouping. These are labeled "Grouped Trades" in a separate column in Table B1. The NAIC data appendix contains more details on this process. From July 2, 2002 to December 31, 2006, the clean NAIC database contains 14,574 bonds. There are 481,135 ungrouped trades, which correspond to 394,679 grouped trades. This compares to 21,217,807 trades on 30,958 bonds in the Cleaned Historical TRACE database over the same period.

Table B2 compares the cleaned NAIC and TRACE datasets by Phase and shows that insurance companies trade very differently than the rest of the corporate bond market for the same time period and universe of bonds.[38] It compares the number of bonds covered, the trading volume, the number of trades, and the trade sizes in both cleaned databases. A high percentage of Phase 1, Phase 2, and Phase 3B TRACE bonds are contained in NAIC (94.2%, 81.7%, and 72.7% respectively). NAIC contains 42.2% of Phase 3A TRACE bonds. NAIC volume, however, is much smaller percentage of TRACE volume for all Phases. For Phase 1 bonds, during the 90 days after the announcement of the Phase, the NAIC volume is 6.3% of comparable TRACE volume. For Phase 2, 3A, and 3B, NAIC volume is 11.5%, 7.2%, and 4.4% of TRACE volume respectively.

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[36] We do not know trade disaggregation changes Bessembinder, Maxwell, and Venkataraman's (2006) results. However, since Edwards, Harris, and Piwowar (2007) results are similar using TRACE data, we assume this issue does not change the results substantially.

[37] 45,902 bonds in the NAIC database are not in the Cleaned Historical TRACE database. A large fraction of these bonds are SEC Rule 144a bonds. SEC Rule 144A bonds are not covered by TRACE during our sample period.

[38] In order to examine trading in Phase 1 bonds before the start of Phase 1, we use NAIC data from the period January 1, 2000 until July 1, 2002. We only compare trading activity between the databases during the TRACE period, which starts July 2, 2002.

The number of NAIC trades is an even smaller percentage of TRACE trades for Phases 1, 2, and 3A. In Phase 3B, the percentage of trades in TRACE is lower than the percentage of volume. This means for Phases 1, 2, and 3A, TRACE trades are usually larger than rest of the market. Grouped NAIC trades are larger than TRACE trades, on average, by a factor of 4.1 in Phase 1, 2.1 in Phase 2, 2.2 in Phase 3A. Thus, NAIC is a small share of TRACE's volume and trades, but the average size of NAIC trades is often larger than the average TRACE trade.

Table B2 also compares price standard deviation between NAIC and TRACE. The standard deviation for NAIC trades is typically much smaller than for TRACE. This is true for each Phase using the ungrouped NAIC trade database, and is true for Phases 1, 2, and 3B using the grouped NAIC trade database. It's worth noting that the NAIC price standard deviation is measured using far fewer CUSIPS and bond-days. In Phase 2 for example, we measure TRACE price standard deviation for 2,130 CUSIPs and 40,713 bond-days, while we only measure it for 261 CUSIPs and 481 bond-days in NAIC using grouped trades. This restricts our ability to draw strong inferences about price standard deviation using the NAIC sample.

We conclude that the NAIC database represents a small fraction of the trading in the corporate bond market covered by TRACE. Summing volume across all four Phases in the 90-days after Phase start, NAIC volume is only 7.6% of total TRACE volume. NAIC trades are also typically larger than those in the TRACE database. It is therefore possible that the effects of transparency may manifest themselves differently in TRACE than in NAIC. As a consequence, conclusions drawn about TRACE from the NAIC dataset may not be representative of the overall corporate bond market.

Trading Activity and Price Dispersion using NAIC data

Table 9 reports volume/issue size and price standard deviation (both grouped and ungrouped) for 90 days before and after each Phase using the NAIC database. It also reports in column (9) coefficients from differences-in-differences regressions similar to those reported in Table 4. The Phase 1 differences-in-differences results in column (9) of Table 9 are not significant for either volume/issue size or price standard deviation. In addition, the within-bond comparisons, shown in columns (5) and (6), are mixed. That is, the fraction of Phase 1 bonds that experience a decrease in volume/issue size is greater than the fraction experiencing an increase, but the fraction of Phase 1 bonds that experience a decrease is price standard deviation is less.

There are several possible reasons for the lack of significant or consistent results for Phase 1. It may be that TRACE has no effect on Phase 1 bonds. It may also be that the insurance segment of the corporate bond market, which NAIC measures, behaves very differently than the remainder of the market. It may also be because the amount of trading captured by NAIC is so much smaller than the entire corporate bond market covered by TRACE, making it difficult to detect changes due to dissemination.

The results for Phases 2, 3A, and 3B provide further evidence on these alternatives explanations. The NAIC price standard deviation results in column (9) for Phases 2 and 3A in Table 9 are not significant, while all of our price dispersion results using the TRACE database found significant declines. Moreover, in Phase 3B, where the TRACE results on trading activity and price standard deviation are strongest, the corresponding NAIC estimates are marginally significant. Thus, the lack of significant Phase 1 NAIC results does not necessarily imply that TRACE did not have an effect in Phase 1.

Dealer Trading Activity

The NAIC database contains additional information not available in TRACE. In particular, it identifies the counterparty dealer opposite the NAIC member for each trade. Bessembinder, Maxwell, and Venkataraman (2006) use this data to examine dealer concentration ratios during Phase 1. Though it only represents dealer trades with insurance companies, this data provides an opportunity to measure how dealers are affected by dissemination. The NAIC Data Appendix describes how we compute trading activity by dealer. We employ our differences-in-differences design to examine dealer volume and the number of trades across all four Phases. We present results for both the top 4 and top 8 dealers. The top 4 dealers cover 37.9% of volume and 32.7% of trades. The top 8 dealers cover 68.4% of volume and 58.6% of trades.[39]

Table 10 reports differences-in-differences estimates of the effect of TRACE on dealer volume and number of trades. For each Phase, we compute the par value of trades and count the number of trades that a counterparty was party to during the 12 weeks before and after the Phase start. We examine weekly volume and number of trades because NAIC trades less frequently. Across Phases, there is a 15.3% reduction in par volume for each of the top 4 dealers due to TRACE and a 15.6% reduction for each of the top 8 dealers. When examining dealer volume estimates by Phase, there is a significant drop in volume traded for both top 4 and top 8 dealers in Phases 1, 3A, and 3B. There is also a reduction in Phase 2, but it is not significant. The analysis on the number of trades per dealer is similar.

Overall, the results indicate that trading activity between dealers and insurance companies is rebalanced away from the largest dealers due to TRACE. If this result holds for the entire corporate bond market, this would indicate that TRACE, although reducing overall trading activity, also leveled the playing field between the largest dealers and the remaining dealers.

VIII. Conclusions and Implications

The introduction of TRACE, which was implemented in four Phases over a three-and-a-half year period, combined with the availability of trading records before and after dissemination, provides a unique opportunity to study how markets respond to transparency. This paper finds that mandated post-trade transparency in the corporate bond market leads to an overall reduction in trading activity. No sample of bonds in any Phase experiences an increase in trading activity and Phase 3B bonds experience a large and significant reduction. For that group, TRACE reduces trading activity by 41.3% in

[39] We explored other divisions such as top 2, top 5, and top 10, but all of the results are qualitatively similar to what we describe herein.

the 90 days following the dissemination of price and volume information. This finding is robust across different measures of trading activity and alternative regression specifications. Event studies support a causal interpretation of our findings since the decrease occurs immediately after the start of dissemination.

Price dispersion also decreases due to TRACE. This decrease is significant across bonds that change dissemination in Phases 2, 3A, and 3B, but is largest, 24.7%, for Phase 3B bonds. This finding is also robust across different measures of price dispersion and alternative regression specifications. Moreover, event studies show that the fall in price dispersion occurs immediately after the start of dissemination. It is important to note, if the transparency introduced in Phase 1 affects bonds that become transparent in subsequent Phases, our estimates are probably lower bounds on TRACE's overall impact.

To further investigate how bond characteristics affect our results, we examine trading activity and price dispersion for samples with the same credit quality and issue size across Phases. We find that the credit quality is the most consistent factor in explaining the reduction in trading activity. High-yield bonds experience a significantly greater reduction in trading activity than investment grade bonds. Our results confirm the view that transparency has a limited impact on the trading activity of the most liquid and investment grade segment of the market. Moreover, our results show that ignoring the less actively traded and high-yield bonds in Phase 3B leads to an incomplete account of TRACE's effect on trading activity.

One possible reason TRACE has different effects on high-yield bonds is that pre-TRACE trading in high-yield bonds may be relatively more opaque than trading in investment-grade bonds. As a result, TRACE may provide more incremental information and thus cause larger change in the high-yield market. A second possible reason is that the lower trading activity in high-yield bonds post-TRACE may be the result of a supply-side response of dealers. Price dispersion falls more for high-yield bonds post-TRACE. In addition, high-yield bonds trade less frequently than investment grade bonds pre-TRACE. The fact that there is a large reduction of price dispersion for thinly traded high-yield bonds may result in lower spreads and thus cause dealers to hold less inventory. This in turn may result in a decrease in trading activity.

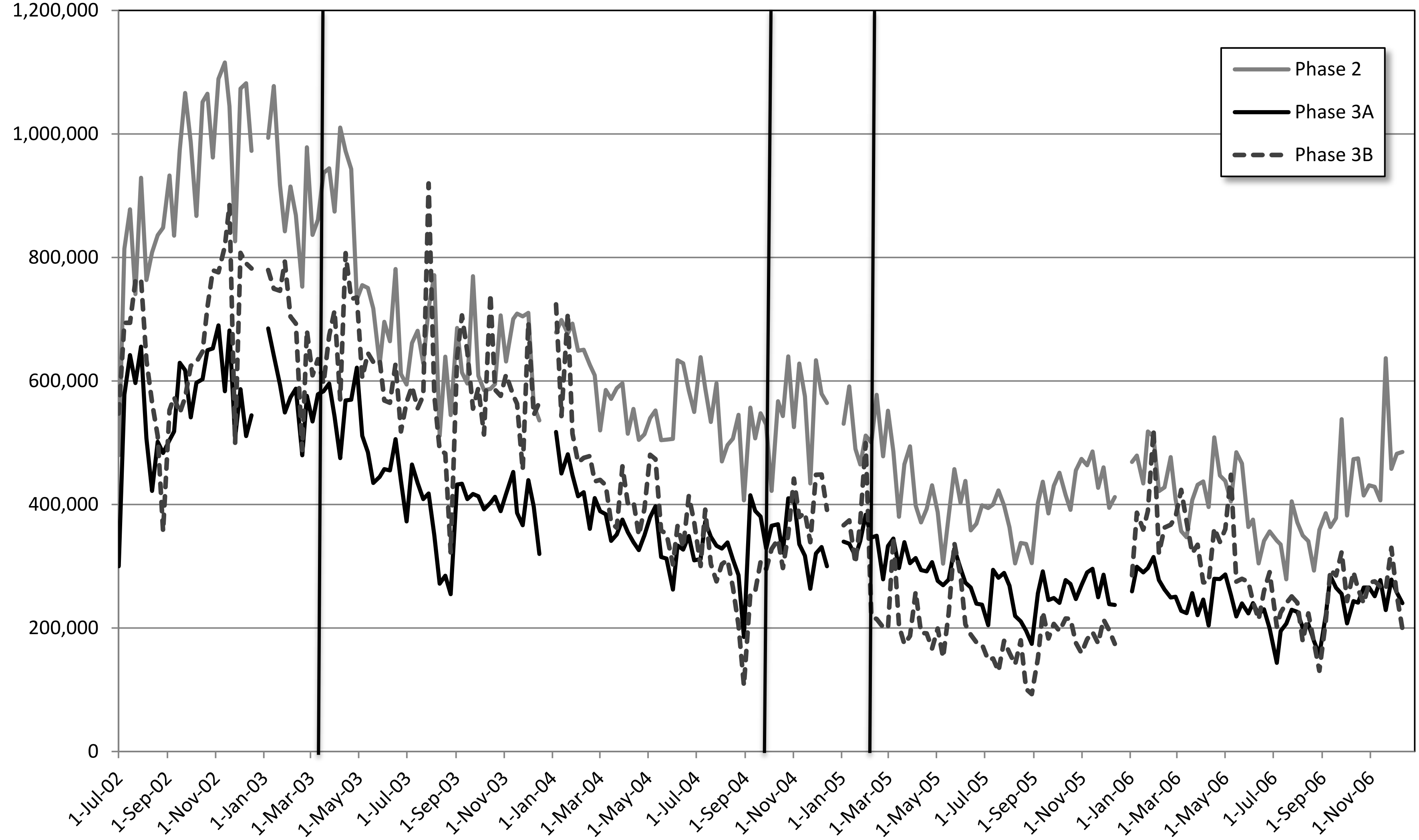
There are several welfare implications of increased transparency in the corporate bond market. One consequence is that it may change the relative bargaining positions of investors and dealers, allowing investors to obtain fairer prices at the expense of dealers. The reduction in price dispersion should allow investors and dealers to base their capital allocation and inventory holding decisions on more stable prices. Therefore, the reduction of price dispersion likely benefits customers and possibly, but not necessarily, dealers.

The implications of a reduction in trading activity are not as clear. Whether a reduction in trading activity is desirable depends on why market participants trade. A decrease in trading activity may be beneficial if much of the trading in a bond is unnecessary "noise" trading. On the other hand, if most trading is information-based, a decrease in trading activity may slow down how quickly prices reflect new information. In addition, if the decrease in trading activity is the result of dealers' unwillingness to hold inventory, transparency will have caused a reduction in the range of investing opportunities. That is, even if a decline in price dispersion reflects a decrease in transaction costs, the concomitant decrease in trading activity could reflect an increased cost of transacting due to the inability to complete trades.

Our results on the corporate bond market have two major implications for the current and planned expansions of mandated market transparency. The implicit assumption underlying the proposed TRACE extensions and the use of TRACE as a template for regulations such as Dodd-Frank is that transparency is universally beneficial. First, it is not clear that transparency for all instruments is necessarily beneficial. Overall, trading in the corporate bond market is large and active, although, as seen, not comparable across all types of bonds. Many over-the-counter securities are similar to the bonds FINRA placed in Phase 3B. That is, they are infrequently traded, subject to dealer inventory availability, and trading in these securities is motivated by idiosyncratic, firm-specific information. Therefore, the expansion of TRACE-inspired regulations, such as those for 144a bonds, asset- and mortgage-backed securities, and the swap market, may have adverse consequences on trading activity and may not, on net, be beneficial.

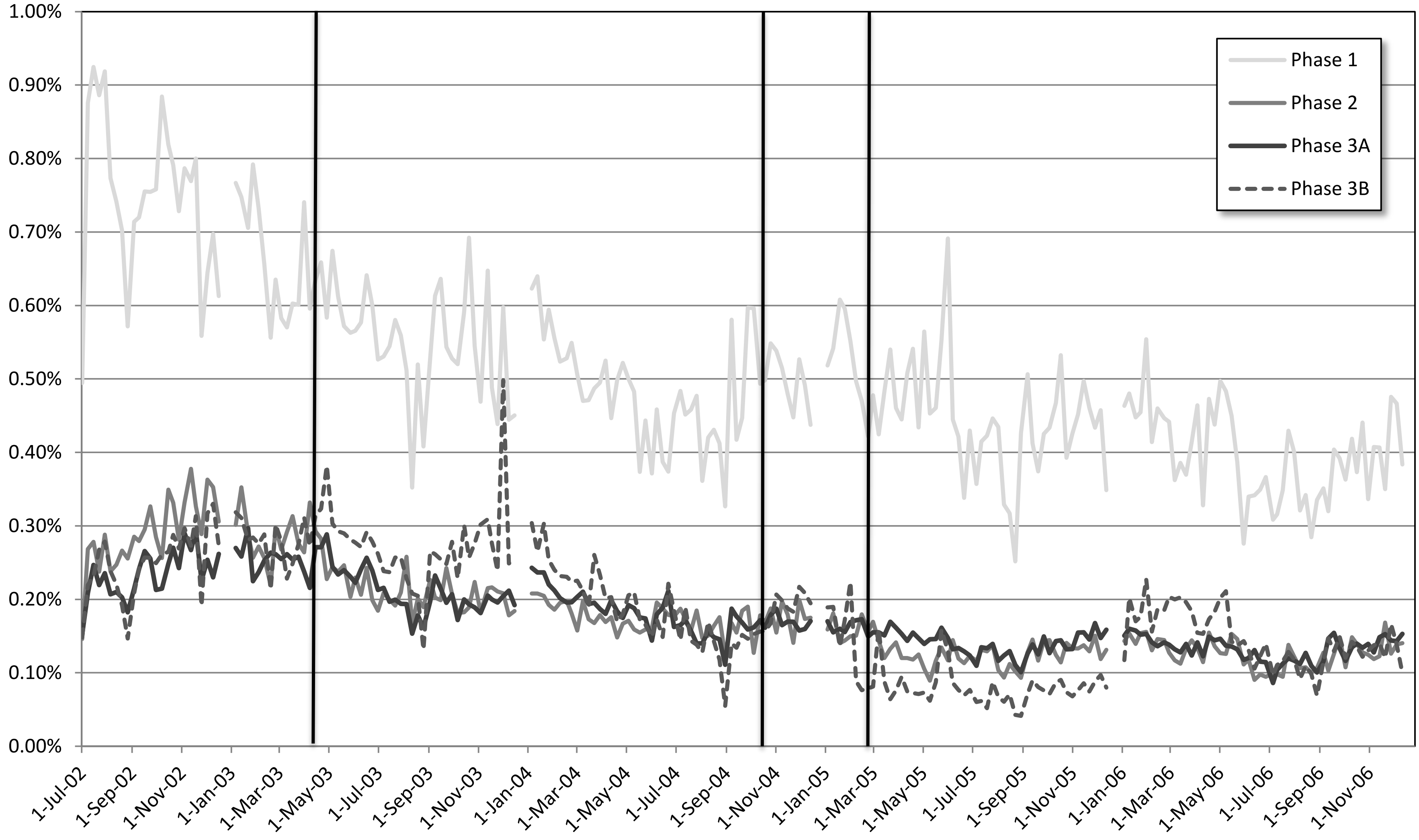
Second, our results indicate that transparency affects different segments of the same market in different ways. As a consequence, our results provide empirical support for the view that not every segment of each security market should be subject to the same degree of mandated transparency. Both academic commentators (French et al., (2010), Acharya et al. (2009)) and leading industry associations (e.g., Financial Services Forum, et al., (2011)) have articulated this position. Despite these recommendations, the expansion of transparency by the Commodity Futures Trading Commission (CFTC) in various swap markets, i.e. interest rate, credit index, equity, foreign exchange and commodities, in December 2012 and February 2013 was immediate for all swaps in those markets. This stands in sharp contrast to FINRA's cautious implementation of TRACE in Phases. The fact that the effect of transparency varies significantly across categories of bonds within the corporate bond market suggests that additional research will be required to evaluate the tradeoffs associated with universal transparency in other over-the-counter securities.

Figure 1. Weekly Trading Volume by Phase



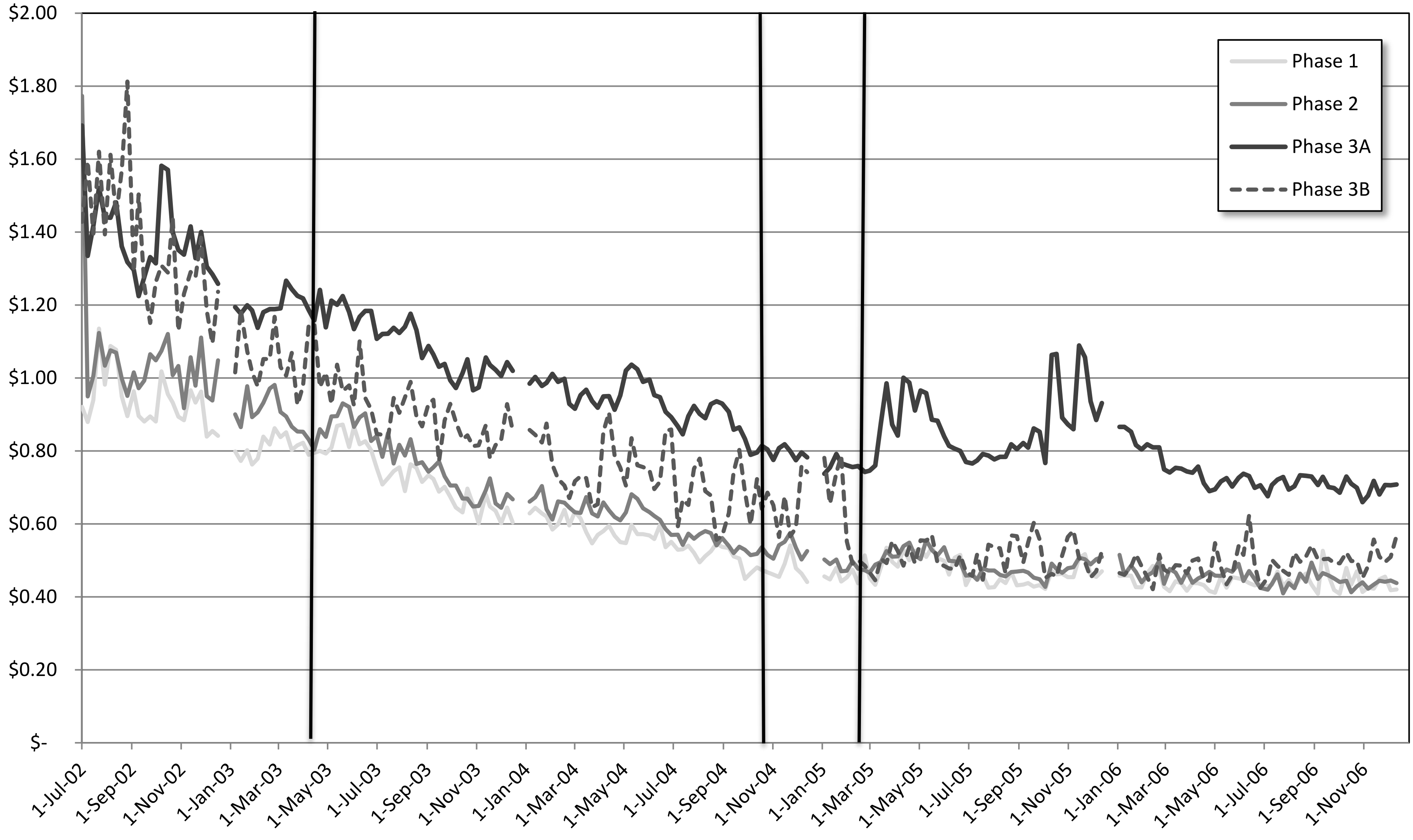
* Figure does not include trading days that SIFMA recommends that bond dealers take off or operate for less than a full day. Figure also does not include the two weeks spanning Christmas and New Year's Day.

Figure 2. Weekly Trading Volume/Issue Size by Phase



* Figure does not include trading days that SIFMA recommends that bond dealers take off or operate for less than a full day. Figure lso does not include the two weeks spanning Christmas and New Year's Day.

Figure 3. Weekly Price Standard Deviation by Phase



* Figure does not include trading days that SIFMA recommends that bond dealers take off or operate for less than a full day. Figure also does not include the two weeks spanning Christmas and New Year's Day.

Figure 4. Event Study for Weekly Volume/Issue Size

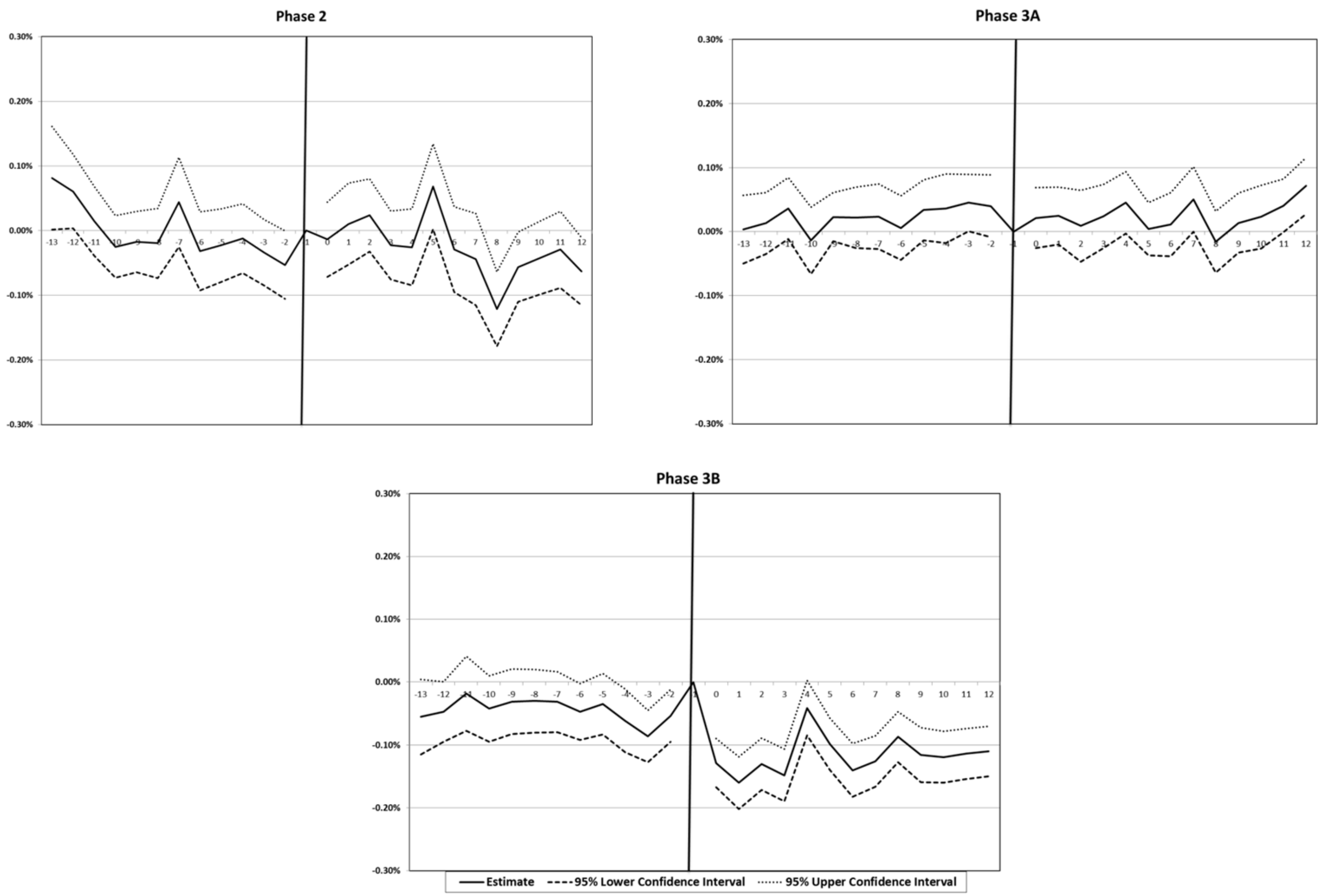


Figure plots coefficients on Disseminate x Week variables from event study regressions where the dependent variable is weekly Volume/Issue Size. Disseminate is an indicator for a bond that becomes disseminated in the Phase. The x-axes represent weeks, where, 0 is week of March 3, 2003 for Phase 2, 0 is week of October 1, 2004 for Phase 3A, and 0 is week of February 7, 2005 for Phase 3B.

Figure 5. Event Study for Weekly Price Standard Deviation

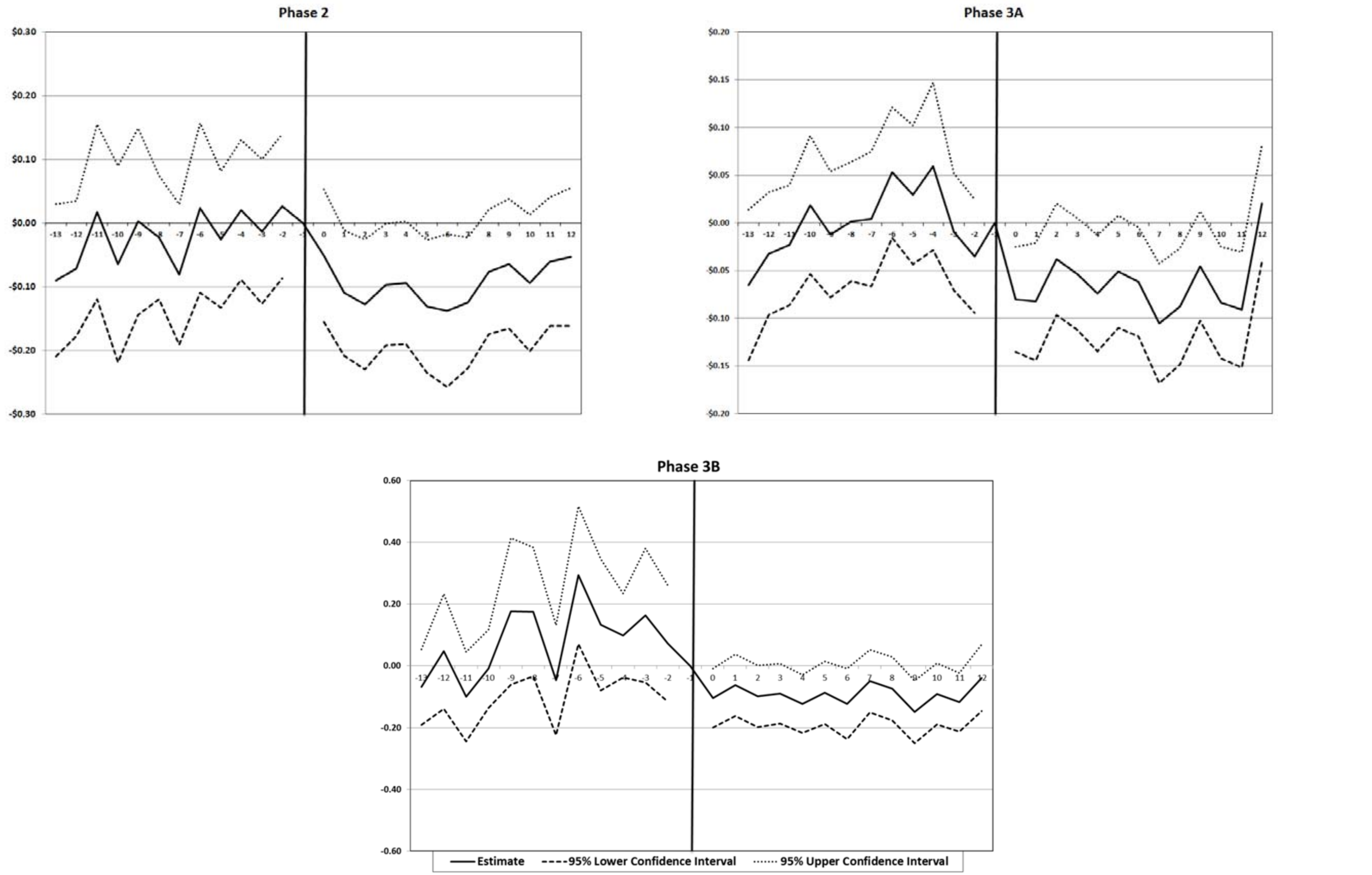


Figure plots coefficients on Disseminate x Week variables from event study regressions where the dependent variable is weekly price standard deviation. Disseminate is an indicator for a bond that becomes disseminated in the Phase. The x-axes represent weeks, where, 0 is week of March 3, 2003 for Phase 2, 0 is week of October 1, 2004 for Phase 3A, and 0 is week of February 7, 2005 for Phase 3B.

Table 1. Timeline of Major TRACE Regulatory Changes

Sample	Date	Bonds Affected	Time to Report
Phase 1	July 1, 2002	Investment Grade TRACE-eligible bonds having an initial issue of $1 billion or greater	75 Minutes
FINRA50	July 1, 2002	50 Non-Investment Grade (High-Yield) bonds disseminated under Fixed Income Pricing System (FIPS). First day is 7/1/02, last day is 7/14/04	75 Minutes
Phase 2	March 3, 2003	All Investment Grade TRACE-eligible bonds of at least $100 million par value (original issue size) or greater rated A- or higher; and 50 Non-Investment Grade bonds	75 Minutes
FINRA120	April 14, 2003	120 Investment Grade TRACE-eligible bonds rated BBB	75 Minutes
n/a	October 1, 2003	All currently disseminated bonds	45 Minutes
Phase 3A	October 1, 2004	All bonds that are not eligible for delayed dissemination (bonds with rating of BBB- or higher)	30 Minutes
Phase 3B	February 7, 2005	All bonds potentially subject to delayed dissemination (bonds with ratings BB+ or lower)	30 Minutes
n/a	July 1, 2005	All currently disseminated bonds	15 Minutes
n/a	January 9, 2006	All currently disseminated bonds	Immediate

Notes. Information from FINRA press releases available at finra.org. Time to report is the amount of time the dealer has to report the transaction to FINRA. FINRA collected information on all TRACE-eligible securities on July 1, 2002. A TRACE-eligible security means all US dollar-denominated debt securities that are depository-eligible and registered by the SEC, or issued pursuant to Section 4(2) of the Securities Act of 1933 and purchased or sold pursued to Rule 144a. FINRA disseminates the transaction for Bonds Affected immediately after the report, except for bonds subject to delayed dissemination. Bonds subject to delayed dissemination must meet certain trading, size, and rating criteria described by Rule 6250(b).

Table 2. Bond Characteristics by Phase

	Phase 1 (1)	Phase 2 (2)	Phase 3A (3)	Phase 3B (4)
Number of Bonds	343	2,538	11,087	2,853
Size at Issue ($M)				
mean	1,466	263	82	181
p10	1,000	100	1	8
p25	1,000	150	3	85
median	1,250	200	12	150
p75	1,750	300	75	232
p90	2,500	500	288	350
Rating at Phase Start				
mean	A	A+	A-	B
p10	AA-	AA	AA	BB+
p25	A+	A+	A	BB-
median	A	A+	A-	B
p75	BBB+	A	BBB	CCC
p90	BBB	A-	BBB-	D
# where rating is from S&P RatingsXpress	331	2,191	7,733	2,274
# where rating is from FISD	12	345	3,319	489
Fixed Coupon Rate				
mean	6.7	6.9	5.8	9.0
median	6.8	6.9	5.9	8.8
number fixed coupon	309	2,155	10,149	2,632
Maturity at Issue (years)				
mean	9.0	15.0	11.8	12.4
median	5.1	10.0	10.0	9.7
Years since Issue (at Phase Start)				
mean	1.9	5.5	3.4	5.9
median	1.5	5.1	1.9	5.7

Notes. Bond issue size, coupon, maturity, and issue date characteristics are from FISD. Bond rating are the most recent rating before the Phase starts. Bond rating characteristics are from S&P RatingsXPress database. If ratings are not available in S&P RatingsXpress, we use ratings from FISD. To assign a FISD rating, we first use the S&P value if it exists, otherwise the Moody's value, otherwise the Fitch value, and otherwise the Duff and Phelps value. Mean ratings are computed by first converting each rating to a number (AAA=1, AA+=2, AA=3, …, and D=22) and then converting the number back to a letter rating.

Table 3. Trading Activity and Price Dispersion for the 90-Day Window around Phase Start

	Mean		Percentiles: 25th		Percentiles: 50th		Percentiles: 75th		Within-Bond Comparison: Before > After	After > Before	Before = After: zero	Before = After: non-zero
	Before (1)	After (2)	Before (3)	After (4)	Before (5)	After (6)	Before (7)	After (8)	(9)	(10)	(11)	(12)
A. Trading Activity												
Volume												
Phase 1 (N=343)	…	11,445,643	…	4,251,581	…	7,828,097	…	13,986,145	…	…	…	…
Phase 2 (N=2,538)	888,352	844,458	57,250	52,459	319,339	299,180	950,000	844,361	51.4%	43.7%	4.9%	0.0%
Phase 3A (N=11,087)	335,026	316,497	0	105	3,361	4,035	30,738	31,228	39.3%	43.9%	16.8%	0.0%
Phase 3B (N=2,853)	366,526	213,035	0	0	3,818	0	357,000	91,475	45.1%	15.2%	39.7%	0.0%
Volume/Issue Size												
Phase 1 (N=343)	…	0.76%	…	0.36%	…	0.59%	…	0.97%	…	…	…	…
Phase 2 (N=2,538)	0.28%	0.27%	0.03%	0.03%	0.15%	0.13%	0.35%	0.32%	51.4%	43.7%	4.9%	0.0%
Phase 3A (N=11,087)	0.16%	0.16%	0.00%	0.00%	0.04%	0.05%	0.13%	0.15%	39.3%	43.9%	16.8%	0.0%
Phase 3B (N=2,853)	0.18%	0.09%	0.00%	0.00%	0.01%	0.00%	0.23%	0.06%	45.1%	15.2%	39.7%	0.0%
B. Price Dispersion												
Price Standard Deviation												
Phase 1 (N=340)	…	0.88	…	0.54	…	0.78	…	1.17	…	…	…	…
Phase 2 (N=2,023)	0.83	0.76	0.37	0.33	0.67	0.65	1.12	1.04	56.6%	43.2%	0.1%	0.0%
Phase 3A (N=6,319)	0.78	0.68	0.35	0.31	0.65	0.57	1.09	0.95	59.6%	40.2%	0.2%	0.0%
Phase 3B (N=1,129)	0.65	0.45	0.24	0.16	0.40	0.30	0.73	0.59	63.5%	36.1%	0.1%	0.3%

Notes. Average daily volume is averaged over all bond-days in either the 90 calendar days before or after the Phase start. If a bond does not trade, it contributes zero daily volume for that day. Average daily volume/issue size is the average of daily volume/issue size calculated in the same manner as average daily volume. For average daily price standard deviation, the sample of bonds is restricted to bonds where there is at least one day in the 90 days before the Phase start with at least two trades and there is at least one day in the 90 days after the Phase start with at least two trades. After computing the within-day price standard deviation for each bond for all days with at least two trades, we average across these days during either the 90 days before or after the Phase start. Reported average daily price standard deviation is the average across these bonds. There is no transaction information for Phase 1 bonds in the 90 days before Phase 1 starts. N refers to the number of bonds that change dissemination status in the Phase. In column (9), Before > After reports the fraction of bonds where the measured outcome is greater in the 90 days before the Phase start than in the 90 days after. In column (10), After > Before represents the reverse of column (9). In column (11), Before=After (zero) reports the fraction of bonds where the measured outcome is equal to zero both before and after. In column (12), Before=After (non-zero) reports the fraction where the measured outcome is non-zero and is equal both before and after.

Table 4. Difference-in-Difference Estimates of Transparency on Trading Activity and Price Dispersion

	Volume / Issue Size (in percent)				Price Standard Deviation			
	Mean for	Estimate			Mean for	Estimate		
	Disseminated	30 days	60 days	90 days	Disseminated	30 days	60 days	90 days
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				A. Pooled				
All Three Phases	0.178	-0.017**	-0.020***	-0.027***	0.901	-0.090***	-0.095***	-0.077***
		(0.008)	(0.006)	(0.005)		(0.013)	(0.010)	(0.009)
		-9.6%	-11.2%	-15.2%		-9.7%	-10.4%	-8.5%
				B. By Phase				
Phase 2	0.279	0.017	-0.001	-0.026**	0.953	-0.099***	-0.090***	-0.070***
		(0.015)	(0.013)	(0.011)		(0.024)	(0.017)	(0.015)
		6.1%	-0.4%	-9.3%		-9.9%	-9.4%	-7.3%
Phase 3A	0.156	-0.011	-0.005	0.003	0.903	-0.057***	-0.071***	-0.058***
		(0.013)	(0.009)	(0.007)		(0.014)	(0.010)	(0.009)
		-7.1%	-3.2%	1.9%		-5.9%	-7.8%	-6.5%
Phase 3B	0.179	-0.082***	-0.074***	-0.074***	0.679	-0.167***	-0.198***	-0.168***
		(0.011)	(0.008)	(0.008)		(0.037)	(0.035)	(0.030)
		-45.8%	-41.3%	-41.3%		-24.4%	-28.7%	-24.7%
H_0: Phase effects equal		0.000	0.000	0.000		0.011	0.002	0.003
# of Phase 2 bonds		2,538	2,538	2,538		1,671	1,921	2,023
# of Phase 3A bonds		11,087	11,087	11,087		4,008	5,463	6,319
# of Phase 3B bonds		2,853	2,853	2,853		797	1,028	1,129
# of bond-days		1,155,677	2,313,806	3,410,347		183,214	376,174	557,057

Notes. This table reports estimates of Disseminate x Post for volume/issue size and price standard deviation. Panel A reports estimates from Phases 2, 3A, and 3B pooled together, while panel B reports estimates for each Phase separately. Robust standard errors clustered by bond and Phase are in parenthesis immediately below the estimates. Mean for Disseminated is the 90-day average for newly disseminated bonds immediately before the Phase start. The third entry in each row is the percentage effect as computed by dividing the estimate by the Mean for Disseminated. Phase effects equal reports p-values of tests that the three Phase estimates are equal. The 30-day regressions use trades from 30 calendar days before and after the Phase change. The 60- and 90-day regressions are defined analogously. For volume/issue size, there are 8,299 Phase 2, 2,020 Phase 3A, and 2,098 Phase 3B control bonds in columns (2)-(4). For price standard deviation, there are 4,057 Phase 2, 1,452 Phase 3A, and 1,430 Phase 3B control bonds in column (6), 5,057 Phase 2, 1,681 Phase 3A, and 1,587 Phase 3B control bonds in column (7), and 5,545 Phase 2, 1,769 Phase 3A, and 1,670 Phase 3B control bonds in column (8).

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Alternative Specifications for Difference-in-Difference Regressions of Trading Activity and Price Dispersion

	Volume / Issue Size (in percent)				Price Standard Deviation			
	Estimate from column (4) of Table 4	With linear and quadratic trends specific to investment grade for each Phase	Without Phase 1 bonds as controls	Sample matched on size, credit rating, time to maturity, and years since issuance	Estimate from column (8) of Table 4	With linear and quadratic trends specific to investment grade for each Phase	Without Phase 1 bonds as controls	Sample matched on size, credit rating, time to maturity, and years since issuance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Pooled								
All Three Phases	-0.027***	-0.013**	-0.026***	-0.018**	-0.077***	-0.075***	-0.080***	-0.077***
	(0.005)	(0.006)	(0.005)	(0.007)	(0.009)	(0.009)	(0.010)	(0.012)
B. By Phase								
Phase 2	-0.026**	-0.017	-0.028***	-0.014	-0.070***	-0.086***	-0.073***	-0.079***
	(0.011)	(0.011)	(0.011)	(0.013)	(0.015)	(0.015)	(0.017)	(0.017)
Phase 3A	0.003	0.007	0.007	-0.014*	-0.058***	-0.053***	-0.062***	-0.077***
	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.009)	(0.010)	(0.016)
Phase 3B	-0.074***	-0.077***	-0.073***	-0.066***	-0.168***	-0.169***	-0.156***	-0.045
	(0.008)	(0.012)	(0.008)	(0.023)	(0.030)	(0.041)	(0.031)	(0.051)
H_0: Phase effects equal	0.000	0.000	0.000	0.096	0.003	0.006	0.015	0.825
# of Phase 2 bonds	2,538	2,536	2,538	2,536	2,023	2,021	2,023	2,021
# of Phase 3A bonds	11,087	11,052	11,087	4,552	6,319	6,307	6,319	3,014
# of Phase 3B bonds	2,853	2,763	2,853	808	1,129	1,111	1,129	325
# of bond-days	3,410,347	3,379,514	3,314,283	1,867,658	557,057	556,024	478,817	430,962

Notes. This table reports estimates of Disseminate x Post from alternative regression specifications. Panel A reports estimates from Phases 2, 3A, and 3B pooled together, while panel B reports estimates for each Phase separately. Robust standard errors clustered by bond and Phase are in parenthesis immediately below the estimates.The sample in columns (2), (4), (6), and (8) excludes unrated bonds. Models with trends in columns (2) and (6) include linear and quadratic functions of time for investment grade and high-yield bonds specific to each Phase. The characteristics used to construct the matched sample in columns (4) and (8) are issue size, credit rating at Phase start, time to maturity at Phase start, and years since issue at Phase start. We divide the sample into four issue size quartiles, and two groups for the other three characteristics: investment grade and high-yield, and above/below the median time to maturity and years since issue. We exclude bonds in cells with 5 or fewer treated bonds or 5 or fewer control bonds. Phase effects equal reports p-values of tests that the three Phase estimates are equal.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. Difference-in-Difference Estimates for Alternative Measures of Trading Activity

	Volume		Probability of Trade		Probability of Trade ≥ $1M		# of Trades		Average Trade Size	
	Mean for Disseminated (1)	Estimate (2)	Mean for Disseminated (3)	Estimate (4)	Mean for Disseminated (5)	Estimate (6)	Mean for Disseminated (7)	Estimate (8)	Mean for Disseminated (9)	Estimate (10)
A. Pooled										
All Three Phases	420,725	-72,439***	0.197	-0.002*	0.046	-0.005***	0.677	-0.131***	669,198	-63,367***
		(24,753)		(0.001)		(0.001)		(0.039)		(15,002)
		-17.2%		-1.0%		-10.9%		-19.1%		-9.5%
B. By Phase										
Phase 2	888,352	-33,792	0.383	-0.018***	0.088	-0.007***	1.344	0.016	782,646	4,854
		(36,570)		(0.002)		(0.002)		(0.047)		(26,537)
		-3.8%		-4.7%		-8.0%		1.5%		0.6%
Phase 3A	335,026	-96,218**	0.177	0.015***	0.036	0.001	0.625	-0.056	535,926	-38,038*
		(46,086)		(0.002)		(0.002)		(0.037)		(19,645)
		-28.7%		9.0%		2.8%		-9.5%		-7.1%
Phase 3B	366,526	-98,344**	0.116	-0.005*	0.052	-0.012***	0.298	-0.487***	1,205,940	-344,005***
		(45,222)		(0.003)		(0.002)		(0.130)		(33,039)
		-26.8%		-4.3%		-23.1%		-163.3%		-28.5%
H_0: Phase effects equal		0.428		0.000		0.000		0.001		0.000
# of Phase 2 bonds		2,538		2,538		2,538		2,538		2,194
# of Phase 3A bonds		11,087		11,087		11,087		11,087		7,478
# of Phase 3B bonds		2,853		2,853		2,853		2,853		1,320
# of bond-days		3,410,347		3,410,347		3,410,347		3,410,347		831,000

Notes. This table reports estimates of Disseminate x Post for alternative measures of trading activity following the 90-day estimates in Table 4. Panel A reports estimates from Phases 2, 3A, and 3B pooled together, while panel B reports estimates for each Phase separately. Robust standard errors clustered by bond and Phase are in parenthesis immediately below the estimates. Volume is the total daily par value of volume, Probability of Trade is 1 if the bond trades at all on the day and 0 otherwise, Probability of Trade ≥ $1M is 1 if there is a bond trade greater than or equal to $1M and 0 otherwise, # of Trades is the number of trades per day, and Average Trade Size is the average size of the trades in a day, conditional on trading. Mean for disseminated is the 90-day average for newly disseminated bonds immediately before the Phase start. Percentage effects are computed by dividing the estimate by the prior mean. Phase effects equal reports p-values of tests that the three Phase estimates are equal. For the first four outcomes, there are 8,299 control bonds in Phase 2, 2,202 control bonds in Phase 3A, 2,098 control bonds in Phase 3B. For Average Trade Size, there are 6,206 control bonds in Phase 2, 1,876 control bonds in Phase 3A, and 1,785 control bonds in Phase 3B.
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Difference-in-Difference Estimates for Alternative Measure of Price Dispersion

	Absolute Spread		10-Day Price Standard Deviation		30-Day Price Standard Deviation	
	Mean for Disseminated (1)	Estimate (2)	Mean for Disseminated (3)	Estimate (4)	Mean for Disseminated (5)	Estimate (6)
			A. Pooled			
All Three Phases	1.914	-0.182***	1.154	-0.100***	1.354	-0.140***
		(0.022)		(0.013)		(0.019)
		-9.5%		-8.7%		-10.3%
			B. By Phase			
Phase 2	2.031	-0.172***	1.300	-0.082***	1.564	-0.104***
		(0.036)		(0.025)		(0.037)
		-8.5%		-6.3%		-6.6%
Phase 3A	1.921	-0.132***	1.133	-0.112***	1.295	-0.145***
		(0.023)		(0.011)		(0.014)
		-6.9%		-9.9%		-11.2%
Phase 3B	1.386	-0.397***	0.943	-0.116***	1.283	-0.214***
		(0.095)		(0.032)		(0.045)
		-28.6%		-12.3%		-16.7%
H_0: Phase effects equal		0.020		0.529		0.172
# of Phase 2 bonds		2,023		2,083		2,103
# of Phase 3A bonds		6,319		6,788		6,951
# of Phase 3B bonds		1,129		1,172		1,201
# of observations		557,057		220,538		112,084

Notes. This table reports estimates of Disseminate x Post for alternative measures of price dispersion following the 90-day estimates in Table 4. Panel A reports estimates from Phases 2, 3A, and 3B pooled together, while panel B reports estimates for each Phase separately. Robust standard errors clustered by bond and Phase are in parenthesis immediately below the estimates.Absolute Spread is the maximum price minus minimum price traded for a bond in a day, Price Standard Deviation over 10 Days is the standard deviation of prices for all trades occuring in 10-day bins, and Price Standard Deviation over 30 Days is the standard deviation of prices for all trades occuring in 30-day bins. Mean for disseminated is the 90-day average for newly disseminated bonds immediately before the Phase start. Percentage effects are computed by dividing the estimate by the prior mean.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8. Difference-in-Difference Estimates by Credit Rating and Issue Size

					Investment grade		High yield	
	Investment Grade	High Yield	Issue Size < $100M	Issue Size ≥ $100M	Issue Size < $100M	Issue Size ≥ $100M	Issue Size < $100M	Issue Size ≥ $100M
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				A. Volume / Issue Size				
All Three Phases	-0.013**	-0.057***	-0.005	-0.038***	0.010	-0.028***	-0.071***	-0.056***
	(0.006)	(0.011)	(0.006)	(0.006)	(0.007)	(0.007)	(0.017)	(0.012)
H_0: Effects equal between		(1)-(2)		(3)-(4)		(5)-(6)		(7)-(8)
p-value		0.001		0.001		0.002		0.488
						(5)-(7)		(6)-(8)
						0.000		0.049
# newly disseminated Phase 2	2,536	0	10	2,526	10	2,526	0	0
# newly disseminated Phase 3A	10,418	634	8,410	2,642	8,382	2,036	28	606
# newly disseminated Phase 3B	233	2,530	677	2,086	81	152	596	1,934
# of bond-days	3,011,573	1,826,801	2,530,591	2,307,783	2,458,151	2,011,931	1,530,949	1,754,361
				B. Daily Price Standard Deviation				
All Three Phases	-0.058***	-0.124***	-0.053***	-0.084***	-0.048***	-0.068***	-0.170***	-0.122***
	(0.009)	(0.017)	(0.010)	(0.010)	(0.010)	(0.011)	(0.059)	(0.017)
H_0: Effects equal between		(1)-(2)		(3)-(4)		(5)-(6)		(7)-(8)
p-value		0.006		0.023		0.169		0.442
						(5)-(7)		(6)-(8)
						0.042		0.008
# of Phase 2 bonds	2,021	0	6	2,015	6	2,015	0	0
# of Phase 3A bonds	5,695	612	4,175	2,132	4,154	1,541	21	591
# of Phase 3B bonds	90	1,021	104	1,007	6	84	98	923
# of bond-days	503,844	373,258	385,712	491,390	383,887	440,940	322,808	371,433

Notes. This table reports estimates of Disseminate x Post for 90-days by credit and issue size categories pooling together Phases 2, 3A, and 3B. Bonds that are unrated are excluded. Standard errors clustered by bond are in parentheses. In Panel A, there are 8,165 control bonds in Phase 2, 2,202 control bonds in Phase 3A, 2,098 control bonds in Phase 3B. In Panel B, there are 5,512 control bonds in Phase 2, 1,769 control bonds in Phase 3A, and 1,670 control bonds in Phase 3B. P-values reported from Chi-Square tests for equality of estimates between specifications.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. NAIC Trading Activity and Price Dispersion for the 90-Day Window around Phase Start

	90-Day Mean		90-Day Median		Before >	After >	Before = After		Difference-in-
	Before	After	Before	After	After	Before	zero	non-zero	Difference Estimate
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
A. Trading Activity									
Volume / Issue Size									
Phase 1 (N=334)	0.06%	0.06%	0	0	51.50%	44.00%	4.50%	0.0%	-0.001
									(0.004)
Phase 2 (N=2,294)	0.05%	0.04%	0	0	44.10%	35.30%	20.70%	0.0%	-0.003
									(0.003)
Phase 3A (N=4,983)	0.02%	0.02%	0	0	24.60%	25.30%	50.10%	0.0%	0.001
									(0.002)
Phase 3B (n=2,319)	0.01%	0.01%	0	0	21.30%	15.70%	63.00%	0.0%	-0.003*
									(0.002)
B. Price Dispersion									
Daily Price Standard Deviation (ungrouped)									
Phase 1 (N=253)	0.22	0.26	0.10	0.12	36.0%	59.0%	5.0%	0.0%	0.092
									(0.089)
Phase 2 (N=392)	0.17	0.26	0.13	0.23	45.0%	36.0%	20.0%	0.0%	-0.163
									(0.121)
Phase 3A (N=464)	0.21	0.39	0.19	0.33	35.0%	35.0%	30.0%	0.0%	0.026
									(0.144)
Phase 3B (N=109)	0.23	0.04	0.19	0.04	32.0%	25.0%	43.0%	0.0%	-0.267*
									(0.144)
Daily Price Standard Deviation (grouped)									
Phase 1 (N=213)	0.36	0.42	0.26	0.27	35.0%	65.0%	0.0%	0.0%	0.146
									(0.163)
Phase 2 (N=261)	0.24	0.40	0.21	0.37	47.0%	46.0%	8.0%	0.0%	-0.259
									(0.233)
Phase 3A (N=273)	0.43	0.70	0.40	0.67	49.0%	37.0%	14.0%	0.0%	0.202
									(0.267)
Phase 3B (N=65)	0.38	0.04	0.31	0.04	45.0%	25.0%	31.0%	0.0%	-0.492*
									(0.280)

Notes. This table reports 90-day before and after comparisons of trading activity and price dispersion using data from the National Association of Insurance Commissioners (NAIC). Average daily volume is averaged over all bond-days in either the 90 calendar days before or after the Phase start. If a bond does not trade, it contributes zero daily volume for that day. For average daily price standard deviation, the sample of bonds is restricted to bonds where there is at least one day in the 90 days before the phase start with at least two trades and there is at least one day in the 90 days after the phase start with at least two trades. After computing the within-day price standard deviation for each bond for all days with at least two trades, we average across these days during either the 90 days before or after the phase start. Reported average daily price standard deviation is the average across these bonds. Ungrouped price standard deviation does not combine trades into a single observation, while grouped price standard deviation is based on combined trades to deal with split reporting issues described in the data appendix. Column (9) reports estimates of the Disseminate x Post in difference-in-difference regressions for 90-days, which parallel those reported in Table 4.
N refers to the number of bonds that change dissemination status in the Phase.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Estimates of Transparency Effects on NAIC Dealer Market Share for 12 Week Window around Phase Start

	Par Volume ($M)				Number of Trades			
	Weekly Average Before		Estimate		Weekly Average Before		Estimate	
	Top 4 Dealers (1)	Top 8 Dealers (2)	Top 4 Dealers (3)	Top 8 Dealers (4)	Top 4 Dealers (5)	Top 8 Dealers (6)	Top 4 Dealers (7)	Top 8 Dealers (8)
				A. Pooled				
All Four Phases	87.59	81.87	-13.36***	-12.74***	35.04	33.97	-3.08***	-2.87***
			(4.97)	(3.37)			(0.96)	(0.792)
			-15.3%	-15.6%			-8.8%	-8.4%
				B. By Phase				
Phase 1	112.64	115.13	-28.06***	-20.22**	40.46	41.88	-6.20***	-4.28**
			(8.19)	(8.88)			(1.92)	(1.82)
			-24.9%	-17.6%			-15.3%	-10.2%
Phase 2	98.50	92.02	-2.648	-5.283	41.06	38.57	-3.66**	-1.84
			(12.56)	(7.41)			(1.66)	(1.47)
			-2.7%	-5.7%			-8.9%	-4.8%
Phase 3A	126.88	108.31	-20.09***	-22.40***	49.52	46.20	-1.04	-4.39**
			(7.64)	(4.22)			(1.95)	(1.85)
			-15.8%	-20.7%			-2.1%	-9.5%
Phase 3B	12.34	12.04	-2.66**	-3.07***	9.13	9.22	-1.43**	-0.97*
			(1.27)	(0.87)			(0.72)	(0.50)
			-21.5%	-25.5%			-15.7%	-10.5%
H_0: Phase effects equal			0.003	0			0.090	0.120
# of Phase 1 counterparties			79	79			79	79
# of Phase 2 counterparties			81	81			81	81
# of Phase 3A counterparties			84	84			84	84
# of Phase 3B counterparties			83	83			83	83
# of counterparty-weeks			7,848	7,848			7,848	7,848

Notes. This table reports estimates of Disseminate x Post for par volume and the number of trades for counterparties in the NAIC database in a difference-in-difference regression following Table 4. Panel A reports estimates from Phases 2, 3A, and 3B pooled together, while panel B reports estimates for each Phase separately. Robust standard errors clustered by bond and Phase are in parenthesis immediately below the estimates. Top 4 and 8 dealers are computed based on rankings of dealers of the total par volume of all trades between 2000-2001. The dealers in the top 4 and 8 are identical if the ranking is based on number of trades between 2000-2001. The time period is 12 weeks before and after dissemination. Counterparties represent 87 composite counterparties constructed from the NAIC dataset. Each dependent variable is a counterparty-week, corresponding to all of the trades with the counterparty among bonds in the Phase for the week. Weekly average before corresponds to the 12 week average for par volume or number of trades for counterparties immediately before the Phase start. Percentage effects are computed by dividing the estimate by the prior mean.
* significant at 10%; ** significant at 5%; *** significant at 1%

A. TRACE Data Appendix

The TRACE dataset we use was purchased directly from FINRA. We refer to this data as the Historical FINRA TRACE dataset since it contains both disseminated and non-disseminated trades, indicated by the Dissemination Flag field (DISSEM_FL). There are also two TRACE datasets available on WRDS, one from FINRA and one provided by Mergent FISD. These databases only contain disseminated trade records that were available to market participants in real time and do not contain any non-disseminated trades.

The Historical FINRA TRACE dataset contains 35,284,669 unique trade records, on 35,695 different CUSIPS, for July 1, 2002 until December 31, 2006. All FINRA trade records are self-reported by FINRA members. To each self-reported transaction report, FINRA adds the time and date that it received the report and a flag indicating whether or not the report was disseminated to the public. Then, FINRA generates a message sequence number that is unique within the reporting day. For transactions that are modifies or cancels, the message sequence number of the original trade is included as a separate field called the "original" message sequence number.

We first take the Historical FINRA TRACE dataset and match it to the universe of corporate bonds in the Mergent FISD database, our source for bond characteristics such as issue size, ratings, maturity, etc. We drop all TRACE bonds that do not match to FISD. We also drop all bonds with equity-like characteristics (convertibles, exchangeables, etc.) since their equity component may be included in the bond price. We next drop all Rule 144a bonds because TRACE does not report trading information on these bonds. Finally, FISD does not report the correct issue size in all cases. For example, there are some bonds with a reported issue size of $0. After hand checking a number of cases with small issue size, we decided to drop all bonds with reported FISD issue size of less than $100,000, including those with issue size of $0. The number of trades eliminated and their corresponding CUSIPs affected by these steps are shown in first section of Table A1.

FINRA reports prices on bond trades differently for principal and agency trades, denoted by the Buyer Capacity field (BUY_CPCTY_CD) or Seller Capacity field (SELL_CPCTY_CD). Prices reported on principal trades include "any markups or markdowns." Prices reported on agency trades do not include the commission charged "since commission is reported in a separate field." (TRACE USER Guide, version 2.2, page 17) To make our prices comparable across all trades, we adjust trade prices for the commission paid whenever the buy or sell commission field is non-empty. A total of 699,833 trades representing 19,999 CUSIPs are modified.

Not all remaining trade records are unique or correct. We eliminate trade records for four main reasons. First, some trades do not take place; they are later modified, revised, or cancelled. Second, some trades are reported more than once. Third, some trade records have erroneous price or volume data. Fourth, some trades have problems with their trade date. Table A1 reports the number of trade records affected for each of these reasons.

TRACE generates extra trade records for modified, cancelled, or reversed trades. Trades cancelled within a day are marked as cancelled, while trades cancelled on subsequent days are marked as reversals. When identifying trades that are subsequently modified, cancelled or reversed, we rely on three data fields: Trade Status (TRC_ST), Message Sequence Number (MSG_SEQ_NB), and Original Message Sequence Number (ORIG_MSG_SEQ_NB). The first field, Trade Status, has a value of "W" if the trade record is a modification and "C" if it is a cancellation of another trade record received by FINRA on the same reporting day. If the trade record is not a cancellation or a modification, Trade Status has a value of "T". For each reporting day, FINRA assigns every trade report a unique Message Sequence Number. The third field, Original Message Sequence Number, is blank unless the trade is a cancellation or modification. In those instances, the Original Message Sequence Number field contains the Message Sequence Number of the trade record that is being cancelled or modified.

We link together the Original Message Sequence Numbers and the Message Sequence Numbers to create chains of trade records, if such chains exist. Each chain starts with the original trade and ends with the last modified or cancelled trade. The existence of a chain means that some trades will be eliminated. For example, if a trade that is reported with message sequence number "1" is modified in a record with message sequence number "2" and then later modified in a record with message sequence number "3", we eliminate the first two records. We link these three records together, starting from record 3 and moving backwards until we reach a record with the original message sequence number (the original trade). In a similar manner, if a trade is later canceled, we link the canceled trade record with the original trade record and eliminate both trade records from our sample. Since it is possible for different trades in a chain to have different dissemination statuses, we treat the terminal trade record in a chain as disseminated if any trade record in the chain was disseminated. If a trade is modified, we remove all records except the last one in the chain. For cancelled trades, we eliminate the entire chain of trades. When a cancelled trade cannot be matched to the original trade, it alone is eliminated.

Trade reversals are identified by the As Of Indicator field (ASOF_CD) by "R". Reversals cannot be tracked using Message Sequence Number and Original Message Sequence Number because the original trade and its reversal are reported to FINRA on different days. Message Sequence Numbers are unique within each reporting day and cannot be linked across days. Therefore, to link a reversal to its original trade, we match based on seven identifying characteristics: CUSIP, execution date, execution time, price, volume, indicator for buyer or seller, and indicator for dealer or customer. Matches with these criteria represent a "seven-way" match.

Using these seven trade characteristics, however, often leads to a many-to-many match; that is, there is often more than one possible pairing. (In fact, it appears that many reversals are the result of a trade being entered twice and the second record being reversed). After matching reversal and non-reversal reports using these seven trade characteristics, we eliminate the minimum number of exact matches. If there is only one exact match, both the reversal and its matched trade are eliminated. If there is more than one exact match, we eliminate the reversal trade and one of the matching trades. Since, by definition, the trades occur at the same time, date, price, and volume, these characteristics are unaffected by the choice of which matching trade we eliminate. For example, if there are 4 reversals and 5 non-reversals, we drop the 4 reversals and drop the first 4 non-reversals. A total of 837,740 trade records were dropped as part of reversals.

Unfortunately, not all reversals have an exact seven-way match. A large number of the unmatched reversals had a six-way match to another trade if we drop the same execution time requirement. Since execution time is self-reported, we assume these six-way matches were the original trades that were meant to be reversed, and we eliminate the reversal and the matched trade from the sample following the steps above. Even after six-way matches, there are 44,849 records labeled as reversals that we were unable to match to an original trade. We dropped these reversals from the dataset, but were unable to identify the original matched trade. In addition, the As Of Code field can also take on the values "X" corresponding to delayed reversal and "D" corresponding to delayed dissemination. We drop these records as well.

After eliminating modified, cancelled, and reversed records (which represent trades that do not actually take place), we next deal with trades that take place, but are reported more than once. There are two ways for duplicate records to occur in the Historical Trace database. The first involves transactions between two dealers, who both report the trade to FINRA, one as a buy trade and one as a sell trade. Both the buy and sell side of inter dealer trades are included in the Historical TRACE database released by FINRA. In the Mergent FISD TRACE dataset on WRDS, only the seller's report of an inter dealer trade is included. To mimic this convention, we eliminate trade records for inter dealer trades submitted by the buying dealer. We drop a total of 6,578,859 trade records where the transaction is labeled as a buy (using the Buy/Sell Indicator, RPT_SIDE_CD) and where the transaction is associated with a duplicate sell transaction. In addition, both the buy and sell records must be labeled as inter dealer trades (using the Contra Party Indicator, CNTRA_MP_ID).

As shown in Table A1, of the 6,578,859 dealer buy records we eliminated, 590,372 correspond to sell records with the same CUSIP, date, price, quantity, inter dealer trade indicator, and execution time. An additional 4,468,884 buy records correspond to sell records that have the same CUSIP, date, price, quantity, inter dealer trade indicator, but a different execution time. As mentioned earlier, execution time is self-reported by both the buyer and seller and we believe that two trades which have a match of all other characteristics other than time are probably duplicates. Finally, 1,519,603 dealer buy records cannot be matched to a dealer sell record. These records are a puzzle given that we have no record of a seller reporting the trade in an inter dealer transaction. To be conservative, we eliminate these remaining unmatched inter dealer buy records.

The second way duplicate trades appear in the database is when the dealer acts as in an agent capacity. If a dealer acts as an agent for a customer, FINRA asks that trade be reported as if the agent "stood between the customer and the contra party" (TRACE USER Guide, version 2.2, page 21). That is, if a dealer sold bonds as an agent for their customer to another party, they would report two records to TRACE: a buy transaction from the customer and a sell transaction to the other party, even though this is a single transaction. We keep only the sell transaction when there is both an agency buy transaction and agency sell transaction with the same price, quantity, execution date, and execution time. This rule leads us to drop 563,658 trade records.

Another reason we eliminate trades from the dataset is that price or volume information appears erroneous. Since, as mentioned above, all trades are self-reported, data entry errors are possible even though FINRA monitors reported trades. We delete records with missing trade prices. We also drop trade records with unreasonably large prices. To compute our definition of unreasonable large prices, we first calculated the maximum "risk free" price of each bond in the sample. The maximum "risk free" price during our time period is the maximum present value of future coupon and principal payments, discounted using the lowest treasury rate observed across all bonds and all days between July 1, 2002 and December 31, 2006. Across all the bonds in our sample, the maximum risk free price is $214. To be conservative, we drop all bond trades that take place at price higher than $220. We also eliminated 4,597 trades where the volume of a single trade was higher than 50% of the issue amount.[40] Finally, we eliminated trades where the volume was reported as less than $1,000.

The last reason we drop records is trade timing issues. We drop any trade that occurs before its offering date or after its maturity date. We also drop any trade that was reportedly executed on a different day than it was reported. Finally, we drop all records that are reported to have occurred on SIFMA holidays. After these eliminations, we are left with 21,149,525 trades involving 30,643 CUSIPs.

The entire dataset of cleaned bonds is not necessarily useful however to evaluate the effect of TRACE. Our empirical strategy is based on comparing a bond's trading behavior when it changes from non-disseminated to disseminated. Many bonds will be disseminated for their entire trading history. These include bonds that belong to a FINRA Phase that are issued after the beginning of the Phase date, and bonds that may be issued before a Phase begins but only trade after the dissemination change date for that Phase. There are also bonds that are always non-disseminated. These are bonds that may mature before the beginning of their Phase date as well as bonds that belong to a Phase but never trade after the Phase begins.

Table A2 outlines the steps from Historical Cleaned Sample in Table A1 to the Cleaned Phase sample, the sample of bonds which exist and have zero or non-disseminated trading before the start of a Phase and zero or disseminated trading after the start of a Phase. We begin with a list of all Phase 1, 2, 3A and 3B bonds. There are 26,955 bonds in this list, of which 20,595 exist in the Cleaned Historical TRACE Sample. They have 17,434,020 trades during our sample period. Thus, about two-thirds of the bonds in our Cleaned Historical TRACE Sample are in our Phase list, but this represents 82.4% of the trades.

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[40] This may represent a data error in FISD issue size. For example, about 2600 of the eliminated records correspond to one company Alestra, which went through an exchange. FISD reports its issue size as $83,000, but through press releases we determined it was at least $400,000,000. Another example is Countrywide CCR.MQ.

We obtained Phases 2, 3A, and 3B from FINRA. FINRA provided us with a list of bonds that began being disseminated at the start of each of the three Phases. This list was provided in a non-electronic format where bonds were identified with ticker symbols. Unfortunately, many ticker symbols longer than six characters were truncated. This was a problem for firms with a four character company ticker symbol which also issued bonds with three character security tickers. In particular, many GMAC bonds were truncated. Since FINRA also provided us with coupon and maturity dates for each bond, we were able to hand-match many of the truncated ticker symbols, but not all. The list of Phase 1 bonds was not provided by FINRA, and we generated it ourselves given the criteria listed by TRACE for Phase 1 bonds. That is, in addition to existing before the beginning of Phase 1, bonds had to be investment grade and have an initial issue size of $1 billion or greater. After determining the set of bonds meeting these criteria, we eliminated all bonds that are on the FINRA lists for Phases 2, 3A or 3B and the bond had to have a disseminated trade before the beginning of Phase 2.

In addition to the four Phases that correspond to the FINRA dissemination dates, FINRA also maintained two other lists of bonds, which we call the FINRA50 and the FINRA120. The FINRA50 represent 50 Non-Investment Grade (High-Yield) securities disseminated under Fixed Income Pricing System (FIPS2). This list of 50 bonds changes over time with bonds both entering and exiting. FINRA lists all of these bonds on their website and there were a total of 149 bonds that were in the FINRA50 at some point during its existence from July 1, 2002 until July 14, 2004. The FINRA120 list is a special set of 120 investment grade rated Baa/BBB that FINRA delayed Phase 2 dissemination for. Phase 2 dissemination started on March 3, 2003 for Phase 2 bonds, but started on April 14, 2003 for the FINRA120. This special sample was created so that FINRA could conduct a controlled experiment to study the effects of dissemination in Phase 2, contained in Goldstein, Hotchkiss, and Sirri (2007).

Table A2 explains how we went from FINRA's list of Phase 2, 3A, and 3B bonds, and our list of Phase 1 bonds, to our cleaned Phase samples. For each Phase list, we only use bonds that exist in our Cleaned Historical TRACE Sample. Some bonds on the FINRA lists did not trade during our sample period and thus are not in the Historical TRACE sample. This is shown between lines 1 and 2 under Phases 2, 3A, and 3B.

We next eliminate any bonds that also exist in the FINRA50 or FINRA120 list. Following this, we eliminate bonds that do not exist (i.e., were not issued or matured) during the period 90 days before until 90 days after the start of the Phase. Finally, we dropped some bonds with data problems. There are a few bonds where FINRA report disseminated trades before the start of the Phase, or non-disseminated trades after start of Phase. After applying these steps for each Phase list, what remains is our cleaned sample by Phases. There are a total of 16,825 bonds in our total cleaned Phase sample representing 14,210,328 trades during our time period.

B. NAIC Data Appendix

The National Association of Insurance Companies (NAIC) dataset we use is from Mergent FISD available on WRDS. The NAIC requires insurance companies to self-report all securities transactions in their financial statements. There are 63,859 bonds with 1,933,095 reported transactions in the NAIC file over the period January 1, 2000 until December 31, 2006. Schedule D of the annual NAIC filings require insurers to report all bond transactions in one of three categories: bonds added to the portfolio during the calendar year and held through the end of the year, bonds deleted from the portfolio during the calendar year that were not added in the same year, and bonds added and deleted in the same calendar year. For each transaction, the database records the CUSIP, date, par value of the transaction, the actual value of the transaction, if it was an addition or deletion, and a field for the counterparty involved in the transaction. Prices are not reported but can be computed from the ratio of the value received in the transaction to the par value of the bonds in the transaction. Importantly, the names of the insurance companies involved in the transactions are excluded from the data.

To make the NAIC analysis comparable to the TRACE analysis, we first match our sample of NAIC bonds with the Cleaned Historical TRACE sample by CUSIP. The universe of bonds which insurance companies trade is much larger than that reported by FINRA. 45,902 NAIC bonds representing 804,685 reported transactions are not included in our Cleaned Historical TRACE sample and are eliminated. Table B1 reports the number of transactions and CUSIPs eliminated by this step.

Next we eliminate reported transactions that are not connected to trades. The NAIC database contains all transactions involving insurance companies' bond portfolios, not only buy and sell transactions, but also other transactions such as bond calls and maturities. The type of transaction is coded in the counterparty field. We eliminate all transactions that change bond portfolio holdings that are not buys or sells. These include the following codes: CALL, CANCEL, CONVERT, EXCHANGE, ISSUE, MATURE, PUT, REDEEM, SINKING FUND, TAX-FREE EXCHANGE, TENDER, TRANSFER, PAYDOWN, and REPLACE.

There are two prevalent entries in the counterparty field comprising almost 15% of the cleaned database that required additional attention: DIRECT and VARIOUS. DIRECT may indicate a direct placement, similar to an underwriting, or it may indicate the name of a counterparty in an actual trade. VARIOUS is simply an ambiguous catch-all, where some records may be actual trades and some are not. To check whether DIRECT and VARIOUS represent actual trades, we matched these NAIC records to TRACE using the CUSIP, price, volume, and date of the transaction. For DIRECT, only about 3% of transactions match into the TRACE dataset, while for VARIOUS only about 1% of transactions match. Because of the problems identifying which of the DIRECT or VARIOUS transactions are actual trades, we eliminate them along with the other codes listed above that are not buys and sells. As shown in Table B1, all such filters eliminate 290,998 reported transactions on 14,095 different bonds.

We eliminate a small number of trades with data issues, i.e. missing prices, negative prices, etc. We next eliminate trades with timing issues, i.e., trades that are executed before or on the bonds' offering or after or on the bonds' maturity date. A large fraction of NAIC transactions take place on the offering and maturity dates. We believe that this is because insurance companies are large customers of bond offerings and purchase the bonds at this time. The NAIC rules require its members to list these purchases as a transaction since the bonds are added to their portfolio. Since these transactions are probably part of the underwriting, we do not include them as trades. If an insurance company holds the bond until its maturity, that transaction will also be recorded by NAIC. Finally, we also exclude transactions listed on bond holidays. These screens shown in Table B1 are similar to those applied to the TRACE dataset in Table A1.

After the screens and matching, there are 16,006 bonds and 693,862 reported transactions (which we believe to be buys and sells) in our "clean" NAIC sample. Importantly, the NAIC time period in Table B1 is thirty months longer than the TRACE time period in Table A1. When we restrict to the time period July 1, 2002 until December 31, 2006, there are 14,574 bonds and 481,135 transactions, as shown in the last three columns of Table B1.

As mentioned above in Section VII, we believe that many trades in TRACE are disaggregated by the NAIC reporting process. When comparing the NAIC and TRACE databases, there are multiple NAIC transactions that match to a single TRACE trade using CUSIP, date, price and counterparty, but not volume. However, if we group NAIC transactions by CUSIP, date, price and counterparty into a single record with a combined volume, many of these grouped NAIC trades match to a corresponding single trade in TRACE.

There are two reasons that trades are disaggregated in NAIC. The first reason is how NAIC requires transactions to be reported on Schedule D of the annual NAIC filing. Insurers must separately report bonds purchased and sold in the same year from bonds purchased and held through the end of the year. This means if an insurance company purchases $1 million par of a bond on January 1, 2001 and sells $500,000 of this before December 31, 2001 and the remaining $500,000 sometime in the following year, under NAIC reporting instructions, this single purchase would be split into two separate purchases of $500,000 each, reported in two different sections of Schedule D. One $500,000 purchase would be reported in the long-term purchase reporting section, and one $500,000 purchase would be reported in the short-term holding section.

When the NAIC database is compiled, the above trade would appear as two purchases of the same bond occurring on the same day at the same price. In TRACE, however, the dealer who sold the bond would report this as one $1 million trade. If we aggregate the volume of the NAIC trades that occur in the same bond, on the same day, at the same price, the NAIC transaction would match to the TRACE trade, as a single trade. It's worth noting that since the insurance company sold the bond holdings as two separate pieces of $500,000 each on two separate days, two distinct sales of $500,000 would be reported as two sales in both NAIC and TRACE.

A second reason for why a single trade may be reported as multiple trades is that distinct subsidiaries of an insurance company may book portions of a trade to their respective division, and each division makes its own statutory filings to the NAIC. This can occur, for instance, if part of a trade is allocated to the property and casualty group and another portion allocated to the life insurance group. In the NAIC database, this appears as two trades, while in TRACE, it appears as one trade.

We attempt to correct for these two reporting problems by grouping transactions that we believe correspond to the same trade. Any records that share the same date, CUSIP, counterparty, transaction type (buy or sell), and have prices within 1 cent of another are grouped and considered a single trade. We show this grouping in Table B1. In the cleaned NAIC file, from January 1, 2000 to December 31, 2006, the number of trades reduces from 693,862 to 567,251.

As discussed in Section VII, grouping trades does not affect our NAIC volume analysis. However, the price standard deviation increases when we group trades. We, therefore, report the analysis of NAIC trades both with and without grouping.

To assign the bonds in NAIC to a FINRA Phase, we simply match the cleaned Phase list from TRACE used in Table A2 to the sample of cleaned NAIC bonds. Table B2 reports the number of NAIC CUSIPs, and both grouped and ungrouped trades in each Phase. Importantly, in Phase 1, we match 323 CUSIPs out of 343 TRACE Phase 1 CUSIPs.

Market Share Analysis

Unlike TRACE, which does not identify the transacting parties, the NAIC database has two fields which identify the counterparty to the insurance company in an NAIC sell or buy trade. These are: NAME OF PURCHASER (in a sell trade by the insurance company) and NAME OF VENDOR (in a buy trade by the insurance company). NAIC does not identify the name of the insurance company involved in the transaction. This means only one side, the non-insurance company side, is identified for each trade. We use this information, to construct a COUNTERPARTY variable.

Importantly, the counterparty field is not always a trading partner. Insurance companies also use this field to identify transactions that are calls, maturities, conversions, etc. and these were excluded from our sample as described above. Moreover, since each insurance company self-reports the data, there are often name variations in the counterparty field. For example, “J P Morgan”, “J P Morgan & Co”, “J. P. Morgan”, “J. P. Morgan Securities” and “J. P. Morgan Securities, Inc.” are listed as counterparties. We could not classify some counterparty names such as “192” or “9-UNIVERSAL LIFE”, so we group these counterparties together with names that appear infrequently into a LEFTOVER category. We grouped by hand the counterparty names into 106 unique trading partners. These correspond to 105 actual trading partners (originally from 7,319 distinct counterparty names), and the LEFTOVER category (which represents 4,714 distinct counterparty names). Importantly, trades in the LEFTOVER category only represent 11.0% of trades and 9.0% of total volume in the Cleaned Historical TRACE dataset.

In addition, because of mergers, some trading partners, which appear to be listed under separate names, are really part of one entity. For example, Salomon Brothers was acquired by Citigroup in 1998, and in our counterparty fields, the trader is sometimes identified as Salomon Brothers and sometimes as Citigroup, even though they were the same entity for our sample period. We examined all merger and acquisition activity for our 106 counterparties and if a merger took place before January 1, 2000 we combine the trading activity under the successor company's name.

The following lists counterparties in our dataset that were acquired before our sample period and the successor name:

- DEAN WITTER was acquired by MORGAN STANLEY on February 05, 1997, so it is called MORGAN STANLEY.
- On June 30, 1997, MONTGOMERY SECURITIES acquired NATIONSBANK, which was acquired by BANK OF AMERICA on September 30, 1998, so MONTGOMERY SECURITIES is called BANK OF AMERICA.
- SALOMON BROTHERS was acquired by CITIGROUP in 1998, so it is called CITIGROUP.

If merger activity occurs during the sample period, we keep the successor name. For instance, BANK ONE CORP was acquired by JP MORGAN on July 01, 2004, so it is called JP MORGAN in our sample. There are 22 counterparties that merged during our sample period:

1) ADVEST was acquired by MERRILL LYNCH on December 02, 2005, so it is called MERRILL LYNCH.
2) ALLIANCE CAPITAL MANAGEMENT was acquired by SANFORD C. BERNSTEIN on October 02, 2000, so it is called ALLIANCE-BERNSTEIN.
3) AMSOUTH BANK was acquired by REGIONS FINANCIAL CORP on November 04, 2004, so it is called REGIONS FINANCIAL CORP.
4) AUTRANET INC was acquired by BNY on February 04, 2002, so it is called BNY.
5) BANK ONE CORP was acquired by JP MORGAN on July 01, 2004, so it is called JP MORGAN.
6) FIRST CHICAGO BANK was acquired by NATIONAL BANK OF DETROIT, which was acquired by BANK ONE CORP in April, 1998, so it is called JP MORGAN.
7) BONDS DIRECT was acquired by JEFFRIES AND CO on October 07, 2004, so it is called JEFFRIES AND CO.
8) CHASE was acquired by JP MORGAN on September 13, 2000, so it is called JP MORGAN.
9) CREDIT LYONNAIS was acquired by CREDIT AGRICOLE on March 13, 2003, so it is called CREDIT LYONNAIS-CREDIT AGRICOLE.
10) DAIN RAUSCHER was acquired by RBC on September 28, 2000, so it is called RBC.
11) DONALDSON LUFKIN JENRETTE was acquired by CREDIT SUISSE on November 03, 2000, so it is called CREDIT SUISSE.
12) FIRST UNION was acquired by WACHOVIA on September 01, 2001, so it is called WACHOVIA.
13) FLEETBOSTON FINANCIAL was acquired by BANK OF AMERICA on April 01, 2004, so it is called BANK OF AMERICA.

14) GRUNTAL was acquired by RYAN BECK & CO on April 23, 2002, so it is called GRUNTAL-RYAN BECK.
15) MORGAN KEEGAN was acquired by REGIONS FINANCIAL CORP on December 19, 2000, so it is called REGIONS FINANCIAL CORP.
16) PAIN WEBBER was acquired by UBS on November 03, 2000, so it is called UBS.
17) PRUDENTIAL SECURITIES was acquired by WACHOVIA on July 01, 2003, so it is called WACHOVIA.
18) SPEAR LEADS & KELLOGG was acquired by GOLDMAN SACHS on September 11, 2000, so it is called GOLDMAN SACHS.
19) STANDISH was acquired by MELLON on July 31, 2001, so it is called MELLON.
20) TUCKER ANTHONY was acquired by RBC on March 08, 2002, so it is called RBC.
21) US BANCORP spun off PIPER JAFFRAY on December 31, 2003, so it is called PIPER JAFFRAY as US BANCORP.
22) WASSERSTEIN & PERELLA was acquired by DRESDNER KLEINWORT on January 01, 2001, so it is called DRESDNER KLEINWORT.

When we consolidate counterparties, we have 617,745 trades conducted by 86 unique traders and 76,116 trades for the LEFTOVER category, for a total of 693,861 trades. The total par volume in the LEFTOVER category is 135,375,226,962, which represents 9.0% of the total NAIC trading activity.

Table A1. Steps from Historical TRACE File to Cleaned Historical TRACE Sample

	CUSIPs (1)	Trades (2)
Source: Historical TRACE File	35,695	35,284,669
Eliminate bonds based on characteristics		
Bonds unmatched to FISD by CUSIP	1,156	200,482
Convertible bonds	1,375	2,297,404
Exchangeable bonds	113	20,420
Other equity-linked bonds	615	221,543
SEC Rule 144a bonds	551	38,583
Bonds with missing issue size or issue size < 100,000	348	95,723
Adjust prices for commissions paid (these transactions are NOT dropped, prices are changed)	19,999	699,833
Eliminate trades which do not take place or when dissemination is delayed		
Modifies: matched to earlier record using sequence number	23,877	883,146
Cancels: matched to earlier record using sequence number	22,557	504,789
Cancels: not matched to earlier record	2,502	4,201
Reversals: matched to earlier record using seven-way match	21,234	837,740
Reversals: matched to earlier record using six-way match	7,507	64,700
Reversals: not matched to earlier record	9,216	44,849
Delayed reversals	2,794	60,698
Delayed disseminations	612	1,382
Eliminate trades which are reported more than once		
Dealer buys (total)	28,417	6,578,859
Dealer buys matched to dealer sells with the same execution time	20,710	590,372
Dealer buys matched to dealer sells with different execution times	26,703	4,468,884
Unmatched dealer buys	26,703	1,519,603
Agency trades (agency buys matched to agency sells)	18,424	563,658
Eliminated trades with price and volume data issues		
Trades with missing price	106	211
Trades with 0 price	0	0
Trades with negative price	0	0
Trades with price greater than 220	497	806
Trades with volume/issue amount ≥ 50% and par value or issue amount is not equal to 0 or 1	2,222	4,597
Trades with volume less than 1000	2,189	5,323
Eliminated trades with timing issues		
Trades executed before bond's offering date	6,654	247,012
Trades executed after bond's maturity date	342	78,052
Trades with different reporting and execution dates	30,736	799,570
Trades that occur on SIFMA Holidays	30,671	581,396
Cleaned Historical TRACE Sample	30,643	21,149,525

Notes. Filters are applied sequentially. This table reports the steps from the historical TRACE file to the Clean Historical TRACE file. Other equity-linked bonds have "KNOCK", "REVERSE", "EQUITY", "LINKED", and "TBD" in the bond's FISD issue name. A seven-way match is based on CUSIP, execution date, execution time, price, quantity, buy-sell indicator, and dealer-customer indicator. A six-way match drops the execution time requirement. Price cutoff of 220 is based on computing a bond's value based on its maturity, coupons remaining and lowest value of the treasury yield curve during our entire sample period. The maximum for our sample is 214, which we round to 220. SIFMA holidays correspond to "Recommended Early Close" and "Recommended Full Close" dates listed at http://www.sifma.org/uploadedfiles/research/statistics/statisticsfiles/misc-us-historical-holiday-market-recommendations-sifma.pdf

Table A2. Steps from FINRA's Phase Listings to Cleaned Phase Sample

	CUSIPs (1)	Trades (2)
Cleaned Historical TRACE Sample (after Table A1)	30,643	21,149,525
Source: FINRA list of Phase 1-3B bonds	26,955	…
Bonds on both FINRA Phase list and Cleaned Historical TRACE Sample	20,595	17,434,020
Phase 1		
list of Phase 1 bonds*	450	4,539,063
bonds in FINRA50 at start of phase	4	32,231
bonds do not exist as of start of phase	60	685,047
bonds do not exist during the period 90 days before until 90 days after start of phase	33	285,253
bonds with non-disseminated trades after start of phase	10	35,034
Cleaned Phase 1 Sample	343	3,501,498
Phase 2		
FINRA's list of Phase 2 bonds	3,747	…
Phase 2 bonds in Cleaned Historical TRACE Sample	3,049	2,934,214
bonds in FINRA50 before or at start of phase	0	0
bonds do not exist as of start of phase	272	21,459
bonds do not exist during the period 90 days before until 90 days after start of phase	229	150,854
bonds with disseminated trades before start of phase	2	4,380
bonds with non-disseminated trades after start of phase	8	25,636
Cleaned Phase 2 Sample	2,538	2,731,885
Phase 3A		
FINRA's list of Phase 3A bonds	16,898	…
Phase 3A bonds in Cleaned Historical TRACE Sample	13,260	8,336,332
bonds in FINRA50 or FINRA120 before or at start of phase	78	603,109
bonds do not exist as of start of phase	983	168,549
bonds do not exist during the period 90 days before until 90 days after start of phase	1,075	259,894
bonds with disseminated trades before start of phase	36	330,722
bonds with non-disseminated trades after start of phase	1	244
Cleaned Phase 3A Sample	11,087	6,973,814
Phase 3B		
FINRA's list of Phase 3B bonds	5,780	…
Phase 3B bonds in Cleaned Historical TRACE Sample	3,678	1,362,059
bonds in FINRA50 or FINRA120 before or at start of phase	26	52,945
bonds do not exist as of start of phase	648	235,319
bonds do not exist during the period 90 days before until 90 days after start of phase	132	46,791
bonds with disseminated trades before start of phase	15	22,135
bonds with non-disseminated trades after start of phase	4	1,738
Cleaned Phase 3B Sample	2,853	1,003,131
Total Cleaned Phase 1-3B Sample	16,821	14,210,328

Notes. This table reports the match between the Cleaned Historical TRACE file and FINRA's Phase Listings. Not all bonds in the TRACE Historical Sample are classified in a FINRA Phase. Excluded bonds are those issued after 7/1/02 that are always disseminated and those that mature before 2/7/05 that are never disseminated. We construct the Phase 1 list by including all bonds with disseminated trades before Phase 2 that are not on the FINRA Phase 2, 3A, or 3B lists. The Phase 2, 3A, and 3B lists were obtained directly from FINRA. The FINRA50 and FINRA120 lists are from www.finra.org. Bonds in FINRA's Phase lists that are not in the Cleaned Historical TRACE Sample have either never traded during the sample period or have been eliminated due to cleaning process in Table A1.

Table B1. Steps from Historical NAIC File to Cleaned Historical Sample

	January 1, 2000 - December 31, 2006			July 1, 2002 - December 31, 2006		
	CUSIPs	Ungrouped Trades	Grouped Trades	CUSIPs	Ungrouped Trades	Grouped Trades
Original Source: NAIC Transactions File	63,859	1,933,095	1,490,831	50,968	1,341,471	1,032,124
Match NAIC Bonds with Cleaned Historical TRACE sample						
CUSIP not found in Cleaned Historical TRACE sample	46,060	805,483	625,403	33,645	533,092	417,881
Eliminate transactions which are not trades						
Non-trade indicated by counterparty field entry (calls, converts, etc.)	13,996	290,802	210,425	13,424	233,247	161,140
Eliminate trades with data issues						
Missing Price	407	879	593	407	879	593
Zero Price (or Zero Par Value)	154	286	265	153	285	264
Negative Price (or Negative Par Value Amount)	151	194	190	132	162	159
Price greater than 220	53	85	80	50	82	77
Trades with volume/issue amount >= 50% & (ParValue or Issue amount notequal to 0 or 1)	359	647	627	235	421	405
Trades with volume less than 1000 dollars	140	295	280	116	249	235
Eliminated trades with timing issues						
Trades executed on or before bond's offering date	7,371	112,413	61,052	5,187	73,700	40,783
Trades executed on or after bond's maturity date	925	1,585	1,461	925	1,585	1,461
Trades executed on weekend or SIFMA Holiday	7,308	26,539	23,305	5,404	16,619	14,525
Post July 2002 trades executed on days with no TRACE trades**	7	13	9	7	13	9
Cleaned Historical NAIC Sample	16,005	693,861	567,250	14,573	481,134	394,678

Notes: Filters are applied sequentially. The CUSIPs column gives total number of CUSIPs eliminated from the database by adding that row's filter. The trades column gives total number of observations eliminated by adding that row's filter. * Price cutoff of 220 based on computing the a bond's maturity, coupons remaining and lowest value of the treasury yield curve during our entire sample period and taking the maximum across bonds. That value of 214 is rounded to 220. **On June 11, 2004, the SEC declared a holiday when because President Reagan died. Grouping is done if the difference in Price is <= |0.01| and the day, counterparty, insurer type, and buy or sell are equal.

Table B2. Comparison of NAIC and TRACE Trading Activity 90 Days After Phase Start

	Phase 1 (1)	Phase 2 (2)	Phase 3A (3)	Phase 3B (4)
		A. CUSIPs		
CUSIPs				
Phase CUSIPs in Cleaned NAIC Dataset	323	2,192	4,710	2,076
Phase CUSIPs in Cleaned TRACE Dataset	343	2,682	11,171	2,855
NAIC CUSIPs / TRACE CUSIPs	94.2%	81.7%	42.2%	72.7%
		B. Volume and Trades		
Volume				
NAIC volume	15,260,658,392	15,072,130,358	14,470,216,388	1,625,677,320
TRACE volume	243,403,051,641	130,940,914,944	200,109,997,753	37,075,185,871
NAIC volume/TRACE volume	6.3%	11.5%	7.2%	4.4%
Trades				
Ungrouped NAIC trades	6,775	15,056	16,231	3,812
Grouped NAIC trades	5,409	12,236	13,056	3,083
TRACE trades	351,606	221,460	404,035	42,645
Ungrouped NAIC trades/TRACE trades	1.9%	6.8%	4.0%	8.9%
Grouped NAIC trades/TRACE trades	1.5%	5.5%	3.2%	7.2%
Trade Size				
NAIC Ungrouped Average Trade Size	2,252,496	1,001,071	891,517	426,463
NAIC Grouped Average Trade Size	2,821,346	1,231,786	1,108,319	527,304
TRACE Average Trade Size	692,261	591,262	495,279	869,391
NAIC Ungrouped Average/TRACE Average	3.3	1.7	1.8	0.5
NAIC Grouped Average/TRACE Average	4.1	2.1	2.2	0.6
		C. Price Standard Deviation		
CUSIPs / Bond-Days used				
Ungrouped NAIC	253 / 1,333	392 / 837	464 / 933	109 / 164
Grouped NAIC	213 / 969	261 / 481	273 / 483	65 / 87
TRACE	340 / 17,087	2,130 / 40,713	6,342 / 70,094	1,129 / 8,786
Price Standard Deviation				
Ungrouped NAIC	0.26	0.26	0.39	0.04
Grouped NAIC	0.42	0.40	0.70	0.04
TRACE	0.88	0.78	0.68	0.45
Ungrouped NAIC Std. Dev./TRACE Std. Dev.	0.30	0.33	0.57	0.09
Grouped NAIC Std. Dev./TRACE Std. Dev.	0.48	0.51	1.02	0.09

Notes. This table reports on comparisons between the cleaned NAIC file and the Historical TRACE file for 90 calendar days after the Phase Start.

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