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Abstract

Mandated post-trade transparency in secondary markets lowers the cost of issuing corporate bonds. We show that costs are lower due to the mitigation of information asymmetry in the issuing process. Three pieces of evidence support this finding. First, new issues with higher information asymmetry experience relatively larger reductions in issuing costs. These bonds also experience lower reductions in trading activity than lower information asymmetry bonds, so liquidity cannot explain these results. Second, when a larger fraction of trades in comparable bonds are made post-trade transparent, new issue pricing improves. This holds when conditioning on expected bond liquidity. Third, transparency raises prices in the secondary market, but not by as much as it does for newly issued bonds.

Keywords: corporate bonds, capital costs, market transparency
JEL Classification: G11, G12, G14, G18

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1 Introduction

Today virtually all US depository-eligible corporate bonds are subject to the "TRACE rules" of the Securities and Exchange Commission. These rules, initially adopted in 2002, require members of FINRA (known as NASD before 2007) to report all transactions in corporate bonds for public viewing (NASD, 2001).[1] Bessembinder, Maxwell, and Venkataraman (2006) find that trade execution costs fall by approximately 50% once a bond's trades are reported in TRACE. Edwards, Harris, and Piwowar (2007) and Goldstein, Hotchkiss, and Sirri (2007) also provide evidence that TRACE had a neutral or positive effect on liquidity.

This link between market structure and secondary market liquidity is well documented in several settings.[2] However, the association between primary markets and secondary markets is less understood. In this paper, we use the implementation of the TRACE program to document a causal link between secondary market frictions and the cost of debt capital in the corporate bond market. We also use a number of empirical strategies to determine the relative importance of possible economic mechanisms that link secondary market transparency and primary market costs. These analyzes allow us to pin down the economic mechanism through which this regulatory reform impacts cost of capital, something that has not previously been achieved.

We document that improved secondary market transparency following the introduction of TRACE is associated with a fall of 14 bps in the yield spread of a typical issue, from a sample mean of 144 bps. A 14 bps lower yield corresponds, at sample mean levels, to a 1.1% increase in price. TRACE also has a negative impact on underpricing and explicit fees

[1]Although the NASD has been known as FINRA since 2007, we use the old acronym in this paper to match the term of our sample.

[2]See for example Madhavan (2000) for a somewhat dated survey of some of this literature. More recent examples include Foucault, Moinas, and Theissen (2007), Hendershott, Jones, and Menkveld (2011) and Menkveld and Zoican (2017).

charged by intermediaries, but the statistical significance of these findings is weaker.

To identify these reductions in costs, we exploit the staggered roll-out of TRACE. Phase 1, July 2002 to February 2003, includes only investment grade bonds with a face values of \$1bn or more. Phase 2, March 2003 to September 2004, includes bonds with face value of \$100m or more and a credit rating of A- or better. Phase 3, October 2004 to February 2005, includes all remaining bonds. The staggered roll-out allows us to estimate the magnitude of transparency-related changes via difference-in-differences regressions both pooled across all bonds and split by roll-out phase.[3] Our results split by phase show that TRACE mainly affects issuing costs for smaller, lower rated bonds.

Having documented these benefits for issuers, we turn our attention to identifying their source. Understanding why this reform matters for capital costs increases our understanding of the economic impact and importance of market microstructure, and can help to inform current and future regulatory reforms in this space.

One theoretical channel by which secondary market transparency could influence primary market prices is secondary market transaction costs. Bessembinder et al. (2006), Edwards et al. (2007), Goldstein et al. (2007) and Asquith, Covert, and Pathak (2019) document the beneficial effect of TRACE on transaction costs. These costs act as a tax on the expected return on an investment in a given security. If TRACE lowers the expected cost of acquiring or liquidating a position, then investors may be willing to pay more for that security all else being equal, or equivalently accept a lower yield (as in Amihud and Mendelson, 1986a or Amihud and Mendelson, 1986b).[4]

[3] Alongside the second phase of the TRACE roll-out, the NASD disseminated trade reports for 120 BBB rated bonds, however these were existing issues rather than new issues and therefore do not affect our sample construction. For the same reason, the FIPS-50 bonds that were subject to limited trade reporting before TRACE do not directly affect our analysis of new bond issuing costs. See NASD (2005) and Asquith, Covert, and Pathak (2019) for details of the phases of TRACE.

[4] Chen, Lesmond, and Wei (2007) and Bao, Pan, and Wang (2011) both find links between bond illiquidity

An alternative but not necessarily mutually exclusive explanation for the reduction in issuing costs is via the effect of transparency on information asymmetry in the issuing process. In bond markets, recent secondary market prices of other comparable bonds are important reference points for pricing new issues. Nikolova, Wang, and Wu (2020) show that information asymmetry problems for new bond issues increase when other bonds from the same issuer trade infrequently or at divergent prices. Auh, Kim, and Landoni (2019) document that underwriters of a new bond issue provide price support for existing bonds of the same issuer before, during and after the issuing process. This increases the reference price for the new bond issue and its issuing price.

Prior to TRACE, agents responsible for more trading activity, such as dealers or active fund managers with high turnover, have an advantage due to the asymmetry in records available: these kinds of traders have greater access to recent trade details than do smaller investors, or buy and hold investors who rarely trade in the secondary market. Investors with less access to trade history may rationally choose to bid conservatively to limit the possibility of the "winner's curse", as outlined in Rock (1986) or Carter and Manaster (1990). After TRACE, this disadvantage vanishes because all traders can observe the TRACE database therefore reducing information asymmetry in the primary market.

We use two empirical strategies to investigate the importance of the information asymmetry and the transaction cost channels. The first strategy examines the role that recent trading in existing bonds plays in the issuing of new corporate debt. If the information channel is important, then recent trading records will provide useful pricing information to investors

and secondary market bond prices. Lin, Wang, and Wu (2011) and de Jong and Driessen (2012) show that sensitivity to aggregate liquidity risk is a priced factor for corporate bonds. Goldstein, Hotchkiss, and Pedersen (2019) show that ex-ante measures of expected liquidity have an economically large impact on offering yield spreads. These papers do not distinguish between the effect of transaction costs and information frictions, both of which affect liquidity.

in new bonds. The TRACE academic data contains trade records for bonds regardless of whether or not these trades were publicly disseminated at the time the trades took place which allows us to accurately identify both the publicly disseminated and non-disseminated (private) trades for any bond in the database. We use this information to determine the amount of public and private secondary trading that takes place in all bonds that are comparable to the new issue (in terms of ratings, maturity and coupon), referred to in industry as "matrix bonds". We show that trading in matrix bonds, specifically, the fraction of trading that is made public affects prices of new issues, conditional on expected bond liquidity in the after-market. Bonds with higher fractions of public trade records, or less information asymmetry receive better pricing than bonds with more information asymmetry.

Our second strategy for separating the information asymmetry and transaction cost channels involves splitting the sample of new bonds based on the level of information asymmetry. We use two proxies for information asymmetry: the number of underwriters, and the number of existing bonds outstanding from the same issuer at the issue date. Underwriters play an important role in information production. Issues with fewer underwriters likely produce less information and therefore information asymmetry will be higher, all else equal. Similarly, investors will have better access to information when companies frequently issue bonds. Therefore, information asymmetry will be higher for bonds with fewer prior issues. Since TRACE eliminates at least one source of information asymmetry, we argue that the policy has a relatively larger information effect for high information asymmetry bonds.

We find that improvements in issuing yields are concentrated in bonds with higher information asymmetry. TRACE causes bonds with fewer than median underwriters or previous issues to fall by between -0.12% and -0.20% in basis point terms. It is plausible that this might be due to increases in trading activity — but trading activity increases most substantially for low information asymmetry bonds — so there is no evidence that the improvements in issuing yields are due to transaction cost reductions. The fact that the beneficial effect of TRACE on issuing costs is concentrated in smaller, less credit-worthy bonds provides additional support for the importance of information asymmetry.[5]

These results provide evidence that information asymmetry has more influence on primary market issuing costs than transactions costs. We next try to disentangle whether this influence comes from information asymmetry in the primary or secondary market. Changes in the information environment in the primary market should not affect prices of seasoned bonds already trading in the secondary market. However, if TRACE impacts information in the secondary market, then we would expect to see similarly sized effects in both the primary and secondary market.

Using a panel of secondary market bond trades, we show that TRACE leads to a statistically significant decrease in yields to maturity. However, the size of the effect is only five basis points for the average bond, or around one third of the estimate for the average bond issued in the primary market. So while transparency is important in both the issuing process and the secondary market, it is more important in the issuing process. This result is intuitive as information asymmetry will be more important in a newly issued bond than in an existing bond.

Our final analysis considers the role of TRACE in the allocation process. If TRACE reduces information asymmetry, smaller investors should be willing to bid more aggressively and expect to receive larger allocations. Using Lipper-eMaxx data for the first quarter after the bond issue we find some support for TRACE increasing the number of holders and

[5] Wei and Zhou (2016) document more informed trading in corporate bonds prior to earnings announcements in lower rated bonds. Li and Galvani (2021) argue that "top" corporate bonds — those that attract more institutional-sized trades — are more informationally efficient than non-top bonds while Edwards et al. (2007) show that transaction costs for large, institutional sized trades are significantly lower for larger bonds.

broadening the holdings. Retail trading activity, proxied by trades of less than \$100,000, is also higher in the first week after issuance, both absolutely and relative to institutional trading.

Together, each of our empirical strategies clearly identify information asymmetry in the issuing process as the important driver of reduced issuing costs for new bonds after the introduction of TRACE. Post-trade transparency gives all investors access to recent reference prices from comparable securities and helps to "level the playing field" between large investors with diverse bond portfolios and smaller investors holding fewer individual bonds.

We are aware of four other papers that investigate the role of TRACE and the corporate bond issuing process. In an unpublished working paper Goldstein and Hotchkiss (2012) examine both underpricing and price dispersion of newly issued corporate bonds using TRACE data. They find that transparency is associated with a reduction in underpricing and price dispersion. Qi and Wang (2016) use TRACE as an instrument for bond liquidity and show that bonds with higher expected liquidity have fewer covenants. Davis, Masler, and Roseman (2018) show that TRACE bonds have lower issuing costs and attempt to relate TRACE status to firm financing behavior. Field, Mkrtchyan, and Wang (2018) show that TRACE allows firms to expand capital expenditures and acquisition activities.

While each of these working papers generates evidence consistent with our findings on the *overall* impact of TRACE, our study is the only one that attempts to shed light on the economic mechanism driving the improvement in capital costs. We go beyond simply showing that there is an association between transparency and capital costs, and identify why this association exists. We clearly demonstrate that it is the effect of TRACE on the information environment that truly matters. Understanding why the reform matters is a crucial piece of evidence for regulators considering how best to design the trading rules for otherwise opaque, OTC markets.

Overall, our evidence also illustrates that the economic consequences of increased transparency in the secondary market for corporate bonds extends to the primary market and therefore the cost of raising debt capital. Some may argue that this is an obvious and intuitive result. However, a survey of international corporate bond markets reveals that most continue to operate with very little transparency (IOSCO, 2017). In the US, recent regulatory proposals have also sought to limit transparency for large corporate bond transactions (SIFMA, 2018). Clear empirical evidence supporting this intuitive result may therefore help drive appropriate regulatory change. Given the economic importance of capital costs, the size of the global bond market, and the opaque nature of OTC trading, our results indicate that significant benefits are obtained by improving transparency in bond markets. Securities regulators should give careful consideration to reforms that achieve this goal, and especially to how any reform may impact the information sets of different bond market participants.

2 Information, liquidity and bond issuing costs

TRACE requires that the details of all secondary market trades in eligible securities are made public. Publishing the price and volume of each trade can affect the cost of capital in the bond market in at least three ways: through transactions costs, changes in information asymmetry in the primary market and changes in information asymmetry in the secondary market. These mechanisms are not mutually exclusive and could simultaneously affect bond issuing costs. We describe each of these mechanisms.

2.1 Transaction costs and issuing costs

The fact that TRACE reduced secondary market transaction costs is well documented (Bessembinder et al., 2006; Edwards et al., 2007; Goldstein et al., 2007; Asquith et al., 2019). Theoretically, TRACE can lower transaction costs by reducing rents charged by market makers and improving competition in the secondary market (Duffie, Dworczak, and Zhu, 2017; Back, Liu, and Teguia, 2020), by helping market makers better manage adverse selection risk (Pagano and Röell, 1996) and better manage inventory risk (Bessembinder et al., 2006).

Even in the absence of any other effect, lowering transaction costs can theoretically increase equilibrium asset prices. Transaction costs act as a tax on the expected return on investing in a given security and if TRACE lowers the expected cost of acquiring or liquidating a position, then investors may be willing to pay more for that security all else being equal, or equivalently accept a lower yield (as in Amihud and Mendelson, 1986a or Amihud and Mendelson, 1986b). These models study asset prices in secondary markets, but the same logic applies to new issues in the primary market. Investors who face non-zero probabilities of liquidating a position prior to maturity will rationally consider the cost of doing so and price a new bond accordingly.

These arguments suggest that TRACE may affect primary market prices by reducing future expected transaction costs for a bond.[6]

[6]There are counter-arguments for why lower transactions costs may not significantly reduce issuing costs in the corporate bond market. First, turnover in the corporate bond market is significantly lower than many other asset classes, especially equities, suggesting that transaction costs may not be so important to the marginal investor. Second, Flanagan et al. (2019) shows that investors may be willing to pay more in the primary market to avoid needing to trade in the secondary market, when doing so is relatively more costly. Finally, at the time of the TRACE program, bond investors did not necessarily know ex-ante that TRACE would reduce trading costs. Transparency might have theoretically harmed liquidity by adversely affecting market makers' ability to unwind large trades (Goldstein et al., 2007).

2.2 Information asymmetry in the issuing process

Prior to TRACE, the details of every bond trade are known with certainty to only two traders: the buyer and the seller. After TRACE, all investors can observe the trading history of every eligible bond, possibly with a short delay depending on the phase of the program. The distribution of information regarding recent bond trades can theoretically affect bond issuing prices, even if the effect of transaction costs on asset prices is insignificant.

In bond markets, recent secondary market prices of other comparable bonds are important reference points for pricing new issues. Nikolova et al. (2020) show that information asymmetry problems for new bond issues are greater when other bonds from the same issuer trade infrequently or at divergent prices (i.e. when observations of reference prices are sparse and subject to noise). Auh et al. (2019) show that the reliance of investors on reference prices incentivizes the dealing desk of the underwriter of a new bond issue to pay higher prices for existing bonds of the same issuer prior to and during the bond offering. By doing so, they increase the reference price for the new bond being issued, and help increase the issuing price. Theoretically, ex-post transparency can relieve information asymmetry, either from informed traders to dealers (Pagano and Röell, 1996) or from dealers to (uninformed) customers (Duffie et al., 2017; Back et al., 2020).

Prior to TRACE, agents responsible for more trading activity, such as dealers or active fund managers with high turnover, have an advantage due to the asymmetry in records available. On average, these kinds of traders have greater access to recent trade details than do smaller investors, or buy and hold investors who rarely trade in the secondary market. Since this information is important for pricing a new bond issue, investors with less access to trade history may rationally choose to bid conservatively to limit the possibility of the "winner's curse", as outlined in Rock (1986) or Carter and Manaster (1990). TRACE eliminates this information advantage and levels the playing field in the issuing process between investors with access to more trading history and those with less. At the margin, the discount required to participate in a new bond offering for uninformed investors will be lower. Though we have in mind information asymmetry between bidders in the primary market, the same arguments can apply to underwriters, who themselves may be uninformed and can learn from the indications of interest of their customers (as in Nikolova et al., 2020).

2.3 Information asymmetry in the secondary market

TRACE may also affect bond issuing costs through a direct effect of information asymmetry on equilibrium asset prices in the secondary market. Easley and O'Hara (2004) show that uninformed investors demand a higher return to hold stocks with more private (and therefore less public) information. This is because, in equilibrium, portfolios of uninformed investors are over exposed to stocks that informed investors do not want to hold and this risk cannot be diversified away by holding more stocks. Lambert, Leuz, and Verrecchia (2012) demonstrate that in a perfectly competitive secondary market, it is the average *precision* of investor information that matters. TRACE makes new information available to previously uninformed traders, which improves the precision of their information. As no single trader is involved in every transaction, even the most active corporate bond traders have access to more information after TRACE and so the precision of their information also improves, implying an increase in average precision across the entire market.

To highlight how this channel is distinct from those described so far, suppose that transaction costs are irrelevant for bond investors (perhaps because the marginal investors perceives an extremely low likelihood of ever trading the bond in the secondary market). Further, assume that, in the issuing process, all relevant private information for pricing the new bond is revealed at the issuing date, so that the mechanism in Section 2.2 is irrelevant. In the future, as private signals are revealed to informed investors, information asymmetry will re-emerge. Those investors who expect to become uninformed in the future must be compensated for this risk. If TRACE helps to eliminate one particular source of information risk — that between investors with high levels of access to past trade records and those with low levels of access to this information — then at the margin, this reduces expectation of losses from trading with informed traders and raises the price of a new bond issue.

A key distinction between the effect of information asymmetry on equilibrium asset pricing discussed here and the effect in the issuing process directly (Section 2.2) is that the equilibrium asset pricing effect should be present in both the primary and the secondary market. If TRACE helps to eliminate a source of systematic risk, then this should raise prices of bonds wherever they are changing hands. If instead, the information asymmetry problems are most acute in the issuing phase, then we expect to see larger effects of TRACE in the primary market, relative to the secondary market.

3 Data and Summary Statistics

Details of all public issuance of investment grade and non-investment grade debt by US-domiciled firms are obtained from the SDC Platinum database. The sample period is July 1, 2000 until February 28, 2007. We choose these start and end dates so as we to cover a period spanning exactly two years prior to the commencement of the TRACE program until two years after the program is completely rolled out across all corporate bond categories.

For each issue, we obtain the issuer, the issue date, the maturity date, the yield spread to benchmark Treasury in basis points (bps), the offer price, the principal, gross proceeds and proceeds net of fees and expenses of the issue (all in $bn), the S&P rating (converted to an integer scale where zero or below represents non-investment grade, i.e. $BB+ = 0$, $BBB- = 1$ and $AAA = 10$) and a 4-digit SIC code. Using an approach similar to Cai, Helwege, and Warga (2007), we exclude shelf issues, 144As, non-underwritten bonds, private placements, mortgage bonds, equipment trust certificates, bonds with a maturity of one year or less, bonds issued in perpetuity, bonds with a face value of \$1m or less, and any issues by banks or agencies. Approximately 20% of these issues do not have 9-digit CUSIPs and another 12% have 9-digit CUSIPs that cannot be matched to the TRACE data (which is needed for calculating the underpricing and liquidity variables). This is due in part to bonds that lack depository-eligible status.

We also obtain TRACE data for all bonds from the TRACE academic corporate bond restricted database. These data contain the price, volume, trade time, customer-dealer trade flag, and customer direction (buy or sell) for all trades in TRACE eligible bonds with at least one NASD member as a counter-party.[7] We follow the procedures described in Dick-Nielsen (2009) to eliminate duplicate reports and to accurately reflect trade reports that are corrected or reversed. For our sample of new issues, we match TRACE trades to the SDC Platinum data using the 9-digit CUSIP, discarding any bonds that cannot be matched.

From TRACE and SDC Platinum, we construct a dataset that contains the issue date, bond maturity at the issue date in years, principal value in \$bn, the numerical S&P bond rating, the log of the yield spread to benchmark Treasury, fees and expenses paid by the issuer as a percentage of the principal value and underpricing over the first two weeks of the issue. The percentage fees and expenses are defined as the difference between the proceeds

[7]It is important to note the distinction between TRACE eligibility and TRACE dissemination. Although trading data were disseminated to the public only for certain bonds at the initial date of the program in 2002, members of the NASD were still responsible for *reporting* trades in all eligible securities (i.e. regardless of principal and rating) to the NASD. These reported but not disseminated data are available in the TRACE Academic database. Researchers are therefore able to analyze bond transaction data from July 1, 2002 onwards regardless of whether or not these trades were publicly available at the time of issue.

paid to the firm net of fees and expenses and the proceeds paid to the firm including these fees and expenses divided by the principal.[8] In line with Cai et al. (2007), underpricing is defined as an excess return on a bond over a benchmark bond index at the two week horizon (consistent with the horizons used in Goldstein and Hotchkiss, 2012).[9] Since we can only construct underpricing after the TRACE sample commences in 2002, we have a smaller sample with which to construct underpricing, as these variables are not recorded for bonds issued in the pre-TRACE component of our sample period (July 2000 to July 2002). This also applies to any variable calculated using TRACE data (such as number of trades after issuance etc). Yield, expenses and underpricing are Winsorized at the 1% level.

The final matched database of new issues contains 1,321 distinct bond issues. Table 1 presents summary statistics for these issues.

[Table 1 about here]

The average bond in our sample has a principal of close to $480m, a maturity of 10.4 years and a yield spread to Treasury of 144 bps. The average issuing expense is 73.5 bps, the mean unadjusted two week return on the issuing price is 33 bps while average underpricing (bond return minus benchmark) is 5 bps over the first two weeks of trading. The median S&P rating of three corresponds to a BBB+ issue. Both the bond principal and maturity appear to have significant skewness, as expected, while the standard deviation of underpricing is more than

[8] Due to the way it is constructed, issuing expense can be negative if the net proceeds recorded in SDC Platinum are larger than the gross proceeds. This applies only to four of our 1,321 observations and since this is most likely an error in the raw data, we treat these values as missing in our analysis. This has no meaningful impact on any of our results for expenses.

[9] For the benchmark bond indices, we use Bank of America Merrill Lynch Investment Grade Corporate Bond Total Return indices covering periods of 3 to 5 years, 5 to 7 years, 7 to 10 years, 10 to 15 years and 15 years or more respectively, available from the St Louis Fed website. For bonds that do not record a secondary market trade within two weeks of the issue date, we use the first trade recorded in TRACE to construct our underpricing variable, as long as this trade takes place no more than one month after the issue date. This reduces the size of the sample of bonds for which we can construct underpricing, but only by approximately five percent relative to no filter based on the date of the first transaction.

ten times larger than the mean or median value, indicating the large degree of dispersion in this variable. For comparison, the average bond size and maturity in Bessembinder et al. (2006) is $462m and 9.99 years. We observe repeat issues by most firms, some of which are across cohorts. There are 487 unique issuing firms in our sample. The median firm issues two bonds during our sample while the 25th percentile firm issues one bond. The median firm's bonds are in a single TRACE cohort.

Macroeconomic data at the time of issuance for each bond are obtained from the St Louis Fed website. These variables include GDP growth (%), the inflation rate (%), the Fed Funds rate (%), the US 10 year on-the-run Treasury yield (bps), the unemployment rate (%) and the spread between Moody's seasoned Baa Corporate Bond and the 10 year Treasury yield (%) which we refer to as the credit spread.[10]

4 Difference-in-difference estimation

Our empirical approach exploits the staggered roll-out of the TRACE program across bonds to identify the effect of increased secondary market transparency on the pricing and cost of primary market issues. To isolate the causal effect of transparency on issuing costs, we use the differing requirements for NASD members to report trades through the TRACE program across different bonds as a treatment effect and estimate the causal effect of transparency using a difference-in-difference approach. Phase 1, beginning in July 2002, requires NASD members to report trades in investment grade bonds that are at least $1bn in size on July 1,

[10] GDP growth is recorded at a quarterly frequency, the Fed Funds rate, CPI and unemployment are monthly, while the 10 year Treasury and credit spread is recorded at the daily frequency. Inclusion of the credit spread is particularly important because there was a sharp reduction in the credit spread during the period that we analyze. Controlling for the spread directly helps to ensure that we do not conflate the effect of transparency with the market-wide reduction in credit spreads. This might occur if the different categories of bonds eligible for TRACE at different times have different sensitivities to credit spreads. We are grateful to Kumar Venkataraman for pointing this out to us.

2002. Phase 2, beginning in March 2003, additionally requires reporting of bonds that are at least \$100m in size and are rated A- or better. Phase 3, beginning October 2004, requires reporting in all other bonds.

We divide principals into three categories related to the cutoffs for each Phase: \$1bn and above, less than \$1bn but equal to or greater than \$100m, and less than \$100m. S&P ratings are divided into four categories: AA- or better (high investment grade and prime issues), A- to A+ (upper medium grade) BBB- to BBB+ (lower medium grade issues) and BB+ and below (non-investment grade issues). We have twelve cohorts formed from a two-way sort on the three principal categories and the four ratings categories. All bonds in a given cohort become TRACE eligible at the same time. We first pool the three events and estimate a single treatment effect via the following regression:

$$y_{ict} = \gamma_c + \rho_t + \beta trace_{ct} + \varepsilon_{ict} \tag{1}$$

where y_{ict} is the dependent variable of interest for bond issue i belonging to cohort c issued at date t, γ_c is a cohort-specific fixed effect for the cohorts defined as separate principal and rating categories (as above), ρ_t is a time fixed effect for the quarter when the bond is issued and $trace_{ct}$ is an indicator variable for whether cohort c is eligible for TRACE reporting when the bond i is issued. The γ_c terms act as fixed effects for the TRACE-eligibility status of each bond, with bonds in each cohort becoming TRACE-eligible on one of the three dates.[11] Our coefficient of interest is β which estimates the change in the expected value of y_{ict} following inclusion in the TRACE program, after controlling for both cohort and time effects. The

[11] Equation (1) is analogous to a standard treatment effects estimator around a single treatment date, but extended to the case with multiple groups and time periods, as per Bertrand and Mullainathan (2003) and Gormley and Matsa (2011) (see Bertrand, Duflo, and Mullainathan, 2002 and Wooldridge, 2007 for discussion).

parameter β is our pooled analogue of the coefficient on the interacted term between the treatment dummy and the post-treatment period dummy in a difference-in-difference model using a single treatment period. β captures the average treatment effect across the multiple events.[12] We estimate our t-statistics using heteroskedasdicity robust standard errors. We use three dependent variables related to issuing costs: (i) the log of the issuing yield spread to benchmark Treasury (ii) new issue underpricing and (iii) the fees and expenses paid (as a fraction of face value measured in bps) in the issuing process, as defined in Section 3.

We also estimate the effect of TRACE using bond specific and macroeconomic control variables in place of the cohort and time fixed effects. This alternative specification is given by:

$$y_{ict} = \alpha + \beta trace_{ct} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict} \tag{2}$$

where x_{ict} is a vector of bond specific controls (log of issue size, bond maturity and bond rating) and z_t are macroeconomic controls (defined in Section 3) at time period t and $trace_{ct}$ as defined in Equation (1). Regressions that exclude bond-specific control variables (but do control for fixed differences in outcome variables across cohorts and time with the fixed effect terms γ_c and ρ_t) are arguably more robust because it is impossible to rule out that these control variables are also affected by the introduction of the TRACE program, for example if issuers also chose to issue larger bonds than they otherwise would have after the program has begun. We estimate the effect of transparency under both specifications to show that our results are not sensitive to the inclusion of controls in place of fixed effects.

It is important to note that our estimates of the TRACE effect are potentially biased towards zero. If TRACE improves pricing of non-TRACE bonds, similar to the findings of

[12]Pooling the three treatment dates into a single regression has the advantage of allowing us to control for cohort-specific effects. The data consist of repeated cross-sections rather than panels (each bond is only issued once) and so we cannot include bond-specific fixed effects in our model.

liquidity spillovers documented in Bessembinder et al. (2006), then the TRACE treatment effect could underestimate the true effect of TRACE. In this sense, our results could be considered a lower bound on the true effect.

4.1 Effect of transparency on bond issuing costs

Table 2 contains the parameter estimates for Equation (1) estimated over the full sample of issues from July 2000 until February 2007, both with time and cohort fixed effects and with bond-specific and macroeconomic controls. The key result from Table 2 is the negative and statistically significant coefficient of β (transparency) on the log of bond yield spreads using either specification, as well as bond underpricing depending on the specification.

[Table 2 about here]

We estimate that TRACE reduces the bond yield spread to benchmark Treasury at issuance by approximately 10% - 13% (in bps terms) over pre-TRACE levels. In terms of actual yield spreads, for a bond issued at the mean yield spread in our sample of 144 bps, the predicted impact of TRACE is a reduction in yield spread of about 14 bps. This represents about one sixth of one standard deviation for this variable. The magnitudes and t-statistics for the TRACE parameter are very similar with and without bond-specific controls and we reject the null of no effect at the 5% level using either specification.

To quantify this effect, we calculate the change in issuing price for an estimated change in yield corresponding to Table 2 for a security that closely resembles the average bond in our sample. For a 10 year bond, paying an annualized coupon of 5.50% on a semi-annual basis issued at a price close to par, a reduction in yield of 14 bps equates to an increase in price of 1.07%. A firm issuing such a bond with $500m principal would receive an additional $5.4m payment for these bonds compared with issuing in the pre-TRACE environment.

Similar effects are present for the explicit expenses associated with a new bond issue, or new bond issue underpricing, but the effects are less robust. For the expenses variable, the estimated parameters both with and without controls are negative. The size of the effects are between 4.8 and 6.2 bps, which represents around 10% of the sample standard deviation, and is much smaller than the effect on bond yields in terms of issuing firms' capital costs. The parameter is also only statistically significant at the 10% level for the non-difference-in-differences specification, and is insignificant for the difference-in-differences specification.

Our main motivation for considering the effect of TRACE on expenses is to ensure that any improvement in bond prices is not obviously offset by increased fees. For example, it may be possible that underwriters just capture a greater surplus in the post-TRACE environment, leaving issuers no better off. We do not find evidence of this. The TRACE-driven improvement in issuing yields results in a net reduction in the cost of capital for the issuing firm.

The β parameter estimates for underpricing indicate a negative effect of TRACE that is statistically significant at the 5% level under the difference-in-differences specification but is not significant at the 10% level using the estimation with controls instead of cohort and time fixed effects (t-statistic of 1.41). As noted in Section 3 we can only construct underpricing after the TRACE sample commences in 2002, so we have a smaller sample for regressions with this dependent variable.

In addition to our main specifications in Table 2, we estimate the effect of TRACE across the three separate roll-out phases by defining three separate treatment effects based on the categories of bonds that become TRACE eligible at different stages of the roll-out. These regressions are analogous to (1) and (2) but where the TRACE dummy is decomposed into three separate treatment variables. The first is an indicator for bond issues that are TRACE eligible in the first phase (investment grade bonds that are at least $1bn in size) and are issued after July 1, 2002. The second treatment effect is for bond issues that are eligible from the second TRACE date (bonds that are at least $100m in size, rated A- or better, issued after March 2003 and are not members of the first cohort). The third is an indicator for all bonds not in the first two categories that are issued after October 1, 2004. These results are contained in Table 3.

[Table 3 about here]

When the effect of TRACE is split by phase, we observe that the improvement in issuing costs is driven by bonds in Phase 2 and 3. For these bonds, we observe a reduction in the log of bond yields of -0.15 in each phase, compared with -0.12 across the whole sample using the fixed effects specification. For bonds in Phase 1, we observe a statistically insignificant effect of 0.03. Qualitatively similar results are obtained using our specification with controls. TRACE does not appear to affect issuing costs for the largest and most liquid category of corporate bonds, and instead is primarily beneficial for smaller bonds with lower credit ratings. Evidence from Wei and Zhou (2016) and Li and Galvani (2021) suggest that these smaller, lower rated bonds have greater information asymmetry than larger, more liquid bonds. Results for fees and underpricing broadly mirror those of yields, but again are less robust across specifications.

While our estimates for explicit expenses and underpricing do not contradict the findings for bond yields, they are economically smaller and also weaker in terms of statistical significance across specifications. Changes in bond yields (and therefore bond prices) directly affect the capital cost of the issuing firm whereas changes in underpricing only directly affect successful bidders in the issuing costs.[13] The theoretical links between prices paid in the

[13]Consider a case where issuing yields are not affected by TRACE, the capital costs of the issuing firm are not

issuing process and either information asymmetry or transaction costs are well established whereas the links between these factors and explicit expenses are less clear. For these reasons we primarily focus on the effect of TRACE on bond yields, rather than underpricing or expenses for the remainder of the paper. However, further analysis of explicit expenses and underpricing can be found in the Internet Appendix.[14]

For our main results, we also present estimates using (i) monthly fixed effects with clustered standard errors (Table IA.1), (ii) standard errors clustered by issuing firm, accounting for correlation in the unobserved component for bonds from the same issuer (Table IA.2), (iii) a sample including non-underwritten bonds (Table IA.3) and (iv) excluding the post roll-out phase of our sample (Table IA.4) in the Internet Appendix. These results are all qualitatively similar to the main results presented in the paper.

4.2 Robustness and issuer behavior around TRACE

Our identification of the effect of TRACE on issuing costs requires that yields in the different cohorts have similar trends in the absence of the treatment. We examine this by plotting, in Figure 1, average secondary market bond yields by cohort from the commencement of TRACE reporting in July, 2002 until the end of the sample February, 2007.

We use secondary market yields because we can observe a bond-level time-series for secondary market yields (rather than a single issuing yield at the issue date in the primary market) and because secondary and primary market yields are closely linked.[15] In the absence of economically large TRACE effects on secondary market prices, evidence that secondary

reduced, even if underpricing falls.

[14]The Internet Appendix is available for download here: `https://www.dropbox.com/s/1o07pqandeivey7/CB_Transparency_IA_Mar2021.pdf?dl=1`.

[15]For example, Table 1 reports average bond underpricing of around five basis points over the first two weeks of issuance.

market yields move in parallel across cohorts over the sample period implies that the returns across the cohorts are driven by similar underlying factors.[16] Figure 1 indicates that average yields move very closely across the three cohorts, suggesting that parallel trends is a valid assumption for our data.

[Figure 1 about here]

TRACE status is not truly random. Issuers may change their behavior strategically in anticipation of TRACE for example by changing the principal of an issue to ensure it is included or excluded from the program. If this were the case, we would expect differences in the size and statistical significance of the treatment effect when we include bond controls compared with cohort fixed effects in Table 2. In fact, we find very similar results with and without these control variables.

We also examine how average bond characteristics (principal, rating and maturity) change around the different phases of the TRACE roll-out. For each characteristic, we split observations into discrete bins and we plot the proportion of issues in each bin around TRACE implementation (Figure 2). There are no obvious differences in the average characteristics across the phases, suggesting that issuers did not change their issuing strategies.

[Figure 2 about here]

We then perform econometric tests for changes in issuing behavior by estimating the following regression of issue characteristics and time dummies:

$$char_{it} = \gamma_t + \tau_1 + \tau_2 + \tau_3 + \tau_4 + \varepsilon_{it} \tag{3}$$

[16]We later test for the effect of TRACE on secondary market yields and find a small but statistically significant effect of around five basis points for a typical bond in our sample, compared with a standard deviation of more than 200 basis points (see Section 6.)

where $char_{it}$ is the characteristic of bond i issued at time t, γ_t is a yearly fixed effect and τ_j is a dummy variable for the beginning of each of the three phases of the TRACE roll-out.[17] We estimate Equation (3) using all bonds in our sample and cluster standard errors at the cohort-time level. Table IA.5 in the Internet Appendix contains these results. The p-value of the joint significance tests for these dummies exceed the 10% in all cases. TRACE roll-out dates do not have any explanatory power for the expected principal, maturity or rating of a bond, in excess of simple year fixed effects.

Having established that TRACE has an economically and statistically significant effect on bond issuing costs, and primarily on the credit spreads at issuance for smaller bonds with lower credit ratings, we next investigate the channels responsible for this effect.

5 The importance of the liquidity and information channels

Section 2 discusses the various ways in which TRACE can affect capital costs in the corporate bond market: information asymmetry in the primary market, information asymmetry in the secondary market, and transaction costs. We first investigate whether the change in primary market pricing observed in Section 4.1 is consistent with a transaction costs effect or an information effect, while carefully noting that these two channels are linked — the information environment can affect the total cost of providing liquidity and therefore transaction costs. We do not yet differentiate between information asymmetry in the primary market or the secondary market but we address this issue directly later in the paper.

We employ two strategies to investigate whether the change in primary market pricing is due to an information asymmetry or a transaction cost effect. The first strategy considers

[17] Since TRACE roll-out dates are within a particular year, the roll-out dummies are not co-linear with γ_t. This issue does prevent our using higher frequency time effects in Equation (3).

whether information regarding recent bond trades is relevant for pricing new bond issues. We do this by estimating whether or not the fraction of trades in matrix bonds that are publicly reported is related to the pricing of new issues. The second strategy examines the effect of TRACE reporting on the pricing of sub-samples of bonds that have different levels of average information asymmetry. We primarily use the number of underwriters and the number of outstanding bonds from the same issuer as proxies for information asymmetry and present similar results using other proxies such as bond size and underwriter experience.

5.1 Matrix bond trading information and issuing costs

An advantage of the TRACE academic data is that these contain trade records for bonds regardless of whether or not trades were publicly disseminated at the time of the trade. We can accurately identify both the publicly disseminated and non-disseminated (private) trades that take place for any bond. We use this information to determine the amount of public and private trading that takes place in all matrix bonds for each new issue in our sample, where matrix bonds are defined as all previously issued bonds that have an identical S&P credit rating, a maturity within six months of the new issue maturity date, and a coupon within one percent of the coupon paid by the new bond issue.[18]

Given their similarity to the new bond issue, recent trade prices for matrix bonds are important reference prices for these new issues. We argue that bonds with more public (private) trading have less (more) information asymmetry with regards to this source of pricing information. If the information channel is important for new bond pricing, bonds

[18] Our definition of matrix bonds follows that of the CFA Institute who describe matrix bonds as "comparable securities having the same or similar credit risk, coupon rate, and maturity" (CFA Institute, 2019). See also Warga and Welch (1993) who describe matrix prices as those obtained from actively traded benchmarks, including bonds with similar ratings, maturities and coupons. Bond characteristics for matrix bonds are taken from Mergent FISD as this data source contains all ratings changes over time.

with a higher fraction of *public* information regarding matrix bond trading should receive relatively better pricing.

For each new issue in our sample, we find all matrix bonds trades in the week prior to the issue date and record the total number of trades in each bond. We break these trades down into those that are disseminated publicly ("public matrix trades") and those that are TRACE reported but not publicly disseminated ("private matrix trades"). We then calculate the fraction of trades in matrix bonds that are public. Each new issue in our sample can be matched to approximately eight matrix bonds and has on average around 144 total trades in matrix bonds in the week prior to the issue date. On average, around 71% of these trades are publicly disseminated (see Table 1).

We use these variables to test for the importance of the information asymmetry channel in regressions that are analogous to the main results presented in Section 4.1:

$$y_{ict} = \gamma_c + \rho_t + \beta_1 \times Frac^{pub}_{ict} + \beta_2 \times N_{ict} + \varepsilon_{ict} \tag{4}$$

$$y_{ict} = \alpha + \beta_1 \times Frac^{pub}_{ict} + \beta_2 \times N_{ict} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict} \tag{5}$$

where y_{ict} is the log of the yield spread, γ_c, ρ_t, x_{ict} and z_t are defined as in Equations (1) and (2), $Frac^{pub}_{ict}$ is the fraction of matrix trades for bond i issued at time t that is TRACE reported and N_{ict} is a proxy for the expected liquidity of the bond being issued. The key parameter is β_1 which estimates the marginal effect of public information regarding recent matrix bond trades on bond issuing costs, conditional on proxies for the expected liquidity of the bond (N_{ict}) and either cohort and time fixed effects or bond and macroeconomic controls.

A key component of Equation (4) is the inclusion of the liquidity proxy N_{ict}. First, the β_2 parameter can help us determine if bonds with higher expected trading activity have better pricing, which aides us in disentangling the two alternative channels. Since N_{ict} represents the expected trading activity of a new bond that is being issued, if expectations of trading activity matter for pricing then new issues with higher values of N_{ict} should receive better pricing, all else being equal.

Equally important, due to the non-random nature of the roll-out of TRACE, where larger or higher rated bonds are included earlier, the fraction of public trading could be correlated with expected liquidity. Excluding total expected liquidity would induce a potential omitted variable bias in these estimates, because bonds with higher fractions of public trading actually have better expected liquidity.

Our main liquidity proxy is the total number of trades in all matrix bonds (referred to as the "matrix trading proxy"). This assumes that investors use the trading activity of matrix bonds prior to the issue date to form their expectations of liquidity for the bond being issued. As a robustness check, we also replace this proxy with the realized number of trades in the new bond in the first 90 days after issuance.[19]

Bond issuing prices can also affect realized after-issue trading activity. For example, a bond that happens to attract abnormally few bidders in the primary market may experience both high yields (due to low competition in the issuing process) and higher than normal trading after issuance as these bidders sell their allocations at a profit in the after-market. Using realized trading as a proxy for expected activity may be endogenous so our regressions using the matrix trading proxy are our preferred specification.

One further complication of estimating Equations (4) and (5) is that the fraction of public trading is correlated with the TRACE status of the bond. Since matrix bonds have the same

[19]Under rational expectations the actual number of trades and the expected number of trades will satisfy $N_{ict} = \mathbb{E}[N_{ict}] + u_{ict}$ where $\mathbb{E}[u_{ict}] = 0$. The realized number of trades can therefore also be considered a noisy proxy for expected liquidity since $N_{ict} = \mathbb{E}[N_{ict}] + v_{ict}$ where $v_{ict} = -u_{ict}$.

rating as the bond being issued, a new issue that is TRACE eligible is likely to have more matrix bonds that are also TRACE eligible. Excluding TRACE status could then lead to a positive and significant coefficient on matrix trading, even if availability of matrix prices is irrelevant but TRACE affects new bond pricing via an alternative channel. We therefore estimate regressions that are identical to Equations (4) and (5) but that additionally control for the TRACE status of the bond at the issue date.[20]

Our sample for estimating the association between matrix trading and issuing yields is from the beginning to the end of the TRACE roll-out. We use this shorter sample period for two reasons. First, TRACE data are needed to estimate matrix trading so we cannot observe the key RHS variables of Equations (4) and (5) until the initiation of TRACE. Second, because $Frac_{ict}^{pub} = 1$ for all bonds issued after TRACE is fully rolled-out, there is no cross-sectional variation in the fraction of matrix trades publicly reported after this date.[21] Table 4 contains parameter estimates for these regressions. Columns (1) and (2) use the matrix bond trading frequency as the liquidity proxy and exclude the TRACE status. Columns (3) and (4) use the perfect foresight liquidity proxy. Columns (5) and (6) are analogous to columns (1) and (2) but also controlling for the TRACE status of the issuing bond. Columns (7) and (8) are analogous to column (3) and (4) but also include the TRACE status control.

[Table 4 about here]

The effect of the fraction of matrix trading is negative in all eight specifications. Bonds with less information asymmetry (higher fractions of public trade records) receive better pricing than bonds with more information asymmetry, conditional on proxies for expected

[20] We thank an anonymous referee for pointing this out.

[21] We also estimate these regressions using the maximum possible sample period (2002-2007) and find consistent results. These results are presented in Table IA.6 in the Internet Appendix.

liquidity, TRACE status and either cohort and time fixed effects or bond and macroeconomic controls. The effect is statistically significant at the 5% level or better for six of these specifications and at the 10% level for one of the two remaining specifications. An increase in public information of ten percentage points decreases the yield spread on a new issue by between 0.8% to 2% (in bps terms) depending on the specification, or by 1.1 to 2.9 bps for a typical (mean) issue in our sample. Moving from all private to all public trading would decrease the yield spread by 12% or 18% (in bps terms), equivalent to 11 to 29 bps for a typical bond in our sample.

Our matrix trading liquidity proxy is insignificant at the 10% level or better, while the realized trading activity proxy is positive and significant. Conditionally, bonds that trade more after issuance have higher yield spreads, but as stated previously, the potential for reverse causality from bond yields to after-issue trading complicates interpreting the coefficient on the realized trading proxy. Together, the coefficients on our liquidity proxies do not clearly support that bonds with higher fractions of matrix trading have better pricing because they have better expected liquidity.

Our key focus in these regressions is on the coefficients on the fraction of public matrix trades and our expected liquidity proxies. Across the eight specifications, these coefficients provide support for the importance of the information channel but not the transactions costs channel. In the two fixed-effects specifications that include TRACE status as a control, this coefficient is negative and significant. In these regressions, TRACE status continues to have explanatory power for bond issuing yields beyond the fraction of matrix trades that are public, expected bond liquidity, cohort fixed effects and time fixed effects. The significance of TRACE status may reflect that trading information from non-matrix bonds can also be helpful for pricing new bond issues. We note that our robustness checks where we include bond issues after the completion of the TRACE roll-out (i.e. after which the fraction of public matrix trades is one for all new bond issues — Table IA.6), the fraction of public matrix trades coefficient is significant in all specifications while TRACE status is not significant.

Table 4 demonstrates that trades in matrix bonds primarily affect prices of new issues not by the expected liquidity of the issue but by the relative amount of this trading which is made publicly available ex-post. Since this fraction directly measures the potential information asymmetry between investors, these results support the importance of information asymmetry in the pricing of new bond issues and do not provide support for the non-informational transaction costs channel.[22]

Our approach for analyzing trading in matrix bonds and issuing costs can possibly shed light on whether TRACE had spillover effects for bonds that were not immediately eligible for public dissemination, similar to those found in Bessembinder et al. (2006). We estimate regressions of Equation (4) on a sub-sample of new issues that contains only bonds that are not subject to TRACE dissemination on issuance (i.e. those with $trace_{ct} = 0$ in Equation (1) or (2)). These results are presented in Table IA.9 and demonstrate that the fraction of trades that are publicly reported have no significant effect on issuing yields for non-TRACE bonds. While this is not consistent with spillovers being present, an important limitation with our approach for detecting spillovers is that there is substantially less variation in the amount of matrix trading in bonds that are not TRACE eligible at issuance date.

[22]We also examine whether the fraction public matrix trading has a discernible effect on explicit fees or underpricing. Table IA.7 in the Internet Appendix shows that there is no evidence to support this. Table IA.8 replaces the liquidity proxies with their logs and provides evidence consistent with the main matrix trading results. For bonds with zero values for the liquidity proxies, we replace these values with a total number of trades equal to one before taking the log.

5.2 Effect of TRACE on new issue sub-samples

Our second strategy for disentangling the information and transaction costs channels involves splitting the sample of new bond issues used in our main regressions into categories based on the level of average information asymmetry. We use two proxies for information asymmetry. The first proxy is number of underwriters (lead, co-lead and co-managers) used in the issuing process. Both theory and existing empirical evidence suggests that information production and collection by underwriting networks provide crucial information for issuers seeking to maximize new issue proceeds (Benveniste and Spindt 1989; Sherman and Titman 2002; Corwin and Schultz 2005). The informational role of issue underwriters suggest, all else being equal, that transparency in the secondary market should be more important in bonds where less of this information is being produced, i.e. bonds with fewer underwriters.

The second proxy is the number of existing bonds outstanding by issuer at the new issue date. Investors face less severe information asymmetry when pricing a new bond from companies that frequently issue bonds compared with those that issue infrequently. Two observations support this intuition. First, frequent issuers are more likely to have a wider base of investors making trades and actively valuing positions in their existing bonds. Information production in the process of trading and valuing these bonds is very likely to be useful for valuing new bonds being offered by the same issuer in the future. Second, the bond issuing process involves meaningful information production (such as in the form of a prospectus) and information transmission from the company to the underwriting syndicate and some institutional investors, or from the underwriting syndicate to their broader customer bases. Relatively more frequent issuing implies, on average, greater information production and transmission compared with infrequent issuing.

TRACE eliminates one source of information asymmetry for all bonds, related to access to reference prices. We argue that the *relative* effect of TRACE on information asymmetry is greater for bonds in the high information asymmetry category. Finding a larger effect of TRACE in the high information asymmetry group is consistent with the information channel. However, an important concern with splitting bonds into categories based on the size of the underwriting syndicate and the number of previous issues outstanding is that these variables can also capture differences in average transaction costs. Di Maggio, Kermani, and Song (2017) show that dealers charge higher spreads in bonds where they have higher market shares (as proxied by inventory). Bond issues with a few dominant underwriters are likely to have greater ownership concentration after issuance. Previous bond issues by the same issuer may help investors in the secondary market negotiate better prices and reduce trading costs. Table 5 demonstrates this point. Bonds in the low information asymmetry categories are larger and more liquid (trade more frequently) than bonds in the high categories.

[Table 5 about here]

Ex-ante differences in the levels of transaction costs across the sample splits is not a direct concern. Instead, it is the possibility that the effect of TRACE on transaction costs differs across the splits that complicates our analysis. We may find that TRACE affects issuing costs for bonds in the high information asymmetry categories more, but it may also drive a larger reduction in transaction costs in high information asymmetry categories.

To address this concern, we also test for the effect of TRACE on bond trading activity in the first 90 days after issuance for each sub-sample. This allows us to test whether any changes in bond issuing costs are consistent with the information asymmetry channel in isolation. A relatively larger reduction in issuing yields in the high information asymmetry category is consistent with the information asymmetry category, but only isolates this channel if there is not a comparable improvement in trading activity in the same category. An improvement in issuing costs for the low information asymmetry category of bonds is inconsistent with the information asymmetry channel, but may be supportive of a transaction costs channel if there are comparable improvements in trading activity in the same category.

Table 6 presents estimates for the effect of TRACE on bond yield spreads at issuance and trading activity over the first 90 days of bond issuance, split by number of underwriters (Panel A) and number of previous issues outstanding by the issuer (Panel B). In both panels, bonds are split by whether or not the number of underwriters or previous issues are below or equal to the median or above the median level. Regressions corresponding to Equations (1) and (2) are estimated on each sub-sample. Column (1) contains the estimated effect of TRACE for all underwritten bonds in our sample (i.e. repeating our main results). Column (2) contains estimates for bonds with less than or equal to the median and Column (3) contains estimates for bond issues with more than the median. All other details are identical to our main regressions.

[Table 6 about here]

Regardless of whether we split our sample by number of underwriters or number of previous issues, the improvement in issuing yields is concentrated in the high information asymmetry (below median) sub-samples. TRACE causes bonds with fewer than median underwriters or previous issues to fall by between -0.12 to -0.21% in basis point terms, effects that are significant at the 5% level or better under all splits and specifications. For bonds with greater than median underwriters or previous issues, the TRACE effect is insignificant even at the 10% level. The point estimates are between -0.07 and 0.01, while the magnitude of the largest t-statistic is no greater than 1.17.

While this result is consistent with the information asymmetry channel, it may be that bonds in the low information asymmetry categories have the greatest TRACE-induced transaction costs improvements. The evidence in Table 6 does not support this interpretation. Transaction costs improvements, as proxied by trading activity, increase most substantially for the low information asymmetry categories of bond issues. For bonds in the above-median underwriters category, the average daily number of trades increased by approximately eight to ten, depending on the specification. For bonds in the above-median previous issues category, the effect is around 6.6 to 11. These effects are significant at the 5% level or better in all cases. For the below-median/high information asymmetry categories, the effect on trading activity never exceeds 2.64 and is only significant at the 10% level in one of the four regressions. Bonds in the different categories have different average levels of trading, but even when scaling by the average trading frequency, TRACE had a larger effect on trading activity for bonds in the low information asymmetry categories.

We also form test statistics for parameter equality across the above median and below median regressions for each category by jointly estimating the equations in columns (2) and (3) of Table 6 in a system. The differences in TRACE coefficients across subsamples split by number of previous issues are significant at the 5% level or better for all combinations of dependent variables and specifications, other than for yield spreads using controls rather than fixed effects, where the difference is significant at the 10% level. For our subsamples split by number of underwriters, the differences are significant at the 10% level or better for three of the four regressions, however we cannot reject the null that the effect of TRACE on yield spreads is the same across underwriter subsamples when using fixed effects.

There are two important limitations with our sub-sample analysis of TRACE and bond issuing costs. The first is that trading frequency is a coarse measure of transaction costs.[23]

[23] An extensive literature tries to estimate liquidity in the corporate bond market using a variety of approaches, including regression-based approaches based on Glosten and Harris (1988) and Madhavan, Richardson, and Roomans, 1997, as used by Han and Zhou (2013), computations using vendor-provided bid-ask spreads, days of zero trading or the LOT measure of Lesmond, Ogden, and Trzcinka (1999), as used by Chen et al.

In our case, we are trying to measure transaction costs over a relatively short window after issuance. Computing regression-based liquidity measures, or even liquidity measures based on daily data, is complicated because of the infrequency of trading over the window. Table 5 shows that the average bond in the sample does not trade at all on 42% of trading days over the first three months after issuance. Even low frequency measures like the Roll (1984) or Corwin and Schultz (2012) require trading on consecutive days.

We focus on daily trading frequency because it is model-free, easily interpreted and not subject to measurement error. As a robustness check, we also estimate the effect of TRACE by sub-sample on the Roll (1984) covariance estimator and on the percentage difference in prices for trades where dealers sell to customers and dealers buy from customers (similar to dealer round trips used in Goldstein et al., 2007). We do not find a significant effect on transaction costs in either sub-sample when using these proxies, which, most importantly for our purposes, fails to support the transaction costs hypothesis (see Table IA.10).

The second limitation is that the choice of the number of underwriters is an endogenous decision made by the firm. Firms may choose to hire more underwriters precisely because they are concerned about low demand for a potential issue. We do not directly address this endogeneity issue but note that the key difference in characteristics between bonds with many vs. few underwriters appears to be based primarily on issue size, and not other characteristics like rating and maturity. As per Table 5, bonds with number of underwriters above median are almost twice as large as bonds with fewer underwriters ($630m vs. $350m) while differences in average bond ratings are less than one quarter of one rating notch and differences in average bond maturities also differ by less than one quarter.

(2007), or estimates based on proxying for midquotes using dealer-to-dealer trades as in (Hendershott and Madhavan, 2015). See Schestag, Schuster, and Uhrig-Homburg (2016) for a review of the performance of different bond liquidity proxies.

As an additional robustness check, we also perform sample splits by bond size and whether a bond has a top 5 underwriter as a lead manager. Larger bonds tend to be traded more frequently and by a wider investor base. Top underwriters are more likely to have ongoing relationships with the largest and most sophisticated bond investors and therefore possibly have less need to widely promote a bond issue to other, less sophisticated investors, though there are counter arguments to this.[24] Underwriter rankings are derived from US corporate bond league tables computed using SDC Platinum data over our main sample period. A top 5 underwriter is ranked fifth or better by market share. Our results using these splits are presented in Table IA.11 in the Internet Appendix. These are consistent with those based on our splits by underwriters and number of previous issues in that TRACE-related improvements in bond yields do not coincide with improvements in trading activity.

Results for the effect of TRACE by sub-samples on explicit expenses and underpricing (Table IA.12) are more mixed, with some evidence of stronger effects on explicit expenses for bonds with more underwriters, but not with more previous issues. It is possible that underwriters compete more in the fee dimension after TRACE but given the lack of general evidence of a large effect in the entire sample, or a convincing theoretical motivation, we are hesitant to make strong claims about the significance of this effect.

Finally, we also exclude the first week of trading when computing our trading activity variables, to avoid potential complications where offering pricing and trading frequency are related. For example, it is possible that heavy trading activity in the first week of trading occurs when some bidders receive relatively large allocations at favorable prices and then "flip" the bond soon after the issue date. However, we find highly consistent results regarding trading frequency when excluding the first week of trading — see Table IA.13 in the Internet

[24]For example, a top underwriter may have more resources to produce information about a bond issue.

Appendix.

6 TRACE and secondary market prices

Our analysis so far demonstrates that TRACE affects primary market issuing costs by reducing information asymmetry. However our results do not necessarily shed light on whether this is due to reduced information asymmetry in the primary market or due to reduced information asymmetry in the secondary market, which can directly affect asset prices as per Easley and O'Hara (2004) and Lambert et al. (2012), or both. If information asymmetry is a sufficiently important friction in the primary market that it affects issuing costs, and TRACE helps to alleviate this friction, then TRACE will improve issuing costs. It is also possible that corporate bond issuing costs fall not because of any changes to the information environment in the primary market, but instead because TRACE reduces information asymmetry in the secondary market, which directly raises the equilibrium secondary market price. If investors in the primary market anticipate higher prices in the secondary market for a TRACE eligible bond because risks related to information asymmetry fall, a rational response is to compete more aggressively in the primary market, raising issuing prices.

We provide evidence about the relative importance of these two possible information channels by examining the effect of TRACE on secondary market yields. The intuition is straightforward. Changes to the information environment in the secondary market can indirectly affect prices in the primary market via a direct effect on secondary market prices. Changes to the information environment that affect the primary market will affect prices in the primary market, but should not directly affect the price of a seasoned bond already trading in the secondary market. If the effect of TRACE in the secondary market is responsible for the improvement in primary market yields, we expect to see similarly sized effects on prices in the primary and secondary market. If instead, the improvement in information asymmetry in the primary market is responsible, we expect to see a larger effect of TRACE in the primary market than the secondary market.

We form a panel of all secondary market bond trades for bonds that can be matched from TRACE to the Mergent FISD database where we observe at least one trade in the six months either side of the TRACE dissemination date for that bond. Table 7 presents summary statistics for the secondary market sample. Bonds in the secondary market are about half as large as the new issue sample but have similar maturities and credit ratings.

[Table 7 about here]

Using this sample we estimate the impact of TRACE transparency on secondary market yields via panel regressions with the general form given by:

$$y_{it} = \mu_i + \rho_t + \beta' x_{it} + \gamma Trace_{it} + \varepsilon_{it} \tag{6}$$

where y_{it} is the volume-weighted log yield for bond i in week t, μ_i is a bond fixed effect, ρ_t is a time (month) fixed effect, x_{it} are time-varying bond controls (rating and years to maturity) and $Trace_{it}$ is a dummy variable for whether or not trades in bond i in week t were publicly disseminated. Inclusion of bond and time fixed effects accounts for all time-invariant bond characteristics (e.g., principal, industry, coupon, issuer characteristics) and macroeconomic effects such as yield curve shifts or time-varying risk aversion. Standard errors are clustered at the unit (bond) level. We estimate Equation (6) without controls or fixed effects, with bond level and macroeconomic controls, with two-way fixed effects and with two-way fixed effects and controls that vary within periods and bonds. The parameter γ estimates the change in secondary market yields around TRACE transparency. Table 8 contains the parameter estimates for these regressions.

[Table 8 about here]

In all specifications with fixed effects and/or controls, TRACE leads to a statistically significant reduction in yields to maturity. The size of the effect is approximately -0.01 to -0.02, with the smaller effect observed when we include time and bond fixed effects. TRACE leads to a statistically significant, but relatively small decrease (increase) in secondary market corporate bond yields (prices). The size of the effect corresponds to around five basis points for the average bond in the sample, or around one third of the estimated effect for the average bond issued in the primary market. TRACE affects prices in both markets, but disproportionately affects the primary market.[25]

Together, our evidence for the primary and secondary markets suggests that trade reporting transparency is important for both the issuing process as well as secondary market trading, but more so for the issuing process. Intuitively, it is reasonable to expect that information asymmetry is more important for a newly issued bond than an existing issue. Over time, secondary market trading will result in continued price discovery and the revelation of private information, as in a standard Kyle (1985) setting. Participants in the primary market must price the bond prior to any secondary market price discovery and access to trade records for other bonds appear to help them do this.

7 TRACE and primary market allocations

Our final examination of the role of TRACE in the primary market pertains to how bonds are allocated in the issuing process. The information asymmetry channels that we have

[25] As a robustness check, we also perform the same analysis where we only include trading in the six month window around the TRACE dissemination date for each bond. These results are presented in Table IA.14 in the Internet Appendix and are consistent with our main results on secondary market yields.

proposed revolve around large, active bond investors having greater information sets with which to price new bond issues compared with smaller, less active bond investors in an opaque environment. Flanagan et al. (2019) and Nikolova et al. (2020) show that investors who trade more actively with underwriters prior to a new issue are awarded higher allocations to new bonds. Nikolova et al. (2020) estimates that first-day profits to primary market investors was $41 billion over the period 2002 to 2014.

If TRACE does indeed alleviate this source of information asymmetry, then it is reasonable to expect allocations of new bond issues to differ before and after TRACE. Smaller investors should be able to bid more aggressively for new issues post-TRACE and at the margin, can expect to receive higher allocations compared with the opaque environment.

To investigate this, we gather bond holdings data from Lipper-eMaxx fixed income database for the first quarter after a bond is issued.[26] We merge this with our main sample of new bond issues to first test how TRACE affects the number of owners reporting non-zero holdings for a newly issued bond and second to test how TRACE affects the distribution of holdings when multiple investors report holdings.

Table 9 presents regressions identical to our main analysis in Section 4.1 using the sample of new bond issues that contain at least one ownership record in the eMaxx data and the dependent variable is the log of number of owners reported in the eMaxx database (column (1)) or a bond ownership Herfindahl-Hirschmann index (HHI) for bonds reporting multiple owners (column (2)). Weights for the HHI are computed using the number of bonds owned by investor i relative to total number of bonds owned by all investors in the eMaxx database and HHI is bound between zero and one. The regressions in column (1) are designed to test whether a larger number of investors have exposure to a new issue in the first quarter of

[26]The Lipper-eMaxx contain quarterly ownership data for US mutual funds, insurers and pension funds and is also used by Becker and Ivashina (2015) and Nagler and Ottonello (2020).

issuance after TRACE is introduced. The regressions in column (2) test whether allocations become less concentrated (designated by a lower HHI) after TRACE, conditional on enough owners reporting holdings to compute an HHI.

[Table 9 about here]

The parameter estimates in Table 9 provide some support that TRACE widens the ownership structure of newly issued bonds. For log of number of owners, the coefficient on TRACE is positive and significant using cohort and time fixed effects but is insignificant when using bond and macroeconomic controls. For the median bond in our sample, with 16 distinct investors reporting non-zero holdings after issuance, we estimate that TRACE increases the number of owners by between two and five holders. The TRACE coefficient for the HHI is negative and significant at the 5% level when using fixed effects and at the 10% level when using controls. The size of the effect is approximately one-third of the median HHI in the sample.[27]

An important constraint with the eMaxx database is that we only observe holdings at quarter-end rather than immediately after issuance. Goldstein and Hotchkiss (2012) show that small and retail investors tend to be active buyers of new bond issues in the days and weeks after trading. We cannot distinguish between allocations obtained in the issuing process and those that are obtained in the secondary market. Nevertheless, our evidence on new bond issue ownership is consistent with TRACE-eligible bonds being more broadly held than those issued in an opaque environment.

Column (3) of Table 9 investigates the effect of TRACE on retail traders in the first

[27] While it is not sensible to compute the HHI for bonds with only one reporting owner (as the index mechanically takes the value of 1 in such a case) we note including these bonds leads to stronger results for the the fixed effects regressions but weaker OLS results that are no longer statistically significant at the 10% level. Details are available upon request.

week after issuance. We define retail traders to be those trading in sizes of $100,000 or less. In column (3) we run our main TRACE regressions but the dependent variable is the number of trades for $100,000 or less in the first week after issuance and uses data after the introduction of TRACE (after which we can observe the number of trades). TRACE has a positive and significant effect on the number of retail-sized trades in the after-market. The size of the effect (6.1 to 6.8 more trades per day depending on the specification) is about 1.5 times as large as the sample mean (4.1). There is also a significant and positive effect on the number of institutional trades, defined as trades for $1m or more, that is equivalent to around 2.1 to 3.2 trades per day (column (4)) however this is smaller in absolute terms and relative to its sample mean (7.5). Secondary market transparency increases the activity of retail traders in the after-market.

The increase in retail trader activity in the after-market may not be unambiguously beneficial for retail traders. For example, retail traders could hypothetically be trading more in the after-market because they receive *less* allocations in the primary market. If this were the case, we would expect to see greater mark-ups in the after-market relative to the offering price, as institutions sell to retail traders at a premium. However, our main results on bond underpricing in Table 2 (which either falls or is unaffected by TRACE depending on the specification) rules out such a mechanism. Retail traders are transacting more frequently and at prices closer to the offer price in the first week after a new bond issue, consistent with improved access to new bond issues.

8 Conclusion

We examine the effect of increased secondary market transparency on primary market pricing and issuance costs. We answer two central questions. First, given the improved trading environment after issuance, do firms find it less costly to issue bonds? Second, if firms do find it less costly to issue, is this because of a reduction in transaction costs, in information asymmetry in the issuing process, or in information asymmetry in the secondary market?

The answer to the first question is yes. Bonds issued in the transparent environment receive significantly higher prices, especially smaller bonds with lower credit ratings. Our subsequent analysis of the role of trading in matrix bonds, the effect of TRACE on sub-samples of new bond issues with different average levels of information asymmetry and the effect of TRACE on secondary market yields points to information asymmetry in the primary market as the key driver of improved pricing. By making reference prices publicly available for a new bond issue, TRACE helps otherwise less informed investors more accurately price a new bond issue in line with Schmidt (2016), Auh et al. (2019) and Nikolova et al. (2020). We cannot find evidence supporting the direct role of transaction costs while effects of TRACE on secondary market prices are significantly smaller than the effect on primary market prices. Evidence from eMaxx ownership records that document a positive effect of TRACE on the breadth of ownership of newly issued bonds, suggesting more diverse access to the primary in the transparent environment. Changes to retail vs. institutional trading activity are consistent with smaller investors having improved access to these bond issues.

While the secondary market structure for corporate bonds has continued to evolve since TRACE — for example, post-crisis regulation affecting market makers (Bessembinder et al., 2006) and growth in trading on electronic platforms (Hendershott and Madhavan, 2015; O'Hara and Zhou, O'Hara and Zhou) — the primary market has changed less markedly.[28] Nagler and Ottonello (2020) argue that changes in dealers' inventory management, driven by

[28] One notable change in the primary market process is the adoption of the Securities Offering Reform rules that streamlined the issuing process for so called "well-known seasoned issuers". These rules became effective 1 December 2005 and our results are consistent whether we exclude all issues from this date. We thank Stanislava Nikolova for pointing out the relevance of this reform.

post-crisis regulation, increase the incentive to place bonds with closely affiliated investors in the primary market. Dealers do this to ensure there are sources for future intermediation in the new issue after-market. This suggests that links between the primary market and secondary markets have strengthened in recent years. Transparency in corporate bond markets also continues to be a topical regulatory issue with dealers unsuccessfully lobbying to pilot test the effects of delaying TRACE reporting of block trades by 48 hours (FINRA, 2019; Bain, 2020).

Future research should consider whether recent increases in transparency in European corporate bonds resulting from the introduction of MiFID II had similar impacts in that jurisdiction and whether increased transparency should be extended to a broader set of bonds. The increase in transparency arising from TRACE suggests that prior research hypotheses can also be extended and prior results revisited. For example, it may now prove possible to address some of the questions asked by Collin-Dufresne, Goldstein, and Martin (2001 p. 2205) about whether institutions are responsible for their finding that variables that should theoretically explain credit spread changes have limited power and that unexplained variation may be due to a common source.

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Table 1: Summary statistics for new bond issue characteristics and matrix trading

This table contains summary statistics for the yield spread to benchmark Treasury at issuance date, total issuing expense, underpricing, bond maturity, principal, credit rating and matrix bond trading for the new bond issues in our sample. Matrix bonds are existing issues that have a maturity date within six months of the new issue maturity date, the same S&P credit rating and a coupon within $\pm 1\%$ of the new issue. Yield spread to benchmark Treasury and total issuing expense are measured in basis points. Total issuing expense is the difference between net proceeds and gross proceeds divided by face value. Underpricing is defined as the log return on issuing price over the first two weeks of trading, in excess of a maturity matched BAML bond index return. Raw returns are the same returns but without an adjustment for market returns. Bond S&P rating is an integer variable where ten represents the highest rating in our sample (AAA) and zero or below represents a sub-investment grade rating. Matrix trades are trades taking place in matrix bonds in the seven days prior to the new issue date. Public (private) matrix trades are the number of trades in matrix bonds that are (are not) subject to TRACE dissemination. Total matrix trades is the sum of public and private matrix trades. The fraction of public matrix trades is the number of public trades divided by the total number of trades. Total matrix bonds is the number of matched matrix bonds for the new issue. Total public matrix bonds is the number of these bonds that are TRACE eligible at the new issue date. The sample includes all straight (non-convertible) underwritten bonds issued by US non-financial firms between July 1, 2000 and February 28, 2007, covering two years before and after the commencement and competition of the TRACE program for corporate bonds.

	Mean	Std. Dev	Min	25%	50%	75%	Max
Yield Spread to Treasury (bp)	144	83.5	27.7	88.0	121	175	455
log($Spread$)	4.83	0.53	3.32	4.48	4.80	5.16	6.12
Total Expense (bp)	73.7	38.2	0.00	48.0	70.7	88.0	229
Raw Return (%)	0.33	1.47	-4.50	-0.44	0.35	1.12	4.35
Underpricing (%)	0.05	1.08	-4.35	-0.36	0.04	0.42	3.26
Maturity (years)	10.4	7.48	2.00	5.00	10.0	10.0	45.0
Principal ($bn)	0.48	0.48	0.00	0.20	0.31	0.55	5.00
S&P Rating	3.49	2.82	-9.00	2.00	3.00	5.00	10.0
Public matrix trades ('00s)	1.19	1.82	0.00	0.00	0.21	1.77	8.30
Private matrix trades ('00s)	0.25	0.62	0.00	0.00	0.00	0.13	3.73
Total matrix trades ('00s)	1.44	1.94	0.00	0.00	0.68	2.13	8.81
Fraction public matrix trades	0.71	0.41	0.00	0.38	1.00	1.00	1.00
Total matrix bonds	8.03	8.87	0.00	0.00	5.00	13.0	49.0
Total public matrix bonds	5.78	8.01	0.00	0.00	1.00	10.0	49.0

Table 2: Effect of TRACE on bond issuing costs

This table contains estimates for the effect of post-trade transparency due to the implementation of the TRACE program on issuing costs for US corporate bonds. The dependent variables are the log of the yield spread to benchmark Treasury at issuance (column (1)), issuing direct expenses and fees (column (2)) and issue underpricing (column (3)). The treatment effect of the TRACE program is estimated as the β coefficient in regressions with the general form $y_{ict} = \gamma_c + \rho_t + \beta trace_{ct} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict}$ where y_{ict} is the dependent variable of interest, γ_c is a cohort-specific fixed effect, ρ_t is a quarter fixed-effect, x_{ict} are bond-specific explanatory variables, z_t are macroeconomic explanatory variables and $trace_{ct}$ is a dummy for TRACE-eligibility at issue date. The model is estimated with fixed effects (γ_c and ρ_t) or with bond-specific and macroeconomic controls. Standard errors are heteroskedasticity robust. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)		(2)		(3)	
	Yield Spread (log)		Expenses		Underpricing	
β	-0.10**	-0.13***	-4.81	-6.17*	-0.29**	-0.19
	(-2.36)	(-3.55)	(-1.38)	(-1.94)	(-2.24)	(-1.41)
Cohort FE	X	-	X	-	X	-
Time FE	X	-	X	-	X	-
Controls	-	X	-	X	-	X
N	1,321	1,321	1,317	1,317	876	876
R^2	0.62	0.61	0.40	0.43	0.08	0.03

Table 3: Effect of TRACE by roll-out phase

This table contains estimates for the effect of post-trade transparency due to the implementation of the TRACE program on issuing costs for US corporate bonds, split by the three phases of the program. Estimates are from difference-in-differences regressions with cohort and time fixed effects or OLS regressions with bond-specific and macroeconomic controls, and three treatment dates. The first (Phase 1) corresponds to bonds in cohorts that are first made TRACE eligible as at July 2002. The second (Phase 2) corresponds to bonds that are first made TRACE eligible between March and April 2003. The third (Phase 3) corresponds to bonds that are first made TRACE eligible in the final phase between October 2004 and February 2005. Standard errors are heteroskedasticity robust. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)		(2)		(3)	
	Yield Spread (log)		Expenses		Underpricing	
Phase 1	0.03	0.01	0.15	-6.66*	0.36	-0.18
	(0.46)	(0.22)	(0.03)	(-1.68)	(0.65)	(-0.99)
Phase 2	-0.15***	-0.24***	-7.21*	-3.15	-0.37*	-0.19
	(-2.98)	(-6.18)	(-1.74)	(-0.94)	(-1.69)	(-1.36)
Phase 3	-0.15***	-0.09**	-2.60	-8.63**	-0.23*	-0.13
	(-2.98)	(-2.15)	(-0.61)	(-2.01)	(-1.65)	(-0.82)
Cohort FE	X	-	X	-	X	-
Time FE	X	-	X	-	X	-
Controls	-	X	-	X	-	X
N	1321	1321	1317	1317	876	876
R^2	0.63	0.63	0.40	0.43	0.08	0.02

Table 4: Effect of trading in existing matrix bonds on issuing yields

This table contains estimates of the effect of trading in matrix bonds on issuing yields for new bonds. The effect of matrix trading on issuing yields is estimated in regressions with the general form $y_{ict} = \gamma_c + \rho_t + \beta_1 \times Frac_{ict}^{pub} + \beta_2 \times N_{ict}^{mat} + \beta_3 \times trace_{ct} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict}$ where y_{ict} is the log of yield spread for bond i in cohort c at time t, γ_c is a cohort effect, ρ_t is a time effect, x_{ict} are bond controls, z_t are macroeconomic controls, $Frac_{ict}^{pub}$ is the fraction of total matrix trading for bond i issued at time t that is public, N_{ict}^{mat} is either the total amount of matrix trading prior to issuance or the realized number of trades for the newly issued bond in the first 90 days after issuance, and $trace_{ct}$ is the TRACE status of the newly issued bond at issue date. Matrix bonds are defined as existing issues with identical credit ratings, maturities within six months of the new issue maturity, and coupons within $\pm 1\%$ of the new issue coupon. The model is estimated with fixed effects (γ_c and ρ_t) or with bond-specific and macroeconomic controls. Standard errors are heteroskedasticity robust. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fraction of public matrix trades	-0.1221*	-0.1811***	-0.1618***	-0.1704***	-0.0848	-0.2037***	-0.1254**	-0.1484***
	(-1.80)	(-2.83)	(-2.69)	(-3.25)	(-1.19)	(-3.02)	(-2.00)	(-2.71)
Total matrix trades	-0.0084	0.0107	-	-	-0.0105	0.0111	-	-
	(-0.75)	(1.08)	-	-	(-0.95)	(1.12)	-	-
Total trades after issue date	-	-	0.0065***	0.0109***	-	-	0.0070***	0.0113***
	-	-	(3.63)	(8.64)	-	-	(3.72)	(8.49)
TRACE Status	-	-	-	-	-0.1177*	0.0513	-0.1371**	-0.0534
	-	-	-	-	(-1.82)	(1.02)	(-2.26)	(-1.17)
N	448	448	448	448	448	448	448	448
Cohort FE	X	-	X	-	X	-	X	-
Time FE	X	-	X	-	X	-	X	-
Bond & Time Controls	-	X	-	X	-	X	-	X

Table 5: Summary statistics by number of previous issues and underwriter subsamples

This table contains means for bond issue characteristics for our sample of newly issued bonds, split by the number of underwriters or the number of previous issues from the same issuer at the new issue date (above or below the sample median). Yield spread to benchmark Treasury and total issuing expense are measured in basis points. Total issuing expense is the difference between net proceeds and gross proceeds divided by face value. Underpricing is defined as the log return on issuing price over the first two weeks of trading, in excess of a maturity matched BAML bond index return. Raw returns are the same returns but without an adjustment for market returns. Bond S&P rating is an integer variable where ten represents the highest rating in our sample (AAA) and zero or below represents a sub-investment grade rating. Number of trades is the daily average over the first 90 days after issuance. Fraction of days with no trading is the number of business days where the bond does not trade divided by the total number of business days in the first 90 days after bond issuance.

		$N(Underwriters)$		$N(Previous\, Issues)$	
	All Bonds	$N \leq \mu_{0.5}$	$N > \mu_{0.5}$	$N \leq \mu_{0.5}$	$N > \mu_{0.5}$
Yield Spread to Treasury (bp)	144	144	144	150	136
log($Spread$)	4.83	4.82	4.84	4.89	4.76
Total Expense (bp)	73.5	73.2	73.8	80.4	65.4
Raw Return (%)	0.33	0.33	0.33	0.46	0.18
Underpricing (%)	0.05	0.05	0.05	0.10	-0.01
Maturity (years)	10.4	9.85	11.1	10.2	10.6
Principal ($bn)	0.48	0.35	0.63	0.44	0.52
S&P Rating	3.49	3.59	3.38	3.14	3.91
No. of Trades	7.25	5.12	9.73	4.86	9.81
Frac. days with no trading	0.41	0.51	0.29	0.48	0.34

Table 6: Effect of TRACE by subsamples

This table contains estimates of the effect of post-trade transparency due to the implementation of the TRACE program on issuing yields and trading activity for US corporate bonds, split by sub-samples based on the number of underwriters (Panel A) and number of previous issues by the issuer (Panel B). The LHS variable is either the issuing yield or the daily average number of trades in the first 90 days after issuance. The treatment effect of the TRACE program is estimated as the β coefficient in regressions with the general form $y_{ict} = \gamma_c + \rho_t + \beta trace_{ct} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict}$ where γ_c is a cohort-specific fixed effect, ρ_t is a quarter fixed-effect, x_{ict} are bond-specific explanatory variables, z_t are macroeconomic explanatory variables and $trace_{ct}$ is a dummy for TRACE-eligibility at issue date. Column (1) contains estimates using all bonds from Table 2. Column (2) contains estimates using all bonds with less than or equal the sample median number of underwriters or previous issues. Column (3) contains the estimates for all bonds with more underwriters or previous bonds than the sample median. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)		(2)		(3)	
	All Bonds		$N \leq \mu_{0.5}$		$N > \mu_{0.5}$	
Panel A: Split by $N(Underwriters)$						
Yield (log)	-0.10**	-0.13***	-0.12**	-0.20***	-0.07	-0.06
	(-2.36)	(-3.55)	(-1.97)	(-3.76)	(-1.13)	(-1.17)
No. Trades	4.92***	6.63***	0.94	2.64*	7.99***	9.74***
	(3.12)	(3.73)	(0.65)	(1.83)	(2.89)	(3.46)
N_{yield}	1,321	1,321	724	724	597	597
N_{nmb}	985	985	531	531	454	454
Panel B: Split by $N(Previous\,Issues)$						
Yield (log)	-0.10**	-0.13***	-0.21***	-0.19***	0.01	-0.06
	(-2.36)	(-3.55)	(-3.52)	(-3.87)	(0.19)	(-1.08)
No. Trades	4.92***	6.63***	0.88	1.07	6.63**	10.9***
	(3.12)	(3.73)	(0.73)	(1.00)	(2.57)	(3.68)
N_{yield}	1,321	1,321	709	709	612	612
N_{nmb}	985	985	510	510	475	475

Table 7: Summary statistics for secondary market bond characteristics

This table contains summary statistics for bond issue characteristics for all bonds present in the Mergent FISD database that can be matched to the TRACE academic dataset on CUSIPs and meet our sample selection criteria outlined in Section 3. The unit of observation is at the bond-week level. The bond yield is volume-weighted by bond-week.

	Mean	Std. Dev	Min	25%	50%	75%	Max
Face Value ($bn)	0.23	0.22	0.01	0.04	0.20	0.30	2.86
Years to maturity	9.06	7.56	1.02	3.15	6.12	13.3	29.9
S&P Rating	3.15	3.71	-12.0	1.00	4.00	6.00	10.0
Yield (%)	5.69	2.06	1.97	4.44	5.46	6.46	14.3
Coupon (%)	6.61	1.35	0.00	5.95	6.70	7.38	15.0

Table 8: Effect of TRACE dissemination on secondary market yields

This table contains coefficient estimates for panel regressions of secondary market bond yields on bond and time fixed effects, time-varying bond controls and bond TRACE dissemination status. The sample includes bond-weeks from the beginning of the TRACE trade reporting until one year after the completion of the roll-out. The general form of the regression model is $y_{it} = \mu_i + \rho_t + \beta' x_{it} + \gamma trace_{it} + \varepsilon_{it}$ where y_{it} is the volume-weighted log yield to maturity for that bond-week, μ_i is a bond fixed effect, ρ_t is a time (month) fixed effect, x_{it} includes the same bond and macroeconomic controls as Table 2 (or the time-varying bond controls if the model includes fixed effects) and $trace_{it}$ is a dummy variable for whether or not trades in bond i in week t are publicly disseminated. The model is estimated without fixed effects or controls (column (1)), with controls but excluding fixed effects (column (2)), with fixed effects but excluding controls (column (3)) and with controls and fixed effects (column (4)). Standard errors are clustered by bond. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)	(2)	(3)	(4)
TRACE Status	0.01	-0.02**	-0.01**	-0.02***
	(1.17)	(-2.55)	(-2.22)	(-3.84)
Bond FE	-	-	X	X
Time FE	-	-	X	X
Controls	-	X	-	X
N_{obs}	588,539	524,249	588,539	524,249
N_{bonds}	4,678	4,678	4,679	4,615

Table 9: Effect of TRACE on bond ownership dispersion and retail vs. institutional trading activity

This table contains estimates of the effect of post-trade transparency due to the implementation of the TRACE program on the number and concentration of bond owners as reported in the eMaxx database and the number of retail-sized and institutional-sized trades in the first week after issuance. The dependent variable is either the log of the number of unique owners as at the first reporting date after the bond is issued (column (1)), the Herfindahl-Hirschmann index calculated using ownership shares, as a fraction of total ownership reported in the eMaxx database (column (2)), the number of retail-sized trades ($\leq \$100,000$) in the first week after issuance (column (3)) and the number of institutional-sized trades ($\geq \$1m$) in the first week after issuance (column (4)). All bonds for which an ownership record can be found in the eMaxx database within 180 days of issuance are included in the ownership regressions. Herfindahl-Hirschmann regressions are conditioned on at least two owners reporting holdings in the eMaxx data for that bond. The treatment effect of the TRACE program is estimated as the β coefficient in regressions with the general form $y_{ict} = \gamma_c + \rho_t + \beta trace_{ct} + \lambda_1' x_{ict} + \lambda_2' z_t + \varepsilon_{ict}$ where γ_c is a cohort-specific fixed effect, ρ_t is a quarter fixed-effect, x_{ict} are bond-specific explanatory variables, z_t are macroeconomic explanatory variables and $trace_{ct}$ is a dummy for TRACE-eligibility at issue date. The model is estimated with fixed effects (γ_c and ρ_t) or with bond-specific and macroeconomic controls. Standard errors are heteroskedasticity robust. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels respectively.

	(1)		(2)		(3)		(4)	
	No. Owners (log)		Herfindahl		No. Trades $\leq 100k$		No. Trade $\geq 1m$	
β	0.40**	0.17	-0.05**	-0.04*	6.11***	6.83***	2.09**	3.20***
	(2.35)	(1.20)	(-2.39)	(-1.87)	(4.74)	(4.46)	(2.02)	(3.13)
Cohort FE	X	-	X	-	X	-	X	-
Time FE	X	-	X	-	X	-	X	-
Controls	-	X	-	X	-	X	-	X
N_{obs}	1,172	1,172	1,073	1,073	985	985	985	985
R^2	0.11	0.10	0.07	0.03	0.30	0.23	0.39	0.42

Figure 1: Trends around TRACE Dates

This figure depicts average secondary market bond yields by TRACE cohorts from the beginning of the TRACE roll-out (July, 2002) until the end of our sample (February, 2007). The sample includes all bonds present in the Mergent FISD database that can be matched to the TRACE academic dataset on CUSIPs and meet our sample selection criteria outlined in Section 3. For each of the three cohorts (Cohort 1: investment grade bonds with face value of $1bn or more, Cohort 2: bonds with rating A- or better and face value of $100m or more, and Cohort 3: all remaining bonds), we calculate the simple average yield by day for all bonds in TRACE and plot these three time series. The dashed vertical lines represent dates that trades for bonds in Cohort 2 and Cohort 3 first became publicly disseminated. Bonds in Cohort 3 are restricted to those with an S&P rating of B- or better, so as to represent newly issued non-investment grade bonds that almost exclusively have a rating of at least this level.

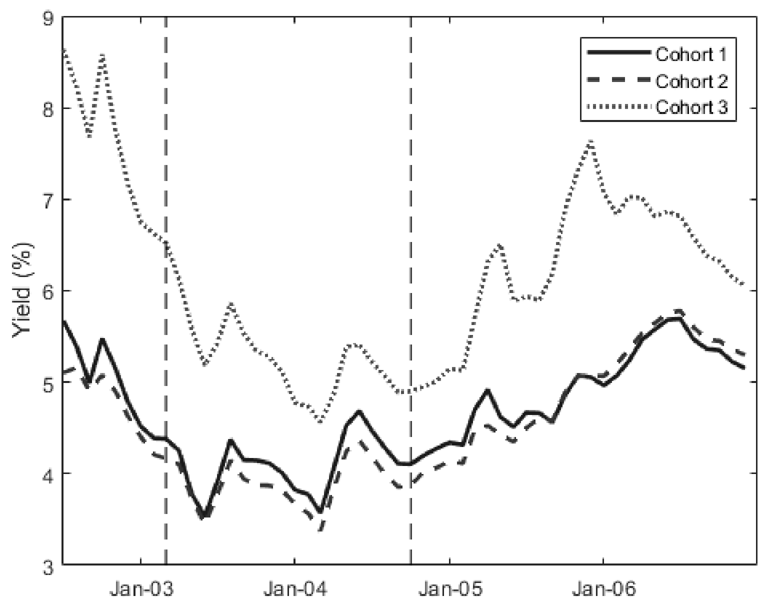
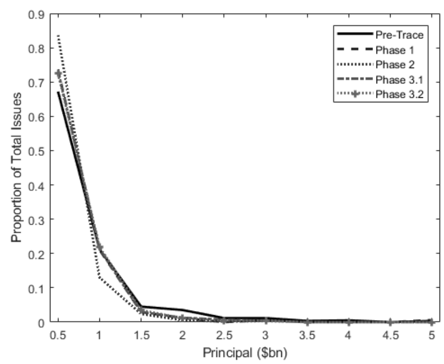


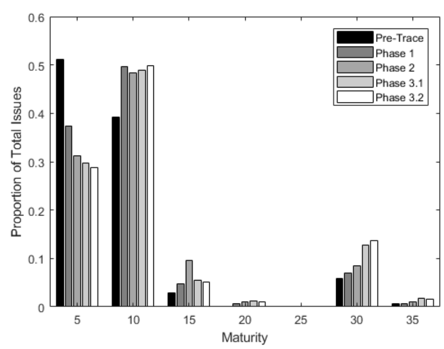
Figure 2: Issue characteristics across TRACE roll-out

These figures depict the distributions of new issue characteristics for each stage of the roll-out of TRACE. The proportion of issues are split into regular bins for principal (Sub-Figure 2a), maturity (Sub-Figure 2b) and S&P rating (Sub-Figure 2c) at each stage of the roll-out of TRACE (pre-TRACE and the three phases of the program). For each phase of TRACE, we calculate the proportion of bond issues in bins of $500m for principal, maturity blocks of five years and ratings notches.

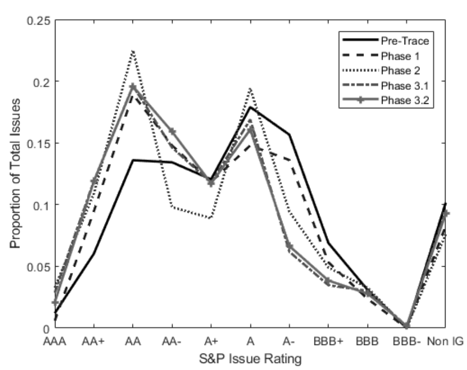
(a) Principal



(b) Maturity



(c) S&P Credit Rating



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