Do Credit Ratings Still Matter?
Evidence from the Municipal Bond Market*

Jess Cornaggia
McDonough School of Business
Rafik Hariri Building
Georgetown University
37th and O St. NW
Washington, DC 20007
(202) 687-0100
jc2394@georgetown.edu

Kimberly J. Cornaggia
Kogod School of Business
American University
4400 Massachusetts Avenue NW
Washington, DC 20016
(202) 855-3908
kcornagg@american.edu

Ryan Israelsen
Kelley School of Business
Indiana University
1309 E. 10th Street
Bloomington, IN 47405
(812) 855-8435
risraels@indiana.edu

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Abstract

Historically, Moody's has rated municipal bonds on a separate, more stringent scale than other asset classes. This double standard ended in the spring of 2010, when Moody's recalibrated the ratings of over $1 trillion of municipal bonds, resulting in upgrades of up to three notches. This event provides a rare opportunity to evaluate the effects of credit ratings free from confounding changes in issuer fundamentals. We find positive cumulative abnormal returns around the recalibration and this effect increases in the magnitude of the upgrade. Further, municipalities with upgraded bonds issue more bonds after recalibration and the new issues have lower offer yields. Additional tests indicate ratings matter because they provide information and because regulated institutions use them to mitigate capital requirements and other compliance costs. Finally, a back-of-the envelope calculation indicates Moody's dual-class rating system was costly to taxpayers, resulting in the forfeit of over $1 billion per year on the recalibrated bonds.

I. Introduction

A large and growing literature considers the information content of credit ratings, the role of ratings in capital markets, and the determinants of information production by credit rating agencies. Theory papers consider the role of regulatory (Opp, et al., 2013) and contractual (Boot, et al., 2007) reliance on ratings. Empirical studies consider the role of rater compensation structure (Jiang, et al., 2012), competition (Becker and Milborne, 2011 and Griffin, et al., 2013), qualitative analysis (Griffin and Tang, 2012), SEC certification (Kisgen and Strahan, 2007 and Bruno, et al., 2013), and credit analyst career concerns (Cornaggia, et al., 2013) on the information produced by the rating agencies. The underlying premise of this literature is that credit ratings are relevant information intermediaries.

The Attorney General of the State of Connecticut further presumes in a July 2008 lawsuit that credit ratings affect bond prices. The State charged that dual-class ratings (i.e., the practice of rating municipal bonds on a more stringent scale than other asset classes) resulted in higher interest costs imposed on taxpayers. The underlying premise of this lawsuit is that the market relied on the credit ratings to price the municipal bonds (munis). The primary purpose of this paper is to test this underlying premise. The second purpose of this paper is to address the channels through which ratings potentially affect prices. We also provide an estimate of the costs to taxpayers of Moody's dual class rating system.[1]

Testing the extent to which ratings inform the market is challenging. A host of papers finds contemporaneous changes in securities prices around ratings changes.[2] However, because ratings changes are correlated with changes in observable fundamentals, it is difficult to ascertain whether ratings contain unique information or simply respond to the same information that markets price.

[1] Moody's stated objective is to rank order securities (municipals according to their expected need for assistance; other securities according to expected losses) and Moody's has long publicized its dual-class rating system along with periodic comparison of default rates. The lawsuit filed by the State of Connecticut was settled for a $900,000 credit from the "Big 3" raters (Moody's, S&P, and Fitch) in 2011.

[2] We review the related literature in Section II.B below.

We exploit Moody's recalibration of its municipal bond ratings scale to avoid this endogeneity problem.

In September 2008, Moody's announced that it would recalibrate munis to align them with the ratings standards faced by other asset classes.[3] It performed the recalibration in April and May of 2010. Because these ratings changes were uncorrelated with changes in issuer fundamentals, they provide a clean test of ratings' price impact. Importantly, not all municipal issues were upgraded. Municipal issuers that were already 'well-calibrated' to the global scale for corporate bonds and other asset classes serve as our control group.[4] Because ratings of 'wrapped bonds' reflect the ratings of the monolines, we include only uninsured bonds in both the control and treatment groups. Our primary sample of bonds constitute a significant portion of the municipal bond market; Moody's recalibrated over 250,000 uninsured issues with a combined face value of nearly $1.25 trillion. This process generated nearly equally-sized treatment and control groups, in the sense that over $642 billion of the bonds experienced upgrades due to recalibration, and over $606 billion did not.

We find that the market re-priced the recalibrated municipal bonds in response to ratings updates. We use secondary market data from the Municipal Securities Rulemaking Board (MSRB) and compute CARs around the recalibration events. Post-recalibration CARs are nearly 40 basis points for munis upgraded one notch relative to municipal bonds that Moody's evaluated but deemed were already well-calibrated to the global scale. This effect increases in the magnitude of the recalibration: Bonds upgraded two (three) notches due to recalibration experience CARs of 80 (140) basis points relative to municipal bonds that were not upgraded.

Next, we test for real economic effects of these credit ratings. Specifically, we are interested in whether the recalibration event lowered the cost of future municipal financing and expanded the debt capacity of the effected municipalities. Because yields and spreads are time-

[3] See "Moody's to Recalibrate its US Municipal Bond Ratings to the Company's Global Rating Scale" dated 9/2/08.

[4] We detail Moody's reported recalibration in Section II.A below.

varying, and because 2010 followed a recessionary period, we employ a multivariate difference-in-difference approach.[5] We find that after recalibration, offer yields on new debt issues for the treatment group decline by 19 basis points relative to the control group. This result is robust to controlling for bond characteristics (par, maturity, coupon, liquidity), sector fixed effects, issuers' average ratings in the pre- or post-recalibration period, and issuance geography or issuer fixed effects. Further, and consistent with our results from the secondary market, the effect is larger in magnitude for municipalities whose bonds experienced larger upgrades. We find that for each notch a municipality's outstanding bonds are upgraded during recalibration, its new issues experience offer yields that are 16 basis points lower than those of the control group.

These magnitudes are economically meaningful. Over $642 billion in municipal debt was upgraded during the recalibration. The product of $642 billion and 19 basis points, our baseline estimate of the effect of recalibration on offer yields, is $1.2 billion dollars. This amount is an estimate of the annual value lost by U.S. taxpayers because of Moody's dual-class rating system. For comparison, the average cost to build a new elementary school is $6 million.[6] Even the most expensive U.S. public school ever, the Robert F. Kennedy Community School in Los Angeles, California, cost $578 million to build, less than half of $1.2 billion.[7] Further, this cost only applies to bonds that were recalibrated. It does not consider forfeited capital on the billions of dollars of municipal debt issued in the decades prior to recalibration.

Next, we check whether the affected municipalities capitalized on their lower borrowing costs. We observe that muni issuance reaches its in-sample peak six months following the recalibration, but only for the affected issuers. This finding provides corroborating evidence that ratings have real economic effects. Importantly, however, our baseline results are not driven by selection biases, whereby upgraded municipalities disproportionately participate in the sample

[5] We examine offer yields as well as spreads because both the benchmark and premiums are time-varying. Because we employ the same contemporaneous benchmark for the treatment and control groups, the second difference is the same whether we use yields or spreads in our difference-in-difference framework.
[6] Source: Reed Construction Data (http://www.reedconstructiondata.com/rsmeans/models/high-school/)
[7] Source: USA Today (http://usatoday30.usatoday.com/news/education/2010-08-22-taj-mahal-schools_N.htm)

after recalibration, or non-upgraded municipalities disappear from the sample after recalibration. We address selection biases by requiring municipalities to issue both before and after recalibration for admission to our multivariate tests. We also find that our results are not driven by municipalities that began in any particular rating category prior to recalibration or ended up in any particular rating category afterward.

Having established real effects of credit ratings, we consider why ratings are relevant. Do ratings contain unique information or do our results reflect increased demand from investors facing regulatory and contractual constraints – or both? In order to distinguish between these explanations, we restrict our treatment sample to one-notch upgrades. We divide this refined treatment sample by whether the upgraded rating migrates into a new broad rating category (e.g., from A1 to Aa3) or remains within a broad rating category (e.g., A2 to A1). Reserve requirements and other ratings-based regulations are typically written around broad rating categories, not individual notches within broad rating categories. Therefore, if our results are exclusive to upgrades that migrate into a new broad rating category, we may conclude that observed re-pricing is driven by regulatory and contractual implications of the credit rating. However, if our results are robust in the subsample of upgrades that do not cross a broad rating category, we can conclude that the price impact reflects information provision. We find evidence for both channels. Multivariate difference-in-difference results from the subsample of upgrades that should not have regulatory significance remain robust. However, the results are 70% larger in economic magnitude for upgrades that should affect regulation-based demand. Although the difference between the divided treatment groups are not statistically significant, the differential magnitude appears in the secondary market data (CARs) as well.

We return to our secondary markets data for a final test of the regulatory compliance effect. We compare the trading volume for recalibrated bonds based on whether the upgrades crossed a regulatory threshold (i.e., a broad rating category). We observe a significant increase in the trading volume for both inter-dealer trades and customer purchases of upgraded bonds that crossed a

regulatory threshold, relative to those that upgraded within the same broad rating category. The effect is stronger for inter-dealer trades than for customer sales further suggesting this trading reflects regulatory demand.

The existing work most similar to ours is Kliger and Sarig (1999). These authors examine the change in Moody's corporate ratings to a more granular scale in 1982 and find that the ratings modifiers impact corporate bond yields. To our knowledge, theirs is the first evidence to show the impact of credit ratings free from confounding effects of contemporaneous changes in issuer fundamentals. However, the speed and ease with which the market can access and process information has increased substantially since 1982. As such, the question of rating agency relevance is again an open one. Our results clearly indicate that Moody's remains a relevant information intermediary. Our additional and novel contributions are (1) an empirical examination of potential channels by which credit ratings impact bond prices, and (2) an estimate of the costs associated with incomparable rating scales. This estimate is highly relevant as the SEC (2011b) considers the Dodd-Frank mandate to standardize credit ratings across all rated securities (see §938).

II. Institutional Background and Literature Review

A. Moody's Dual Class Ratings

Unlike Moody's Global Scale ratings, which are designed to measure expected losses among corporate bonds, sovereign debt, and structured finance products, Moody's Municipal Rating Scale historically measured the how likely an entity is to require extraordinary support from a higher level of government in order to avoid default; Moody's (2007, page 2). Moody's (2009) attributes its dual rating system to the preferences of the highly risk averse investors in municipal bonds. In an earlier comment on the dual scales, Moody's (2002, page 11) reports that if municipal bonds were rated on the corporate scale, (1) nearly all general obligation (GO) and essential service revenue bonds would be rated Aa3 or higher and (2) GO bonds in default with anticipated full recovery would likely be rated Ba1.

This mapping is time varying, however. Trzcinka (1982) examines municipal bond ratings from 1970-1979 around Moody's change from investor-paid to issuer-paid and concludes that municipals were, on average, more risky than corporates of the same rating. Cornaggia, et al. (2013) provide a comprehensive comparison of ratings by asset class and find that public finance was significantly less risky than corporate bonds in each subsequent decade (1980s, 1990s, and 2000s). The dual class rating system persisted for decades until Moody's recalibrated its municipal ratings to align them with the Global Scale in April and May of 2010. This recalibration was systematic, intended to enhance the comparability of ratings across asset classes, and advertised (Moody, 2010) as follows.

> *"Our benchmarking analysis … will result in an upward shift for most state and local government long-term municipal ratings by up to three notches. The degree of movement will be less for some sectors … which are largely already aligned with ratings on the global scale. Market participants should not view the recalibration of municipal ratings as ratings upgrades, but rather as a recalibration of the ratings to a different scale … does not reflect an improvement in credit quality or a change in our opinion…"*

Moody's (2010) summarized their expectation for probable recalibration by sector:

- General obligation (GO) ratings will change by an average of two notches, with a range of zero to three notches.
- State and local government sales and special tax obligations will generally move up by one notch.
- Most housing, healthcare and other enterprise sectors should not change because they are already well-calibrated with the global scale. Those that change will move up by one notch.

The recalibration was tentatively advertised to be implemented in stages over a four week period. Thus, while the systematic nature of the recalibration was known in advance, the market did not know which particular ratings would update on a particular date or the extent (zero to three notches) to which any particular issues would update. This staging allows additional tests of treatment issuers against other treatment issuers on dates prior to their recalibration. Finally, and importantly for our study, Moody's advertised that any ratings under review for upgrade or downgrade prior to recalibration would remain under review – not lumped into these massive

ratings changes. As such, this recalibration avoids the endogeneity problem faced by prior studies of ratings changes and market prices.

B. Related Literature

The literature examining the extent to which credit ratings inform markets stems back at least to Hettenhouse and Sartoris (1976), Weinstein (1977), and Pinches and Singleton (1978). These early papers are followed by Ingram, et al. (1983), Holthausen, and Leftwich (1986), Hand, et al. (1992), Goh and Ederington (1993), Hite and Warga (1997), Ederington and Goh (1998) and Dichev and Piotroski (2001). This literature reports mixed results, but overall suggests that (1) markets move prior to rating agencies and (2) markets respond to ratings changes. Most authors conclude from point (1) that markets price information not reflected by the credit ratings. Conclusions from point (2) are more challenging because the rating changes (a) are correlated with changes in issuer fundamentals and (b) have regulatory implications (Ellul, et al., 2011.)

A complementary line of research considers the avenues by which credit ratings 'matter' to issuing firms including access to capital, cost of capital, corporate capital structure, and investment decisions; see Faulkender and Petersen (2006), Kisgen (2006, 2009, 2012), Sufi (2009), Hovakimian, et al. (2001), and Tang (2009). However, the impact of credit ratings on corporate finance and investment decisions may reflect their regulatory implications (Kisgen and Strahan, 2010; Opp, et al. 2013) rather than their information content.

The information content of ratings is generally gauged with horseraces of rating agencies against each other (Strobl and Xia, 2010; Xia, 2013) against quantitative models (Cornaggia Cornaggia, and Xia 2013) or against securities markets (Bruno, et al., 2013; He, et al., 2012). Jorion, et al. (2005) provide evidence on Moody's role as an information provider with an analysis of an exogenous change in regulation. These authors document an increased sensitivity of securities prices to ratings changes following Regulation Fair Disclosure (Reg. FD). Because rating agencies were exempt from Reg. FD, this regulation increased the relative importance of

rating agencies in the market for information. The Dodd-Frank Act of 2010 repealed rating agencies' exemption from Reg. FD and thus presumably ended this information advantage.

Our contribution to this literature is a clean test of the price impact of credit ratings without the confounding effects of changes in issuer fundamentals, an analysis of the channel through which ratings affect prices (information or regulatory compliance), and an estimate of the cost to taxpayers of Moody's dual class system.

III. Data Collection and Sample Description

Our municipal bond data consist of ratings from both Moody's and Standard and Poor's (S&P), bond market transaction prices and volume from the Municipal Securities Rulemaking Board (MSRB), and issue/issuer characteristics from Ipreo. From Moody's, we collect ratings data on every municipal bond issue by a state or local government that had a "Change in Scale" on April 16, April 23, May 1 or May 7 in 2010, as well as the ratings on all past and future issues by the same organizations. More than $3 Trillion dollars of outstanding municipal bonds were directly affected by this recalibration event. We focus on the $1.25 Trillion dollars' worth of uninsured bonds as well as uninsured new issues after the event. Table A.I presents the number of issues and cumulative par value recalibrated on each date.

In March 2010, Moody's advertised a zero to three notch range in upgrades associated with the eminent recalibration. Table A.II reports the migration matrix for these recalibrated bonds. The proportion of bonds upgraded varies by initial rating. Of those rated Aa1, only 41% upgraded to Aaa. No other bonds reached the Aaa level. No other initial rating level retained more than 50% of its original bonds. The majority of upgrades remain within the original broad rating classes Aa and A. However, the majority of bonds (64.3%) originally in Baa categories migrated into A categories. Only 11 bonds were upgraded more than three notches (from A3 to Aa2).

From the Ipreo i-Deal new issues database, we gather data on new issues including offer yield, sale date, maturity date, par value, coupon rate, and issuer characteristics as well as information on insurance and other support. We compute credit spreads as the difference between

offer yield and the after-tax yield (assuming 35% marginal tax rate) on the maturity-matched treasury security as of the date of issuance. Treasury securities have maturities of one, three, and six months, and one, two, three, five, seven, ten, 20, and 30 years. We match each municipal bond to the treasury with the closest maturity. For example, if a municipal bond was issued on 1/1/2010 with a maturity of 8 years, we match it to the yield on the 7 year treasury on 1/1/2010. We exclude any new issues that carry insurance. Figure 1 displays the dollar volume of insured and uninsured municipal bond issues by month from January 2009 through October 2012. Our sample of uninsured bonds dominates this market.

[Insert Figure 1 here.]

A. Descriptive Statistics

Table I displays summary statistics for the sample of uninsured bonds. Panel A contains the full sample, including bonds with ratings that did not change as a result of recalibration. The variable *Notches* in Table II is not directly comparable to the transition matrix in Table A.II, which shows individual bonds' ratings immediately before and after recalibration. In Table I, *Notches* is an issuer-level variable measuring the difference in ratings of issuer debt before and after the recalibration event. The average 0.8 *Notches* is skewed by the Aaa observations. We employ a standard numerical transformation of Moody's rating scale ascending in credit quality (Aaa = 21, Aa1 = 20, …, C = 1). However, none of our sample bonds have ratings lower than Baa3. The average bond in ours sample is rated approximately Aa2 at issuance.

Panel B reports summary statistics separately for the subsamples of bonds that were and were not upgraded as a result of the recalibration. As expected, given the Aaa upper bound, the average upgraded bond received a lower rating at issuance than the average bond that retained its rating through recalibration. Conditional on an upgrade, the average upgrade was 1.3 notches. We measure offer yields three different ways for completeness: raw offer yield (*Offer yield*), spread to after-tax treasury (*Spread to after-tax treasury*), and spread to pre-tax treasury (*Spread to treasury*) The average raw offer yield (3.08 percent) for the subsample of bonds that are upgraded is similar

but slightly lower compared to the control group (3.11 percent). We test the statistical significance of these spreads in univariate and multivariate settings in Section IV below.

[Insert Table 3 here.]

Table I Panel C reports summary statistics separately for issues in the year prior to recalibration and the subsequent year. The average offer yield and magnitude of change in issuers' ratings is similar in both time periods.

B. Secondary Market Data

We gather secondary market trading data from the MSRB Electronic Municipal Market Access (EMMA) database. The MSRB reports all trades of municipal bonds in the EMMA database. The transaction data include prices, dollar volume, trade time, and whether the transaction was a "customer" buy or sell or an "inter-dealer"/"inter-bank" transaction. No distinction is made in the data between retail and institutional customers. For transactions involving a "customer", the yield is included.[8] Municipal bond dealers range between discount brokerages, full service brokerages, municipal advisors, and investment banks.[9]

Calculating abnormal returns for bonds is generally more problematic than for stocks. One of the biggest reasons is the lack of liquidity relative to equity markets. Furthermore, the typical municipal bond is less liquid than the typical corporate bond. However, there is still a substantial amount of trading in a subset of bonds. During the 41 trading days in April and May of 2010, more than $300 Billion of municipal bonds changed hands in more than a million transactions, representing more than 100 thousand unique securities.

Using corporate bond trading data, Bessembinder, et al. (2008) show that calculating abnormal returns using trade-weighted prices increases the power of the test and reduces Type 1 errors relative to using end-of-day prices. Accordingly, we calculate returns by trade-weighting. In particular, we calculate the daily price, P_t, as

[8] The reported yield is the lower of the yield-to-call and the yield-to-maturity.

[9] See http://www.msrb.org/msrb1/pqweb/registrants.asp for a current list of MSRB registered broker-dealers.

$$P_t = \sum_{i=1}^{N} \frac{tradesize}{\sum_{j=1}^{N} tradesize_j} price_i$$

on days with at least one trade, and the most recent price on days with no trades. After trade-weighting the prices the returns, R_t, are defined as

$$R_t = \frac{P_{t+1} - P_t}{P_t}$$

In addition to examining returns, we investigate how trading volume is affected by the recalibration. We separate trading volume using the MSRB's breakdown of trades into "Inter-dealer trades", "Customer purchases" and "Customer sales".

IV. Empirical Results

A. Price Impact of Ratings Recalibration

Before we examine the effect of the recalibration on the price and quantity of new municipal issues, we study the secondary market return behavior for outstanding bonds. This analysis allows us to focus on a more-narrow window around the event, which should limit the influence of any other contemporaneous events on prices and yields. Unfortunately, most of the trading volume for municipal bonds occurs right around the date of issuance. In fact, many municipal bonds are never traded. However, there is still a subset that trades relatively frequently. In the two months surrounding the recalibration, about $300 Billion dollars of bonds that had a "change in scale" were traded. We examine the effect of an upgrade on the abnormal returns in this more liquid subset of bonds.

For each of the four recalibration dates, and for one-, two-, and three-notch upgrades, we calculate cumulative abnormal returns (CARs) from 10 trading days before the event to 30 trading days after. As described in the data section, we trade-weight prices and then calculate returns based on these adjusted prices. Only bonds that trade at least three times during the window are included. We form an equal weighted portfolio for zero-, one-, two-, and three-notch upgrades and calculate cumulative returns starting 10-days before the event date. Only bonds that had an announcement

on that date are included. The CARs are then calculated by subtracting the zero-notch portfolio's cumulative return. To test significance, a difference in means test is performed under the assumption of different variances for the two averages.

Table II provides the number of bonds that are included in the return portfolios. For the first date, there are 1,135 bonds in the benchmark portfolio and 3,721, 364, and 887 bonds in the one-, two-, and three-notch portfolios, respectively. In the final three dates, there are too few three-notch upgrades to estimate portfolio returns with any precision. The same is true of two-notch upgrades on the final date. There are fewer than 1,000 bonds in the remaining portfolios, with the exception of the zero-notch portfolio on the final date, which has 4,657.

[Insert Table II here.]

Figure 2 plots the CARs for each of the three upgrade sizes for the four dates as well as 95% confidence intervals for the first date – April 16. This is the most "clean" event of the four, as there is no overlap with the other three dates until trading day +5, and there are more traded bonds for all three levels of upgrades than the other dates. The results are striking. The CARs increase over time and are larger for the bonds which had larger upgrades. There is some run-up before the event, suggesting that the market may have anticipated which bonds were to be upgraded, but most of the increase comes after the event. After the recalibration date, all of the CARs are statistically significant. The three remaining dates provide similar evidence, but there are too few 3-notch upgrades and there may be confounding effects given that the overlap before the event dates.

[Insert Figure 2 here.]

B. Evidence from New Issues

We test the effect of the ratings recalibration on municipal bond spreads using a difference-in-difference approach for the full sample of municipal bonds issued in the year before and the year following the four recalibration dates. We partition bonds by a) whether their issuers' outstanding bonds were upgraded as a result of recalibration, and b) whether they were issued

before or after the recalibration event. These results are found in Table III Panel A. We find that after recalibration, offer yields on new debt issues for the treatment group decline by 19 basis points relative to the control group (using spread to pre-tax treasury as the dependent variable). This result is robust to controlling for bond characteristics (par, maturity, coupon, liquidity), sector fixed effects, issuers' average ratings in the pre- or post-recalibration period, and issuance geography or issuer fixed effects. Further, and consistent with our results from the secondary market, the effect is larger in magnitude for municipalities whose bonds experienced larger upgrades. Panel B shows that for each notch a municipality's outstanding bonds are upgraded during recalibration, its new issues experience offer yields that are 16 basis points lower than those of the control group.

[Insert Table III here.]

We repeat this analysis conditioning on issuers' average credit ratings in the pre-calibration and, separately, post-recalibration periods period in Table IV. This analysis allows us to determine whether our results are widespread, or simply driven by issuers initiating in or ending up in one or two select rating categories. We find that the negative and significant coefficient on the interaction term remains in two of three subsamples (bonds whose issuers' had average ratings in the A-range and Aa-range prior to recalibration) whether we split the sample by initial or final issuer rating. However, we observe a positive and significant coefficient on the interaction term for bonds whose issuers had average ratings in the Baa-range prior to recalibration. This results could reflect a small sample bias. Indeed, the sample from which this result derives contains only 956 bonds. Further, Panel B indicates this unusual result may be driven by outliers. In Panel B, we again use the magnitude of the upgrade to capture the recalibration effect, instead of a simple dummy variable indicating whether or not the bond's issuer was upgraded during recalibration. The coefficient on the interaction term in column (1) in Panel B is no longer significant.

C. Why Do Ratings Affect Prices?

Next, we explore the extent to which this observed pricing impact is a result of the information content of the credit rating, as distinct from the regulatory demand (i.e., higher credit ratings translate into lower reserve requirements and other costs associated with regulatory compliance). Because the greatest regulatory consequences occur below the Baa level, and because all of our municipal bonds are rated Baa or higher, we expect that the observed price impact reflects information provision. However, there are some regulatory considerations across the investment grade categories in our sample.[10] Ratings thresholds for establishing capital charges vary by regulator, but in general crossing broad ratings categories (i.e. from Baa to A) have greater consequence than moving a notch or two within a broad category (i.e. from Baa3 to Baa1).

We therefore test for the influence of regulatory demand in Table V by comparing the upgrades that cross a broad rating category (columns 1 through 3) to those that remain within the original broad category (columns 4 through 6). We include a maximum one notch upgrade in both panels to ensure that our test does not capture variation in upgrade size. The 19 basis point diff-in-diff documented in Table III underestimates the price impact (22 basis points) of ratings that cross a broad category. This finding indicates that upgrades with a reduction in the costs associated with regulatory compliance have a greater price impact than upgrades that do not increase regulatory demand. However, the price impact (13 basis points) observed among the upgrades without regulatory consequences (Panel A) remains significant at 1%. The finding suggests that a significant portion of the price impact is attributable to information provision.

[Insert Table V here.]

C.1. Trading Volume

To the extent that regulatory friction explains the price impact of ratings on new issues, it may also explain the CARs observed in the secondary market. Specifically, if regulatory compliance costs fall as a result of the upgrade, we should expect increased demand for the

[10] NAIC guidelines treat Aaa, Aa, and A similarly (0.30% capital charge) with 3x increase to 0.96% capital charge for Baa ratings; see Becker and Ivashina (2012). Under Basel guidelines, single A rated bonds carry a higher charge than Aa or Aaa; details available here: www.bis.org/publ/bcbs128b.pdf.

upgraded bonds irrespective of their credit risk. To test this, we restrict our attention only to bonds that saw upgrades and examine the effect of crossing a regulatory threshold (i.e., broad rating class) on trading volume in a diff-in-diff framework. For each bond that had at least one trade in the month before or after its "change in scale", we calculate the average daily trading volume during the 20 trading days before and after the event coming in the form of "Inter-dealer trades", "Customer purchases" and "Customer sales". In some cases, this number is zero. To capture the regulatory effect, we define the variable "New broad rating category" and set it equal to 1 if the a bond upgraded from below Aaa to Aaa, from below Aa3 to at least Aa3 and from below A3 to at least A3, and zero otherwise. To capture the general effect of the upgrade, we set the variable "After recalibration" to 0 before the event and 1 after. We pool all 4 events together and run a diff-in-diff regression using the log of (1 plus) average trading volume for each of the measures. We estimate the regression separately for bonds that had upgrades of 1 notch and upgrades of 2 notches. Table VI provides the results.

[Insert Table VI here.]

There are a total of 45,834 bonds that were upgraded one-notch and had at least one trade during this period. There is a positive, statistically-significant increase in trading volume for both inter-dealer trades and customer purchases of upgraded bonds that crossed a regulatory threshold relative to those that did not. There is no statistically significant differential effect on customer sales for one-notch upgrades. These results suggest that some of the upward price pressure as a result of the upgrades is caused by increased demand from regulated investors mitigating compliance costs. For larger upgrades, the effect is even stronger, though there is less than a tenth the number of observations.

We pursue this question with our secondary market returns data, as well. We focus on bonds with one-notch upgrades in Figure 3. We split the bonds by those whose upgrades migrated into a new broad rating category and those that remained within the same broad rating category. As with our earlier CAR plots, the comparison group consists of municipal bonds that were

recalibrated on April 16, 2010, but not upgraded. Although the two plots are not statistically different, we observe evidence consistent with our multivariate offer yields tests: the CARs for bonds that upgrade one notch into new broad rating categories are larger than the CARs of bonds that upgrade one notch but remain within a broad rating category.

[Insert Figure 3 here.]

C. Did Municipalities Capitalize?

We consider that if higher bond ratings lower borrowing costs, newly upgraded municipalities enjoy increased debt capacity. Results reported in Table III are consistent with this conjecture. Issuers who do not upgrade issue virtually identically in the periods preceding and following the recalibration event (N=10,392 and N=10,376). In contrast, issuers that upgrade increase issuance in the latter period (N=15,411 before and N=19,150 after). However, this comparison ignores potential differences in issue size. Figure 3 plots the dollar volume of issue per month from January 2009 through October 2012 for both groups. Issuers that upgraded issued more debt than the issuers that did not upgrade both prior and after recalibration. However, the difference between the groups is greater in the latter time period. Indeed, municipal issues reach their in sample peak six months following the recalibration event – but only for the treatment group.

[Insert Figure 4 here.]

V. Did Standard & Poor's Also Recalibrate Its Ratings on Municipal Bonds?

Our focus thus far has been on the behavior of Moody's ratings and how the company's recalibration affected the pricing of municipal debt. However, given that Moody's and Standard & Poor's compete in the ratings industry and dominate the landscape, it is natural to ask whether and to what extent S&P adjusted its municipal ratings around the time of Moody's recalibration. Unlike Moody's, however, S&P has long maintained that it never had a dual-class rating system:

"We have always had one scale, a consistent scale that we have tried to adopt across all our asset classes."

-- Deven Sharma, President, Standard & Poor's (S&P), July 27, 2011[11]

Therefore, if S&P's municipal ratings are already properly calibrated to its global scale, S&P should not update its ratings around the time Moody's recalibrated.

We examine S&P's ratings around the time of Moody's recalibration in Table VII. We begin with the sample of bonds that Moody's upgraded (i.e., the bonds that migrate to higher rating categories in the transition matrix in Table A.II). We observe ratings at two points in time for these bonds: 1) immediately before Moody's upgraded them, and 2) whenever their S&P ratings change next, subject to a one-year time constraint. In other words, if S&P does not update a bond's rating within one calendar year of Moody's recalibration, we do not include it. Table VII shows the transition matrix based on these two observed ratings. It appears that although S&P did not formally recalibrate the ratings of municipal bonds, the company exhibits an unusual proclivity for updating the bonds' ratings to AA+. This shift applies to bonds rated AAA, as well as bonds with lower starting ratings.

[Insert Table VII here.]

VI. Conclusion

We exploit Moody's recalibration of its dual-class rating system to shed light on the extent to which credit ratings affect market prices. We find robust evidence that Moody's dual class ratings system resulted in higher borrowing costs to taxpayers compared to those enjoyed by corporations and other asset classes with similar expected losses. The price impact of Moody's ratings on outstanding bonds appears driven largely by regulated institutions mitigating

[11] Testimony before the U.S. House of Representatives, Committee on Financial Services, Oversight and Investigations Subcommittee, 2129 Rayburn Office Building, Washington DC, July 27, 2011.

compliance costs. However, we find significant reduction in offer yields and credit spreads among the marginally upgraded municipalities that do not cross a regulatory threshold. We conclude that Moody's ratings continue to play a significant role in the market for information and have real effects on the price and quantity of municipal bond issues.

Appendix A: Supplemental Tables Describing Moody's Recalibration

Table A.I
Par Values of Bonds Upgraded on Recalibration Dates

This table displays the number and total par value of uninsured municipal bonds for which Moody's issued a "Change in Scale" rating action between April 16, 2010 and May 7, 2010. We collect ratings data on bonds issued by state or local governments from Moody's.

	All "Change in Scale" rating actions		"Change in Scale" is an upgrade		"Change in Scale" results in no change in rating	
Recalibration date	N bonds	Total par	N bonds	Total par	N bonds	Total par
April 16, 2010	90,873	$568,700,000,000	72,295	$468,200,000,000	18,578	$100,500,000,000
April 23, 2010	55,929	$96,970,000,000	42,769	$70,450,000,000	13,160	$26,520,000,000
May 1, 2010	54,104	$118,200,000,000	40,550	$72,300,000,000	13,554	$45,900,000,000
May 7, 2010	65,858	$464,300,000,000	8,944	$31,530,000,000	56,914	$432,700,000,000
Sum:	266,764	$1,248,170,000,000	164,558	$642,480,000,000	102,206	$605,620,000,000

Table A.II
Ratings Migration Matrix for Moody's "Change in Scale" Rating Actions

This table displays a ratings migration matrix for uninsured municipal bonds for which Moody's issued a "Change in Scale" rating action. The horizontal axis represents bonds' ratings before the first recalibration date (April 16, 2010) and the vertical axis represents the bonds' ratings after the fourth and final recalibration date (May 7, 2010). We collect ratings data on bonds issued by state or local governments from Moody's.

		Rating before scale change										
		Aaa	Aa1	Aa2	Aa3	A1	A2	A3	Baa1	Baa2	Baa3	Sum
	Aaa	46,851	20,404									67,255
	Aa1		17,579	40,536	5	29						58,149
	Aa2			14,204	43,229	14,620		11				72,064
Rating	Aa3				6,413	7,009	14,098	16				27,536
after	A1					4,321	3,560	9,838	4,525			22,244
scale	A2						4,333	1,418	598	2,245		8,594
change	A3							3,575	449	87	1,042	5,153
	Baa1								1,502	81	614	2,214
	Baa2									1,759	74	1,833
	Baa3										1,042	1,042
	Sum	46,851	37,983	54,740	49,647	25,979	22,008	14,858	7,074	4,172	2,772	266,084

Table A.III
Moody's Credit Ratings on New Issues after the Recalibration Event

This table displays summary statistics of municipal bond ratings averaged at the issuer level. We focus on issuers whose bonds received a "Change in Scale" rating action from Moody's. "Change in Scale" rating actions resulted in either no change to the rating or an upgrade ranging in size from one to three notches. *Before recalibration* is the rating on outstanding bonds that Moody's recalibrated, measured immediately prior to recalibration. *Recalibrated* is the resulting rating after recalibration. *New issues after recalibration* is the rating on new bonds issued within one calendar year of recalibration. We translate Moody's 21-point alphanumeric scale into a numeric scale such that Aaa = 21, Aa1 = 20, ..., C = 1. We collect ratings data on bonds issued by state or local governments from Moody's.

	Issuers who issue new bonds in the calendar year following recalibration			Issuers who do not issue new bonds in the calendar year following recalibration		
	N issuers	Avg. rating	SD (notches)	N issuers	Avg. rating	SD (notches)
Before recalibration	3,190	17.1 (≈A1)	2.0	10,456	16.1 (≈A2)	2.2
Recalibrated	3,190	18.3 (≈Aa3)	1.7	10,456	17.5 (≈Aa3)	2.1
New issues after recalibration	3,190	18.3 (≈Aa3)	1.7			

Table A.IV
Within-Issuer Distribution of Ratings before and after Recalibration

This table displays summary statistics of the issuer-level standard deviation of municipal bond ratings around recalibration. Issuers must have at least two bonds outstanding at the time their bonds' ratings are recalibrated for inclusion to this table. We translate Moody's 21-point alphanumeric scale into a numeric scale such that Aaa = 21, Aa1 = 20, ..., C = 1. We collect ratings data on bonds issued by state or local governments from Moody's.

	N issuers	Mean	SD	Min	25%	Median	75%	Max
Before "Change in Scale" rating action	9,714	0.202	0.521	0	0	0	0	9.899
After "Change in Scale" rating action	9,714	0.206	0.544	0	0	0	0	10.607

Table A.V
Subsequent Rating Changes after Recalibration

This table displays summary statistics on the difference between municipal bond ratings after recalibration and recalibrated ratings, measured in notches. A bond's rating must update again after a "Change in Scale" rating action for inclusion to this table. Types of updates include upgrades, downgrades, or affirmations. The sample ends in October 2012. We translate Moody's 21-point alphanumeric scale into a numeric scale such that Aaa = 21, Aa1 = 20, ..., C = 1. We collect ratings data on bonds issued by state or local governments from Moody's.

Panel A. Rating Differences

	N bonds	Mean	SD	Min	25%	Median	75%	Max
All bonds with rating updates after recalibration	57,933	-0.081	0.531	-9	0	0	0	13
Bonds with rating updates within one calendar year after recalibration	42,533	-0.077	0.545	-9	0	0	0	13

Panel B. Rating Differences Split by Size of Upgrade due to Recalibration

	N bonds	Mean	SD	Min	25%	Median	75%	Max
All bonds with rating updates after recalibration								
No change	21,288	-0.013	0.388	-8	0	0	0	13
1 notch	20,548	-0.064	0.464	-8	0	0	0	6
2 notch	13,481	-0.179	0.703	-9	0	0	0	7
3 notch	2,612	-0.261	0.806	-7	0	0	0	5
Bonds with rating updates within one calendar year after recalibration								
No change	16,329	-0.011	0.399	-8	0	0	0	13
1 notch	15,579	-0.056	0.465	-8	0	0	0	6
2 notch	8,766	-0.193	0.76	-9	0	0	0	7
3 notch	1,859	-0.286	0.85	-7	0	0	0	4

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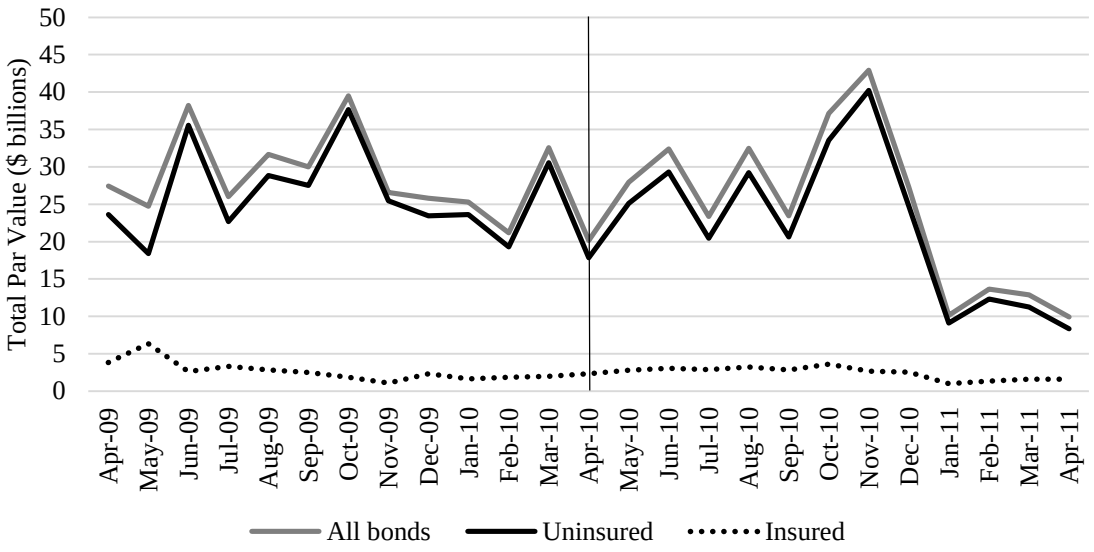

Figure 1. Dollar volume of issues per month. This figure displays the total par value of municipal bonds issued per month from April 2009 to April 2011. We split the sample by whether the bonds are wrapped with third-party insurance. The vertical line denotes April 2010, the month with the first and most prominent recalibrations. The data come from the Ipreo i-Deal new issues database.

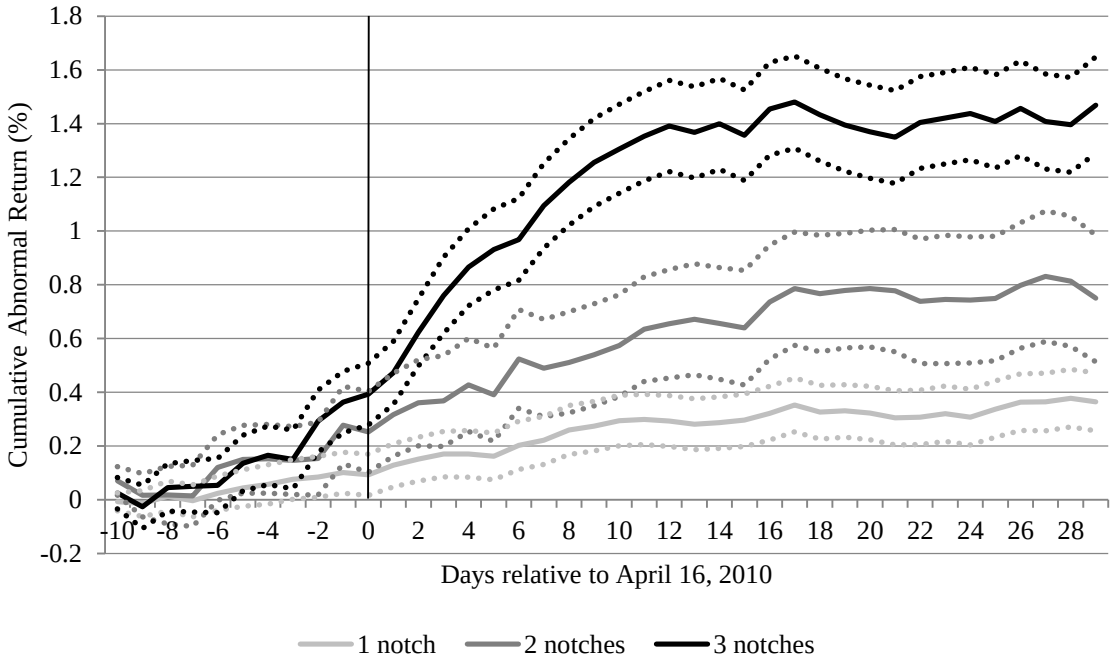

Figure 2. Cumulative abnormal returns around first recalibration date. This figure displays cumulative abnormal returns of outstanding municipal bonds that Moody's upgraded on April 16, 2010, the first of four recalibration dates. We split the bonds by the size of the upgrade (one, two, or three notches). The comparison group consists of municipal bonds that were recalibrated on April 16, 2010, but not upgraded. We gather secondary market trading data from the MSRB Electronic Municipal Market Access (EMMA) database.

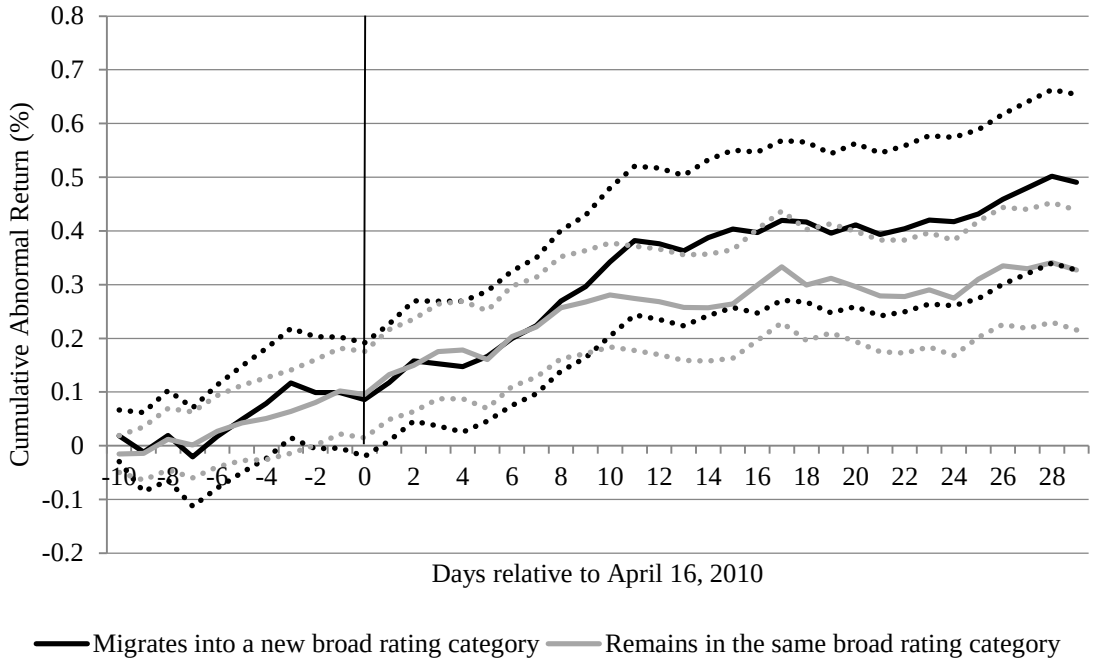

Figure 3. Cumulative abnormal returns around first recalibration date for municipal bonds with one-notch upgrades. This figure displays cumulative abnormal returns of outstanding municipal bonds that Moody's upgraded one notch on April 16, 2010, the first of four recalibration dates. We split the bonds by whether the upgraded rating migrated into a new broad rating category or remained within a broad rating category. For example, a one-notch upgrade from A1 to Aa3 would migrate into a new broad rating category, whereas a one-notch upgrade from A2 to A1 would remain within a broad rating category. The comparison group consists of municipal bonds that were recalibrated on April 16, 2010, but not upgraded. We gather secondary market trading data from the MSRB Electronic Municipal Market Access (EMMA) database.

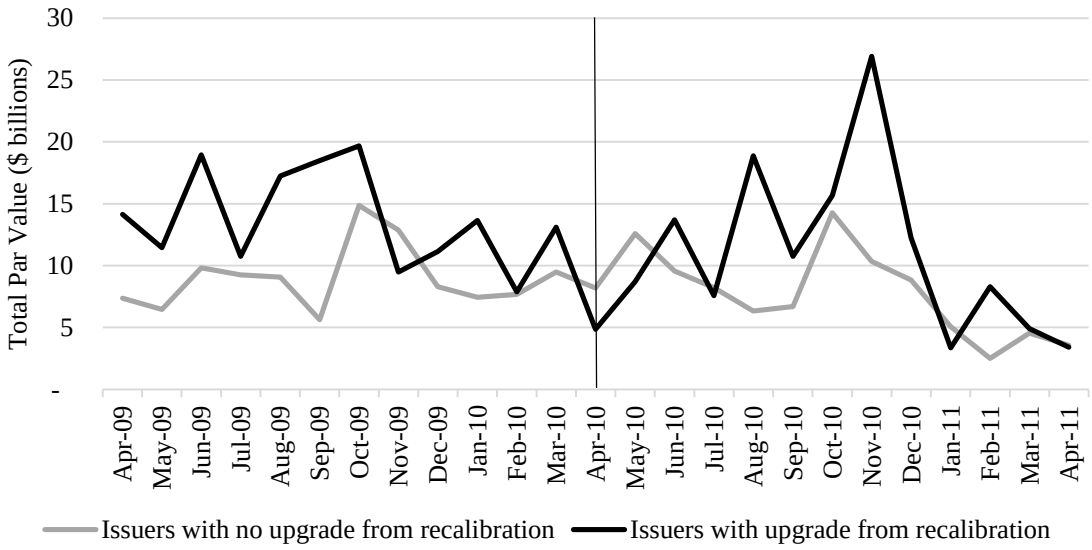

Figure 4. Dollar volume of issues per month by whether the issuers are upgraded. This figure displays the total par value of uninsured municipal bonds issued per month from April 2009 to April 2011. We split the sample by whether Moody's upgrades any of the issuers' outstanding bonds during a recalibration event. The vertical line denotes April 2010, the month with the first and most prominent recalibrations. The data come from the Ipreo i-Deal new issues database.

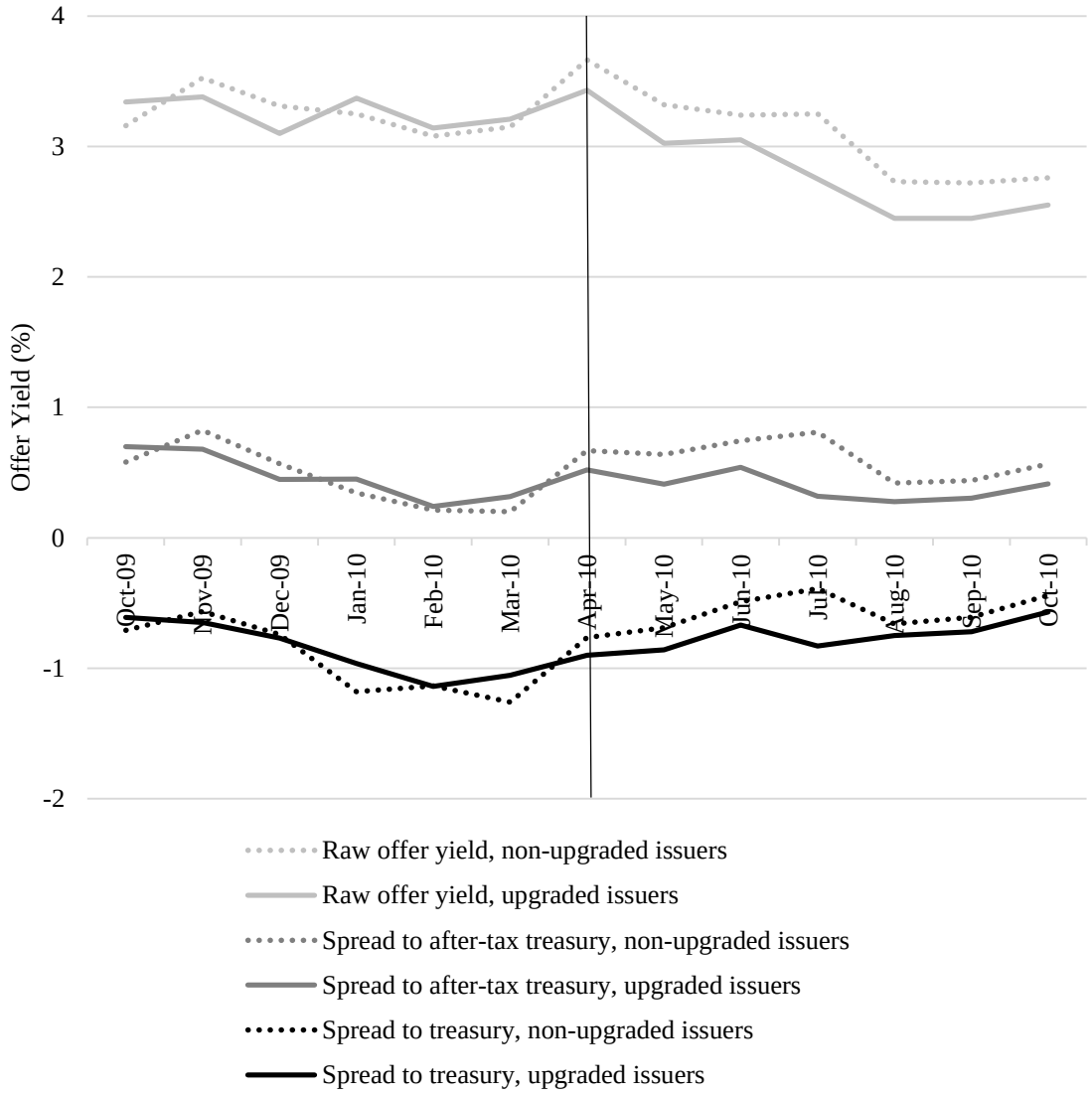

Figure 5. Offer yields on new issues around recalibration. This figure displays average offer yields on new municipal bond issues according to whether the issuers' bonds were upgraded during recalibration. We measure offer yields in three ways. First we use raw offer yields. Second, assuming a tax rate of 35%, we compute the spread between a bond's raw offer yield and the after-tax yield of the U.S. treasury bond with the closest maturity on the day of issuance. Third, we compute the spread between a bond's raw offer yield and the yield of the U.S. treasury bond with the closest maturity on the day of issuance. The vertical line denotes April 2010, the month with the first and most prominent recalibrations. Offer yield data come from the Ipreo i-Deal new issues database.

Table I
Summary Statistics for Observations in Multivariate Regressions

This table displays summary statistics for uninsured municipal bonds issued in the calendar year before April 16, 2010 (the first recalibration date) and the calendar year after May 7, 2010 (the fourth and final recalibration date). In order for a bond to be in the sample, we require its issuer to issue at least one new bond in both time periods. *Offer yield* is the raw offer yield on the bond. *Spread to after-tax treasury* is the difference between a bond's offer yield on the date of issue and the after-tax yield of the U.S. treasury bond with the closest maturity on the same day. We assume a tax rate of 35%. *Spread to treasury* is the difference between a bond's offer yield on the date of issue and the yield of the U.S. treasury bond with the closest maturity on the same day. *Rating at issue* is a numerical translation of Moody's 21-point alphanumeric scale. Ratings are increasing in credit quality, such that Aaa = 21, Aa1 = 20, ..., C = 1. *Par* is the bond's par value measured in millions of dollars. *Maturity* is the bond's maturity measured in years. *Coupon* is the bond's coupon expressed as a percentage. *Outstanding bonds* is the number of other bonds outstanding for the issuer at the time of issuance. *GO* is an indicator variable taking a value of one if the bonds is a general obligation bond and zero if the bond is a revenue bond or other type. We calculate the average rating of all outstanding bonds for each issuer before (*Issuer rating pre-recalibration*) and after (*Issuer rating post-recalibration*) the recalibration dates. *Notches* represents the change in this number rounded to the nearest whole number. Panel A displays summary statistics for all of the bonds used in the baseline multivariate regressions. Panel B splits the sample by whether Moody's upgraded the issuers' outstanding bonds during the recalibration events. Panel C splits the sample by whether the bonds were issued in the year before the recalibration events or after. Bond characteristics come from the Ipreo i-Deal new issues database. We collect ratings data from Moody's.

Panel A. Full Sample

	Offer yield	Spread to after-tax treasury	Spread to treasury	Rating at issue	Par	Maturity	Coupon	Outstanding bonds	GO	Issuer rating pre-recal.	Issuer rating post-recal.	Notches
N bonds	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908
Mean	3.0908	0.7073	-0.5761	18.8 (≈Aa3)	6.2	8.9	3.77	650	0.50	18.5 (≈Aa3)	19.3 (≈Aa3)	0.8
SD	1.4317	1.0445	0.9540	1.6	32.4	6.3	1.25	909	0.50	1.6	1.4	0.7
Min	0.0800	-2.9945	-4.6500	11	0.0	0	0.00	1	0	11	11	0
p25	2.0000	-0.0825	-1.2700	18	0.5	4	3.00	167	0	17	19	0
p50	3.1400	0.5530	-0.6900	19	1.3	8	4.00	348	0	19	19	1
p75	4.1000	1.3580	-0.0100	20	3.9	12	5.00	708	1	20	20	1
Max	10.0000	7.1140	6.6000	21	2,110	48	10.00	6,109	1	21	21	4

Panel B. Full sample split by whether issuers' bonds are upgraded during recalibration

	Offer yield	Spread to after-tax treasury	Spread to treasury	Rating at issue	Par	Maturity	Coupon	Outstanding bonds	GO	Issuer rating pre-recal.	Issuer rating post-recal.	Notches
No change in ratings due to recalibration												
N bonds	25,153	25,153	25,153	25,153	25,153	25,153	25,153	25,153	25,153	25,153	25,153	25,153
Mean	3.1087	0.7256	-0.5576	19.3	6.6	9.0	3.79	718	0.34	19.3	19.3	0.0
SD	1.4168	1.0334	0.9476	1.7	28.8	6.5	1.26	849	0.48	1.6	1.6	0.0
Min	0.0800	-2.9945	-4.6500	11	0.0	0	0.00	2	0	11	11	0
p25	2.0200	-0.0610	-1.2400	18	0.6	4	3.00	188	0	18	18	0
Median	3.2000	0.6080	-0.6400	20	1.6	8	4.00	464	0	20	20	0
p75	4.1300	1.4030	0.0400	21	4.8	13	5.00	821	1	21	21	0
Max	8.3700	5.9325	4.6200	21	1,850	42	8.37	5,739	1	21	21	0
Ratings upgraded due to recalibration												
N bonds	38,755	38,755	38,755	38,755	38,755	38,755	38,755	38,755	38,755	38,755	38,755	38,755
Mean	3.0792	0.6955	-0.5881	18.5	6.0	8.8	3.75	606	0.60	17.9	19.2	1.3
SD	1.4412	1.0515	0.9579	1.5	34.5	6.2	1.24	943	0.49	1.4	1.1	0.5
Min	0.1000	-2.5360	-4.0900	11	0.0	0	0.00	1	0	12	13	1
p25	1.9700	-0.0970	-1.2800	18	0.4	4	3.00	152	0	17	19	1
Median	3.1000	0.5190	-0.7200	19	1.1	8	4.00	287	1	18	19	1
p75	4.0800	1.3285	-0.0400	19	3.4	12	5.00	626	1	19	20	1
Max	10.0000	7.1140	6.6000	21	2,110	48	10.00	6,109	1	20	21	4

Panel C. Full sample split by period of issuance

	Offer yield	Spread to after-tax treasury	Spread to treasury	Rating at issue	Par	Maturity	Coupon	Outstanding bonds	GO	Issuer rating pre-recal.	Issuer rating post-recal.	Notches
Issued in the year before recalibration												
N bonds	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362	33,362
Mean	3.2462	0.7258	-0.6313	18.5	6.6	9.1	3.89	647	0.50	18.5	19.3	0.8
SD	1.4141	1.0791	0.9924	1.7	33.3	6.4	1.21	885	0.50	1.6	1.4	0.7
Min	0.0800	-2.9945	-4.6500	11	0.0	0	0.00	6	0	12	13	0
p25	2.2000	-0.0990	-1.3600	18	0.5	4	3.00	170	0	18	19	0
Median	3.3000	0.5923	-0.7500	19	1.5	8	4.00	348	1	19	19	1
p75	4.2100	1.4200	-0.0100	20	4.3	13	5.00	717	1	20	20	1
Max	8.5000	6.7400	6.6000	21	1,750	48	8.50	6,030	1	21	21	4
Issued in the year after recalibration												
N bonds	30,546	30,546	30,546	30,546	30,546	30,546	30,546	30,546	38,755	30,546	30,546	30,546
Mean	2.9211	0.6871	-0.5157	19.2	5.8	8.7	3.63	653	0.60	18.5	19.3	0.8
SD	1.4317	1.0050	0.9063	1.4	31.4	6.2	1.28	934	0.49	1.6	1.3	0.8
Min	0.2000	-2.5535	-4.0900	11	0.0	0	0.00	1	0	11	11	0
p25	1.7700	-0.0685	-1.1700	19	0.4	4	2.88	163	0	17	19	0
Median	2.9500	0.5135	-0.6300	19	1.1	8	3.95	348	1	19	19	1
p75	3.9600	1.2920	0.0000	20	3.5	12	4.88	705	1	20	20	1
Max	10.0000	7.1140	5.5600	21	2,110	42	10.00	6,109	1	21	21	4

Table II
Distribution of Credit Rating Changes on Recalibration Dates for Bonds Used in CAR Calculations

This table displays distributions of bonds according to the magnitude of credit ratings changes during recalibration events. For admission to this table, we require bonds to have sufficient secondary market trading data to calculate cumulative abnormal returns. Bond characteristics come from the Ipreo i-Deal new issues database. We collect ratings data from Moody's.

	Magnitude of rating change			
Recalibration date	0 notches	1 notch	2 notches	3 notches
April 16, 2010	1,135	3,721	364	887
April 23, 2010	309	785	231	23
May 3, 2010	587	733	205	13
May 7, 2010	4,657	562	4	1

Table III
The Effect of Recalibrated Ratings on Offer Yields

This table displays OLS regression results with various measures of offer yields as the dependent variable. Columns (1) through (3) use *Offer yield*, the raw offer yield on the bond. Columns (4) through (6) use *Spread to after-tax treasury*, the difference between a bond's offer yield on the date of issue and the after-tax yield of the U.S. treasury bond with the closest maturity on the same day. We assume a tax rate of 35%. Columns (7) through (9) use *Spread to treasury*, the difference between a bond's offer yield on the date of issue and the yield of the U.S. treasury bond with the closest maturity on the same day. Panel A captures the effect of the recalibration on offer yields with *Upgrade*, a dummy variable taking a value of one if the issuer of the bond experienced an upgrade on its outstanding bonds during any of the recalibration events and zero if the issuer's bonds experienced no change in their ratings. *Post recalibration* is a dummy variable taking a value of one if the bond was issued in the calendar year after the issuer's bonds were recalibrated by Moody's, and zero if the bond was issued in the calendar year prior to the recalibration events. *Par* is the bond's par value measured in millions of dollars. We use the natural log of one plus this value in the regressions. *Maturity* is the bond's maturity measured in years. *Coupon* is the bond's coupon expressed as a percentage. *Outstanding bonds* is the number of other bonds outstanding for the issuer at the time of issuance. We use the natural log of one plus this value in the regressions. *GO* is an indicator variable taking a value of one if the bonds is a general obligation bond and zero if the bond is a revenue bond or other type. *Issuer rating pre- (post-) recalibration* is the average rating of the bond's issuer's outstanding bonds before (after) the recalibration events rounded to the nearest whole number. This variable is a numerical translation of Moody's 21-point alphanumeric scale. Ratings are increasing in credit quality, such that Aaa = 21, Aa1 = 20, ..., C = 1. Panel B captures the effect of the recalibration on offer yields with *Notches*, the difference between *Issuer rating post-recalibration* and *Issuer rating pre-recalibration*, rounded to the nearest whole number. Bond characteristics come from the Ipreo i-Deal new issues database. We collect ratings data from Moody's. We cluster standard errors by issuer. Standard errors are in parentheses below coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Upgrade Dummy

	Offer yield			Spread to after-tax treasury			Spread to treasury		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post recal. × Upgrade	-0.16	-0.15	-0.13	-0.18	-0.18	-0.17	-0.19	-0.19	-0.20
	(0.03)***	(0.03)***	(0.04)***	(0.03)***	(0.03)***	(0.04)***	(0.04)***	(0.04)***	(0.04)***
Post recalibration	-0.09	-0.09	-0.11	0.15	0.16	0.16	0.28	0.29	0.31
	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***
Upgrade	-0.07	0.07		-0.09	0.07		-0.06	0.07	
	(0.03)**	(0.03)**		(0.03)***	(0.03)**		(0.03)***	(0.03)**	
Par	-0.19	-0.20	-0.22	-0.07	-0.07	-0.07	-0.00	-0.00	0.01
	(0.02)***	(0.02)***	(0.01)***	(0.01)***	(0.01)***	(0.01)***	(0.01)	(0.01)	(0.01)
Maturity	0.15	0.15	0.15	0.10	0.10	0.10	0.07	0.07	0.07
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Coupon	0.33	0.33	0.36	0.17	0.17	0.17	0.08	0.08	0.07
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***
Outstanding bonds	-0.00	-0.00	-0.12	-0.00	-0.00	-0.36	-0.00	-0.00	-0.48
	(0.01)	(0.01)	(0.09)	(0.01)	(0.01)	(0.10)***	(0.01)	(0.01)	(0.11)***
GO	-0.16	-0.15	-0.25	-0.19	-0.18	-0.28	-0.21	-0.19	-0.29
	(0.03)***	(0.03)***	(0.05)***	(0.03)***	(0.03)***	(0.05)***	(0.03)***	(0.03)***	(0.05)***
Issuer rating pre-recal.	-0.12			-0.13			-0.14		
	(0.01)***			(0.01)***			(0.01)***		
Issuer rating post-recal.		-0.13			-0.14			-0.15	
		(0.01)***			(0.01)***			(0.01)***	
Constant	2.89	3.08	1.39	1.75	1.99	1.38	1.13	1.40	1.37
	(0.16)***	(0.18)***	(0.57)**	(0.16)***	(0.18)***	(0.61)**	(0.17)***	(0.19)***	(0.68)**
State of issue FE?	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	N/A
Issuer FE?	No	No	Yes	No	No	Yes	No	No	Yes
Adjusted R^2	0.77	0.77	0.81	0.64	0.64	0.72	0.44	0.44	0.55
Observations	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908

Panel B. Magnitude of Upgrade in Notches

	Offer yield			Spread to after-tax treasury			Spread to treasury		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Post recal. × Notches	-0.14	-0.14	-0.11	-0.15	-0.15	-0.14	-0.16	-0.16	-0.16
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***
Post recalibration	-0.08	-0.08	-0.09	0.16	0.16	0.17	0.29	0.29	0.32
	(0.02)***	(0.02)***	(0.03)***	(0.02)***	(0.02)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***
Notches	-0.03	0.09		-0.05	0.09		-0.06	0.10	
	(0.02)	(0.02)***		(0.02)**	(0.02)***		(0.02)**	(0.02)***	
Par	-0.19	-0.19	-0.22	-0.07	-0.07	-0.07	0.00	0.00	0.01
	(0.02)***	(0.02)***	(0.01)***	(0.01)***	(0.01)***	(0.01)***	-0.01	-0.01	-0.01
Maturity	0.15	0.15	0.15	0.10	0.10	0.10	0.07	0.07	0.08
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Coupon	0.38	0.38	0.39	0.19	0.19	0.18	0.08	0.08	0.07
	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***	(0.02)***
Outstanding bonds	0.02	0.02	-0.19	0.01	0.01	-0.39	0.00	0.00	-0.50
	(0.01)**	(0.01)**	(0.09)**	-0.01	-0.01	(0.10)***	-0.01	-0.01	(0.12)***
GO	-0.18	-0.18	-0.21	-0.20	-0.20	-0.25	-0.2	-0.2	-0.28
	(0.03)***	(0.03)***	(0.05)***	(0.03)***	(0.03)***	(0.04)***	(0.03)***	(0.03)***	(0.05)***
Issuer rating pre-recal.	-0.12			-0.14			-0.15		
	(0.01)***			(0.01)***			(0.01)***		
Issuer rating post-recal.		-0.12			-0.14			-0.15	
		(0.01)***			(0.01)***			(0.01)***	
Constant	2.89	2.89	1.83	1.89	1.89	1.60	1.35	1.35	1.46
	(0.18)***	(0.18)***	(0.58)***	(0.18)***	(0.18)***	(0.62)**	(0.19)***	(0.19)***	(0.69)**
State of issue FE?	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	N/A
Issuer FE?	No	No	Yes	No	No	Yes	No	No	Yes
Adjusted R^2	0.78	0.78	0.82	0.65	0.65	0.72	0.44	0.44	0.55
Observations	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908	63,908

Table IV
Multivariate Regressions Split by Pre- or Post-Recalibration Ratings

This table displays OLS regression results with *Spread to treasury* as the dependent variable. *Spread to treasury* is the difference between a bond's offer yield on the date of issue and the yield of the U.S. treasury bond with the closest maturity on the same day. The first set of columns restrict the treatment and control samples to bonds issued by municipalities with average ratings prior to recalibration of Baa3, Baa2, or Baa1 (column (1)); A3, A2, or A1 (column (2)); and Aa3, Aa2, or Aa1 (column (3)). The second set of columns restrict the treatment and control samples to bonds issued by municipalities with average ratings after to recalibration of A3, A2, or A1 (column (4)); Aa3, Aa2, or Aa1 (column (5)); and Aaa (column (6)). Panel A captures the effect of the recalibration on offer yields with *Upgrade*, a dummy variable taking a value of one if the issuer of the bond experienced an upgrade on its outstanding bonds during any of the recalibration events and zero if the issuer's bonds experienced no change in their ratings. *Post recalibration* is a dummy variable taking a value of one if the bond was issued in the calendar year after the issuer's bonds were recalibrated by Moody's, and zero if the bond was issued in the calendar year prior to the recalibration events. *Par* is the bond's par value measured in millions of dollars. We use the natural log of one plus this value in the regressions. *Maturity* is the bond's maturity measured in years. *Coupon* is the bond's coupon expressed as a percentage. *Outstanding bonds* is the number of other bonds outstanding for the issuer at the time of issuance. We use the natural log of one plus this value in the regressions. *GO* is an indicator variable taking a value of one if the bonds is a general obligation bond and zero if the bond is a revenue bond or other type. We calculate the average rating of the bond's issuer's outstanding bonds before and the recalibration events, rounding each to the nearest whole number. These variables are numerical translations of Moody's 21-point alphanumeric scale. Ratings are increasing in credit quality, such that Aaa = 21, Aa1 = 20, ..., C = 1. Panel B captures the effect of the recalibration on offer yields with *Notches*, the difference between the average rating of the bond's issuer's outstanding bonds before and the recalibration events. Bond characteristics come from the Ipreo i-Deal new issues database. We collect ratings data from Moody's. We cluster standard errors by issuer. Standard errors are in parentheses below coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Upgrade Dummy

	Full sample split by ratings in the pre-recalibration period			Full sample split by ratings in the post-recalibration period		
	Baa-range	A-range	Aa-range	A-range	Aa-range	Aaa
	(1)	(2)	(3)	(4)	(5)	(6)
Post recal. × Upgrade	0.68	-0.27	-0.13	-0.15	-0.15	-0.31
	(0.26)**	(0.12)**	(0.04)***	(0.15)	(0.04)***	(0.07)***
Post recalibration	-0.31	0.27	0.28	0.27	0.27	0.34
	(0.25)	(0.11)**	(0.04)***	(0.11)**	(0.04)***	(0.05)***
Upgrade	0.00	0.04	-0.1	0.33	0.03	0.16
	(0.25)	(0.08)	(0.04)**	(0.08)***	(0.04)	(0.06)***
Par	-0.07	0.05	-0.02	0.04	-0.01	-0.04
	(0.08)	(0.02)**	(0.02)	(0.02)*	(0.02)	(0.02)*
Maturity	0.04	0.07	0.07	0.06	0.08	0.09
	(0.02)**	(0.01)***	(0.00)***	(0.01)***	(0.00)***	(0.00)***
Coupon	0.38	0.09	0.1	0.19	0.08	0.02
	(0.12)***	(0.04)**	(0.02)***	(0.06)***	(0.02)***	(0.02)
Outstanding bonds	-0.14	-0.04	-0.01	-0.05	-0.01	-0.01
	(0.14)	(0.02)**	(0.01)	(0.02)**	(0.02)	(0.02)
GO	-0.17	-0.31	-0.2	-0.22	-0.21	-0.15
	(0.27)	(0.06)***	(0.03)***	(0.07)***	(0.03)***	(0.05)***
Constant	-0.79	-1.01	-1.49	-1.3	-1.51	-1.61
	(0.92)	(0.18)***	(0.09)***	(0.25)***	(0.10)***	(0.14)***
State of issue FE?	Yes	Yes	N/A	Yes	Yes	N/A
Issuer FE?	No	No	Yes	No	No	Yes
Adjusted R^2	0.53	0.47	0.41	0.50	0.40	0.40
Observations	956	15,034	39,572	6,196	44,322	12,641

Panel B. Magnitude of Upgrade in Notches

	Full sample split by ratings in the pre-recalibration period			Full sample split by ratings in the post-recalibration period		
	Baa-range	A-range	Aa-range	A-range	Aa-range	Aaa
	(1)	(2)	(3)	(4)	(5)	(6)
Post recal. × Notches	0.16	-0.15	-0.13	-0.08	-0.14	-0.24
	(0.10)	(0.05)***	(0.03)***	(0.06)	(0.03)***	(0.06)***
Post recalibration	-0.09	0.25	0.28	0.25	0.29	0.33
	(0.26)	(0.09)***	(0.03)***	(0.10)**	(0.03)***	(0.05)***
Notches	-0.29	0.02	-0.05	0.17	0.11	0.14
	(0.26)	(0.04)	(0.03)*	(0.04)***	(0.03)***	(0.04)***
Par	-0.08	0.05	-0.02	0.04	0.00	-0.04
	(0.08)	(0.02)**	(0.02)	(0.02)	(0.02)	(0.02)*
Maturity	0.04	0.08	0.07	0.06	0.08	0.09
	(0.02)*	(0.01)***	(0.00)***	(0.01)***	(0.00)***	(0.00)***
Coupon	0.39	0.09	0.1	0.19	0.08	0.02
	(0.12)***	(0.04)**	(0.02)***	(0.06)***	(0.02)***	(0.02)
Outstanding bonds	-0.08	-0.05	-0.01	-0.06	0.00	-0.01
	(0.15)	(0.02)***	(0.01)	(0.02)***	(0.02)	(0.02)
GO	-0.15	-0.29	-0.21	-0.24	-0.23	-0.15
	(0.27)	(0.06)***	(0.03)***	(0.09)***	(0.03)***	(0.05)***
Constant	-0.54	-0.97	-1.54	-1.21	-1.59	-1.61
	(1.07)	(0.18)***	(0.09)***	(0.24)***	(0.09)***	(0.14)***
State of issue FE?	Yes	Yes	N/A	Yes	Yes	N/A
Issuer FE?	No	No	Yes	No	No	Yes
Adjusted R^2	0.52	0.47	0.41	0.50	0.40	0.40
Observations	956	15,034	39,572	6,196	44,322	12,641

Table V

The Effect of Recalibrated Ratings on Offer Yields: Information versus Regulation-Based Demand

This table displays OLS regression results with *Spread to treasury* as the dependent variable. *Spread to treasury* is the difference between a bond's offer yield on the date of issue and the yield of the U.S. treasury bond with the closest maturity on the same day. The treatment sample in this table consists of bonds issued by municipalities who experienced upgrades of one notch on their outstanding bonds due to Moody's recalibration. The control sample consists of bonds issued by municipalities that experienced no change in the ratings of their outstanding bonds due to recalibration. Columns (1) through (3) restrict the treatment sample to bonds issued by municipalities whose upgraded ratings migrated into a new broad rating category. Columns (4) through (6) restrict the treatment sample to bonds issued by municipalities whose upgraded ratings remained within a broad rating category. *Upgrade* is a dummy variable taking a value of one if the issuer of the bond experienced an upgrade on its outstanding bonds during any of the recalibration events and zero if the issuer's bonds experienced no change in their ratings. *Post recalibration* is a dummy variable taking a value of one if the bond was issued in the calendar year after the issuer's bonds were recalibrated by Moody's, and zero if the bond was issued in the calendar year prior to the recalibration events. *Par* is the bond's par value measured in millions of dollars. We use the natural log of one plus this value in the regressions. *Maturity* is the bond's maturity measured in years. *Coupon* is the bond's coupon expressed as a percentage. *Outstanding bonds* is the number of other bonds outstanding for the issuer at the time of issuance. We use the natural log of one plus this value in the regressions. *GO* is an indicator variable taking a value of one if the bonds is a general obligation bond and zero if the bond is a revenue bond or other type. *Issuer rating pre- (post-) recalibration* is the average rating of the bond's issuer's outstanding bonds before (after) the recalibration events rounded to the nearest whole number. This variable is a numerical translation of Moody's 21-point alphanumeric scale. Ratings are increasing in credit quality, such that Aaa = 21, Aa1 = 20, ..., C = 1. Bond characteristics come from the Ipreo i-Deal new issues database. We collect ratings data from Moody's. We cluster standard errors by issuer. Standard errors are in parentheses below coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Upgrades into new broad rating category			Upgrades within broad rating category		
	(1)	(2)	(3)	(4)	(5)	(6)
Post recal. × Upgrade	-0.22	-0.22	-0.23	-0.13	-0.13	-0.13
	(0.05)***	(0.05)***	(0.06)***	(0.04)***	(0.04)***	(0.04)***
Post recalibration	0.28	0.28	0.31	0.29	0.29	0.31
	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***	(0.03)***
Upgrade	0.00	0.16		-0.17	-0.02	
	(0.04)	(0.05)***		(0.04)***	(0.04)	
Par	-0.02	-0.02	-0.01	-0.02	-0.02	0.00
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)
Maturity	0.08	0.08	0.08	0.07	0.07	0.07
	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***	(0.00)***
Coupon	0.06	0.06	0.07	0.1	0.1	0.10
	(0.03)**	(0.03)**	(0.03)**	(0.02)***	(0.02)***	(0.02)***
Outstanding bonds	-0.01	-0.01	-0.42	-0.01	-0.01	-0.44
	(0.01)	(0.01)	(0.13)***	(0.01)	(0.01)	(0.12)***
GO	-0.21	-0.21	-0.25	-0.18	-0.18	-0.26
	(0.03)***	(0.03)***	(0.05)***	(0.03)***	(0.03)***	(0.06)***
Issuer rating pre-recal.	-0.16			-0.15		
	(0.01)***			(0.01)***		
Issuer rating post-recal.		-0.16			-0.15	
		(0.01)***			(0.01)***	
Constant	1.61	1.61	1.00	1.46	1.46	1.01
	(0.29)***	(0.29)***	(0.79)	(0.23)***	(0.23)***	(0.69)
State of issue FE?	Yes	Yes	N/A	Yes	Yes	N/A
Issuer FE?	No	No	Yes	No	No	Yes
Adjusted R^2	0.46	0.46	0.54	0.44	0.44	0.53
Observations	32,112	32,112	32,112	46,858	46,858	46,858

Table VI
Regulation-Based Changes in Trading Volume around Recalibration Events

This table displays OLS regression results with the log of one plus the average daily trading volume as the dependent variable. We restrict the sample to bonds that experienced upgrades of one notch (Panel A) or two notches (Panel B) and we parse the data by the type of transaction: Inter-dealer trades, Customer purchases, or Customer sales. *New broad rating category* is a dummy variable taking a value of one if the upgraded bond migrated into a new broad rating category and zero if the upgraded bond remained within the same broad rating category. *Post recalibration* is a dummy variable taking a value of one for volume observations averaged over 20 days after a recalibration event and zero for volume observations averaged over 20 days before a recalibration event. We gather secondary market trading data from the MSRB Electronic Municipal Market Access (EMMA) database. We collect ratings data from Moody's. Standard errors are clustered at the CUSIP level and reported in parentheses below coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. One-notch Upgrades

	Type of transaction		
	Inter-dealer trades	Customer purchases	Customer sales
New broad rating category × Post recalibration	0.21**	0.28***	0.03
	(0.09)	(0.11)	(0.10)
New broad rating category	-0.10	-0.15**	0.18***
	(0.07)	(0.07)	(0.07)
After recalibration	-0.41***	-0.65***	-0.21***
	(0.05)	(0.05)	(0.05)
Constant	3.57***	5.57***	4.40***
	(0.03)	(0.03)	(0.03)
Adjusted R^2	0.002	0.005	0.001
Observations	45,834	45,834	45,834

Panel B. Two-notch Upgrades

	Type of transaction		
	Inter-dealer trades	Customer purchases	Customer sales
New broad rating category × Post recalibration	0.45**	0.98***	-0.26
	(0.23)	(0.28)	(0.24)
New broad rating category	-0.16	-0.34**	0.49***
	(0.18)	(0.17)	(0.16)
After recalibration	-0.66***	-1.53***	0.25
	(0.20)	(0.25)	(0.21)
Constant	3.47***	5.68***	3.15***
	(0.16)	(0.15)	(0.14)
Adjusted R^2	0.002	0.010	0.001
Observations	3,857	3,857	3,857

Table VII

(How) Did Standard & Poor's Respond to Moody's Recalibration?

This table displays a ratings migration matrix for Standard & Poor's credit ratings around the time Moody's recalibrated its municipal bond ratings. We begin with uninsured municipal bonds that Moody's upgraded during the recalibration. The horizontal axis represents the bonds' ratings from Standard & Poor's before the first recalibration date (April 16, 2010) and the vertical axis represents the next bond rating assigned by Standard & Poor's within one calendar year of the recalibration. We only admit a bond to this sample if Standard & Poor's upgrades, downgrades, or affirms the bond's rating within one calendar year of Moody's recalibration. We collect ratings data on bonds issued by state or local governments from Moody's and Standard & Poor's.

		Rating before scale change										
		AAA	AA+	AA	AA-	A+	A	A-	BBB+	BBB	BBB-	Sum
Rating after scale change	AAA	1,166	2,331		190	156	4	29	72			3,948
	AA+	28,797	1,914	7,249	4,175	5,130	1,768	1,819	47	186	184	51,269
	AA	50	592	138	2,442	1,303	69			21		4,615
	AA-	421	159	1,958	427	2,771	66	149				5,951
	A+	34	31	101	2,076	198	1,915	40	19			4,414
	A	94	29	3	396	583	136	681		45		1,967
	A-	129	17		160		3,451	251	647	29		4,684
	BBB+					270	1,596	326		346	132	2,670
	BBB	93	23	90	154	64	7,850	71	236	4	212	8,797
	BBB-									60		60
	Sum	30,784	5,096	9,539	10,020	10,475	16,855	3,366	1,021	691	528	88,375