Credit Ratings Overreliance in Municipal Bonds Market*

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Abstract

In this paper, I explore the effect of bounded rationality in the context of municipal bond investing by studying the impact of the simultaneous mass-scale credit ratings upgrade (recalibration) on the yields of municipal bonds. In contrast to predictions of the semi-strong efficient market hypothesis, I document significant post-recalibration yield declines at the long end of the yield curve for securities with highest upgrades. I explain this reaction by the combination of municipal market segmentation by maturity and individual investors' bounded rationality that causes overreliance on credit ratings per se. Municipal bonds are extremely heterogeneous, municipal financial reporting is opaque, so the cost of acquiring and processing information is very large for a non-professional municipal investor. As a result, individual investors rely excessively on credit ratings as a convenient credit risk summary. This finding has a direct implication for regulation of credit rating industry given the fact that the credit rating agencies claim no legal responsibility for the quality of information they provide.

Keywords: Credit ratings; Market overreaction; Credit rating changes; Fixed income; Term structure of interest rates; Municipal bonds; Event analysis, Bounded rationality.

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1. **Introduction**

In April and May of 2010 two major credit rating agencies (Moody's and Fitch) underwent a systematic overhaul of the way they assign ratings to state and local governments. The industry refers to this overall effort as "recalibration". As a result, ratings for tens of thousands of municipal bonds were upgraded to be comparable in terms of a level of credit risk to ratings of corporate and sovereign bonds. Recalibration was exogenous, i.e. it was not accompanied by any fundamental improvement in issuers' risks. In addition, it was carried over simultaneously for all bonds of a specific type. Moody's did it in 3 days (April 19, May 2, and May 10); Fitch did it in 2 days (April 5 and April 30, 2010).

I test the efficiency of the municipal bond market and the influence of rating agencies by analyzing the municipal bonds yields and aggregate market characteristics around the recalibration announcement and actual rating changes. If it was, as announced, a pure change of rating "labels" (i.e. a AA municipal bond became a new AAA), we should not expect any reaction in the efficient market. Even if it was a signal of the major change of the municipal securities rating model, this information was not new for the market as 1) all 3 major credit rating agencies had acknowledged that municipal bonds were underrated compared to corporate bonds years ago (Moody's in 2000 and Fitch in 1999[3]), 2) Moody's disclosed the full mapping of municipal ratings scale into the corporate one[4] in 2007, and 3) Moody's and Fitch had contemplated the recalibration since 2008[5].

The two agencies stressed in their announcements that "(t)his recalibration does not reflect an improvement in credit quality or a change in our credit opinion for rated municipal debt issuers" and "(m)arket participants should not view the recalibration of municipal ratings as rating upgrades, but rather as a recalibration of the ratings to a different rating scale"[6]. But did market participants follow the suggested way?

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[3] Moody's 2000 Default Study; Fitch 1999, 2003, 2007 Default Studies

[4] Moody's, The U.S. Municipal Bond Rating Scale: Mapping to the Global Rating Scale And Assigning Global Scale Ratings to Municipal Obligations, March 2007

[5] Moody's and Fitch have solicited the public feedback on their respective plans to transition municipal bond ratings to the global scale that would have resulted in the municipal ratings upgrade. As a result of received comments, the recalibration was announced on 09/02/2008 by Moody's. However, in October of 2008 both Moody's and Fitch deferred the recalibration plan citing the extraordinary turmoil in the financial market in the wake of Lehman Brothers bankruptcy.

[6] Recalibration of Moody's U.S. Municipal Ratings to its Global Rating Scale, Moody's Investors Service, March 2010.

Anecdotal evidence shows substantial decrease in spreads for a variety of municipal securities following the recalibration. As an example, take the 10-year California general obligation bond yield spread over the index of AAA rated municipal bonds. On March 16, 2010 Moody's announced it would recalibrate its ratings in a way that indicated that California's rating would be significantly upgraded. On March 25, 2010 Fitch made a similar announcement. By the time both rating agencies began implementing the recalibration in early April, the California spread had already tightened 20 basis points (see Figure 1). Under the ratings overhaul, California was raised two notches[7] (from BBB+ to A) by Fitch and three notches (from Baa1 to A1) by Moody's. After that the spread dropped 22 basis points and the total spread change equaled 42 basis points from March 16 until April 27 (the 10-year California GO spread over the triple-A was 148 basis points on March 15; on April 27 it was 106 basis points making the spread decline equal 28% of the pre-announcement level).

As long as ratings upgrade was not substantiated by the improvements in the credit risk profile of the municipal bonds, theoretically there should be no market reaction if markets are efficient at either strong, semi-strong, or weak level. However, empirically we observe significant yield declines for California general obligation bonds. We suggest that this reaction can be explained by the combination of municipal market segmentation by maturity and individual investors' overreliance on credit ratings per se (ratings myopia).

It is important to estimate the direct impact of ratings on yields because yields, as the major part of municipal borrowing cost, have traditionally displayed great sensitivity to bonds' ratings. The lower the rating, the higher the interest required by the bond buyers. When Fitch and Standard & Poor's downgraded California bonds from A-plus to A in February 2009 that added about $213 million to the cost of the $6.54 billion sale of California bonds on March 24, 2009[8]. Policy debates on the regulation of capital markets and the role of credit ratings agencies, in particular, would, therefore, be well served by an enhanced understanding of the link between ratings and yields.

Unfortunately, no "clean" empirical test has been performed. The problem, plaguing any effort to measure the effects of the rating change, is the fact that the rating change is usually a response to

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7 A notch is defined as a step on alphanumeric rating scale (e.g., from A2 to A1 on the scale used by Moody's).

8 California State Treasury Office estimations

changes in fundamental factors. A bond's yield is likely to depend simultaneously on its rating as well as public information about economic, financial and political characteristics of the issuer and security itself (fundamental credit risk factors, see Figure 2). Yields depend on ratings independently of the issuer's publicly observable fundamental characteristics because the raison d'etre for ratings is that they contain information that can only be obtained through costly search and processing. Bond ratings have their own intrinsic signaling value, and an issuer's purchase of ratings for a fee can be considered an attempt to distinguish its issue from others of similar fundamentals, thereby avoiding the "average quality pricing" described by Akerlof (1970). In reality, rating changes are usually triggered by changes in fundamental risk factors, so when researchers find a price reaction to rating change, it is not clear how much of it is due to the rating change per se and how much is due to the triggering fundamentals.

There are some econometric techniques (e.g., Liu, Thakor, 1984) that try to disaggregate the total effect into the fundamentals and rating components. The main empirical challenge is identifying the causal effect of ratings on security prices, holding security fundamentals fixed. Recalibration is a unique event in the sense that ratings were changed and change was unrelated to other determinants of bond prices (rating change was an exogenous event). Thus, we have a “pure” case scenario instead of a contaminated one. A pure case is superior to a contaminated one as it produces a direct effect instead of a mathematical approximation.

While there is considerable evidence that rating downgrades do in fact impart stock prices, the same studies usually find no significant effect for rating upgrades or reviews for upgrade. Evidence is mixed for generally much more illiquid corporate debt market and virtually non-existent for municipal debt.

Our study extends recent papers testing how ratings affect bond yields and regulatory value of credit ratings. Kisgen and Strahan (2010) studied bond yields as a reaction to an unexpected expansion in the pool of Nationally Recognized Statistical Ratings Organizations (NRSRO), whose ratings can be legally used for regulation purposes. Firms that were rated by the new credit rating agency better than by the other NRSROs experienced a 39 basis point drop in bond yields. In contrast to previous literature, we study a natural experiment, where the rating effect is direct and "pure" (uncontaminated by the fundamental credit risk improvement).

A concurrent working paper by Cornaggia et al (2015) studied the recalibration of 2010 performed by Moody's and confirmed that the upgrades lowered credit spreads and the effect is stronger for more opaque municipal issuers. Our study confirms the effect of recalibration for 3 credit rating agencies, but explores the issue more from a buy-side perspective and its regulatory implications.

In addition to testing the aggregate price effect of credit rating upgrade, our research also touches the most recent studies of investors overreliance on ratings, their failure to perform additional due diligence (Ashcraft et al, 2011, for MBS securities).

The following sections will provide a review of the recalibration and previous literature on the effects of rating changes on the security prices (section 2), research design, hypotheses, and data (section 3), empirical results (section 4). We discuss various robustness checks in section 5.

2. Research Motivation

2.1. Recalibration

On March 16, 2010 Moody's announced it would recalibrate its ratings[9]. The recalibration was expected to be implemented in stages and to occur over a four week period. On March 25, 2010 Fitch unveiled the similar announcement. The two agencies stressed in their press releases that the recalibration must not be interpreted as improvement in the credit quality of the underlying securities[10] and that it was prompted solely by the significant discrepancies in the historical default rates of municipal and corporate bonds with the same ratings.

At Moody's, the change was implemented on April 19, April 26, May 3, and May 10, 2010, impacting 70,000 credits and 18,000 issuers[11]. Fitch recalibrated 38,000 municipal credits in two days on April 5 and April 30, 2010 (see Table 1 for the timeline). The upgrades were mechanical and

[9] Retrieved from: http://www.moodys.com/research/Moodys-US-Municipal-Ratings-to-Move-to-Global-Scale-Beginning--PR_196360

[10] Recalibration of Moody's U.S. Municipal Ratings to its Global Rating Scale, 2010.

[11] Retrieved from: http//www.bondbuyer.com/news/-1009571-1.html

depended only on the prior rating and type of the bond, without individual review. Tables 4 contains the list of state ratings before and after the recalibration.

California and Puerto Rico were the biggest gainers under the Moody's recalibration. Both states were upgraded three notches by Moody's (the maximum ratings ascension under the recalibration) and two notches by Fitch. California's new rating became A1 from Moody's and A from Fitch. Puerto Rico was changed to A3 from Baa3, which is the lowest rung of investment grade on Moody's rating scale.

Illinois moved from an A2 to an Aa3 on Moody's scale. New York was given an Aa2, compared with its previous Aa3 rating. Five states -- Indiana, Iowa, New Mexico, Tennessee, Texas -- moved up to the highest rating of Aaa, the same as the U.S. government.

Not all states saw their ratings change. Those that had already attained Aaa ratings remained the same. Florida, Washington, Kansas and Minnesota also had the same ratings on the new scale, although their outlooks were generally changed to stable from negative.

Despite being part of the general municipal securities pool due to tax exemption, some sectors were determined to bear more similarities to corporate credits and were left out of the rating migration. These bonds include: special tax (sales, hotel, gas, etc.) rated Baa2 and below; public power; airports; toll roads; stadiums; private higher education, charter schools; 501(c)(3)s hospitals; housing; land secured; military housing; short-term ratings.[12]

2.2. Literature Review

2.2.1. Credit Ratings Impact on Security Prices

There are two ways to examine whether certain credit rating impacts security prices:

- Examine whether credit ratings help to explain cross-sectional differences in security prices (correlation, cross-sectional regressions);
- Examine how changes in ratings impact security prices (event analysis).

The first approach involves studying the relation between security prices (yield spreads, stock

[12] Short-term ratings are assigned to obligations with an original maturity of thirteen months or less. See "Rating Symbols and definitions, Moody's Investors service, August 2014". Retrieved from: https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_79004

returns, CDS spreads) and security credit rating, controlling for security issuer and issue characteristics (e.g., West (1973), Liu and Thakor (1984), Ederington, Yawitz, and Roberts (1984, 1987)). Even though such studies usually find significant relations, there is possibility that credit ratings have no effect per se, instead, they merely proxy for omitted, public information that influence security prices. Second approach allows to overcome this major disadvantage by analyzing the reactions of security prices to rating changes (event study). In this case each security serves as its own control, which means that all pricing-relevant factors are controlled for. In addition, this method allows to distinguish between price reaction to credit rating downgrades and upgrades.

There is considerable empirical evidence that rating downgrades do in fact impact security prices, but the same studies usually find no significant effect for rating upgrades or reviews for upgrade in equity markets and find mixed response in bond markets. Three arguments can explain such asymmetric reaction of security prices to downgrades and upgrades:

- asymmetric reputation loss functions faced by credit rating agencies (Holthausen and Leftwich, 1986). Rating agencies are presumed to be punished more severely if they do not detect credit deterioration (and keep their ratings too high) rather than improvement (if their ratings are too low). Hence, they allocate more resources to revealing negative credit information than to positive ones.
- price pressure. While certain downgrades force selling transactions by federally regulated investors, upgrades do not force buying transactions (Steiner and Heinke, 2001, Hand et al, 1992, Hite and Warga, 1997).
- issuers tend to bias their public information releases toward good news. Taking into account that rating changes tend to lag (rather than lead) security-price changes (Ederington and Goh, 1998), by the time of credit rating upgrade security prices might have already reacted to the positive public information.

Table 5 contains summary of the existing research on credit rating upgrades (reviews for upgrade, or credit watch placing for positive reasons). Section A and section B cover studies with U.S. and international data correspondingly. As you can see, in US rating upgrades are almost uniformly insignificant in highly liquid markets (equity and derivatives). For large and actively traded firms, any rating premium is quickly arbitraged-out as a result of more extensive research coverage and low transaction costs in equity market. In less liquid corporate bonds market evidence depends on a sample composition: there is virtually no reaction to upgrades within investment grade, some feedback for rating upgrades from non-investment to investment grade (Hite and Warga, 1997) and for bonds rated below B (Jorion and Zhang, 2004). This result is in line with liquidity argument that rating change effect is more pronounced for less liquid securities/markets, because lower rated bonds are less liquid than investment grade bonds.

Empirical research in foreign markets is consistent with those using U.S. data (see Table 5, Section B). One interesting nuance is reported by Elayan, Hsu, and Meyer (2003). They study the New Zealand market and found that rating changes have a weaker impact on firms that are cross-listed in the United States and, thus, are covered by more equity analysts.

Notable feature of the previous research is that ratings upgrades were triggered by changes in fundamental risk factors (hard information about the financial and economic health of the issuer and specific security provisions) and the timing of those upgrades are usually different for a different security depending on the idiosyncratic changes of fundamentals factors. One exception is Kliger and Sarig (2000). They compared corporate bond yields before and after Moody's added modifiers to its rating scale in April 1982, increasing the fineness of their ratings measure (e.g., an A-rated firm then became an A1, A2 or A3 rated). Because previous fine ratings were not available, Kliger and Sarig (2000) had to use a proxy for the direction of the rating change. They run a cross-sectional regression of bond yield changes from the end of March to the end of April 1982 onto the change of risk-free interest rate and a number of rating indicators. They found that rating upgrade was associated with lower corporate bond yields.

Compared to other markets, studies of municipal bonds and credit rating changes are scarce and outdated with the latest one being produced in 1983. Importantly, all of them use monthly data that brings the problems of low power of tests and confounding events. Simulating event studies with various methodologies, Brown and Warner (1985) found the power of tests using monthly returns to be approximately three to four times lower than tests using daily returns.[13] In addition, the use of monthly returns makes controlling for confounding events difficult[14].

[13] Tests using monthly returns have a higher probability of Type II error, accepting the null hypothesis of no information content when it should be rejected.
[14] A confounding event is other issue- or issuer-specific information, released simultaneously with the information event

2.2.2. Excessive Sensitivity of Security Prices to Credit Rating Changes

My study touches a relatively recent strand of research on the excessive sensitivity of security prices to credit ratings. This line of research emerged in the aftermath of the financial crisis, when policymakers became concerned with the increasingly influential status of credit rating agencies in economy and the declining quality of their products that was believed to substantially contribute into the crisis development. In particular, regulators are concerned about non-sophisticated investors who rely heavily (or even exclusively) on the reputation of the rating agencies and perform minimum (if any) additional due diligence on the credit quality of the securities they purchase.

This opinion was conveyed by politicians and market participants in a number of hearings before the Congress or other federal agencies. For example, in a May 2009 hearing of the House of Representatives, Rep. Hensarling argued that "Unfortunately, many investors, due to legal imperatives or practical necessity, relied exclusively on ratings from the three largest CRAs, without performing their own conservative due diligence."[15] Same opinions were expressed at the public Field Hearing on the State of the Municipal Securities Market, held by SEC in San Francisco and Washington in 2010: market participants have indicated that retail investors primarily focus on interest rate, maturity and credit rating[16]. This concern is particularly worrying given the credit rating agencies legal defense strategy against the U.S. government claims of rating fraud. Specifically, in their motion to dismiss the case in April 2013, S&P "..claim[s] that, out of all the public statements that S&P made to investors, issuers, regulators, and legislators regarding the company's procedures for providing objective, databased credit ratings that were unaffected by potential conflicts of interest, not one statement should have been relied upon by investors, issuers, regulators, or legislators who needed to be able to count on objective, data-based credit ratings." [17] They further argue that those statements are purely

being studied.

[15] Hearing before the Subcommittee on Capital Markets, Insurance, and Government Sponsored Enterprises of the Committee on Financial Services. U.S. House of Representatives, 111th Congress, 1st Session, May 19, 2009. Retrieved from: http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg51592/html/CHRG-111hhrg51592.htm

[16] The same view was expressed in *The Handbook of Municipal Bonds* (1st ed. 2008) by S. Feldstein and F. Fabozzi.

[17] U.S. v. McGraw-Hill Cos., 13-cv-00779, U.S. District Court, Central District of California (Santa Ana), Civil Minutes Transcript, July 8, 2013. Retrieved from: http://online.wsj.com/public/resources/documents/sandpcalif0709.pdf

"aspirational claims" and "puffery" and, therefore, are not "actionalble" (i.e. imply no legal responsibility).[18]

Ashcraft et al (2011) confirmed investors' excessive reliance on ratings by analyzing relative predictive power of initial ratings for ex post security default. In particular, they regressed the MBS yields and ratings separately onto a long list of variables that control the security's fundamental credit risk (e.g., bond seniority and data on the underlying mortgage pool). Then, they created a scatterplot of residuals from both regressions that showed a strong negative association between residual credit rating and residual yield spread. They hypothesized that ratings either contained valuable additional information about credit risk not reflected in the data (e.g., undisclosed private information available to rating agencies), or MBS yields were excessively sensitive to ratings, relative to their informational content. They further looked at relative impact of ratings and yields spreads at issuance on security ex-post defaults and found that "ratings are much less predictive for default than for initial security prices, by as much as an order of magnitude". At the same time, fundamentals strongly predict default conditional on ratings, even though these variables are nearly uncorrelated with initial spreads, after controlling for ratings.

Kisgen and Strahan (2009) test an additional explanation of why investors consider ratings valuable beyond their generic informational function. They use the certification of a fourth credit rating agency by the SEC to conclude that ratings-contain regulatory value for investors that are subject to ratings based regulations. While this argument works well for institutional investors and may explain the result obtained by Ashcraft et al (2011) for MBS securities, it is not valid for individual investors.

2.2.3. Heterogeneous Agents Theory

Our research is also related to heterogeneous agent theory of asset pricing that conjecture existence of different types of security traders in the market: noise (or liquidity) traders, speculators, and fundamental traders (Smith et al. (1988), DeLong et al. (1990), Lei et al. (2001), Haruvy and Noussair (2006), Baghestanian et al (2013)). The classification of types of traders can be based on the

[18] U.S. v. McGraw-Hill Cos., 13-cv-00779, U.S. District Court, Central District of California (Santa Ana), Civil Minutes Transcript, July 8, 2013. Retrieved from: http://online.wsj.com/public/resources/documents/sandpcalif0709.pdf

information set available (informed speculators and fundamentalists vs uninformed noise traders), the level of analytic sophistication traders are assumed to possess, and/or different information search cost faced by different traders. Many academic models of tranching and securitization are based upon the assumptions of differentially informed investors in senior and junior securities. For example, Boot and Thakor (1993) argue that in a setting with costly information acquisition more senior securities are absorbed by noise traders, whereas informed traders buy the junior securities. Adelino (2009) empirically shows that AAA-rated MBS securities contain no information value (are not predictive of ex-post security default or downgrade) in contrast to AA and lower rated securities. Other models with a similar separation between informed and uninformed investors include Riddiough (1997) and Pagano and Volpin (2008).

In our study we conjecture separation of informed and uninformed investors not only by security rating or seniority claim, but for different maturities of the same security.

3. Research Design

3.1. Study Methodology.

This study can be considered as a test of the semi-strong efficient market hypothesis (Fama, 1970[19]) there we examine whether security prices (bond yields in our case) respond to publicly available information about an issuer (i.e., change of ratings).

To examine the reaction of municipal bonds to their recalibration we use an event study framework (Campbell, Lo, and MacKinley, 1997). We consider two types of events with respect to state level bonds: recalibration announcements by Moody's and Fitch (made on two separate days one week apart) and recalibrations itself (performed on two separate days two weeks apart). See Table 1 for the exact timeline. We analyze indices of yields of the most liquid type of municipal bonds: state level general obligation bonds. We follow the data from 2 months prior to Moody's recalibration announcement (Moody's was the first to make an announcement) and until 2 months post Moody's recalibration of state level bonds (Fitch was the first to recalibrate its state level ratings). The index of all AAA rated obligations of the same type (general obligation) and maturity was used as a benchmark.

[19] Robert (1967) was the first to state a distinction between weak and strong forms of efficient market.

AAA rated municipal obligations were either not subject to recalibration as they already bore the highest rating, or they were upgraded 1 notch from AA+/Aa1. As a robustness check, we used yields for Maryland bonds that were always AAA-rated.

The standard event study methodology is usually applied to non-overlapping events that facilitates statistical testing by reasonably assuming absence of correlation between individual securities. In our case we have complete event overlap as recalibration was performed simultaneously for all securities by a particular rating agency. Thus, absence or correlation assumption does not hold and this might bias our standard event study results. We use bootstrap significance tests, unit root stationarity tests and regression analysis to check robustness of our inferences.

3.2. Empirical Hypotheses

3.2.1. Efficient Market Hypothesis

In their announcements the two agencies emphasized that the recalibration of municipal ratings was a change of the rating scale and the resulting upgrades were not prompted by any credit quality improvements. The fact that municipal securities were largely underrated had been widely known for years. Credit ratings agencies acknowledged it publicly on several occasions since 1999, when the first large scale default study was undertaken by Fitch[20]. Moreover, in March 2007 Moody's released the report that showed the precise correspondence between municipal and corporate bond ratings[21]. Finally, on July 31, 2008 Fitch and September 2, 2008 Moody's announced that they were starting to upgrade municipalities (recalibrate), but the plan was postponed after the major financial markets turmoil unwrapped in the aftermath of September, 15 2008 Lehman Brothers bankruptcy filing. Thus, in April 2010 the new higher ratings of the municipal bonds presumably contained no new material information about the level of credit risk of those securities. Hence, we formulate our first hypothesis:

Semi-strong Efficient Market Hypothesis (1):

Yields of recalibrated securities should not change because no relevant public information was released that signaled simultaneous market-wise credit quality improvement for municipal issuers.

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[20] Moody's 2000 Default Study; Fitch 1999, 2003, 2007 Default Studies.

[21] Moody's, The U.S. Municipal Bond Rating Scale: Mapping to the Global Rating Scale And Assigning Global Scale Ratings to Municipal Obligations, March 2007

We do not expect this hypothesis to be accepted due to significant illiquidity of municipal market. By virtually all common measures of liquidity, municipal bonds are among the most illiquid traded assets (see Chapter 1, section 1 for further discussion).

It was claimed that the primary motivation behind the recalibration was to make municipal bond ratings comparable in terms of a level of credit risk to ratings in corporate and sovereign sectors. Empirically this implies that municipal and corporate bond yield curves for the same rating should get closer to each other post recalibration.

Yield Curves Convergence Hypothesis (2):

The spread between yields of the municipal and corporate bonds of the same rating is expected to shrink.

Our next hypotheses assume the existence of certain inefficiencies in the market. Our third and fourth hypotheses are based on market segmentation. Our fifth and sixth hypotheses test the extent of Moody's market power and regulatory value of credit ratings.

Although these rating increases do not reflect actual credit quality enhancement, the perception of improvement, particularly from unsophisticated investors (primarily households), might increase demand for many of the bonds with upgraded ratings. Credit ratings are generally intended to indicate the relative degree of credit risk of an obligor or debt instrument rather than be an absolute measure of a specific default probability or loss expectation. For example, Fitch states that "[c]redit ratings are opinions on relative credit quality and not a predictive measure of specific default probability"[22] and that "[r]atings are intended to be rank orderings"[23]. Similarly, Moody's states that its rating system is a "relative (or ordinal), rather than an absolute (or cardinal) ranking system". In addition, Moody's emphasizes that its ratings are meant to communicate not a specific expected loss or expected loss range to an obligation, but, instead, that a higher-rated security "likely has a lower expected loss" than a lower-rated one[24].

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[22] Fitch, Definitions of Ratings and Other Forms of Opinion. Retrieved from: http://www.fitchratings.com/web_content/ratings/fitch_ratings_definitions_and_scales.pdf.

[23] Credit Rating Standardization Study: Comments from Fitch Ratings, Release No. 34-63573; File No. 4-622. Retrieved from: http://www.sec.gov/comments/4-622/4622-16.pdf

[24] Credit Rating Standardization Study: Comments from Moody's Investors Service, Release No. 34-63573; File No. 4-622. Retrieved from: http://www.sec.gov/comments/4-622/4622-15.pdf

Unsophisticated investors perceive credit quality of a certain security by judging the distance between its rating and the highest rated category (a AAA security of the appropriate type). We illustrate this using the following schematic model. Assume,

X – risk factors (economy, finance, government, debt); P=f(X) – probability of default and asset recovery in the case of default is a function of risk factors.

r – rating, $r \in \{R\}$.

{R} is a distribution of rating categories for a specific asset class. These categories are identified by a letter (A, B, C, D) and a modifier (+ /- or 1/2/3) combination (AAA, Aa1, AA+ etc). The set of those categories contains discrete, totally strictly ordered elements that are bounded from above (AAA/Aaa) and below.

R_1 – before recalibration; R_2 – post recalibration

Ω_1: $X \rightarrow p(X) \rightarrow R_1$ Ω_2: $X \rightarrow p(X) \rightarrow R_2$

Ω is a function that maps specific credit risk characteristics into a rating. No inverse mapping exists (ratings cannot be inverted into unique characteristics or even probabilities).

Because ratings are bounded from above, Ω_2 is not a parallel shift of Ω_1. The upgrade was asymmetric: lowest ratings got the highest boost, highest were not changed at all. As a result, the distance to the highest rating category shrank for the recalibrated securities. We can visualize this relationship by simplifying X to one-factor (for example, state budget deficit). The larger is the state budget deficit, the lower is the rating of the state bonds. Figure 3 depicts the relationship between bond credit risk and its credit rating. Bold blue and bold orange step-like shapes depicts pre- and post-recalibration relationships (Ω_1 and Ω_2) correspondingly.

Unsophisticated investors (individuals, households) are taking ratings in general at a face value. Individuals are prone to that because they face limited attention as a consequence of the vast amount of information available in the environment, and of limits to information processing power (Hirshleifer and Teoh, 2003). Attention is selective because it requires effort (substitution of cognitive resources from other tasks; see, e.g., Kahneman, 1973), or using economic terms, it is costly. For an individual investor the cost of information search and its full cognitive processing is likely to be higher than the expected benefit. It is especially true in such an opaque and highly fragmented market as municipal securities. Thus, an individual investor is likely to use a shortcut by focusing on aggregated information - a rating, as a low-cost overall summary of security risk.

Unsophisticated investors make their investment decision based only on the final rating that is higher post recalibration. They do not see the whole relationship chain that goes from issuer and issue characteristics to the rating. Everything that is beyond the final rating is presumed to be a "black box" for unsophisticated investors. In turn, sophisticated investors understand the whole relationship, so they are not expected to be misled by the scale change.

Taking into account that about half of all municipal bonds are held by households directly, we hypothesize increased interest in upgraded securities and its magnitude is higher for securities that received higher upgrade. Hence, California that received the highest rating boost (3 notches by Moody's and 2 notches by Fitch) is expected to have stronger yield declines compared to states were upgraded only one notch.

Relative Demand Impact Hypothesis (3)

Yield effect is stronger for states that obtained higher upgrades.

3.2.2. Market segmentation

Historically, there have been three alternative theories of how equilibrium yields are determined in the debt markets. The "bank tax arbitrage hypothesis" (Fama, 1977) conjectured that municipal yields are determined by commercial banks as the marginal investors in the municipal market. However, following the tax reforms in the 1980's banks lost their tax advantages and possibility to arbitrage. The second theory (Miller, 1977; Buser and Hess, 1986) emphasizes the role of nonfinancial corporations as suppliers of corporate debt and equity. Corporations issue an amount of debt such that for a marginal investor, choosing between tax-exempt and taxable debt, the effective tax rate on interest income is the corporate tax rate. This model was extended to incorporate progressive personal income taxes, however, neither the original nor the extended models accommodate variations in the spread across maturities: municipal yields have almost always increased monotonically with maturity and the slope of the municipal yield curve has almost always exceeded the slope of the U. S. Treasury yield curve.

The only theory explaining variation of differences in taxable and tax exempt yields across maturities is the "preferred habitat" (or market segmentation) model. In its broad sense, this model holds that there are different classes of investors that have preferences for particular types of securities and that a lack of substitution between groups prevents arbitrage and implies that yield spreads are determined by the relative demand and supply for each group separately (Campbell, 1980). In its narrow sense this model implies that different classes of investors hold long- and short-term bonds, with institutional investors predominating at short maturities and households purchasing most long-term debt (Mussa and Kormendi, 1979; Hendershott and Koch, 1977; Kidwell and Koch, 1983). Different classes of investors do not view municipal securities of different maturities as substitutes and, thus, do not shift between maturities to take advantage of actual or perceived yield discrepancies. In its strongest form, these maturity preferences are rigid as in the case when regulation prohibits substitution. A weaker form of segmentation exists when participants have the capacity to substitute between maturities, but substitution can be induced only by substantial yield premiums and/or cost savings. More important is that regardless of its form, segmentation must appear in both security supply and demand for it to affect relative yields. If it exists on only one side of the market, participants on the other side can shift between securities of different maturities and arbitrage out any yield discrepancy.

On the supply side, municipalities have distinct preferences in issuing debt with different maturities. Legal restrictions and other factors require tax-exempt borrowers to use long-term bonds to finance capital expenditures, and short-term debt to smooth fluctuations in revenues. In most instances, borrowers can use long-term debt for current operations only by constitutional amendment or public referendum. Thus, most municipal governments are effectively prohibited from substituting between short-term and long-term debt in order to take advantage of actual or perceived yield discrepancies.

On the demand side, institutional investors exhibit a well-defined preference for short- and intermediate- term municipal securities motivated by the objective to match the maturity structure of their assets/investments and liabilities in order to maintain liquidity and meet cash management needs. The main types of institutional investors in the municipal market are:

- commercial banks. Their preferences for short-term bonds was well documented in the 1980s and did not change despite the decline of their municipal holdings after the tax reforms of 1982, 1984, and 1986.
- property and casualty insurance companies. In 2012 77% of their municipal bonds exposure were under 15 year maturity[25].
- money market mutual funds. As of May 2012, tax-exempt money market funds held an estimated 74 percent of outstanding short-term state and local government debt[26].

Kidwell, Koch, Stock (1987) offer an additional factor that makes segmentation by maturity even more pronounced: differing state personal income tax codes. Many states with personal income taxes do not exempt income from out of state municipal securities, hence, affected by this policy individual investors (households) generally prefer in-state issues. On the other hand, differences in the personal income tax does not affect commercial banks and property-casualty insurance companies that dominate short-term market.

Kidwell and Koch (1983), Hendershott and Kidwell (1978), Kidwell and Koch (1982) and Poterba (1989), Kidwell, Koch, Stock (1987), Mitchel et all (1992), Leonard (1998) find evidence consistent with market segmentation although Campbell (1980) and Arak and Guentner (1983) find little or no evidence of segmentation.

More recently the preference for longer term muni bonds for individuals is confirmed indirectly by Green et al (2007b). In particular, they show that the probability for a particular municipal investor of being uninformed is positively related to bonds maturity. Also, they find that the dealer price markup is higher for retail transactions and for bonds with longer maturity. Taking into account that retail (small size) transactions are more likely to be attributed to individual investor, we may say that they prefer longer maturities.

If households are more prone to be misled by the recalibration, the yields of the long-term bonds would be the ones that change the most.

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[25] National Association of Insurance Commissioners, capital markets, Special Report, June 28, 2013.

[26] Retrieved from: http://www.ici.org/mmfs/background/faqs_money_funds#Whattypesofinvestmentsdomoneymarketfundshold

Market Segmentation Hypothesis (4):

For long term maturities yield change is stronger than for short-term.

3.2.3. Credit Rating Agency Reputation and Credit Ratings Regulatory Value

Also, we would like to test which rating agency induces more impact on municipal bond prices. There are several studies that show that market considers Moody's to be a more reputable (e.g. Livingston, Wei, and Zhou , 2010) compared to Fitch that has relatively short market history and rates significantly lower number of municipal securities.

Credit Rating Agency Reputation Hypothesis (5):

There is a stronger reaction to Moody's announcement and recalibration.

In addition to its information content, rating changes might impact prices because of buying or selling pressure from restricted investors. Many mutual funds, pension funds and other institutional investors face legal or statutory (self-imposed) restrictions that are contingent on ratings as a measure of risk. They are restricted from holding debt securities rated below a pre-defined threshold. For example, California state regulations 8 prohibit California-incorporated insurance companies from investing in bonds rated below single-A (see Kisgen, 2007). Thus, insurance companies in California may consider buying issues which are upgraded from Baa to A categories[27]. Many trustees use credit ratings to give guidelines to fund managers as well. Finally, many financial contracts link payment conditions to credit ratings.

Regulatory reliance on ratings is mechanical, because such use of ratings is not responsive to quality. It implies that investors prefer "higher" rated securities independent of the underlying risk of the securities. We test the single-A threshold empirically by studying the California yields before and after recalibration that resulted in California general obligations to be upgraded from BBB to A- by Fitch and from Baa1 to A1 by Moody's. Therefore, even if rating announcements convey no new information about the creditworthiness of issuers, institutional and regulatory constraints may still cause them to have an impact on asset prices by increasing demand for newly upgraded securities

[27] Similarly, SEC Rule 2a-7 states that money market mutual funds are required to limit investments in bonds rated an A or better.

and, as a result, reducing yields of the bonds with short- and medium term maturities (part of the market dominated by property and casualty insurance companies). Because regulatory reliance on ratings is mechanical, it can have any effect on bond prices only after the recalibration itself.

Ratings Regulatory Value Hypothesis (6):

Recalibration may be followed by the short- and medium term maturity yield reduction.

3.3. Data Description

This study analyzes the behavior of yields for municipal bonds that were recalibrated in the spring of 2010 in comparison to municipal market benchmark yields on "prime" bonds (bonds with the highest, AAA, credit rating). In particular, we look at the indices of fixed rate state level general obligation bonds between January 18, 2010 and June 11, 2010 (2 months before recalibration announcement and 2 months after actual ratings upgrade, the total of 104 trading days). During this period of time California state level bonds rating and outlooks were stable (except for recalibration).

Yields were extracted from the option-free Bloomberg fair market (BFV) yield curves that are available separately for 19 states (see the full list in Table 6). The BFV yield curves are computed for par bonds for every trading day and are derived from the zero coupon by utilizing bonds with similar characteristics and prices at par (equal to bond nominal value or par value). The option-free yield curve is built using option-adjusted spread (OAS) model and bond prices from the Municipal Securities Rulemaking Board and new issues calendars.

The benchmark yield in the municipal market is the yield of "prime" municipal bonds of the same type as above (i.e. state level general obligations with an average rating of 'AAA' from Moody's and Standard & Poor's). The benchmark controls for shifts in real interest rates, expectations of inflation, and broad liquidity and tax factors in municipal market. Some contemporary municipal bond studies continue the tradition of using Treasury securities as a benchmark assuming that liquidity and tax factors are constant over time. Indeed, before 2007 Treasury and prime municipal indices used to be closely correlated with any shifts in the former almost always had a direct impact on the latter and most individual investors even viewed Treasuries and prime municipal bonds as substitutes. But it was shown by a number of papers, liquidity premium and tax discount for municipal bonds vs Treasuries is far from stable. The most recent financial crisis highlighted that Treasury and municipal markets are driven by substantially different forces that made the two market indices negatively correlated in 2009-2010.

Short description statistics can be found in Table 7 in the appendix.

4. Empirical Results

4.1. Univariate Analysis

4.1.1. Trading volume

Our empirical analysis starts with looking at the aggregate trading dynamics in the municipal market around the time of recalibration.

Figure 5 contains 4 graphs that summarize month-by-month municipal bonds trading in terms of the number of unique securities traded, number of trades, amount of bond par value traded, and average trade size for the period from June 2000 to December 2011. Each graph contains 4 curves that corresponds to the 3 types of trades (customer buy, customer sell, or interdealer trade) and their sum (all trades).

As you can see, the number of unique securities, the number of trades and the face value (par amount) of bonds traded increased in March 2010, the month when the recalibration was announced both by Moody's and Fitch. The number of unique securities (as identified by their CUSIP code) and the total face value of bonds traded (par amount) amplified by 14 and 31 percent correspondingly compared to February 2010, which was the largest month-to-month growth since October 2008, the month following the epic Lehman Brothers bankruptcy. The number of trades grew by 18% in March 2010, and it was the most significant month-to-month increase since June 2009.

We collected the same data at daily frequency. As it is shown in Figure 6, the number of trades and daily par values are very volatile, but bounded within a narrow band of values. On March 25, 2010, the day Fitch announced the recalibration, and May 6, 2010, after Moody's recalibrated local governments, there were prominent spikes in par value of the customer buy trades. There was a similar increase in customer sell par amount on April 5, 2010, after Fitch was the first to start recalibration. Taking into account that the number of trades on those days did not show a comparable growth, we infer that the average size of trade on those days was higher than usual.

Tables 8-10 contain state level statistical data on the average face value of the bonds traded, the average daily number of trades, and average daily number of unique securities traded. By looking at Table 8 one can notice substantial increase in the bond face value in the same quarter as the recalibration announcements (Q1 2010) for Illinois, Missouri, and New Jersey, and the quarter when recalibration was performed (Q2) for Connecticut and Washington.

The data in Table 9 demonstrates that average daily number of trades increased in both announcement and recalibration quarters (Q1 and Q2 2010) in Arizona, Illinois, Pennsylvania, and Texas. In California, Florida, Kentucky, Louisiana, Massachusetts, Nevada, New Jersey, New York, North Carolina, and Puerto Rico trade growth was limited by announcement quarter. In Michigan, Connecticut there was a sharp growth in the number of trades in the recalibration quarter (Q2 2010).

Table 10 reveals that the average daily number of unique securities in California, Florida, Illinois, Massachusetts, New York, Pennsylvania, Texas increased following the recalibration announcement, even before the recalibration was implemented. All of those states ratings were upgraded 1-3 notches. It might be a sign that some investors who were not limited by regulatory or statutory requirements were misled by recalibration.

Overall, aggregate market and state level trading data provide some local (short-term) evidence to reject weak market efficiency hypothesis (and, hence, a semi-strong as well). However, over the longer-term timeframe the aggregate changes we observe are still within the historic boundaries.

4.1.2. Yield Spreads: Event Analysis

Next, we investigate how yield spreads respond to Moody's and Fitch recalibration announcements and actual ratings upgrades. We concentrate on the California state level general obligation (G.O.) bonds. California is the largest and most liquid municipal market[28] and it benefited the most from the recalibration: California state level bonds received the highest upgrade, three notches from Moody's and two notches from Fitch (see Table 4 for the complete list of rating

[28] According to MSRB 2010 Annual Report, California represents 19% of the total par value of municipal bonds traded. In New York, which is second largest market, daily bond turnover is 40% lower, than in California.

upgrades for all states). Hence, the power of our tests is the largest for California. Indeed, if we plot time series of yields for all states and different sizes of rating upgrade (Figure 9), we can see that California (the only state with an average upgrade of 2.5 notches) enjoyed drastic yield declines post-recalibration.

To determine the impact of ratings recalibration on municipal yields, a standard market adjusted event study is employed. Daily market index adjusted yield spreads (or risk premia) were computed by using the bond yield analog of "market adjusted" model with a beta of one and an alpha of zero (Campbell, Lo, and MacKinlay, 1997):

$$YS_{jt} = Y_{jt} - Y_{jt}^{m}$$

where Y_{jt} – the yield on California state level G.O bond with maturity *j* at day *t*, Y_{jt}^{m}- the corresponding yield on the AAA-rated state level G.O bonds for the same maturity *j* and day *t*.

AAA index benchmark and each state index were matched by maturity, security type (we considered only indices of state level general obligation bonds), tax status, adjusted for call features using option-adjusted analysis, so that the resulting yields spread reflects differences in credit quality, state specific supply and demand, and liquidity of the state level securities. During the sample period there were no fundamental reasons for any of these factors to cause spread decline:

-Fiscal situation in California was deteriorating (and that was the reason California G.O. bonds were downgraded by S&P on January 13, 2010, before our sample started).

-There was no unusual changes in bond issuance patterns (we made a rigorous headline news search for California in the sample period).

-We also checked whether the observed yield decline was a seasonal event, but found no evidence of it: California yields were increasing in March –April 2009, the opposite of what we observe for 2010.

-Insurance companies that are the major institutional holders of municipal bonds were reducing their municipal holdings at that time[29].

Thus, recalibration was the only event that can explain considerable shrinking of yields despite state

[29] NAIC reports.

fiscal situation worsening, seasonal factor, and municipal bond sell-off by insurance companies that were pushing yields up in the sample period.

Figure 7 contains cumulative spread changes computed for various maturities. Table 11 presents the mean spread changes and their significance for 1, 5, 30, and 60-day post-event windows for 4 types of events (2 recalibration announcements and 2 recalibrations). Consistent with our hypothesis 5, there was an immediate reaction for Moody's announcement, but it was localized only for short-term bonds reflecting their relative higher liquidity. Announcement by Fitch followed Moody's by a week, but it generated significant reaction only from the medium-term bonds. However, it can be the delayed effect of Moody's announcement that caught on the less liquid medium-term bonds. Another week later, Fitch recalibrated state level general obligations, however, it had only marginal impact and only for bonds with 15, 17 years maturity, confirming the previous conjecture (hypothesis 5) that Fitch is a substantially less influential player and market reacts much strongly to Moody's.

The most significant spread declines were observed after Moody's recalibration with the largest economic impact for the long-term bonds. Overall, the market exhibited a wave-like response to recalibration announcements and actual ratings upgrades that goes in line with our market segmentation hypothesis 4, there the most sophisticated investors trade short-term bonds (and react swiftly to market news) and less sophisticated investors hold long-term municipal debt (and are slow to react to market news). In addition, these results also support Moody's greater market impact (hypothesis 5), but contradict efficient market hypothesis 1 and provide conflicting evidence about ratings regulatory value.

There is one significant drawback in the design of event study. Computing our spread measure we implicitly assumed one-to-one relation between the state level bond yields and AAA-rated municipal bond yields, which may not be true in reality. However, state of California bonds have considerably lower credit ratings and, thus, are less liquid than the AAA-rated bonds. Regression analysis will avoid this drawback as well as include other potentially important control variables.

4.1.3. Yield spreads: structural break test

Another method that confirms a structural break in yield spreads during recalibration is the stationarity tests of the yield spread series. The methodology includes performing unit root test on the residuals of yield spreads, identifying structural breaks (if any exists), and checking whether they coincide with recalibration. We use Perron (1994) Innovational Outlier-2 (IO2) version of the unit-root test that allows for gradual change in both the intercept and the slope of the trend function. According to Vogelsang and Perron (1998) and Pahlavani, Valadkhani and Worthington (2005), this model is appropriate where it is more logical to conceptualize the breaks as occurring gradually rather than suddenly. Our estimation procedure is the following:

1. Pool the calculated yield spreads (California index minus AAA index matched by maturity and date) and regress yield spread onto the maturity, its square and its cube. Estimate residuals (e_t).
2. Make a scatter plot of residuals for each day (Figure 8). You can observe a clear shift in yield spread levels during recalibration.
3. To confirm our visual observation, we formally estimate the Perron (1994) IO2 model for residuals using each recalibration date as a possible "structural break" date.

$$e_t = \alpha + \theta * DU_t + \beta * t + \gamma * DT_t + \delta * D(T_b)_t + \rho * y_{t-1} + \sum_{i=1}^{k} C_i * \Delta y_{t-i} + \varepsilon_t$$

where Tb is the possible date of the structural break; DUt is the indicator variable for the change in level (DUt = 1 if t > Tb , or 0 otherwise); DTt is the indicator variable for the change in trend (DTt = t if t > Tb , or 0 otherwise); D(Tb)t is the so called crash dummy, which captures a possible and sudden shift in the series (D(Tb)t = 1 if t = Tb+1 , or 0 otherwise).

The number of lags, k, is selected endogenously using the sequential t-statistics method suggested by Ng and Perron (1995). First, we find the maximum value of k (k_{max}) by using Hayashi's (2000) criterion: $k_{max} = 12(T/100)^{1/4}$, there T is number of observations. Then, the unit root test is performed for k_{max}. If it is significant at 10% level, the procedure stops; if not, this step is repeated for consecutively lower k.

Table 14 contains the results of dating possible structural change break. They confirm that the yield spread series contains a structural break that coincides with the recalibration events. These findings, in turn, conflicts with efficient market hypothesis 1.

4.2. Regression Analysis

4.2.1. California

For each maturity *j* we estimate the following regression model:

$$Yield_{j,t}^{California} = \alpha_j + \beta_{j,1} * Yield_{jt,}^{AAA} + \beta_{j,2} *(Bond\ Supply_{j,t}) + \beta_{j,3}*t + \beta_{j,4}*(AMA_{j,t}) + + \beta_{j,5}*(AFA_{jt}) + $$
$$+ \beta_{j,6}*(AMR_{jt}) + \beta_{j,7}*(AFR_{jt}) + \varepsilon_{jt}$$

where the dependent variable is an index of daily yields for California state level G.O. bonds ($Yield_{j,t}^{California}$) with maturity j.

Maturity-matched index of AAA-rated municipal bonds ($Yield_{jt,}^{AAA}$) controls for the general municipal market trends. Even though the recalibration was the market-wide event for municipal bonds, it did not affect the majority of the AAA-rated bonds that were previously AAA-rated and only a few became AAA as a result of a 1 notch recalibration. Even if some of the recalibration effect is incorporated in the AAA-rated municipal securities, our results represent a lower bound of the overall recalibration effect on California municipal bonds (a net effect for the California bonds in addition to overall municipal market impact).

We use change in Bond Buyer's 30 day visible supply index ($Bond\ Supply_{j,t}$) to take into account the effect of possible changes of aggregate bond issuance around the end of the first quarter.

The control variables also include 4 dummy variables that are equal to one for all observations that follow each of the 4 recalibration events (two announcements and two recalibrations30). In particular, AMA is equal to one for all observations dated After Moody's Announcement; AMR - After Moody's Recalibration; AFA – After Fitch Announcement; AFR – After Fitch Recalibration. The coefficients for these variables indicate the change in yield level after each announcement or recalibration event. We do not use a single day dummy due to illiquid nature of the municipal bond market there any reaction is likely to be spread out later in time. Moreover, the selected specification

[30] Only these 4 events are related to state level G.O. bonds, whose yields are the dependent variables in our regressions. The other 4 dates listed in Table 1 were the dates when local level bonds were recalibrated.

for the event dummies reflects structural shifts in yield patterns prompted by recalibration that is the primary point of interest of this study.

As it was previously noted, empirical studies from 1970s-1990s found that municipal debt market is segmented by maturities and types of investors with individual investors dominating long end of the yield curve and institutional investors occupying short-term debt market to match the term structure of their assets/investments and liabilities. Various studies found that yield spreads vary with bond maturity (e.g., Kidwell, Marr, and Thompson, 1984, Chaplinsky and Ramchand, 2004). However, most of them pool yields across maturities and use maturity as a control variable. By doing so, they are implicitly assuming that yield change is constant or has other smooth continuous representation (concave or convex) as we go from shorter maturity to a longer one. In contrast, we would like to test whether maturity effect is asymmetric (and possibly not concave or convex), so we model yields for each maturity by a separate equation. We have 13 regressions in total (M = 2, 3, 5, 7, 9, 10, 12, 15, 17, 19, 20, 25, 30 years). The standard errors in all regressions are clustered and cross-correlated because all bonds were upgraded at the same time. Estimating the model as a system of seemingly unrelated regressions (SUR) captures the efficiency due to the correlation of disturbances across equations. In this case each equation has its own vector of parameters $\boldsymbol{\beta}_j$. We iterate over the estimated disturbance covariance matrix and parameter estimates until the parameter estimates converge.

Each regression covers 105 daily observation (Jan 18, 2010-June 11, 2010).

Table 15 summarizes the results of this estimation.

Market index is highly significant for short-term and long–term maturities. However, its coefficient is far lower than one (that we assumed for the event study). It means that yields of bonds of individual states are less sensitive to market moving information reflecting geographical segmentation within municipal market. Coefficient for time trend is very significant revealing serial correlation in the yields (or market inertia due to relatively low liquidity).

We summarized the total recalibration effect for each maturity by computing the sum of coefficients for individual recalibration dummies (overall post-recalibration effect).

As predicted by the market segmentation hypothesis bonds with various maturities show asymmetric reactions. In particular, short- and medium-term bonds had relatively modest overall yield declines. Yields on 2 and 3 years bonds declined by 12 and 17 basis points immediately after the recalibration was announced by Moody's on March 16th. However, they climbed up after Fitch announcement and Fitch recalibration, before going down again after Moody's recalibration.

The group of bonds with maturities of 5, 7, 9, 10, and 12 years did not react to Moody's announcement, but yields for these bonds increased by 10-22 basis points after Fitch announcement and by additional 5-18 points after Fitch's recalibration. After Moody's recalibration those yields declined by 18-22 basis points. Within this group, bonds with shorter maturities were posting higher yield increases after Fitch's announcement and Fitch's recalibration. As a result, the overall post-recalibration effect was yield increase by 18 and 11 points for 5 and 7-year maturities respectively, and near zero effect for 9, 10, and 12 years.

Another group of bonds that behave similarly consists of bonds with maturities of 15, 17, 19 and 20 years. Those bonds show small yield declines after Moody's announcement, offsetting increases after Fitch announcement, and significant declines after Moody's recalibration. As long as post-Moody's recalibration effect is stronger (in absolute terms) for longer maturities, the overall effect is larger negative for the same securities.

Lastly, consistent with hypothesis 5, we observe at best relatively small reaction to any announcement and Fitch's recalibration for bonds with maturities of 15 - 30 years. However, there was a massive yield decline after Moody's recalibration: cumulative 38 and 45 basis point for 25 and 30 year maturities respectively.

Fitch's announcement and recalibration coefficients were relatively small or statistically insignificant in this specification - the result that supports Moody's significance hypothesis 5. In table 16 we provide an alternative model specification that excluded both Fitch's indicator variables. As a result, for short and medium-term maturities variation in dependent variable is absorbed into market index and overall effect is much more negative; for 17, 19. 20, 25, and 30 the coefficients for the remaining variables remain almost unchanged. This means that for 2-15 years bonds Fitch is still a significant source of information and should not be discarded. This is in line with our argument that 2-15 years market is prevailed by sophisticated investors.

1.2.2. Multiple States

We added data from 17 other states, for which G.O. yield indices were available. We scaled each announcement and recalibration dummy by the average amount of upgrade each state received. In particular, we estimated the following model:

$$Yield_{jt,}^{state} = \alpha_j + \beta_{j,0}*Yield_{jt,}^{AAA} + \beta_{j,1}*(Bond\ Supply_{j,t}) + \beta_{j,2}*t + \beta_{j,3}*Upgrade_{j,t}*(AMA_{j,t}) +$$
$$+ \beta_{j,4}*Upgrade_{jti}*(AFA_{jti}) + \beta_{j,5}*Upgrade_{jti}*(AMR_{jti}) + \beta_{j,6}*Upgrade_{j,t}*(AFR_{j,t}) + \varepsilon_{jti}$$

We used the following values for the upgrade received by each state:

i) California – 2.5 (3 notches from Moody's and 2 notches from Fitch; highest upgrade);

ii) Connecticut, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Texas, Wisconsin – 1 notch upgrade;

iii) Florida, Washington – 0.75 (1 notch upgrade from Fitch and outlook upgrade from Moody's);

iv) Minnesota – 0.25 (outlook upgrade from Moody's)

v) Georgia, Maryland, North Carolina, South Carolina, Virginia – 0, no upgrade;

By modifying our dummy variables we are testing our hypothesis 2 (higher upgrade corresponds to higher yield spread reduction). So, we expect at least some of those dummies to be negative and significant.

Again, we model each maturity separately (M = 2, 3, 5, 7, 9, 10, 12, 15, 17,19, 20, 25, 30 years) and estimate them simultaneously as a system using SUR. The results are in Table 17. Surprisingly, all announcement and recalibration dummies are positive, that is the opposite of what we observed in California.

We estimated a number of various system specifications: without Fitch dummies, with original/unscaled dummies, with dummies indicating whether the new rating was crossing a broad rating category (e.g., from Baa/BBB to A or from A to Aaa/AA), without California data. For neither specification any of the original or modified recalibration dummies were significantly negative (in most cases they were significantly positive).

To explain this result, we generated the graphs of state yield indices separately for each level of upgrade and found that California was the only state that show massive yield declines after recalibration; yields for the rest of the states barely changed. California was the state that stood out by its substantially lower state G.O bond ratings before the recalibration (the other states were mostly AAA or AA rated) and it was upgraded the most. Taking into account that we see reaction for California and don't see it for the other states, we conjecture that investors are more sensitive to either rating changes for lower rated securities or for more pronounced changes, or both. The former effect was shown theoretically and confirmed empirically by Jorion and Zhang (2006) for stock prices using a structural, Merton-type model (they found much stronger stock price effects for rating changes for low-rated firms relative to high-rated firms).

4.3. Convergence

It was stated by Moody's and Fitch that the objective of municipal bond ratings recalibration was to have municipal bonds being "comparable in terms of a level of credit risk to ratings in corporate and sovereign sectors". In order to test whether this objective was achieved, we performed two tests:

- compared two index yields for: California state G.O. bonds and U.S. corporate bonds with a broad A1 rating. As a result of ratings recalibration California G.O. bonds were upgraded 3 notches by Fitch (moved from the Baa1 to A1 rating).
- compared two index yields for bonds issued in the same industry by municipal and corporate issuers across the country. The only industry that allowed such comparison was utilities. All corporate and municipal bonds in this case were rated AA/Aa.

Ratings comparability means that different securities with the same credit rating should have the same after-tax yields: Ym=(1-t)Yc where Ym – is yield on a tax-exempt (municipal) bond and Yc is yield on a taxable (corporate) bond, t – tax rate for a marginal bondholder. Hence, Ym/Yc=(1-t). It was claimed that municipal bonds were underrated prior to recalibration, so Ym/Yc was larger than (1-t). Municipal ratings recalibration was presumed to correct this discrepancy by making Ym/Yc ratio lower.

Figure 10 depicts ratio of California G.O. bond yield index to broad U.S. corporate industrial bonds index with the same rating. Figure 11 has the ratio of municipal to corporate bond indices for bonds issued in the same industry (utilities) in the whole U.S. Ratios for 3 year bonds are very volatile and show no distinct pattern around the recalibration. For California-U.S. Corporate bonds, ratios for 5 and longer maturities increased after Moody's announcement, declined after Fitch's announcement and dropped slightly more after Moody's recalibration, before taking off and getting higher than the pre-recalibration level.

Results for utility bonds are similar except for lack of pronounced reactions during recalibration announcements and rating changes (this is expected because we consider all bonds, majority of which were not G.O. and upgraded). Ratios became higher post-recalibration across all maturities. These results contradict our hypothesis 2 (i.e., there was no convergence of yields for similar municipal and corporate bonds).

5. Results Robustness

The municipal bond recalibration was performed during the extensive fiscal monetary expansion policy ("quantitative easing") that caused yields for many benchmark interest rates to decline. Treasury bonds yields were continuing to decline at the time of recalibration. However, yields for AAA rated municipal bonds barely changed in the sample period, while for California they dropped significantly.

We performed an extensive news headline search for concurrent events related to California looking for something that might had sent a signal of improved risk. Contrary, all the fundamental factors show increasing risk for municipals in general (and California in particular) putting upward pressure onto municipal bond yields. Fiscal situation was deteriorating for the U.S. municipalities, most of the states were dealing with substantial budget deficits. Specifically, California had the largest state budget gap (18.8%) in 2009[31], – and that was the reason for California G.O.s downgrade by S&P on January 13, 2010.

We also analyzed whether the observed yield trends were merely a seasonal feature. We checked the yield trends for other years and found that yields were increasing in March-April 2009. This is a well-known trend in municipal market – investors tend to sell tax-exempt securities or avoid buying them to help make their April 15 tax payments.

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[31] National Conference of State Legislatures, July 2009. Retrieved from: http://www.ncsl.org/documents/fiscal/StateBudgetUpdateJulyFinal.pdf

Consecutively, we cannot think of any plausible explanation that would explain how recalibration could have been regarded as containing a new (private or public) information about fundamental improvements in the credit quality of the upgraded bonds.

6. Conclusions

Credit rating is a very important determinant of the municipal borrowing cost. However, it is difficult to estimate the "pure" effect from credit ratings because credit rating changes are commonly prompted by the changes in the credit quality (riskiness) of the bond issuer. In that case, there are two types of effect on borrowing costs: the generic credit quality change effect and the proprietary credit rating effect. We have to use econometric models to separate the two effects with a certain degree of precision. The uniqueness of this study is that the credit rating change was isolated, simultaneous, and not related to any change in the underlying issuer's credit quality. Thus, the recalibration provides an unprecedented opportunity to get an insight into the direct linkage between credit ratings and municipal borrowing cost by studying the dynamics of the secondary market municipal yields.

This study provides evidence that municipal bond issuers benefited from the municipal bonds recalibration - the massive credit ratings upgrades they had lobbied for years.

As it was shown, this benefit was not particularly pronounced in the aggregate market data relative to the significance of the recalibration event, even though we can see that the number of unique securities, the number of trades and the aggregate face value of bonds traded increased in March 2010, the month when the recalibration was announced both by Moody's and Fitch. Even if we use regression analysis for the pooled data on several states the obtained results are contradictory.

The picture is different if we narrow down our research to specific states. We were comparing the yields for the specific state general obligation bonds relative to the wider benchmark index (yield for the AAA-rated municipal bonds index matched by maturity). Massive yield declines were pronounced for California, the state that obtained the greatest credit ratings boost. The declines in California general obligations yields relative to AAA-rated municipal bond index ranged from 20 basis points at the short end of the yield curve (2-3 years) to 45 bps for the bonds with 30 years of maturity.

In order to check whether the recalibration attained its objective, we compared yields for California municipal bonds and U.S. Corporate Bonds with a broad A rating[32], yields for bonds issued in utility industry by municipal and corporate issuers across the country and AA/Aa rated. The evidence is the opposite of what was expected.

Regression analysis confirmed significant recalibration effect that was different along the yield curve that in turn was an evidence of market segmentation across the maturities. The most statistically and economically significant bond yield decline was due to Moody's announcement in short-term bonds, Fitch announcement in mid-maturity bonds, and Moody's recalibration for bonds with mid and long maturities. Bonds at the longest end of yield curve received the largest drop of the yields. This can be interpreted as a signal that households were misled by the credit ratings upgrades that were unaccompanied by the underlying credit quality improvements

[32] California G.O. bonds obtained A1/A rating as a result of recalibration.

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Appendices

Table 1. Recalibration timeline.

March 16, 2010	Moody's announced it would recalibrate its ratings. Due to the number of municipal ratings (nearly 18,000 issuer and security combinations covering approximately 70,000 ratings), the recalibration will be implemented in stages and is expected to occur over a four week period
March 25, 2010	Fitch announced recalibration.
April 5, 2010	Fitch recalibrated ratings of U.S. states, Puerto Rico, the District of Columbia and New York City credits.
April 19, 2010	Moody's recalibrated all state governments and local governments in CA, IL, MN, NY, TN, WI
April 26, 2010	Moody's recalibrated local governments in FL, IA, KY, MA, MI, NJ, OH, PA, TX, WA
April 30, 2010	Fitch recalibrated ratings of investment-grade local general obligation bonds, special tax-backed bonds, water/sewer and public power distribution bonds and public higher education bonds were adjusted similarly. Ratings in the sectors listed above that were below investment grade were considered for recalibration on a case-by-case basis. As a result, at Fitch the percentage of muni bonds rated AA or better rose to 82% from 52.7% before the recalibration in April.
May 3, 2010	Moody's recalibrated local governments in AK, AL, AR, AZ, CO, CT, DE, GA, HI, ID, IN, KS, LA, MD, ME, MO, MS, MT, NC, ND, NE, NH, NM, NV, OK, OR, RI, SC, SD, UT, VA, VT, WV, WY
May 10, 2010	Moody's recalibrated health care, higher education, housing & state revolving funds, pooled ratings, public infrastructure including airports, toll roads & public power

Sources: 1. Moody's Global Scale Rating Recalibration Schedule. Retrieved from: http://www.moodys.com/newsandevents/topics/us-municipal-rating-recalibration---gsr/-/007016/1/4294964496/4294965962/0/-/0/tp

2. Fitch Recalibration Schedule. Retrieved from: http://www.naic.org/documents/committees_e_rating_agency_101118_hearing_fitch_doc4.pdf

Table 2. Moody's Primary Algorithm by Sector (Upward Shift in Ratings, # of notches)

Muni-cipal scale rating	General Obligation; Water & Sewer; Distribution-Only Utilities; Municipal Utility Districts (MUDs)	Special tax (non-go); mass transit; non-utility enterprises; tax increment financing districts (tifs); grant anticipation revenue bonds (garvees)	Public universities and public university foundations	Health care; housing; private k-12 & charter schools; private universities & other not-for-profits; transportation & other infrastructure enterprises; power generating utilities; state revolving funds; bond banks; federal leases
Aaa	0	0	0	0
Aa1	0-1	1	0-1	0
Aa2	1	1	1	0
Aa3	1	1	1	0
A1	2	1	1	0
A2	2	1	1	0
A3	2	1	1	0
Baa1	3	1	1	0
Baa2	3	0	1	0
Baa3	2-3	0	1	0
Ba1 and below	0	0	0	0

Source: Recalibration of Moody's U.S. Municipal Ratings to its Global Rating Scale, 2010. Retrieved from: http://www.moodys.com/newsandevents/topics/us-municipal-rating-recalibration---gsr/-/007016/1/4294964496/4294965962/0/-/0/tp

Table 3. Fitch's Primary Algorithm by Sector (Upward Shift in Ratings, # of notches)

Municipal scale rating	Local General Obligationand credits dependent on them; Public power distribution and water and sewer credits	Appropriation-backed debt	Special tax-backed bonds	Public higher education
AAA	0	0	0	0
AA+	1	0	1	0
AA	1	1	1	0
AA-	1	1	1	1
A+	1	1	1	1
A	2	1	1	1
A-	2	2	1	1
BBB+	2	2	1	1
BBB	2	2	1	1
BBB-	2	2	1	1
BB+ and below	Case-by-case	Case-by-case	Case-by-case	Case-by-case

Source: Fitch Ratings, 2010. Retrieved from: http://www.naic.org/documents/committees_e_rating_agency_101118_hearing_fitch_doc4.pdf

Table 4. Magnitude of Recalibration for State General Obligation Bonds

	Moody's			Fitch		
	Rating before	Rating after	# of notches up	Rating before	Rating after	# of notches up
Alabama	Aa2	Aa1	1	AA	AA+	1
Alaska	Aa2	Aa1	1	AA	AA+	1
Arizona	Aa3	Aa2	1			
Arkansas	Aa2	Aa1	1			
California	Baa1	A1	3	BBB+	A	2
Colorado						
Connecticut	Aa3	Aa2	1	AA	AA+	1
Delaware	Aaa	Aaa	0	AAA	AAA	0
Florida	Aa1	Aa1	0*	AA+	AAA	1
Georgia	Aaa	Aaa	0	AAA	AAA	0
Hawaii	Aa2	Aa1	1	AA-	AA	1
Idaho	Aa2	Aa1	1			
Illinois	A2	Aa3	2	AA	AA+	1
Indiana	Aa1	Aaa	1			
Iowa	Aa1	Aaa	1	AA+	AAA	1
Kansas	Aa1	Aa1	0			
Kentucky	Aa2	Aa1	1			
Louisiana	A1	Aa2	2	AA-	AA	1
Maine	Aa3	Aa2	1	AA	AA+	1
Maryland	Aaa	Aaa	0	AAA	AAA	0
Massachusetts	Aa2	Aa1	1	AA	AA+	1
Michigan	Aa3	Aa2	1	A+	AA-	1
Minnesota	Aa1	Aa1	0*	AAA	AAA	0
Mississippi	Aa3	Aa2	1	AA	AA+	1
Missouri	Aaa	Aaa	0	AAA	AAA	0
Montana	Aa2	Aa1	1			
Nevada	Aa2	Aa1	1	AA	AA+	1
New Hampshire	Aa2	Aa1	1	AA	AA+	1
New Jersey	Aa3	Aa2	1	AA-	AA	1
New Mexico	Aa1	Aaa	1			
New York	Aa3	Aa2	1	AA-	AA	1
North Carolina	Aaa	Aaa	0	AAA	AAA	0
North Dakota	Aa2	Aa1	1			
Ohio	Aa2	Aa1	1	AA	AA+	1
Oklahoma	Aa3	Aa2	1	AA	AA+	1
Oregon	Aa2	Aa1	1	AA	AA+	1
Pennsylvania	Aa2	Aa1	1	AA	AA+	1
Rhode Island	Aa3	Aa2	1	AA-	AA	1
South Carolina	Aaa	Aaa	0	AAA	AAA	0
Tennessee	Aa1	Aaa	1	AA+	AAA	1
Texas	Aa1	Aaa	1	AA+	AAA	1
Utah	Aaa	Aaa	0	AAA	AAA	0
Vermont	Aaa	Aaa	0	AA+	AAA	1
Virginia	Aaa	Aaa	0	AAA	AAA	0
Washington	Aa1	Aa1	0*	AA	AA+	1
West Virginia	Aa3	Aa2	1	AA-	AA	1
Wisconsin	Aa3	Aa2	1	AA-	AA	1
Wyoming						
Puerto Rico	Baa3	A3	3	BBB-	BBB+	2

Table 5. Credit Ratings Upgrade Effect on Security Prices: literature review

Section A. U.S. Markets

Market	Significant Reaction	Insignificant Reaction
CDS	• Micu, Remolona, Woldridge (2006)	• Goh and Ederington (1993) • Norden and Weber (2004) • Hull, Predescu, White (2004)
ABS		• Ammer, Clinton (2004)
Stock	• Kliger and Sarig (2000) significant for 2 out 3 upgrade proxies used and only for one-week post-event window	• Pinches and Singleton (1978) • Stickel (1986) • Holthausen and Leftwich (1986) • Stickel (1986) • Glascock, Davidson, Henderson (1987) • Hand, Holthausen, Leftwich (1992) • Elayan, Maris, Maris (1990) • Elayan, Maris, Young (1996) • Barron, Clare, Thomas (1997) • Dichev, Piotroski (2001)
Corporate bonds	• Hand, Holthausen, Leftwich (1992) for unexpected and non-contaminated upgrades • Hite and Warga (1997) for investment boundary only • Kliger and Sarig (2000) • Jorion and Zhang (2004): below rating B	• Weinstein (1977) • Zaima and McCarthy (1988) • Hand, Holthausen, Leftwich (1992) – full sample • Hite and Warga (1997) • Jorion and Zhang (2004): above rating B
Municipal bonds	• Katz (1974) • Ingram, Brooks, Copeland (1983)	• Hettenhouse, Sartoris (1976)

Section B. Foreign Markets

Market	Significant Reaction	Insignificant Reaction
CDS	• Micu, Remolona, Woldridge (2006)	
Stock	• Elayan, Hsu, Meyer (2003) • Creighton, Gower, Richards (2004)	• Brooks, Faff, Hillier, Hillier (2004)
Corporate bonds	• Creighton, Gower, Richards (2004)	• Matolcsy, Lianto (1995) • Steiner, Heinke (2001) • Ory, Raimbourg (2011)
Sovereign bonds	• Cantor, Packer (1996)	• Larrain, Maltzan, Reisen, 1997 • Reisen, Maltzan, 1997

Table 6. Variables Description

Variable	Definition
State General Obligation Bond Yield Indices in: California, Connecticut, Florida, Georgia, Maryland, Massachusetts, Michigan, Minnesota, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Texas, Virginia, Washington, Wisconsin	Yields on these bonds were extracted from data points on the corresponding fair market yields curves. The curves are populated with the state level general obligation bonds issued by the corresponding state. The option-free yield curve is built using option-adjusted spread (OAS) model. The yield curve is comprised from contributed pricing from the Municipal Securities Rulemaking Board, new issues calendars, and other proprietary contributed prices. Yields are for 2, 3, 4, 5, 7, 9, 10, 12, 15, 17, 19, 20, 25, 30 years. The yield at each maturity point represents the composite yield of securities around that maturity. Data source: Bloomberg.
US Municipal General Obligation AAA	Yields were extracted from the corresponding yield curve. The yield curve is populated with US municipal general obligations (G.O.) with an average rating of AAA from Moody‘s and S&P. Data source: Bloomberg.
Treasury Bonds and Notes (GO82).	Data source: Bloomberg.
US Composite Corporate Bonds A1, Industrial (C005)	The curve is populated with USD denominated senior unsecured fixed rate bonds issued by domestic industrial corporations with an average rating of A1/A+ from Moody's and S&P. Data source: Bloomberg.
US Composite Corporate Bonds AA, Utilities (C033)	The curve is populated with USD denominated senior unsecured fixed rate bonds issued by domestic corporations operating in utilities sector and with an average rating of AA/Aa2 from Moody's and S&P. Data source: Bloomberg.
US Municipal Obligation, Utilities, AA	Yields were extracted from the corresponding yield curve. The yield curve is populated with US municipal bonds with an average rating of AAA from Moody‘s and S&P and issued by the entities operating in utilities sector. Data source: Bloomberg.
Bond Buyer 30 day bond supply	The 30-day visible supply is compiled daily from The Bond Buyer's Competitive and Negotiated Bond Offerings calendars. It reflects the dollar volume of bonds expected to reach the market in the next 30 days. Issues maturing in 13 months or more are included. Data source: Bond Buyer

Table 7. Data Summary Statistics

	Maturity	Obs	Mean	Std. Dev.	Min	Max
California Municipal general obligations bonds index	2y	125	1.37696	.1104698	1.16	1.56
	3y	125	1.81872	.1229541	1.62	2
	4y	125	2.25336	.1277532	2.05	2.45
	5y	125	2.71328	.1449125	2.48	2.95
	7y	125	3.61344	.1610956	3.33	3.84
	9y	125	4.26392	.1461158	4.01	4.47
	10y	125	4.46896	.1276956	4.24	4.65
	12y	125	4.71504	.098297	4.55	4.87
	15y	125	4.94216	.1027649	4.75	5.08
	17y	125	5.08392	.1143064	4.88	5.23
	19y	125	5.23296	.1404717	4.99	5.4
	20y	125	5.3068	.1708262	5.03	5.51
	25y	125	5.52512	.2340066	5.14	5.8
	30y	125	5.54904	.2255547	5.18	5.8
AAA-rated Municipal general obligation bonds	2y	125	.63896	.0771239	.51	.84
	3y	125	.95736	.1031218	.81	1.17
	4y	125	1.67056	.1265313	1.43	1.9
	5y	125	2.38624	.1081044	2.18	2.6
	7y	125	2.92136	.1111838	2.74	3.14
	9y	125	3.15864	.107436	2.97	3.36
	10y	125	3.55144	.0627682	3.43	3.69
	12y	125	3.7676	.0365751	3.7	3.86
	15y	125	3.83048	.0345444	3.77	3.91
	17y	125	3.92792	.0301153	3.84	3.99
	19y	125	4.01936	.0277007	3.94	4.08
	20y	125	4.08112	.0239022	4.02	4.13
	25y	125	4.39448	.0299853	4.31	4.44
	30y	125	4.442	.0267002	4.36	4.48

Table 8. Average Daily Par Amount In Millions Of $, By State

	2009				2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Alabama	95.8	139.1	141.3	194.0	138.2	183.7	111.4	152.1	71.4	79.7	114.1	71.2
Alaska	49.1	115.4	189.9	173.5	191.1	136.9	118.8	117.3	118.1	74.8	98.0	91.4
Arizona	206.4	182.0	146.2	126.5	154.9	164.2	141.9	109.6	140.3	111.2	115.0	139.3
Arkansas	22.5	28.7	20.4	22.8	17.2	26.4	26.0	28.0	16.5	21.8	19.2	19.8
California	2,650.2	3,239.4	3,402.8	3,270.9	3,082.0	2,834.7	2,491.9	3,087.9	2,476.3	2,354.9	2,579.2	1,843.8
Colorado	242.5	265.3	249.0	230.5	184.5	204.1	185.9	224.1	171.6	222.9	234.3	174.2
Connecticut	193.5	144.9	176.7	199.4	163.2	241.1	144.8	191.0	166.7	174.6	174.7	160.4
Delaware	69.0	24.5	24.1	66.8	60.9	87.2	38.8	56.5	23.7	28.5	29.4	30.8
District of Columbia	142.6	95.7	134.1	88.6	92.9	82.5	93.6	101.6	130.9	88.1	100.7	81.0
Florida	1,180.6	973.8	857.3	647.3	752.7	737.0	796.5	729.8	574.2	542.8	523.5	478.3
Georgia	374.9	418.9	341.7	351.6	353.4	281.7	293.0	252.7	238.6	246.6	225.5	204.6
Hawaii	37.8	59.9	43.8	38.8	51.6	35.8	32.3	54.0	38.4	29.2	40.3	74.1
Idaho	35.7	32.7	15.9	22.4	27.6	25.5	23.9	17.6	13.2	22.4	27.2	15.4
Illinois	615.4	574.6	510.8	423.9	676.8	655.0	562.4	705.1	631.6	546.6	515.1	554.9
Indiana	253.8	203.3	219.7	243.1	265.1	268.2	242.4	205.0	202.8	171.2	185.4	157.8
Iowa	73.9	62.6	77.2	46.0	67.3	74.0	57.3	53.7	52.9	58.2	49.3	84.3
Kansas	58.3	81.9	74.5	86.4	84.4	95.0	82.7	77.8	75.3	66.7	75.7	63.8
Kentucky	205.5	149.8	198.8	314.3	234.9	290.8	116.8	104.6	91.1	110.0	119.5	100.2
Louisiana	105.2	124.3	169.0	136.7	136.6	132.2	313.2	333.3	253.7	273.0	301.7	251.5
Maine	13.8	24.7	23.0	23.1	17.1	26.2	19.0	23.1	24.7	31.1	25.8	31.0
Maryland	203.4	193.6	159.1	176.9	157.6	193.9	192.9	177.1	199.5	200.9	250.6	304.3
Massachusetts	510.6	435.2	473.4	498.7	510.9	499.6	468.1	508.5	450.0	505.7	432.6	403.2
Michigan	256.6	308.8	280.5	269.8	272.4	277.9	233.9	280.6	228.7	215.7	269.5	269.2
Minnesota	157.1	140.8	159.8	224.6	179.3	128.8	192.2	147.0	146.9	132.2	140.5	170.4
Mississippi	75.0	72.8	107.2	160.0	185.2	150.6	278.6	222.5	300.8	271.8	214.3	239.5
Missouri	158.8	139.4	174.1	151.7	220.6	251.4	182.1	202.6	145.8	164.6	162.5	141.8
Montana	8.9	5.9	5.7	3.4	16.6	16.7	8.6	13.8	10.8	7.2	9.6	9.4
Nebraska	59.3	46.5	69.8	34.6	37.3	82.2	69.5	70.3	35.7	45.1	56.1	52.7
Nevada	137.4	110.8	83.3	100.5	142.8	102.2	86.6	92.6	98.7	85.1	84.8	108.3
New Hampshire	53.4	60.8	62.6	63.9	49.6	107.0	50.8	50.7	51.6	48.0	69.7	47.0
New Jersey	394.4	549.0	436.7	410.3	502.6	503.8	437.9	547.8	472.9	445.8	409.1	509.4
New Mexico	31.3	40.4	44.8	76.0	57.7	54.3	66.4	56.6	36.0	30.6	27.4	26.0
New York	1,700	1,619.5	1,662.8	1,819.0	1,844.2	1,790.3	1,593.8	1,773.9	1,776.0	1,623.8	1,496.7	1,538.0
North Carolina	322.7	351.5	277.8	234.5	288.3	261.6	232.5	215.4	225.2	239.2	232.3	232.9
North Dakota	5.2	7.4	14.8	12.3	14.3	13.2	9.0	15.7	11.5	13.0	16.8	15.4
Ohio	346.5	330.0	363.4	336.5	324.2	355.8	360.7	390.0	345.3	319.4	313.1	263.8
Oklahoma	92.1	75.5	76.4	55.3	53.5	62.0	85.0	65.0	70.4	62.9	53.5	62.9
Oregon	133.3	117.4	91.0	90.3	105.9	159.9	87.6	83.1	102.0	138.5	99.1	78.4
Pennsylvania	557.6	527.3	524.7	514.5	486.2	553.7	546.1	464.8	456.3	473.8	420.5	447.4
Puerto Rico	540.4	680.8	495.4	531.1	588.1	621.9	689.8	537.1	630.7	522.0	426.4	526.7
Rhode Island	37.5	31.1	41.8	24.5	28.4	41.6	34.1	27.1	67.9	33.1	42.1	27.4
South Carolina	111.4	109.3	112.2	126.9	106.3	132.6	126.2	133.8	118.2	98.7	108.0	115.8
South Dakota	11.2	12.6	9.9	12.3	10.9	10.4	9.7	11.9	10.9	11.0	14.7	13.0
Tennessee	218.1	242.6	191.2	162.7	163.4	229.9	182.1	155.6	128.5	104.0	125.3	133.7
Texas	1,386	1,145.9	1,461.2	990.3	1,057.9	1,147.6	1,525.1	1,464.2	1,091.6	1,100.5	1,275.8	1,004.9
Utah	90.6	116.7	98.5	72.5	90.5	153.7	96.2	76.2	95.4	86.7	87.4	54.4
Vermont	17.6	22.4	18.4	15.0	18.4	29.2	32.0	28.1	21.3	10.8	26.6	19.7
Virgin Islands	1.5	6.2	1.2	11.2	6.3	3.0	12.2	3.8	3.6	3.8	3.5	4.4
Virginia	209.6	297.1	183.9	246.8	232.2	233.7	226.3	233.2	202.1	211.9	197.6	191.9
Washington	256.8	241.0	262.0	226.5	222.6	302.1	280.4	279.1	272.4	227.8	238.1	232.4
West Virginia	21.1	22.7	30.6	29.1	26.2	52.9	35.1	28.0	33.6	24.6	30.4	22.8
Wisconsin	205.4	172.8	159.1	125.2	136.6	134.4	128.2	157.2	142.4	149.3	179.0	128.4
Wyoming	24.9	34.4	86.8	73.5	51.3	39.1	59.0	57.4	55.6	56.7	58.1	57.1
Unavailable	52.2				62.8	42.3	30.9	51.7	31.4	84.9	176.2	80.3

Table 9. Average Daily Number Of Trades By State, 2007–2010

	2009				2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Alabama	386	397	530	504	449	488	450	496	493	454	496	454
Alaska	120	111	113	110	118	96	97	113	125	105	89	107
Arizona	834	843	690	671	765	867	758	720	919	778	664	726
Arkansas	158	252	167	199	189	208	165	235	180	208	162	174
California	6,271	6,509	6,662	6,397	6,595	6,283	6,270	6,314	6,737	6,119	6,180	6,034
Colorado	678	647	700	786	699	685	634	814	787	653	615	647
Connecticut	579	531	578	571	550	631	499	647	670	535	549	549
Delaware	134	72	58	121	94	108	63	113	97	65	76	117
District of Columbia	319	243	301	209	192	221	236	229	244	311	234	257
Florida	2,593	2,557	2,579	2,304	2,681	2,604	2,521	2,419	2,717	2,492	2,397	2,228
Georgia	849	824	804	908	885	771	850	881	1,058	932	816	866
Hawaii	160	190	149	151	179	170	138	221	221	180	197	185
Idaho	113	82	72	71	97	73	134	118	111	82	101	68
Illinois	1,484	1,266	1,432	1,193	1,706	1,822	1,977	2,254	2,206	1,675	1,629	1,751
Indiana	691	625	650	636	615	45	570	583	671	606	588	577
Iowa	213	241	288	220	211	272	217	244	250	279	214	216
Kansas	308	400	337	389	366	373	308	331	345	330	309	310
Kentucky	469	378	383	363	440	424	397	372	437	424	369	384
Louisiana	389	404	491	387	452	385	398	440	427	364	380	394
Maine	102	143	150	146	107	174	137	163	149	148	126	129
Maryland	637	585	548	553	532	544	513	580	761	630	569	615
Massachusetts	1,115	1,085	981	1,002	1,194	1,166	939	1,068	1,273	1,143	971	987
Michigan	1,312	1,316	1,134	1,179	1,171	1,441	1,164	1,232	1,273	1,161	1,032	1,056
Minnesota	641	575	583	689	724	579	598	676	757	569	548	581
Mississippi	139	145	155	183	150	139	145	166	167	157	166	154
Missouri	710	595	713	624	680	810	633	811	705	681	597	630
Montana	66	61	59	53	66	102	67	115	77	79	69	60
Nebraska	324	251	282	222	239	251	230	285	289	253	249	237
Nevada	371	315	272	324	429	351	374	344	356	319	312	320
New Hampshire	115	99	149	164	115	169	108	117	138	116	108	118
New Jersey	1,683	1,873	1,819	1,647	1,866	1,770	1,701	2,066	2,219	1,805	1,565	1,555
New Mexico	148	166	156	132	154	145	146	149	185	143	124	115
New York	4,980	4,441	4,021	4,081	4,212	4,101	3,861	4,247	5,201	4,228	3,755	3,879
North Carolina	927	805	842	699	800	709	637	869	964	744	630	647
North Dakota	40	35	74	69	67	66	45	70	61	56	58	65
Ohio	1,253	1,079	1,243	1,332	1,223	1,285	1,297	1,402	1,501	1,239	1,104	1,136
Oklahoma	227	211	260	208	231	245	270	249	300	229	211	239
Oregon	537	553	370	444	502	487	449	482	579	574	411	389
Pennsylvania	1,890	2,056	1,974	1,789	1,890	1,930	2,047	2,051	2,182	1,976	1,709	1,820
Puerto Rico	1,470	1,561	1,233	1,233	1,374	1,253	1,361	1,124	1,535	1,280	1,146	1,157
Rhode Island	142	157	138	146	157	184	128	150	169	193	150	130
South Carolina	509	551	490	497	490	499	517	545	679	510	470	478
South Dakota	50	59	54	62	41	52	59	52	68	49	45	57
Tennessee	503	444	437	440	469	473	394	418	458	371	372	405
Texas	3,381	3,164	3,308	2,765	3,047	3,101	3,208	3,334	3,778	3,241	3,205	2,837
Utah	195	190	191	147	184	198	163	197	251	206	177	143
Vermont	93	87	83	48	84	57	70	83	73	58	69	60
Virgin Islands	24	26	25	45	40	31	41	37	36	37	31	47
Virginia	734	823	615	661	731	701	632	758	838	738	735	741
Washington	861	760	839	844	789	845	818	921	1,131	855	800	793
West Virginia	95	98	116	149	136	106	123	115	109	105	115	116
Wisconsin	557	566	583	527	560	524	430	531	572	472	470	430
Wyoming	24	24	39	42	36	43	28	33	44	27	34	35
Unavailable	46	57	43	61	38	45	41	32	30	43	41	43

Table 10. Average Daily Number Of Securities By State, 2007–2010

	2009				2010				2011			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Alabama	142	133	156	169	156	169	165	171	180	173	170	156
Alaska	43	42	42	42	46	43	40	44	50	46	38	37
Arizona	295	307	259	275	297	326	276	296	370	319	268	266
Arkansas	57	72	58	68	70	71	65	84	54	77	60	65
California	2,309	2,428	2,250	2,112	2,437	2,435	2,312	2,331	2,664	2,418	2,284	2,140
Colorado	226	240	234	235	253	264	250	289	301	258	243	224
Connecticut	207	214	205	199	226	248	217	248	271	229	214	197
Delaware	37	29	23	34	35	37	27	37	40	30	32	36
District of Columbia	54	60	65	60	64	73	75	78	87	83	76	70
Florida	867	845	840	810	953	938	899	874	1,031	925	889	760
Georgia	274	272	280	272	310	297	287	299	367	338	305	286
Hawaii	49	62	50	56	61	68	54	69	86	75	69	66
Idaho	35	32	30	27	32	31	37	41	42	35	35	27
Illinois	485	466	459	464	579	590	608	628	723	572	567	511
Indiana	232	237	222	223	239	252	216	246	265	243	212	205
Iowa	85	101	77	87	96	110	90	95	99	116	93	86
Kansas	127	128	126	110	140	131	122	130	139	136	129	114
Kentucky	161	145	152	138	161	153	165	158	169	174	143	136
Louisiana	111	108	122	113	129	120	127	129	136	119	128	120
Maine	45	47	48	51	44	58	50	59	59	59	47	43
Maryland	210	211	189	206	212	220	206	235	288	246	228	223
Massachusetts	384	405	356	369	448	410	351	399	475	444	374	348
Michigan	459	427	426	393	447	449	417	425	477	410	387	341
Minnesota	231	248	243	268	257	258	259	293	282	256	262	258
Mississippi	56	60	58	66	64	60	61	64	71	72	65	64
Missouri	213	200	215	201	233	244	225	254	240	241	223	219
Montana	23	22	20	17	19	21	21	27	21	23	22	20
Nebraska	88	88	83	77	78	88	79	98	86	89	87	82
Nevada	113	103	90	96	122	120	113	122	143	127	119	116
New Hampshire	41	41	48	50	46	55	47	48	57	52	47	48
New Jersey	657	623	603	632	680	688	655	691	813	708	612	577
New Mexico	57	67	59	56	66	65	60	68	81	66	57	52
New York	1,563	1,451	1,346	1,369	1,528	1,525	1,431	1,494	1,801	1,601	1,409	1,338
North Carolina	287	275	285	269	309	283	252	316	362	295	264	242
North Dakota	17	16	25	25	20	23	17	23	23	22	22	27
Ohio	404	402	416	423	425	445	440	470	556	472	443	387
Oklahoma	79	88	84	76	86	91	87	88	111	97	87	86
Oregon	180	185	145	160	177	177	170	184	222	213	160	154
Pennsylvania	618	605	595	580	675	682	680	681	755	702	650	616
Puerto Rico	338	307	304	310	344	345	333	319	355	333	306	296
Rhode Island	53	56	53	54	57	71	51	52	73	67	56	51
South Carolina	173	172	168	177	182	194	185	196	250	194	191	175
South Dakota	16	17	17	18	18	22	22	22	23	19	19	19
Tennessee	162	152	159	163	177	173	157	170	179	150	150	152
Texas	1,051	1,090	1,082	1,023	1,142	1,169	1,146	1,201	1,351	1,253	1,206	1,051
Utah	76	75	77	62	78	86	72	78	105	88	80	69
Vermont	25	24	27	19	25	21	27	30	28	23	26	21
Virgin Islands	9	8	8	9	11	10	10	9	11	9	11	9
Virginia	260	292	237	264	281	288	255	308	343	306	296	265
Washington	273	287	286	287	304	330	310	360	400	352	330	296
West Virginia	36	35	35	38	39	37	38	39	41	38	39	39
Wisconsin	197	197	200	194	215	215	191	218	235	211	202	185
Wyoming	9	9	11	12	11	13	10	14	15	12	14	14
Unavailable	15	15	17	16	12	12	13	12	12	13	9	13

Table 11. Significance of Cumulative Changes (1, 5, and 30 days post-recalibration window)

Basis points changes. Significance level and corresponding cut-off t-statistics: t=1.645 – 5%; 2.327 – 1%; 1.28 – 10%.
T-statistics were computed using pre-recalibration period variance (40 trading days).

	Moody's announcement		Fitch announcement		Fitch recalibration		Moody's recalibration		Overall 30 days since Moody's announcement	Overall 60 days since Moody's announcement
	1 day yield change	5 days yield change	1 day yield change	5 days yield change	1 day yield change	5 days yield change	1 day yield change	5 days yield change	30 days Yield change	60 days Yield change
2y	-10.00***	-15.00***	0.00	0.00	0.00	1.00	5.00**	-5.00	-16.00	-22.00
3y	-6.00**	-12.00**	-3.00	-3.00	2.00	5.00	0.00	-8.00	-16.00	-18.00
5y	0.00	-6.00	-5.00**	-5.00	1.00	2.00	-4.00*	-14.00***	-25.00**	-19.00
7y	-2.00	-7.00*	-2.00	-2.00	-1.00	-1.00	-3.00*	-21.00***	-29.00***	-18.00
9y	-1.00	-6.00*	-3.00*	-3.00***	0.00	-3.00	-3.00*	-9.00**	-28.00***	-20.00
10y	1.00	-5.00	-3.00*	-3.00***	-1.00	-3.00	-2.00	-7.00*	-30.00***	-21.00*
12y	1.00	-3.00	0.00	0.00	0.00	-3.00	0.00	-9.00***	-24.00***	-20.00*
15y	0.00	-2.00	-1.00	-1.00	-1.00	-6.00**	-3.00**	-10.00***	-15.00**	-13.00
17y	0.00	-2.00	0.00	0.00*	-1.00	-5.00*	-5.00***	-12.00***	-19.00**	-16.00*
19y	-1.00	-4.00	0.00	0.00	0.00	-3.00	-3.00**	-17.00***	-27.00***	-24.00**
20y	0.00	-5.00*	1.00	1.00**	1.00	-2.00	-5.00***	-23.00***	-32.00***	-30.00***
25y	0.00	0.00	0.00	0.00	0.00	-4.00	-5.00***	-25.00***	-36.00***	-44.00***
30y	0.00	0.00	0.00	0.00	0.00	-3.00	-5.00***	-25.00***	-38.00***	-45.00***

Table 12. Correlation Matrix: California G.O. Bonds Yield Indices by Maturity

1/3/2005-4/5//2013

Maturity	2 years	3 years	4 years	5 years	9 years	10 years	12 years	15 years	17 years	19 years	20 years	25 years
3 years	0.99	1										
4 years	0.97	0.99	1									
5 years	0.93	0.97	0.99	1								
9 years	0.62	0.70	0.78	0.85	1							
10 years	0.54	0.62	0.71	0.79	0.99	1						
12 years	0.39	0.49	0.58	0.67	0.95	0.97	1					
15 years	0.19	0.29	0.39	0.49	0.85	0.90	0.97	1				
17 years	0.08	0.19	0.29	0.39	0.79	0.85	0.93	0.99	1			
19 years	0.00	0.10	0.20	0.31	0.74	0.80	0.90	0.97	0.99	1		
20 years	-0.04	0.06	0.16	0.27	0.71	0.78	0.88	0.97	0.99	0.99	1	
25 years	-0.16	-0.06	0.05	0.16	0.62	0.70	0.82	0.92	0.96	0.98	0.99	1
30 years	-0.16	-0.06	0.04	0.15	0.61	0.69	0.81	0.92	0.96	0.98	0.99	0.99

For the whole sample yield correlation declines uniformly as the distance between bond maturities becomes longer. For example, correlation between yields on 2 and 3-year bonds is almost one, it drops to zero for the same 2 year and 19 years bond, and is negative for 30 years bonds (-0.34). In the recalibration sample (60 days before and after recalibration) correlation is also declining with the distance between maturities, but it never becomes negative, the lowest level is between 2 years and 30 years bonds (0.16). This is an evidence of the correlation pattern change around recalibration.

12/21/2009-6/1/2010

Maturity	2 years	3 years	4 years	5 years	9 years	10 years	12 years	15 years	17 years	19 years	20 years	25 years
3 years	0.94	1										
4 years	0.86	0.95	1									
5 years	0.80	0.89	0.98	1								
9 years	0.88	0.91	0.91	0.89	1							
10 years	0.85	0.88	0.89	0.88	0.99	1						
12 years	0.76	0.81	0.85	0.87	0.96	0.98	1					
15 years	0.74	0.81	0.79	0.77	0.93	0.93	0.93	1				
17 years	0.73	0.78	0.74	0.71	0.91	0.91	0.91	0.99	1			
19 years	0.70	0.73	0.68	0.65	0.88	0.89	0.89	0.96	0.99	1		
20 years	0.70	0.73	0.66	0.63	0.87	0.87	0.86	0.95	0.98	0.99	1	
25 years	0.61	0.64	0.58	0.56	0.80	0.80	0.81	0.91	0.94	0.96	0.97	1
30 years	0.59	0.61	0.55	0.54	0.79	0.79	0.79	0.89	0.92	0.95	0.96	1.00

Table 13. California and AAA Municipal Index: Pairwise Correlations

Full sample

Maturities		California G.O. Bond Yield Index							
		2	3	5 years	7 years	10 years	15 years	20 years	30 years
AAA Muni Index	2 years	0.96							
	3 years	0.97	0.95						
	5 years	0.98	0.98	0.92					
	7 years	0.97	0.98	0.95	0.86				
	10 years	0.92	0.95	0.98	0.94	0.78			
	15 years	0.78	0.83	0.91	0.93	0.88	0.70		
	20 years	0.66	0.73	0.83	0.89	0.90	0.80	0.65	
	30 years	0.54	0.62	0.76	0.88	0.95	0.88	0.77	0.68

Recalibration

Maturities		California G.O. Bond Yield Index							
		2	3	5 years	7 years	10 years	15 years	20 years	30 years
AAA Muni Index	2 years	-0.07							
	3 years	-0.15	-0.11						
	5 years	0.00	0.07	0.24					
	7 years	0.25	0.29	0.45	0.30				
	10 years	0.65	0.73	0.82	0.75	0.68			
	15 years	0.49	0.57	0.78	0.71	0.66	0.52		
	20 years	0.23	0.27	0.31	0.40	0.36	0.54	0.49	
	30 years	0.81	0.78	0.79	0.86	0.85	0.81	0.75	0.69

Table 14. Dating of a Structural Change

date	p-value of structural break dummy	R^2 of regression	Number of lags of dependent variable
March 16, 2010	0.00	0.73	12
March 25, 2010	0.00	0.73	12
April 5, 2010	0.00	0.73	12
April 19, 2010	0.09	0.74	11

Table 15. Seemingly Unrelated Regression: California. Specification I (1/18/2009-6/11/2010).

Seemingly unrelated regression, iterated; p-value in parentheses

Dependent variable: CA Municipal Index	Maturities (Years)												
	2	**3**	**5**	**7**	**9**	**10**	**12**	**15**	**17**	**19**	**20**	**25**	**30**
AAA Muni Index (maturity matched)	**0.55 (0.00)**	**0.40 (0.00)**	0.07 (0.14)	**0.07 (0.07)**	0.02 (0.51)	0.03 (0.32)	0.01 (0.81)	**0.15 (0.00)**	**0.23 (0.00)**	**0.15 (0.00)**	**0.12 (0.03)**	**0.47 (0.00)**	**0.49 (0.00)**
Bond Buyer 30 day Bond supply change	0.01 (0.70)	0.02 (0.39)	0.00 (0.97)	-0.00 (0.93)	-0.01 (0.83)	-0.01 (0.60)	-0.02 (0.31)	-0.00 (0.98)	-0.00 (0.75)	-0.02 (0.32)	-0.01 (0.59)	-0.01 (0.86)	-0.01 (0.83)
Time trend	**-0.12 (0.00)**	**-0.17 (0.00)**	**-0.32 (0.00)**	**-0.36 (0.00)**	**-0.24 (0.00)**	**-0.20 (0.00)**	**-0.16 (0.00)**	**-0.12 (0.00)**	**-0.08 (0.00)**	**-0.06 (0.01)**	**-0.05 (0.10)**	**-0.08 (0.09)**	-0.03 (0.47)
After Moody's Announcement	**-0.12 (0.00)**	**-0.17 (0.00)**	-0.03 (0.28)	-0.02 (0.57)	-0.02 (0.36)	0.00 (0.84)	0.02 (0.24)	**-0.04 (0.00)**	**-0.04 (0.00)**	**-0.06 (0.00)**	**-0.09 (0.00)**	-0.04 (0.21)	-0.02 (0.43)
After Fitch Announcement	**0.05 (0.06)**	**0.10 (0.00)**	**0.22 (0.00)**	**0.22 (0.00)**	**0.14 (0.00)**	**0.12 (0.00)**	**0.10 (0.00)**	**0.09 (0.00)**	**0.07 (0.00)**	**0.06 (0.00)**	**0.05 (0.01)**	0.03 (0.45)	0.02 (0.67)
After Fitch Recalibration	**0.07 (0.00)**	**0.11 (0.00)**	**0.18 (0.00)**	**0.18 (0.00)**	**0.12 (0.00)**	**0.10 (0.00)**	**0.05 (0.00)**	-0.01 (0.62)	**-0.03 (0.03)**	**-0.03 (0.09)**	-0.03 (0.16)	-0.04 (0.21)	**-0.06 (0.10)**
After Moody's Recalibration	**-0.07 (0.00)**	**-0.13 (0.00)**	**-0.22 (0.00)**	**-0.27 (0.00)**	**-0.26 (0.00)**	**-0.24 (0.00)**	**-0.18 (0.00)**	**-0.14 (0.00)**	**-0.16 (0.00)**	**-0.23 (0.00)**	**-0.28 (0.00)**	**-0.38 (0.00)**	**-0.39 (0.00)**
Number of Obs	105	105	105	105	105	105	105	105	105	105	105	105	105
R^2	0.80	0.88	0.76	0.82	0.90	0.92	0.90	0.93	0.95	0.95	0.96	0.93	0.93
Overall post-R effect	-0.07	-0.09	0.18	0.11	0	-0.02	-0.03	-0.09	-0.16	-0.26	-0.32	-0.38	-0.45

Breusch-Pagan test of independence: chi2(78) = 3145.162, Pr = 0.0000

Table 16. Seemingly Unrelated Regression: California. Specification II (1/18/2009-6/11/2010).

Seemingly unrelated regression, iterated; p-value in parentheses

Dependent variable: CA Municipal GO Index	Maturities (Years)												
	2	**3**	**5**	**7**	**9**	**10**	**12**	**15**	**17**	**19**	**20**	**25**	**30**
AAA Muni Index (maturity matched)	**0.69 (0.00)**	**0.62 (0.00)**	**0.24 (0.00)**	**0.15 (0.00)**	**0.20 (0.00)**	**0.21 (0.00)**	**0.18 (0.00)**	**0.22 (0.00)**	**0.24 (0.00)**	**0.16 (0.00)**	**0.11 (0.02)**	**0.38 (0.00)**	**0.41 (0.00)**
Bond Buyer 30 day Bond supply change	0.00 (0.78)	0.00 (0.65)	0.00 (0.75)	-0.00 (0.75)	-0.00 (0.67)	-0.00 (0.51)	-0.00 (0.24)	-0.00 (0.59)	-0.00 (0.39)	-0.00 (0.17)	-0.00 (0.39)	-0.00 (0.74)	-0.00 (0.73)
Time trend	**-0.06 (0.04)**	**-0.07 (0.03)**	**-0.14 (0.02)**	**-0.15 (0.01)**	**-0.07 (0.03)**	**-0.06 (0.02)**	**-0.07 (0.00)**	**-0.08 (0.00)**	**-0.07 (0.00)**	**-0.04 (0.04)**	-0.03 (0.18)	**-0.09 (0.04)**	-0.05 (0.22)
After Moody's Announcement	**-0.10 (0.00)**	**-0.13 (0.00)**	**0.09 (0.01)**	**0.09 (0.01)**	**0.04 (0.04)**	**0.05 (0.00)**	**0.06 (0.00)**	-0.01 (0.66)	-0.01 (0.34)	**-0.03 (0.01)**	**-0.07 (0.00)**	-0.03 (0.21)	-0.03 (0.31)
After Fitch Announcement													
After Fitch Recalibration													
After Moody's Recalibration	**-0.05 (0.00)**	**-0.08 (0.00)**	**-0.15 (0.00)**	**-0.20 (0.00)**	**-0.20 (0.00)**	**-0.19 (0.00)**	**-0.16 (0.00)**	**-0.13 (0.00)**	**-0.16 (0.00)**	**-0.23 (0.00)**	**-0.28 (0.00)**	**-0.39 (0.00)**	**-0.41 (0.00)**
Number of Obs	105	105	105	105	105	105	105	105	105	105	105	105	105
R^2	0.78	0.82	0.58	0.68	0.85	0.89	0.86	0.91	0.94	0.95	0.95	0.93	0.92
Overall post-R effect	-0.15	-0.21	-0.6	-0.11	-0.16	-0.15	-0.10	-0.13	-0.16	-0.26	-0.35	-0.39	-0.41

Table 17. Seemingly Unrelated Regression: (18 states)

Dependent variable: State G.O. Yield	Maturity (years)												
	2	**3**	**5**	**7**	**9**	**10**	**12**	**15**	**17**	**19**	**20**	**25**	**30**
AAA Municipal Index	**0.67**	**0.72**	**0.67**	**0.62**	**0.46**	**0.41**	**0.40**	**0.36**	**0.26**	**0.09**	**0.16**	-0.04	-0.08
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	(0.75)	(0.55)
Bond Buyer 30 day Bond supply change	0.00	0.00	0.00	0	0	0	0	0	0	0	0	0	0
	(0.65)	(0.69)	(0.80)	(0.69)	(0.92)	(0.97)	(0.95)	(0.92)	(0.99)	(0.99)	(0.98)	(0.92)	(0.93)
Time Trend	**-0.002**	**-0.003**	**-0.003**	**-0.004**	**-0.005**	**-0.005**	**-0.005**	**-0.004**	**-0.004**	**-0.004**	**0.004**	**-0.004**	**-0.004**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Upgrade*After Moody's Announcement	**0.14**	**0.16**	**0.22**	**0.23**	**0.28**	**0.29**	**0.28**	**0.24**	**0.27**	**0.28**	**0.29**	**0.28**	**0.30**
	(0.00)	**(0.00)**	**(0.00)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0.00)**	**(0.00)**
Upgrade*After Fitch Announcement	**0.06**	**0.06**	**0.07**	**0.09**	**0.07**	**0.06**	**0.07**	**0.07**	**0.06**	**0.06**	0.05	0.04	0.05
	(0.00)	**(0.01)**	**(0.01)**	**(0.01)**	**(0.06)**	**(0.07)**	**(0.03)**	**(0.01)**	**(0.04)**	**(0.08)**	(0.12)	(0.21)	(0.24)
Upgrade*After Fitch Recalibration	0.03	**0.04**	**0.05**	**0.08**	**0.09**	**0.08**	**0.05**	0.03	0.03	0.02	0.03	0.02	0.02
	(0.16)	**(0.06)**	**(0.04)**	**(0.01)**	**(0.01)**	**(0.01)**	**(0.06)**	(0.18)	(0.32)	(0.40)	(0.34)	(0.52)	(0.53)
Upgrade*After Moody's Recalibration	0.02	0.02	0.01	0.01	0.02	0.02	0.002	0.01	0.02	0.01	0.004	-0.005	0.00
	(0.17)	(0.23)	(0.65)	(0.58)	(0.41)	(0.49)	(0.90)	(0.55)	(0.31)	(0.51)	(0.88)	(0.83)	(0.99)
Number of Observations	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879
R^2	0.45	0.47	0.49	0.43	0.40	0.42	0.45	0.42	0.41	0.36	0.34	0.29	0.28

Table 18. Seemingly Unrelated Regression: (18 states)

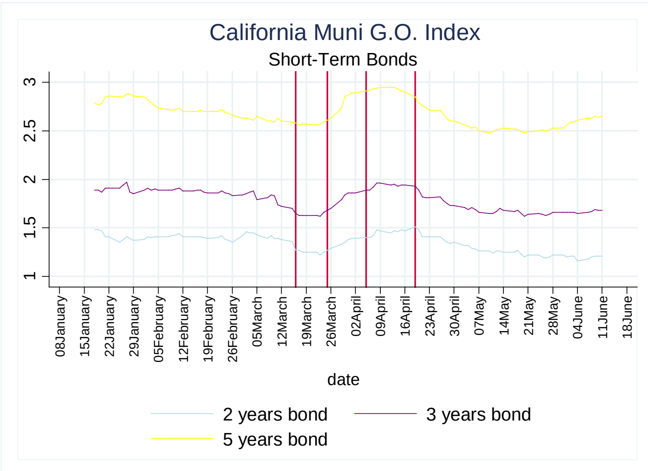
Dependent variable: State G.O. Yield	Maturity (years)												
	2	**3**	**5**	**7**	**9**	**10**	**12**	**15**	**17**	**19**	**20**	**25**	**30**
AAA Municipal Index	**0.69**	**0.73**	**0.68**	**0.65**	**0.48**	**0.43**	**0.42**	**0.41**	**0.28**	**0.10**	**0.15**	0.02	-0.01
	(0)	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	**(0)**	(0.90)	(0.93)
Bond Buyer 30 day Bond supply change	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(0.78)	(0.78)	(0.89)	**(0.00)**	(0.96)	(0.99)	(0.89)	(0.99)	(0.90)	(0.92)	(0.96)	(0.98)	(0.98)
Time Trend	**-0.002**	**-0.003**	**-0.004**	**-0.004**	**-0.005**	**-0.005**	**-0.005**	**-0.004**	**-0.004**	**-0.004**	**-0.004**	**-0.004**	**-0.004**
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**
Upgrade*After Moody's Announcement	**0.19**	**0.22**	**0.29**	**0.33**	**0.37**	**0.37**	**0.35**	**0.30**	**0.32**	**0.33**	**0.34**	**0.32**	0.34
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	(0.00)
Upgrade*After Moody's Recalibration	**0.05**	**0.06**	**0.06**	**0.08**	**0.09**	**0.08**	**0.05**	**0.05**	**0.05**	**0.04**	**0.03**	0.02	0.03
	(0.00)	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.00)**	**(0.01)**	**(0.05)**	(0.29)	(0.19)
Number of Observations	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879	1879
R^2	0.44	0.47	0.48	0.42	0.39	0.42	0.44	0.41	0.40	0.36	0.34	0.29	0.27

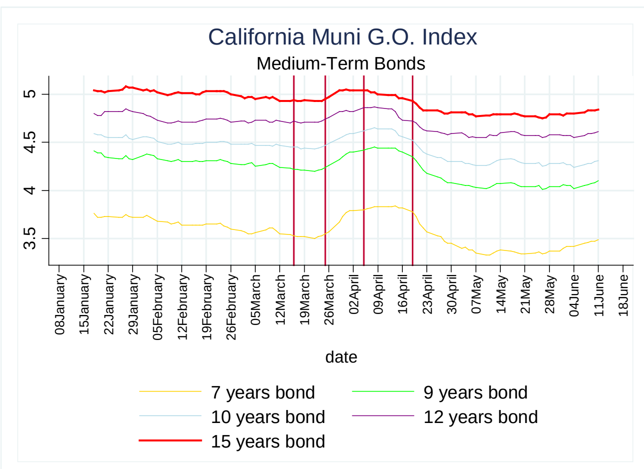
Table 19. Average Daily Trade Size, Fixed Coupon Bonds, $ millions.

Final Maturity	2007	2008	2009	2010 Q1	2010 Q2	2010 Q3	2010 Q4
0–9Months	2.809	1.303	1.083	1.018	1.311	1.302	1.375
>9Months–2Years	1.164	1.223	1.034	0.724	1.048	1.570	1.012
>2Years–5Years	0.230	0.241	0.259	0.291	0.257	0.261	0.286
>5Years–10Years	0.190	0.168	0.167	0.172	0.171	0.175	0.183
>10Years–15Years	0.219	0.181	0.154	0.152	0.151	0.161	0.152
>15Years–20Years	0.243	0.222	0.157	0.151	0.149	0.154	0.154
>20Years–30Years	0.258	0.217	0.172	0.155	0.154	0.157	0.163

Average trade size was computed by dividing average daily par amount traded by average daily number of trades. Both indicators are reported in MSRB Fact Book 2010.

Figure1. California General Obligation Municipal Bond Yield, 1/18/2010 – 6/11/2010





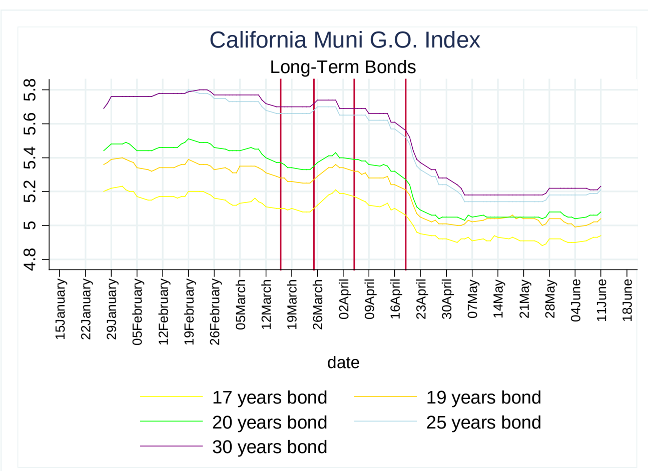


Figure 2. Illustrating Direct and Indirect Ratings Effects

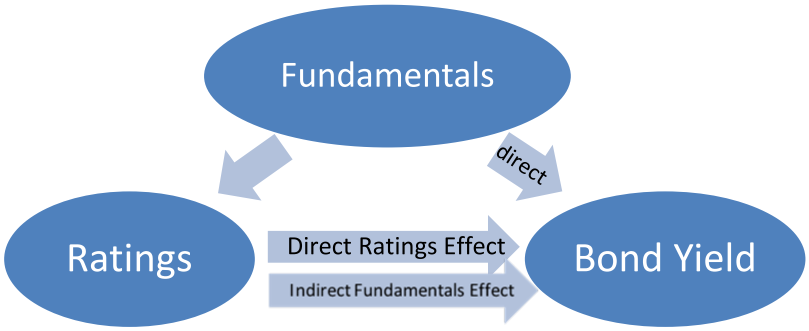


Figure 3. Illustrating Relative Demand Impact

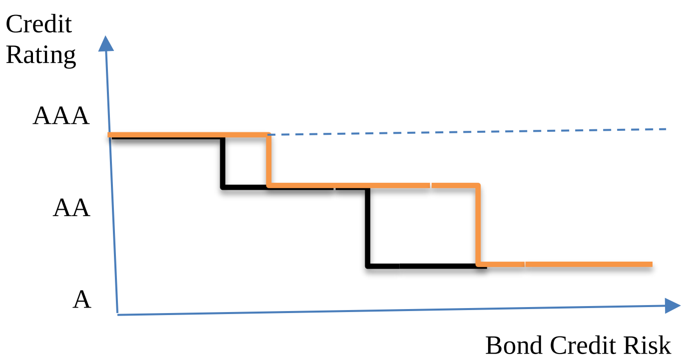


Figure 4. Illustrating State Yield Factor Decomposition

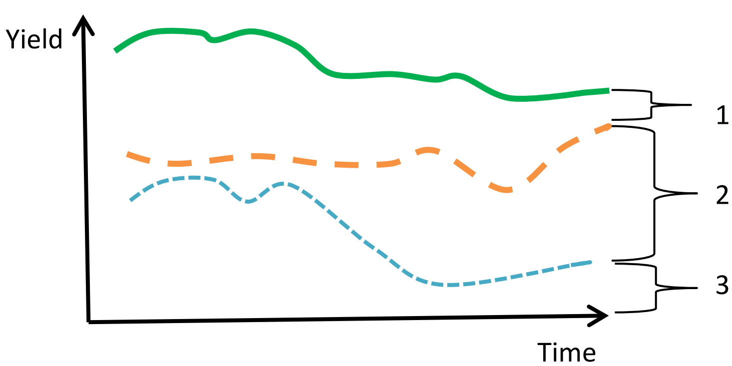


Figure 5. Monthly Trading Summary

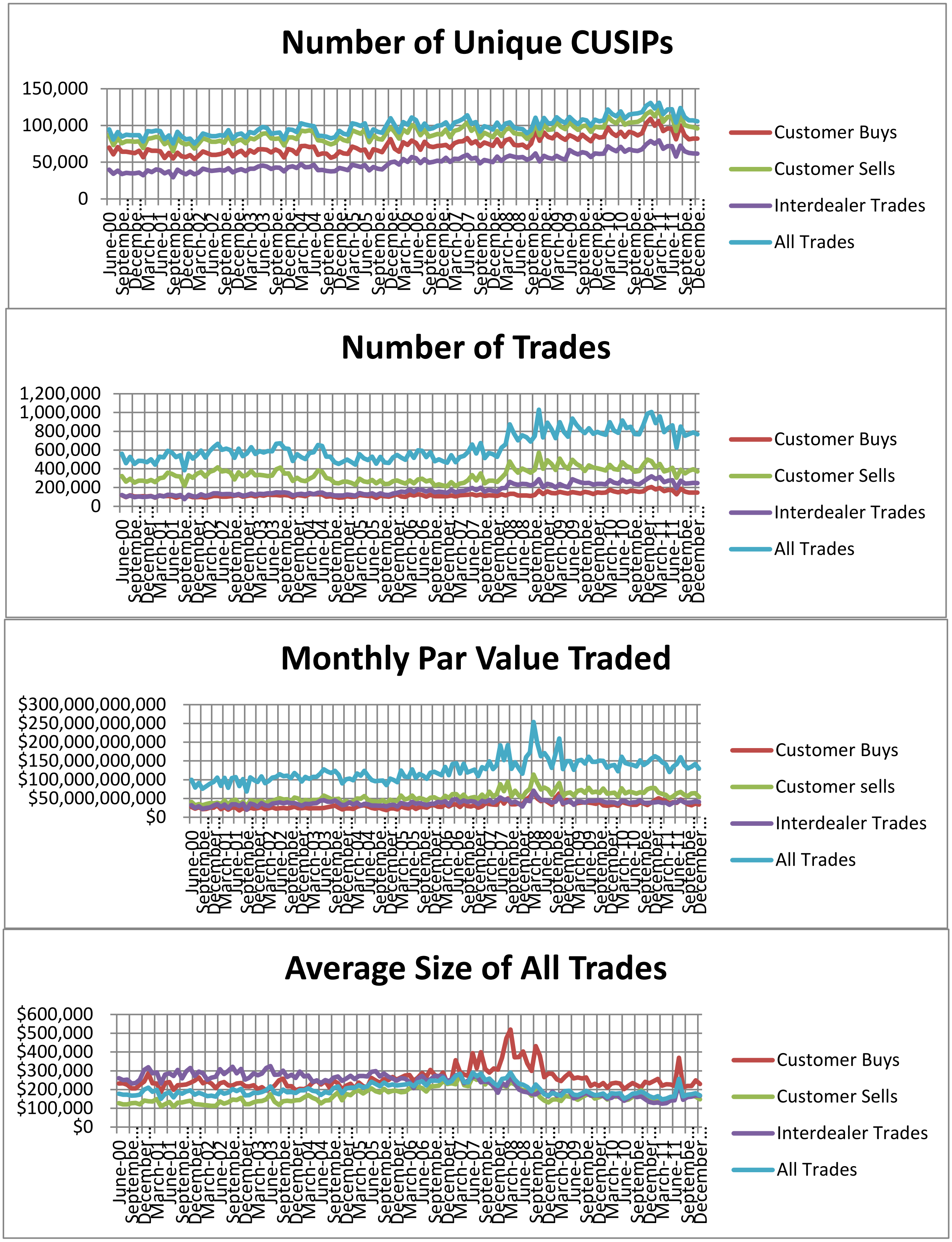
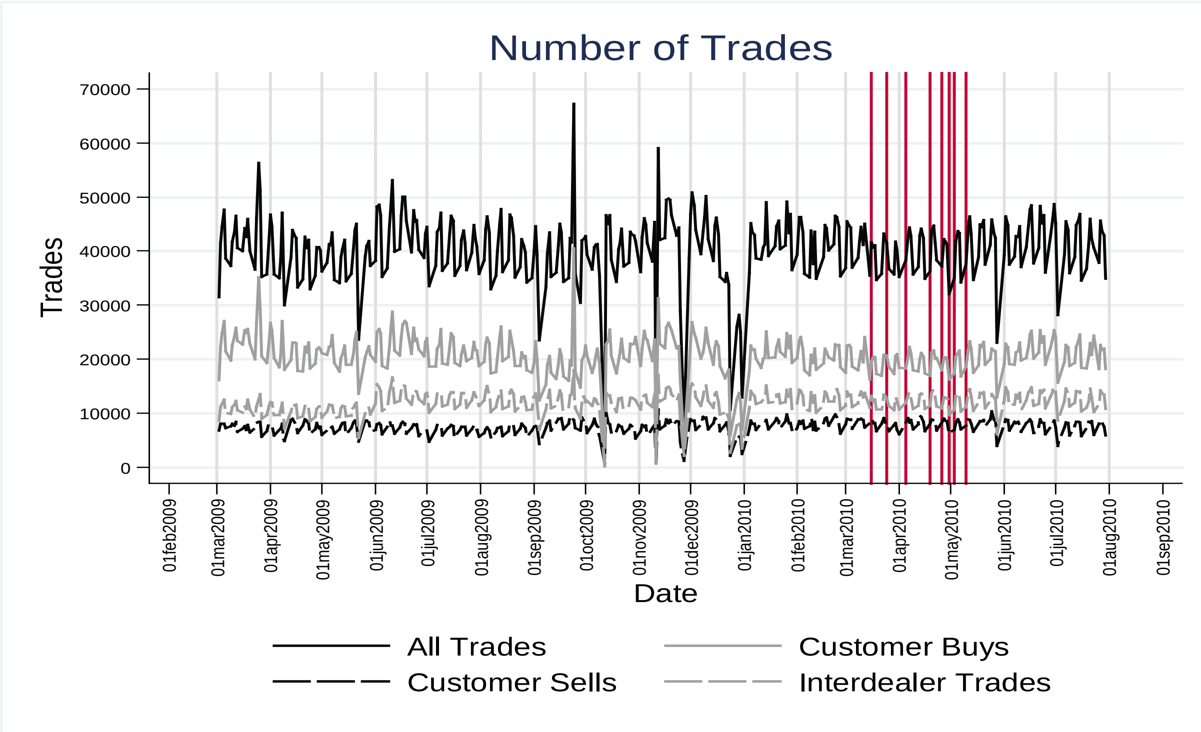


Figure 6. Daily Trading Summary



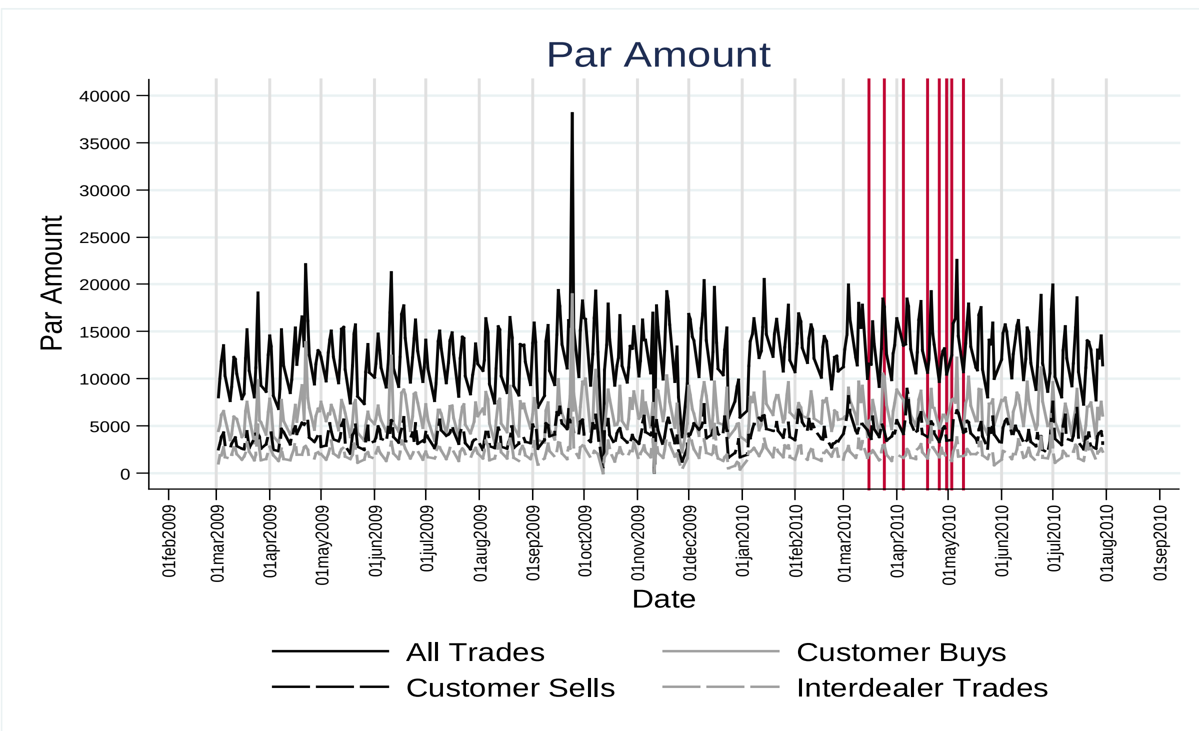
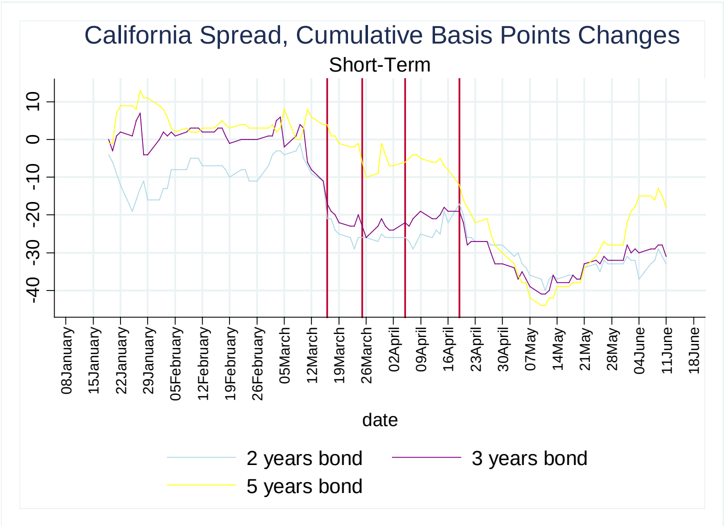
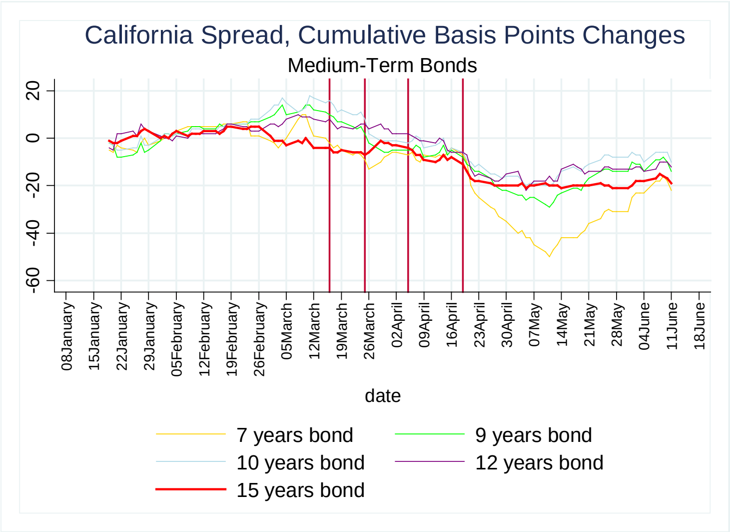


Figure 7. California –AAA Municipal Index Spread: Cumulative Changes (basis points)





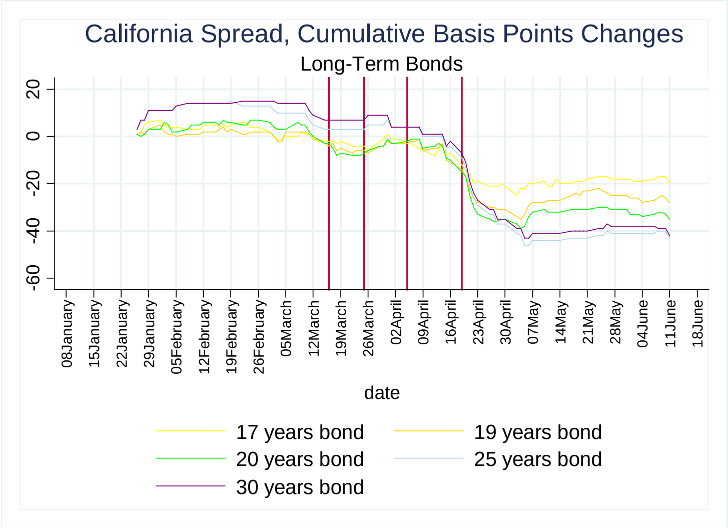


Figure 8. Stationarity Check.

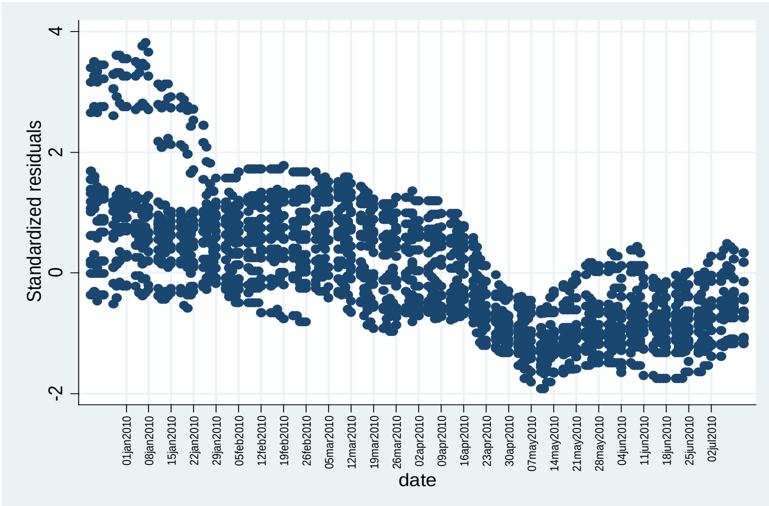
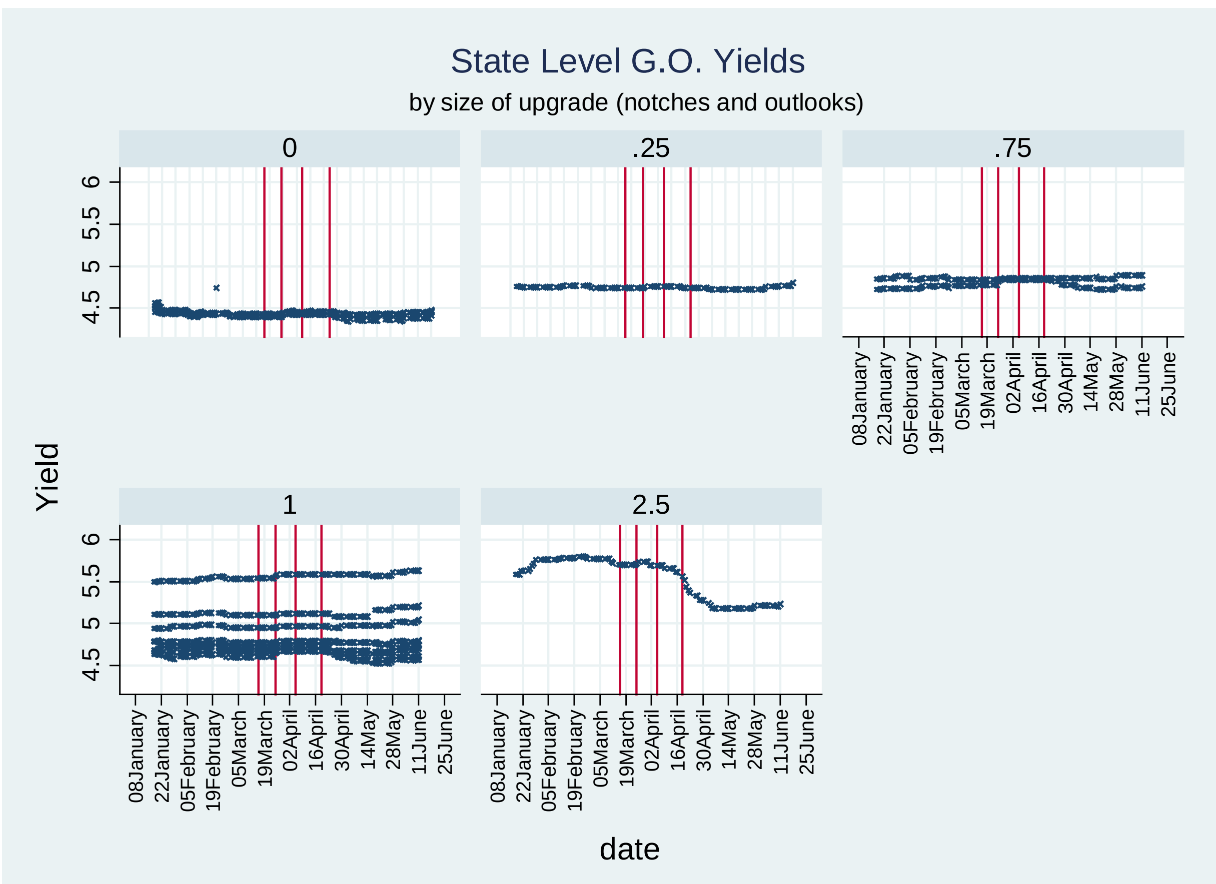


Figure 9. State level G.O. bond yields, maturity =30 years, by size of upgrade



Note: Size of upgrade = average number of notches and outlooks from Moody's and Fitch.
1 notch =1, outlook=0.5

Figure 10. Yield convergence I (G.O. bonds): Ratio of California G.O. Yield to US Corporate Bonds Rated A1.

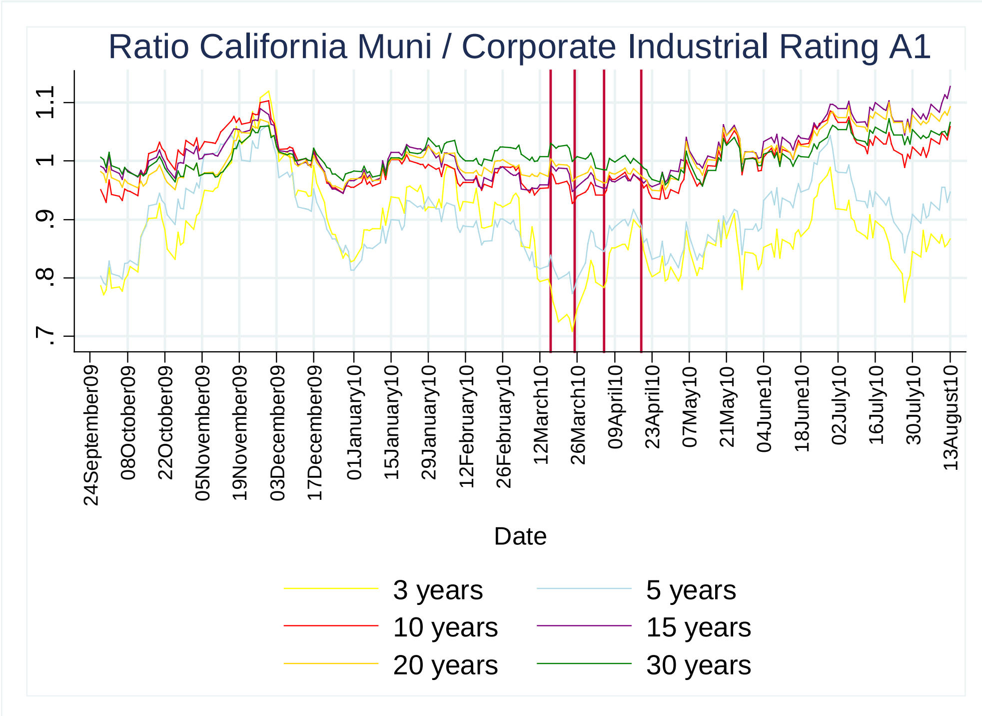


Figure 11. Yield convergence II (Non-G.O. bonds): Ratio of Municipal to Corporate Yields for Utilities bonds rated AA.