The Price of Safety: The Evolution of Insurance Value in Municipal Markets*

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Abstract

We examine the benefits of bond insurance to taxpayers using comprehensive data and selection models to control for fundamentals and the endogenous choice to insure. Prior to 2008, when insurance provided AAA coverage, insurance saves issuers 9 bps, on average. Because the monolines were downgraded in 2008-2009 and because general obligation bonds were upgraded due to Moody's scale recalibration in 2010, the distance between the credit quality of the insured issuers and of the available insurance shrinks from both sides. Since 2008, insurance is associated with offering yields 4 bps higher than otherwise similar uninsured issuers; only the lowest-rated issuers obtain gross benefit. Although prior evidence from secondary markets suggests that insurance generally provides value to investors, our results from primary markets indicate that insurance generally provides no value to taxpayers who pay the premiums.

Keywords: bond insurance, municipal bonds, yield inversion, municipal market liquidity, propensity score matching IPWRA

JEL Classification: G01, G12, G22, H74

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1 Introduction

The purpose of this paper is to test whether bond insurance provides value to investors in and issuers of municipal bonds (munis). This question is important because the cost of insurance is borne by taxpayers.[1] This question remains unanswered by a literature providing mixed evidence based on relatively small samples of munis issued in particular states (e.g., Texas, California, New York) or in limited time periods.

In theory, insurance should reduce the cost of municipal borrowing by reducing expected default costs, providing due diligence, and improving price stability and market liquidity. Indeed, these are claims made by insurers.[2] From the literature, Thakor (1982) models a signaling benefit, Nanda and Singh (2004) indicate a tax benefit, and Gore et al. (2004) find that insurers reduce asymmetric information costs. It is further intuitive that bond insurers provide more reliable certification than the credit rating agencies (CRAs), given that insurers potentially incur losses in the event of issuer default; see Bergstresser et al. (2015). Still, prior empirical studies document a yield inversion in the secondary market, where insured bonds have higher yields than uninsured bonds during the 2008 financial crisis suggesting that insurance has no value precisely when needed most; see Bergstresser et al. (2010), Lai and Zhang (2013), and Chun et al. (2018).

We bring a more comprehensive dataset to the question of insurance value than prior studies. We examine the direct and indirect value of municipal bond insurance with a sample of over 700,000 munis issued over the last 30 years with data on issuers, insurers (if insured), issue characteristics including the time series of changes in underlying credit quality, and secondary market activities. Importantly, we examine not only the secondary market value

[1]Municipal bond insurance premiums peaked at approximately $1.5 billion per year in 2007 (see Joffe, 2017). Although the industry contracted following the financial crisis of 2008, the fraction of newly issued bonds with insurance has rebounded since 2012. See Section 2.1 for more details.

[2]The largest public provider of municipal bond insurance sponsors articles promoting the value of their products at www.municipalbonds.com. See, for example, "Top 5 Reasons You Should Choose Insured Muni Bonds Over Uninsured" available here: http://www.municipalbonds.com/bond-insurance/top-5-reasons-should-choose-insured-muni-bonds-over-uninsured/.

of insurance to investors, but also the primary market value to the taxpayers paying the premiums.

Our results suggest that the yield inversion observed in secondary markets during the financial crisis is attributable to the financial distress and downgrades of the major insurers. After losing their Aaa certification, bond insurers were rated at or below most munis' underlying credit ratings. We find that the secondary-market yield inversion is driven by the insured munis with credit ratings at or above the ratings of the downgraded insurers.[3] In all time periods, including the crisis, lower-rated bonds with insurance continue to face lower yields than their uninsured counterparts with the same underlying ratings. We conclude from our secondary market results that insurance is valuable to investors, provided the insurance company is of higher credit quality than the insured issuers.

Because insurers claim that insurance improves secondary market liquidity, and because many issuers are interested in refunding, we further consider that lost liquidity associated with the loss of Aaa insurance might play a role. However, using transaction costs estimated following Harris and Piwowar (2006), we find little difference in the liquidity of insured versus uninsured bonds of similar credit quality, either before or since the crisis.

We then focus on the primary market and measure the direct benefit to issuers as a reduction in true interest costs (TIC) at issuance. We take seriously the endogenous choice by issuers whether or not to insure their bonds and the potential for such selection to influence our empirical results. Because credit ratings are coarse measures of credit risk (see Goel and Thakor, 2015), there exists variation in credit quality within each rating category; some issues have higher credit quality than the average for the rating while others have lower-than-average quality. The most transparent highly-rated issuers, observable as high-quality to market participants, have less need for insurance to signal their quality. If insurance is purchased only by opaque and lower-quality issuers within each rating category, then we should observe

[3]Conversations with municipal advisors and underwriters at the 2018 Brookings Conference on Municipal Finance indicate that some dealers price insured bonds based on the insured rating, rather than the underlying rating, regardless of which is higher.

a yield inversion (higher yields faced by insured bonds than uninsured bonds with the same credit rating) in the primary market, even if insurance lowers TIC.

In order to test the effect of insurance on pricing, given the selection effects described above, we first thoroughly control for observable issue characteristics and macroeconomic variables in OLS regressions. Given our comprehensive set of publicly and commercially available data, we believe that any risk factor omitted from our model would be difficult for muni bond investors (primarily retail investors) to observe and price.[4] Next, we employ two types of selection adjusted models to further control for the endogenous choice by issuers to insure their bonds. The first is a propensity score matching model, based on which we calculate average treatment effects to cleanly estimate the value of insurance. The second is a "doubly-robust" inverse-probability weighted regression adjustment (IPWRA) model that controls for the endogenous choice to insure yet remains robust to potential misspecification.

Over the entire period from 1985-2016, we find that issuers accrue a total benefit of $459 million over the entire 31 year period, roughly equivalent to the premiums collected by an insurer (MBIA) in just one year, 2004. In the pre-crisis period (1985-2007), when bond insurers were almost universally rated Aaa, we find that insurance lowers issuance costs even on a dollar-weighted basis. However, in the period since 2008, we find no evidence that insurance lowers the average municipal issuers' borrowing costs, even in gross terms, after controlling for credit quality and the endogenous choice to insure. Only a relatively small number of low-rated issuers obtain any direct benefit of insurance. We conclude that the majority of highly-rated issuers are subsidizing these low-rated issuers. Similar to the results from the secondary market, time series analysis indicates that this lack of insurance value

[4]In addition to underlying and insured credit ratings, we control for each bond the choice to insure, the prior use of insurance by the issuer, the size of the specific bond as well as the size of the full issue, bond maturity and squared maturity to account for its non-linear effects, an indicator for underwriter, a discrete count of the number of underwriters and advisors for the issue, an indicator for whether the bond is bank qualified, an indicator for whether the issue is negotiated or competitively offered, state fixed effects, specified use of proceeds (general purposes, water and sewer, K-12 education, higher education, or other uses), and macro-economic factors including contemporaneous Baa–Aaa credit spread, the slope of the yield curve (10Y–1Y Treasury yields), the 10Y Treasury constant maturity yield, and the inflation rate.

stems from the relative quality of insurers vis-a-vis insured issuers. Because the monolines were downgraded in 2008-2009 and because general obligation bonds were upgraded due to Moody's scale recalibration in 2010, the distance between the credit quality of the insured issuers and of the available insurance shrinks from both sides.

Because the gross value of insurance is only positive among a small number of lowest-quality municipal issuers, any insurance premium represents negative value for most municipal issuers. Based on data from MBIA and AMBAC annual reports on premiums collected and percentage of market share, we estimate that municipalities paid over $17 billion dollars directly to insurers from 1995–2008.[5] In 2017, we estimate that the two remaining bond insurers (Assured Guaranty and subsidiaries and the much smaller Build America Mutual) collected approximately $250 million in premiums.

While it is puzzling that highly-rated issuers pay for insurance without commensurate economic benefits, paying for coverage that provides little value is consistent with prior literature documenting an "over-insurance" phenomenon. For example, Shapira and Venezia (2008) document the irrational consumer preference of full-coverage (zero-dollar deductible) automobile liability, medical insurance, and consumer product policies (e.g., fabric stain coverage sold in furniture stores and TV and appliance warranties sold by major retailers). Much different from those covered losses, where premiums are paid by the policies' direct beneficiaries, we find evidence of an over-insurance phenomenon when premiums are paid by one party (taxpayers) and any insurance payout goes to another party (investors).

We quantify the over-insurance – money left on the table – across municipalities and find that it correlates (negatively) with municipal government quality, proxied by prosecutions and convictions of public servants. We also consider the role of municipal advisor incentives and interests of influential underwriters who must carry bonds they cannot readily place. We find that municipalities hiring large, influential advisors or underwriters leave the most money on the table. These results are relevant to the current policy debate over municipal

[5] See Figure A.1 in the Internet Appendix.

advisor incentives.[6] In addition to the empirical results discussed above, we contribute to the literature this more granular measure of money left on the table by poorly advised municipalities which compliments the prior work from Ang et al. (2017) and should prove useful to future research on municipal issuer behavior.

Our paper proceeds as follows. We briefly describe the municipal bond insurance market and related literature in Section 2 and provide a detailed description of our data in Section 3 including details on our bond transaction cost function estimation. We examine the secondary market value of insurance (reduced yield and/or increased liquidity) in Section 4. In Section 5, we examine the primary market value of insurance (reduction in total interest costs) to the issuers. In Section 6, we explore the relationship between the over-insurance phenomenon and the quality of municipal governance as well as the fulfillment of fiduciary duties of advisors and underwriters. Finally, Section 7 concludes.

2 Background and Related Literature

2.1 Evolution of municipal bond insurance

In 1971, the American Municipal Bond Assurance Corporation (AMBAC) began writing insurance to guarantee timely payment of muni issues in the event of default by the municipality. AMBAC was quickly joined by a competitor, the Municipal Bond Insurance Association (MBIA), which formed as a joint entity by major property and casualty insurers of the day (Aetna, Travelers, Cigna, Fireman's Fund, and Continental). The well-publicized financial distress of New York City, and default by Washington Power Supply (in 1983), increased demand for muni insurance. AMBAC and MBIA were later joined by Financial Guaranty Insurance Company (FGIC) and Financial Security Assurance (FSA) in 1983 and

[6] See Bergstresser and Luby (2018) for a discussion of the variation in the quality and incentives of the municipal advisors who advise issuers on bond insurance, investment of bond proceeds, escrow arrangements, and the use of derivatives. Prior to the Dodd Frank Act of 2011, municipal advisors were not required to exhibit any particular qualifications, register with any regulatory authority, and held no fiduciary duty to the municipalities they advised. These advisors commonly solicited business for third parties, such as bond insurance companies. During our sample period, some advisors are affiliated with broker-dealers that also provide underwriting services.

1985, respectively. The subsequent default by Orange County, CA (in 1994) further increased demand. The so-called "big four" were joined in the early 2000s by other insurers, most notably Assured Guaranty Corporation (AGC), Radian Guaranty, XL Capital Assurance (XLCA), and CDC IXIS Financial Guaranty (CIFG). By the end of 2006, the monoline insurance market was insuring 49% of all new issues, and $2.3 trillion of par outstanding.[7] The market remained concentrated with the big four insurers controlling nearly $2 trillion of that $2.3 trillion amount.

Figure 1 plots the ascent in the popularity of bond insurance in the General Obligation (GO) bond market and its subsequent crash during the financial crisis. In the pre-crisis period, a high of over 60% of GO bonds are insured. By 2010, the percentage was closer to 10%. Since the depth of the crisis and the demise of the largest monolines, the remaining market (a much smaller number and amount) was ceded to Assured Guaranty who wrote virtually all the municipal bond insurance issued from 2009 to 2012.[8] Beginning in 2013, Build America Municipal (BAM), a mutually incorporated insurer, emerges as a serious competitor in the post-crisis market. By 2016, the percentage of GO bonds with insurance rebounds to about 20% representing approximately 7% of issuance volume.

2.2 Contribution to prior literature

Prior empirical research documents several puzzles in the muni market. The first such puzzle examined extensively is the evidence that long-term tax-exempt yields are too high relative to after-tax yields on taxable bonds.[9] Related papers appeal to the tax-sensitivity of muni investors to explain other puzzling phenomena; see Starks et al. (2006) and Landoni (2018) regarding the "January effect" and the original issue premium, respectively. Finally,

[7] Bond insurers are referred to as "monolines" because they are prohibited by insurance regulators from providing other types of coverage such as property & casualty or life & health insurance.

[8] Assured Guaranty operates in this market with two subsidiaries, AGC and Assured Guaranty Municipal (AGM). For details on the demise of the monoline insurance industry, see Moldogaziev (2013) and Cornaggia et al. (2018b).

[9] For examples, see Trzcinka (1982), Kidwell and Trzcinka (1982), Skelton (1983), Buser and Hess (1986), Kochin and Parks (1988), Green (1993), Green and Oedegaard (1997), Chalmers (1998), Chalmers (2006), and Longstaff (2011).

Ang et al. (2017) document the puzzling evidence that the widespread advance refunding by municipal issuers is exercised prematurely and at a net present value loss.

The improved disclosure of trade prices via the Electronic Municipal Market Access database and issuer fundamentals made available by the Municipal Securities Rulemaking Board (MSRB) helped expand the literature to analyze market efficiency (as in Downing and Zhang, 2004, Harris and Piwowar, 2006, Green et al., 2007, and Schultz, 2012), real economic effects of muni rating changes (as in Adelino et al., 2017 and Cornaggia et al., 2018a), the relative importance of default, liquidity, and tax components in muni credit spreads (e.g., Wang et al., 2008, Ang et al., 2014, and Schwert, 2017), municipality financing constraints (Ang et al., 2017), market segmentation (e.g., Pirinsky and Wang, 2011, Schultz, 2012, and Babina et al., 2017), muni market information environment (Gao et al., 2018a and Cornaggia et al., 2018b), and the effects of state bankruptcy policies (Gao et al., 2018b).

To this growing literature, we analyze the value of credit enhancement provided by the monoline insurers, specifically to municipal issuers in the form of reduced interest costs at issuance. Prior empirical analysis of insurance value (discussed below) has focused primarily on secondary market value (to investors) and/or employed relatively small samples from individual states or in specific time periods. We believe that the question of insurance value is even more important in the primary markets (i.e., to the taxpayers paying the premiums) and we bring the question to the entire market for GO bonds over a 30-year period. We focus on GO bonds because of their homogeneity due to recourse to tax revenues, because taxpayers at large bear the cost of buying insurance on GO bonds, and for consistency with prior literature, e.g., Kidwell et al. (1987); Bergstresser et al. (2010); and Bergstresser et al. (2015). We find evidence that, in the absence of Aaa-rated municipal insurers, only low-rated issuers derive economic benefits from purchasing insurance.

2.3 Prior evidence of insurance value

Early empirical evidence from Cole and Officer (1981) indicates a significant negative difference between the true interest cost with and without insurance suggesting that insurance provides at least a gross benefit in lowering financing costs. Adding data on insurance premiums for 333 MBIA-insured bonds, Kidwell et al. (1987) estimate a net benefit increasing in issuer credit risk: on average, issuers purchasing bond insurance enjoyed issuance costs 22 bps lower than their uninsured peers (after accounting for the 11 bps average premium) with Baa rated issuers saving 59 bps. More recently, Wilkoff (2013) finds that insurance lowers yields by 8 bps, on average.

However, recent empirical studies suggest less benefit over time. Analyzing a sample of bonds issued in California and New York, Bronshtein (2015) finds that the value of insurance has fallen from over 3% of deal value in years prior to the financial crisis to below 1% of deal value after the crisis. Kriz and Joffe (2017) also analyze bonds issued in California and find that insurance conveys no significant value to issuers in that state after including comprehensive issuance costs.

Based on a sample of munis issued in 2015, Landoni (2017) finds that the tax-arbitrage value of insurance suggested by Nanda and Singh (2004) is negligible, and even negative under a realistic calibration. Cornaggia et al. (2018b) find that insured bonds of various credit quality price identically to true Aaa uninsured bonds (indicating that insurance is valuable) prior to the crisis, but then returns on insured bonds diverge from true Aaa returns after the financial crisis. Other studies of secondary markets document a negative benefit of municipal bond insurance over time and during the crisis period in particular; see Bergstresser et al. (2010), Lai and Zhang (2013), and Chun et al. (2018).

In contrast to the apparent decline in insurance benefit, evidence from Ely (2012) suggests that the cost of coverage is increasing. Converting the mean values in Ely (2012) to a basis point cost using the method in Kidwell et al. (1987) yields a 7.3 bps premium in 2008 and

2009 compared to a 2.5 bps premium from 2004 to 2007. We aim to resolve the apparent puzzle that issuers are paying more for a less valuable product with models that control for selection bias. Issuers choose whether to purchase insurance and prior evidence suggests, for example, that issuers in more corrupt locations are more likely to buy insurance; see Butler et al. (2009). However, we find that insurance only lowers borrowing costs among the lowest quality issuers. For most municipalities, our results indicate that gross value of insurance is small. This result remains even after controlling for underlying credit quality and the endogenous choice to insure. We are the first to document yield inversion in the primary market. Because taxpayers pay the insurance premiums, we believe that the value of insurance to issuers is even more important than that to secondary market investors.

3 Data

3.1 Primary market data

We construct our sample from a variety of sources to comprehensively describe the municipal bond universe up to June 16, 2016, the cutoff date for our access to the Mergent Municipal Bond Securities (Mergent) database. We start with 3,555,964 bonds issued by 53,045 municipal issuers across different levels of government. From there we limit our sample to only tax-exempt, semi-annual fixed rate coupon bonds that are unlimited tax general obligations (GO bonds), issued between 1985 and June 2016, have a positive offering amount and coupon rate, and represent new borrowing.[10] We also exclude all bonds that are offered via unconventional channels (e.g. limited offerings, private placements, and remarketing), and a small number of bonds that are issued by U.S. territories other than Puerto Rico.

[10] We also exclude a small number of CUSIPs that are the pre-refunded portion of an original new borrowing bond. When a bond gets pre-refunded, the pre-refunded portion and the remaining balance become two separate CUSIPs in the Mergent database but retain all issuance characteristics of the original bond. For analysis related to the primary market, we exclude both CUSIPs to avoid double counting. For analysis related to the secondary market, we exclude only the pre-refunded CUSIPs, given that trading activity in the original bond switches to that of the remaining-balance CUSIP after the pre-refunding date.

Our primary market analysis requires rating and insurer's ID at issuance. Cornaggia et al. (2018b) document key limitations of the Mergent data, including over-written bond ratings and insurer providers; that is, Mergent overwrites these values as they change over time. In addition, for insured bonds, Mergent only records the rating of the insurer and not the rating of the underlying credit. Because the majority of municipal bonds have changes in insurer (mainly due to the restructurings in the monoline insurance industry after the crisis), credit rating, or both over our sample window, relying exclusively on Mergent data would result in erroneous inferences. We therefore employ the reconstructed time series of original and subsequent insurers of each bond available from Cornaggia et al. (2018b) and supplement the credit ratings with a comprehensive history of S&P and Moody' ratings for municipal bonds obtained directly from these rating agencies' websites.[11] We convert character ratings into numeric ratings with 21 corresponding to the highest credit quality and 1 the lowest. Many bonds are rated by more than one credit rating agency; when rating information is available from multiple rating agencies, we employ the harshest as our measure of underlying credit quality. We report the distribution of underlying credit rating categories of the sample bonds in the Internet Appendix (Table A.1). Note that all insured GO bonds with Aaa underlying rating were issued prior to the loss of Aaa insurance. We find no evidence that Aaa-rated issuers purchase lower-rated insurance.

From Moody's press releases and news updates available on their website, we obtain the credit rating history of the insurers. We obtain data on corporate restructuring dates from a wide variety of sources, including Moldogaziev (2013) and insurers' websites.

3.2 Secondary market data

We obtain trade data for the bonds in our sample from the MSRB (available on WRDS) from January 2005 to December 31, 2018. We then filter the trade data by removing primary market transactions (i.e., when-issued trades, offering takedown trades, and trades within

[11] We are grateful to Ryan Israelsen for providing us these data up to and including 2012, originally collected for analysis in Cornaggia et al. (2018a), and Marc Joffe for providing post-2012 ratings history from Rule 17g-7(b) data at http://www.ratingshistory.info.

two weeks of issuance), trades that occur less than one year prior to maturity, a handful of trades with size of less than $1,000, and price outliers (bonds with prices less than 50 or higher than 150, following Schwert, 2017).

We use the trade data for two purposes. One is to analyze trading activities and the yields at which municipal bonds trade in the secondary market. Because we care about prices paid or received by investors, we examine only customer trades. Our sample after cleaning has 8,582,171 customer trades in 307,126 bonds. The second use of the trade data is to estimate transaction costs as our measure of bond liquidity, following the methodology developed by Harris and Piwowar (2006). We estimate transaction costs for the full trade sample period, as well as separately for the three sub-sample periods: pre-crisis (2005–6/2007), crisis (7/2007–6/2009), and post-crisis (7/2009–end). A detailed description of our transaction cost estimation applied to the MSRB data is in the Internet Appendix.

4 Value of insurance to investors

According to bond insurers, insured bonds are more attractive than uninsured bonds of comparable quality due to an extra layer of credit protection, and are thus easier to trade in the secondary market. Figure 2 provides ex post anecdotal evidence of the insurance value in the rare event of a municipal default. However, any preference for insured bonds breaks down during the crisis; in this period, Bergstresser et al. (2010) find that insured yields are higher than uninsured yields for bonds in the same underlying credit category. We conjecture that this yield inversion is a consequence of the turmoil in the insurance industry during the crisis period, coupled with the facts that (1) muni investors rely heavily on insurer credit rating and (2) rating agencies were slow to update insurer ratings; see Cornaggia et al. (2018b). In order to test our conjecture, we first establish a baseline estimate of insurance value following Bergstresser et al. (2010) in subsection 4.1. In subsection 4.2, we introduce variation in insurer credit quality. Because credit quality is correlated with liquidity, we test in subsection 4.3 the extent to which disruption in bond liquidity explains the yield inversion.

4.1 Insurance value in secondary market trading

We run the following regression on the cross section of bond-trade observations separately for each month and each underlying credit category, controlling for bond characteristics and trade characteristics:

$$\begin{aligned} y_{i,j} \;=\; & I_{buy,i,j}(\beta_1 + \beta_2 \text{LnTradeSize}_{i,j}) + I_{sell,i,j}(\beta_3 + \beta_4 \text{LnTradeSize}_{i,j}) \\ & + \beta_5 \text{Mat}_i + \beta_6 \text{Mat}_i^2 + \beta_7 \text{LnIssueSize}_i + \beta_8 \text{LnBondSize}_i + \beta_9 I_{insured,i} + \epsilon_{i,j}, \end{aligned} \quad (1)$$

where $y_{i,j}$ is the trade yield on bond i and trade j. Mat is the maturity of the bond, and Mat^2 is included in the regression to account for possible non-linear effects of maturity on trade yield. $LnBondSize$ is the logged size of the bond, while $LnIssueSize$ is the logged size of the issue that includes the bond. $LnTradeSize$ is the logged size of the trade, with I_{buy} or I_{sell} indicating whether the trade is a customer buy or customer sell. The value of insurance is reflected in β_9, the coefficient on the insurance dummy $I_{insured}$ that captures the difference in trade yields between insured and uninsured bonds, holding all else constant. If insurance is valuable, we should observe negative β_9 indicating that insurance lowers the trade yield (or equivalently, increases the value of the bond).

Table 1 shows the estimated value of insurance based on the specification in Equation (1) for each underlying rating category. Panel A reports the time-series average of β_9 based on 36 monthly regressions for the pre-crisis period from 2005 through 2007. Panel B reports β_9 based on 132 monthly regressions for the period from 2008 through 2018. Alongside the estimates, we report the t-statistics (*t-stat*) and the average number of bond-trade observations (*Nobs*) in the monthly regressions for the given underlying rating category. We compute t-statistics for the average estimates using the corresponding time-series standard errors.

Despite having a longer data sample period and more complete data on credit rating histories, we find largely similar results to those in Bergstresser et al. (2010), namely that insurance is valuable before the crisis but that it negatively affects bond value in the period since the start of the crisis. The pre-crisis insurance coefficients are invariably negative in Panel A, confirming that trade yields on insured bonds are lower than those of uninsured bonds across all underlying credit rating categories, including unrated bonds. Panel B shows the yield inversion (i.e., positive estimates) in the 2008-2018 period on insured bonds with high underlying credit quality (A and above ratings) as well as those unrated. However, different from Bergstresser et al. (2010), we find that insurance is still valuable to relatively low quality bonds, i.e., those with underlying credit rating of Baa.[12] The trade yield on these bonds is about 66 bps lower than that on their uninsured counterparts. The results here suggest that the deterioration of the insurance quality through the crisis (resulting in the lost opportunity to purchase Aaa certification) might help explain why the value of insurance is inverted only on higher quality bonds, but not on the low quality bonds for which the insurance rating is still higher than the underlying bond rating.

4.2 Does insurance value depend on the insurer's credit rating?

The analysis in Bergstresser et al. (2010) assumes that all insurers provide the same insurance value. This is likely reasonable in the pre-crisis period when virtually all major insurers are Aaa-rated. However, as discussed in Cornaggia et al. (2018b) and references therein, the monoline insurers were downgraded in 2008 and 2009 and went through bankruptcies or restructuring activities. MBIA and AMBAC lost their Aaa certification in June 2008. After the newly established Berkshire Hathaway Assurance Corp lost its Aaa rating in April 2009, there are no longer any Aaa rated monoline insurers. After this point, insured ratings were at best Aa, others A or Baa. If the secondary market prices insured bonds at the insurance rating rather than the underlying rating as suggested by the results from Cornaggia et al. (2018b), then such bonds could exhibit yield inversion following the insurer's downgrade.

To test the role of contemporaneous insurance rating, we augment the regression model specified in Equation (1) with indicators to differentiate insurance's credit quality:

[12]We exclude from our analysis a handful of non-investment grade bonds.

$$y_{i,j} = I_{buy,i,j}(\beta_1 + \beta_2 \text{LnTradeSize}_{i,j}) + I_{sell,i,j}(\beta_3 + \beta_4 \text{LnTradeSize}_{i,j}) + \beta_5 \text{Mat}_i + \beta_6 \text{Mat}_i^2 + \beta_7 \text{LnIssueSize}_i + \beta_8 \text{LnBondSize}_i + \beta_{Aaa} I_{Aaa} + \beta_{Aa} I_{Aa} + \beta_A I_A + \beta_{Baa} I_{Baa} + \epsilon_{i,j} \quad (2)$$

where I_{Aaa}, I_{Aa}, I_A, and I_{Baa} indicate whether the contemporaneous insurance rating is Aaa, Aa, A, or Baa. Because Moody's provides a more comprehensive coverage of the monoline industry, we use Moody's rating history for all insurers in our data sample. The exception is the new entrant BAM which is rated only by S&P. Based on this history, we are able to assign the prevailing insurance credit quality for each bond at the time of each trade.

The value of insurance for each insurance rating category is captured by β_{Aaa}, β_{Aa}, β_A, and β_{Baa} respectively. As before, we run the regressions separately for each month and each underlying credit rating category. We report the time-series average of insurance value estimates over the period since the crisis in Table 2.[13] In the trade data sample for this period, the percent of insured bond-trade observations with Aaa-rated insurance falls to about 9.5% from 96% in the pre-2008 period, while that of Aa-, A-, and Baa-rated insurance increases to about 26%, 22%, and 27% respectively. In addition to each insurance value estimate and its corresponding t-statistics, we also report the number of monthly regressions ($Nregs$) for which such value is estimable (requiring observations with such insurance rating in monthly cross sections). Here, several important results emerge.

First, Aaa-rated insurance continues to be valuable in the post-crisis period. All estimates are significantly negative and the value is higher for lower underlying quality. Insured yields are about 9 bps, 14 bps, and 21 bps lower than uninsured yields for Aa-, A-, and Baa-rated bonds. Unrated bonds with Aaa-rated insurance trade at yields that are roughly 20 bps lower than uninsured unrated bonds. This result indicates that there is no yield inversion if the insurance is of the highest quality (Aaa), although such Aaa insurance exists for only a few months into the crisis period.

[13]In untabulated results for the pre-crisis period, we find almost identical findings to those in Table 1.

Second, we observe yield inversion only when the contemporaneous insurance rating is at or below the underlying rating, and not when insurance rating is above the underlying rating. For example, the Aa-rated insurance wrap is valuable to A- and Baa-rated bonds but not valuable to bonds whose underlying credit quality is already Aa. Likewise, A-rated insurance is valuable to Baa-rated bonds, but not Aa- and A- rated bonds. This result is consistent with a secondary market that prices insured bonds at their insurance rating and not at their underlying rating even when the former falls below the latter. This interpretation is further consistent with Cornaggia et al. (2018b), who provide initial evidence of insurance rating stickiness in secondary market pricing of insured bonds based on the behavior of bond portfolios insured by MBIA and AMBAC through their credit rating downgrades.

The finding that insurance has negative value for high quality bonds is puzzling. One possible explanation is that these bonds originally carry a higher quality insurance. When that insurance value subsequently falls due to downgrades of the monolines, investors sell (or are forced to sell) them off at the insurance rating rather than at the higher intrinsic credit quality. This reaction could arise due to dealers understanding the insured/underlying rating dichotomy better than the unsophisticated retail investors dominating this market, or due to different clienteles in insured and uninsured bonds.

To test the clientele hypothesis, we split our sample into two sub-samples: 1) the "lost Aaa" sub-sample, consisting of bonds issued prior to 2008 and insured by the four major pre-crisis Aaa-rated insurers (MBIA, AMBAC, FGIC, and FSA), together with the "control" bonds being uninsured bonds issued prior to 2008, and 2) the "never Aaa" sub-sample, consisting of bonds issued after 2008 during which only Aa-or-below insurance wrap is available, together with the "control" bonds being uninsured bonds issued after 2008. We then rerun our regression model specified in Equation (2) on these sub-samples. To save space, we tabulate these results in the Internet Appendix (Table A.2) in Panels A and B respectively.

It is interesting to see in Panel A that the yield inversion does not occur among bonds that previously carried the Aaa insurance prior to the crisis. That is, there is little evidence to attribute the yield inversion to portfolio rebalancing following the monoline downgrades. In contrast, Panel B indicates that the yield inversion still occurs among high quality bonds that are issued in the post-crisis period for which Aaa insurance is no longer available. Only lower quality bonds continue to enjoy lower trading yields due to insurance, as indicated by the consistently negative loading on the insurance dummy. This results leads us to conclude that the yield inversion phenomenon documented since the crisis is likely due at least in part to the disappearance of Aaa insurance wrap in the market place and the new lower (and more diverse) insurance quality era. Without Aaa certification, insurance does not provide much benefits to investors in highly-rated munis.

4.3 Liquidity value of insurance

Bond insurers further suggest that insurance increases the liquidity of bonds in the secondary market. If so, the improved liquidity should lower trade yields of insured bonds, and disruption in market liquidity of insured bonds during the crisis might help explain the yield inversion phenomenon. We examine bond liquidity, as measured by transaction costs, before and since the crisis in order to test this hypothesis.

We plot the transaction cost curves for insured bonds and non-insured bonds in Figure 3. The figure indicates that on average, insured bonds are slightly more expensive to trade. However, this figure masks any additional heterogeneity among bonds. We thus estimate a weighted least squares regression of transaction cost on the insurance dummy $I_{insured}$, controlling for bond characteristics (bond size, issue size, maturity, coupon, bank-qualified status, whether the bond is issued at a discount or premium), dummy variables for issuer ratings ($I.Rating$), state fixed effects for the top 10 states (in terms of GO bond issuance volume), and macroeconomic variables at the time of bond issuance ($MacroVar$). Macroeconomic variables include the Baa–Aaa credit spread, the slope of the yield curve measured by the difference between the 10Y and 1Y Treasury yields, the 10Y Treasury constant maturity yield, and the inflation rate. Following Harris and Piwowar (2006), the weights used in the regression are the inverse of the estimated variance of the transaction cost estimate appearing on the left hand side of the regression model:

$$\begin{aligned}\text{TransCost}_i &= \alpha + \beta_1 I_{insured,i} + \beta_2\text{LnBondSize}_i + \beta_3\text{LnIssueSize}_i + \beta_4\text{LnMaturity}_i \\ &\quad +\beta_5\text{Coupon}_i + \beta_6\text{BankQlf}_i + \beta_7\text{DiscountBond}_i + \beta_8\text{PremiumBond}_i \\ &\quad +\gamma_1\text{I.rating}_{it} + \gamma_2\text{Top10State}_i + \gamma_3\text{MacroVar}_i + \epsilon_i. \end{aligned} \tag{3}$$

To save space, we report the results in the Internet Appendix (Table A.3). We run the regression for five trade sizes that reflect the most frequently occurring trade sizes at the retail and institutional levels. Once we properly account for the heterogeneity in the cross section of insured bonds, it seems that insurance does help reduce transaction costs for larger trade sizes, but the magnitude of the reduction is economically small. The saving in transaction cost due to insurance is less than 2 bps, which is negligible when the (untabulated) average transaction cost is 85 bps for a $10,000 trade and 38 bps for a $200,000 trade.

To control for possible vintage effects not fully captured by macroeconomic variables prevailing at the time of bond issuance, we repeat the regression separately for three vintages of bond issue years: 1) bonds that are issued between 1985 and 1999, 2) bonds that are issued between 2000 and 2007, and 3) bonds that are issued between 2008 and 2016. We report the result of this vintage analysis in the Internet Appendix (Table A.4). Here, we report only the coefficient on the insurance dummy, our variable of interest, together with the adjusted R-squared from the regressions and the associated number of observations used. For bonds that are issued between 2000 and 2007, the golden era of the monoline industry with an almost universal Aaa insurance wrap, insurance delivers liquidity benefit, and the transaction cost savings occur for most trade sizes. For bonds that are issued from 2008 onward (when the industry goes through downgrades and restructurings and thus Aaa insurance is no longer available), there is no significant improvement in transaction costs for insured bonds, except for very small trade sizes ($20,000 and below). Overall, we conclude that the economic magnitude of the liquidity value of insurance, if any, is small.

Clearly, liquidity in markets changes through time and the financial crisis caused liquidity disruptions in many markets. To ensure that the crisis (or other time periods) is not causing our results, we repeat the transaction cost estimation procedure for 3 subperiods: 1) the pre-crisis sub-sample, which includes all trades between 2005 and June 2007, 2) the crisis sub-sample, which includes all trades between July 2007 and June 2009, and 3) the post-crisis sub-sample, which includes all trades between July 2009 and June 2016 (the end of our data sample). We find that the costs to trade small trade sizes steadily fall through all subperiods. For example, the cost to trade $5,000 in a muni bond is roughly 100 bps in the pre-crisis period, reduced to 96 bps in the crisis period and further to 83 bps in the post-crisis period.

We compare transaction costs of insured and uninsured bonds by subperiods in Figure A.2 in the Internet Appendix. Contrary to insurers' claims, insured bonds in general have slightly higher transaction costs than uninsured bonds. Through the crisis and after the crisis, the transaction cost function of an average insured bonds increasingly converge to that of an average uninsured bond. To assess the statistical significance of the liquidity value of insurance after controlling for the cross sectional variation in bond characteristics, we repeat the regression model in Equation (3) separately for the pre-crisis, crisis, and post-crisis estimates of transaction costs, and report the coefficient on the insurance dummy in Table A.5 in the Internet Appendix. Here, we see that there is no difference in transaction costs of insured versus uninsured bonds during the crisis. Thus, liquidity is not likely to explain the yield inversion. After the crisis, insurance appears to save investors some transaction costs, but the magnitude of the saving (around 4 or 5 bps) is again economically small relative to the average transaction costs.

5 Value of insurance to municipal issuers

We have documented in previous sections the heterogeneity in insurance value for secondary market investors. However, in our sample, it is the issuing municipalities in the primary market (and ultimately their taxpayers) who pay the premiums to the insurance companies.[14] To assess the direct benefit of insurance to issuers (which we measure by the reduction in offering yield, or TIC), we proceed by first examining simple summary statistics on differences. We then control for issuer and time-period specific characteristics using OLS regressions and then further control for the endogenous choice by issuers to insure their bonds with semi-parametric and robust selection-adjusted models.

5.1 Unconditional values of insurance

Table 3 shows the unconditional differences between insured and uninsured yields, along with differences in characteristics between insured and uninsured issues over time. Positive differences reflect higher values for insured bonds compared to uninsured bonds. Over the entire sample period, insured bonds' offering yields are 48 bps higher than uninsured bonds on average. However, as the subperiod analysis reveals, this is entirely due to the large and positive differences in the 2008–2016 period. This likely reflects a movement in lower-rated issuers buying insurance from lower-rated insurers in the post-crisis period, emphasizing the importance of controlling for the choice to purchase insurance. In contrast, insured bonds have lower yields than uninsured bonds in the pre-crisis period. The distributions of insured and uninsured offering yields, plotted in Figure 4, demonstrate that the change between the pre- and post-crisis period is not only in the central tendency, but a shift in the entire distribution. The distribution of insured yields is lower than that of uninsured yields prior to the crisis, but shifts higher during and following the crisis.

We test whether the yield inversion in the lower panel of Figure 4 is driven by 2008 specifically and the flight-to-quality during the crisis. We plot (but do not display) the density separately by year and find that the yield inversion in Figure 4 exists in each year since 2008, which rules out any particular vintage effect. We further investigate this distributional shift by rating category and find that the yield inversion in Figure 4 exists for bonds rated Aa

[14] Our insurance dummy reflects the insurance status at issuance. We discard a small number of bonds where investors pay for secondary market insurance.

or A (the majority of bonds as per Table A.1). For bonds rated Baa and below, we find no yield inversion, as shown in Figure 5.[15]

We also observe in Table 3 that uninsured bonds are larger in issue size, have shorter maturities, and have more favorable underlying ratings by almost two notches on average (and nearly three notches in the post-crisis period), providing preliminary evidence of a selection effect. We examine this effect explicitly in Section 5.3.

5.2 OLS estimates of insurance value

Kidwell et al. (1987) examines the value of insurance to issuers in the beginning years of the monoline bond insurance market, using data from 333 MBIA-insured bonds (and 2,393 "control" uninsured bonds) issued from 1975 to 1980. Using a modified version of their methods, we extend their analysis to the 1985–2016 period. We first estimate a pooled multivariate regression model including an insurance dummy as an explanatory variable. We then reestimate the model only for uninsured bonds, and use the parameter estimates to predict the offering yields on insured bonds with equivalent characteristics ("fitted yield"). The direct benefit of insurance is then the difference between the actual yield and the fitted yield. Negative values indicate a gain to the issuer because the insured bond is issued with a lower yield than an equivalent uninsured bond.[16] We only observe insurance premia in the two states with mandatory disclosure (i.e., CA and TX). Based on these disclosures, we note that insurance premium is paid as a separate fee and not part of the offering yields.

5.2.1 Baseline OLS model of insurance value

We follow a large literature in estimating the determinants of municipal bond yields, and employ the following *initial* model for offering yields:

[15] Figures by year and by each rating category are available from the authors.

[16] This is the same concept as the Gross Price Benefit (GPB) in Kidwell et al. (1987), however we instead express the benefit as a negative number, reflecting the lower borrowing costs achieved by the issuer.

$$
\begin{aligned}
\text{OffYield}_{it} = \; & \alpha + \beta_1 \text{Insured}_i + \beta_2 \text{CallDummy}_i + \beta_3 \text{LnBondSize}_i + \beta_4 \text{LnIssueSize}_i \\
& + \beta_5 \text{LnMaturity}_i + \beta_6 \text{I.Rating}_i + \beta_7 \text{BankQlf}_i \\
& + \gamma_1 \text{MacroVar}_t + \gamma_2 \text{BigState}_i + \epsilon_{it}, \qquad (4)
\end{aligned}
$$

where $OffYield_{it}$ is the offering yield of bond i issued in month t, and other variables are as previously described. We also include (but do not tabulate) $BigState$ dummy variables for the high-issuance states (CA, TX, IL, and NY).[17]

Table 4 presents estimates of the pooled regression (with robust standard errors clustered at the issue level) over the entire sample period, and for three subperiods: 1985–1999; 2000–2007; and 2008–2016. We observe that the model fits the data well, with an R^2 for the entire period of over 91%. Insurance has a gross benefit of 5.76 bps over the entire period. However, consistent with the unconditional results in the previous section, this benefit dissipates over time, becoming a cost of 1.82 bps in the period since the crisis. Coefficients for controls are sensible, with longer maturities and lower ratings being associated with higher yields.

In Table 5, we report the average difference between actual and fitted yields on insured bonds by year, based on the procedure in Kidwell et al. (1987). Specifically we run the regression specified in Equation (4) using only uninsured bonds (and obviously omitting the insurance dummy variable) separately for each year and then form predicted values for the insured bonds in that year. The difference reported is then the actual offering yield less the fitted (predicted) yield, averaged for that year. We report both the simple average and the weighted average (based on bond size) of the yield differences. The results by rating class appear in Table 6.

Overall, the gross benefit of insurance estimated via these cross-sectional fitted regressions is 6.3 bps, which is similar to insurance premiums previously documented, although data on insurance premiums are limited. For instance, Liu (2012) finds that in CA from 2001 to 2005,

[17] Excluding these state dummies or including additional state dummies as we do in the enhanced model does not materially affect our estimates.

the overall average premium is 3.72 bps, but with AA borrowers paying approximately 2 bps and BBB+ borrowers paying 8 bps. These values are consistent with the costs documented in Texas by Ely (2012). However, the implication that bond insurance is "fairly priced" disappears when the data is disaggregated by rating and year. For borrowers with an underlying rating of Aa3 or greater, any insurance premium seem to be wasted; conversely, bond issuers with Baa ratings and below seem to reap significant gains in yield for any premiums previously documented in the literature.

The mean difference in offering yields does not translate into a dollar cost estimate easily; multiplying the mean difference by the total issuance amount will give biased estimates of the economic impact due to heterogeneity. To estimate the true total economic cost/benefit of insurance to issuers, we first multiply the difference in offering yield at the bond level by bond size. We then treat this amount as an annuity paid each year until the bond's maturity and calculate the present value using the 1-year US Treasury rate at issuance before aggregating across bonds. We report this aggregate number as the "Dollar Loss" in both Table 5 and Table 6 and then convert into percentage terms by dividing by the aggregate amount of insured debt that year.[18] Because insurance tends to be purchased by smaller issuers, we also compute a size-weighted difference in yield (which we report as % W.A. in the tables) which more accurately captures the economic effects of the yield differences. Based on this measure, the yield benefits of insurance dissipate for issuers with ratings higher than A1 and is less than 1 bps for the entire sample.

The mean difference in yields indicates that insurance slightly lowers yields vs. comparable uninsured issues in the period before 2012. However, in dollar terms, insurance has an aggregate economic loss in each year from 1997 to 2002. Over the entire sample period from 1985 to 2016, we estimate a collective loss to issuers (taxpayers) in foregone yield of

[18]We discount at the riskfree rate here for two reasons. First, it is somewhat consistent with the present valuing of insurance promised and not yet paid in the financial statements of the insurers, which is done at the riskfree rate. Second, we are attempting to not introduce another potentially correlated source of heterogeneity by discounting at the offering yield. Discounting at the offering yield leads to a very slightly smaller loss than we report; not discounting at all leads to a slightly larger one.

$256.6 million. In percentage terms, issuers overpay nearly 10 bps in aggregate, even before accounting for premiums paid. These premiums are substantial. Using information from the insurers' 10-Ks, we calculate that AMBAC collected $4.7 billion and MBIA collected $5.2 billion from US domestic municipal issuers in the 1995–2008 period. Extrapolating using reported market shares by MBIA and AMBAC to the rest of the industry results in a total of $17.1 billion paid in premiums by taxpayers during this period. Finally, we note that the yield differences and percentage losses are an order of magnitude higher in the 2012–2016 period. Figure 1 shows that this period corresponds with an uptick in insurance popularity with over 5000 newly issued bonds ($3.5 billion) insured in 2015 alone.

From Table 6, we see that the benefit to insurance is increasing almost monotonically as credit quality decreases, with Baa1 issuers receiving a gross reduction in yield of 12.8 bps (size-weighted), but with Aa2 issuers issuing bonds at nearly 4 bps (size-weighted) higher than equivalent uninsured issues. Estimated dollar losses indicate that high-rated issuers (above A1) subsidize low-rated issuers (A2 and below).

5.2.2 Expanded OLS model of insurance value

The model in Equation (4) produces an R^2 of over 91%. Still, critical omitted variables could be producing the results documented above. We therefore expand the model by adding controls for many potential determinants of yield that previous studies have not included. The expanded model is defined as:

$$
\begin{aligned}
\text{OffYield}_{it} = \alpha &+ \beta_1 \text{Insured}_i + \beta_2 \text{LnBondSize}_i + \beta_3 \text{LnIssueSize}_i + \beta_4 \text{Maturity}_i \\
&+ \beta_5 \text{Maturity}_i^2 + \beta_6 \text{CallDummy}_i + \beta_7 \text{I.Rating}_i + \beta_8 \text{I.UnderwriterDec}_i \\
&+ \beta_9 \text{NumOfAgents}_i + \beta_1 0 \text{BankQlf}_i + \beta_{11} \text{Comp}_i + \beta_{12} \text{Neg}_i + \gamma_1 \text{MacroVar}_t \\
&+ \gamma_2 \text{BiggerState}_i + \gamma_3 \text{UseOfProceeds}_i + \gamma_4 \text{PrevInsurance}_i + \epsilon_{it}. \qquad (5)
\end{aligned}
$$

In this model, we add new variables as controls for the underwriting and advisory process. Since it is possible that underwriters influence the choice to buy insurance, we include $NumOfAgents_i$ for the total number of advisors and underwriters for the bond issue, and

$I.UnderwriterDec_i$ which are dummy variables representing whether the bond issue was underwritten by an underwriter in the 1st, 2nd, 3rd, etc. decile of insured/uninsured issuance in the year the bond was issued. We also include dummy variables for whether the issue is negotiated (Neg) or competitively offered ($Comp$); a substantial fraction of issues have no information which we include as a base category. We expand the state dummies in the vector $BiggerState$ to include the 10 largest issuers (as well as NJ, which we include as a high state/local tax jurisdiction), and we move to a slightly more flexible non-linear specification for the effects of maturity. We also add a vector of dummy variables in $UseOfProceeds$ for the issues' primary purpose, creating categories for General Purposes, Water and Sewer, K-12 Education, Higher Education, and All Other Uses. Lastly, since the choice to purchase insurance may persist over time, we include $PrevInsurance$ indicating whether the issuer insured nearly all, none, or a mixed amount of their issues in the previous period (pre–2000, 2000–2007, and 2008–2016).

After estimating Equation (5) each year and forming fitted values as previously discussed, we report yield differences and dollar losses by year in Table 7 and by rating category in Table 8. While many of the added controls are significant in the pooled time period regression, jointly they increase R^2 by less than 1 percentage points for all periods, for instance, raising the R^2 for the full period to 91.9%. Since many of these determinants of offering yields have never been investigated, we note that (as expected) negotiated offerings have higher yields than competitive offerings by about 10 bps in the full sample, and that Water and Sewer GO bonds have slightly (11 bps) higher yields than General Purpose GO bonds. Finally, issuers with little previous insurance purchases tend to have slightly (3 bps) lower yields than issuers who tend to insure more in prior periods. We explicitly examine the impact of these variables on the likelihood of an issuer to purchase insurance in Section 5.3.[19]

Table 7 shows the similar patterns as in the initial model, but with overall insurance value of 7.5 bps (3.3 bps size-weighted). Differently from Table 5, there is now a total dollar gain

[19] Full expanded regression model results are available on request.

over the entire sample period of $495 million dollars; over half of this gain is attributable to 2003.[20] As before, there is a dramatic shift from insurance benefits to insurance costs in the post-crisis period.

Again, Table 8 shows that high-rated purchasers subsidize low-rated purchasers of insurance, although the breakpoint is now Aa3 (size-weighted). We observe from Tables 7 and 8 that the expanded year-by-year OLS model produces marginally positive insurance value over the full time period, compared to the marginally negative value in Tables 5 and 6. Still, our basic conclusions and the puzzling post-crisis primary market yield inversion are unchanged. The importance of the additional controls in the expanded model points to the critical need to use models which explicitly account for the choice of issuers to buy insurance. We investigate next this possibility (that within each group with common characteristics, such as ratings, only the poorest quality issuers purchase insurance) and that selection effects drive our results in the next section.

5.3 Selection-adjusted models of insurance value

Whether or not to purchase insurance is a choice by the issuer and as Table 3 makes clear, there are substantial differences between insured and uninsured bonds. Indeed in the post-crisis period, issuers that choose insurance are rated nearly 3 notches below those who do not. Prior literature on municipal bond insurance value does not explicitly address this choice, probably due to limited sample sizes. We control for selection bias here in two ways. First, we use a classic propensity scoring model to estimate the probability of insurance usage using a probit model of selection. Second, we use an inverse-probability weighted regression adjustment (IPWRA) model, which improves upon the propensity-score model. While the matching step of propensity-scoring is non-parametric, it is highly prone to potential misspecification of the selection model. This is especially problematic because we have very little guidance on what determines the choice of insurance for municipal issuers. In contrast, IPWRA models have an attractive doubly-robust property: estimates are consistent if *either*

[20]For perspective, this value is close to the $458 million in domestic premiums collected by MBIA in 2004.

the selection equation or the outcome equation is correctly specified. Leveraging on the well-established literature that examines determinants of offering yields, the outcome model linking offering yields to their determinants is much more likely to be correctly specified, lending more confidence to the results obtained from the IPWRA model.

5.3.1 Propensity score model of insurance value

For the propensity scoring model, we use a "kitchen-sink" approach and use all the covariates in Equation (5), using the insurance dummy as the dependent variable instead of offering yield and estimating via probit. We then match each treated (insured) bond to its 3 nearest (uninsured) neighbors based on this score and calculate the yield differences. We calculate standard errors as in Abadie and Imbens (2016) to account for the fact that the scores themselves are estimates. Table 9 presents the marginal effects from the probit equation. As expected, longer maturity and larger bonds are more likely to be insured, as are lower-rated bonds. There is virtually no relationship between callability and the choice to purchase insurance. Water bonds are significantly more likely to be insured than those for general purposes. We also show that insurance choices are very persistent, with heavy purchasers of insurance in previous periods much more likely to purchase insurance in the current one. State effects are included but not tabulated to save space, but PA, NJ, and CA issuers tend to be much more likely to insure their bonds than TX, MD, or MN issuers.

Panel A of Table 10 presents the results from the propensity-scoring method. Controlling for the decision to insure over the entire period, insurance saves issuers approximately 2.7 bps in yield. This is similar to the premiums charged by insurers (documented by Liu, 2012 and Ely, 2012), but this effect obscures significant variation across periods. Prior to the crisis, insurance value is consistent with estimates by Kidwell et al. (1987). After the crisis, lower rated insurance does not lower yields. This pooled-by-period model, controlling for the time variation in macroeconomic variables, facilitates the best matches and Panel A results indicate that the results in Tables 7–8 are not entirely attributable to a selection effect.

5.3.2 IPWRA model of insurance value

We recognize that propensity score models are dependent on the selection model, which in this case is the choice to purchase insurance, and prior literature offers little guidance on this choice. A new approach based on Cattaneo (2010) to control for selection effects augments the regression for the outcome variable (the offering yields) with probability weights derived from a probit model for the selection variable (the insurance choice). The key advantage of this approach is that estimates are consistent if either the outcome model (Equation 6) or the selection model (Equation 7) is correct. In our case, this allows us to leverage our guidance on the proper model for the outcome variable given the large literature on the determinants of offering yields (e.g., Equation 5) while controlling parametrically for the choice of insurance. Specifically, we estimate the outcome model on offering yields:

$$\begin{aligned} \text{OffYield}_{it} \;=\; & \alpha + \beta_1 \text{LnIssueSize}_i + \beta_2 \text{Maturity}_i + \beta_3 \text{Maturity}_i^2 + \beta_4 \text{I.Rating}_i \\ & + \beta_5 \text{CallDummy}_i + \beta_6 \text{BankQlf}_i + \beta_7 \text{Comp}_i + \beta_8 \text{Neg}_i \\ & + \gamma_1 \text{MacroVar}_t + \gamma_2 \text{BiggerState}_i + \gamma_3 \text{UseOfProceeds}_i + \epsilon_{it}, \end{aligned} \tag{6}$$

and the selection model to generate probability weights for the outcome model:

$$\begin{aligned} \text{Insured}_i \;=\; & \alpha + \beta_1 \text{LnIssueSize}_i + \beta_2 \text{Maturity}_i + \beta_3 \text{Maturity}_i^2 + \beta_4 \text{I.Rating}_i \\ & + \beta_5 \text{I.UnderwriterDec}_i + \beta_6 \text{NumOfAgents}_i + \beta_7 \text{BankQlf}_i + \beta_8 \text{Comp}_i \\ & + \beta_9 \text{Neg}_i + \beta_{10} \text{CallDummy}_i + \gamma_1 \text{BiggerState}_i + \gamma_2 \text{UseOfProceeds}_i \\ & + \gamma_3 \text{PrevInsurance}_i + \epsilon_i. \end{aligned} \tag{7}$$

Note that β_4 and β_5 in Equation (7) are both vectors of coefficients for the ratings and underwriter decile dummies. As noted earlier, there is virtually no guidance in the literature for the variables in the selection model in Equation (7). For instance, it is unclear whether the NY dummy best represents demand effects for primary issue purchasers in the state of NY (presumably because of the higher tax rates that are shielded and other home biases) or whether issuers in NY choose to be insured differently than in the rest of the country. We test the robustness of our results to the inclusion of only big state (CA, NY, IL, TX) dummies in both regressions; big state dummies in the outcome equation and all state dummies in the selection equation; raw and quadratic maturity effects in both equations; and interactions of issue amount and rating in the selection equation. All of these specifications produce similar results for the mean offering yield by insurance status. We present the expanded model defined above in Panel B of Table 10 for the full period and each subperiod.

For the full period there is a small economic difference between insured and uninsured yields (insured yields are 5.4 bps lower). This overall effect obscures again the vast dispersion between the early years of the insurance market and the period since 2008. In the early period (1985–1999), the gross benefit of insurance to issuers was about 9 bps, and in the "heyday" of bond insurance (2000–2007), the benefit was 8.6 bps. The benefit reverses after 2008, with insured bonds facing 3.9 bps higher yields than uninsured bonds after explicitly controlling for both characteristics and selection in a doubly-robust empirical model.

Put differently, the unconditional difference of 63 bps in offering yields from Table 3 in the post-crisis period is narrowed to 3.9 bps by controlling for endogeneity and characteristics, but in no model is it erased. Insurance appears valuable only to the lowest rated issuers. As such, the substantial premiums paid represent additional negative value to taxpayers. The price of safety paid by taxpayers appears to be economically large and increasing, without delivering commensurate benefits. Essentially, there is money left on the table. We next ask whether the government quality of a given municipality, the potential conflict of interest of underwriters, and the fulfillment of fiduciaries duties by advisors play a role.

6 Determinants of Money Left On the Table

We first construct a measure of "money left on the table" for the insured bonds in our sample. Using the difference in yield from the expanded model in Equation 5, we calculate the dollar loss per bond as described in Section 5.2.1. We then scale the dollar loss by bond size and express the fraction in basis points. Our measure thus represents the fraction of total proceeds "left on the table" (and not a measure of yield). We then use this measure of money left on the table to examine the potential role of municipal government quality, municipal advisor incentives, and influential underwriters who must carry bonds that cannot be readily placed.

6.1 Quality of Municipal Government

Butler et al. (2009) report that issuers in states with higher corruption, and indication of low government quality, face higher offer yields on their bonds. We conjecture that low quality governments leave more money on the table for a variety of reasons including corruption and lack of due diligence.[21] However, testing our conjecture requires reliable measures of municipal government quality. Cordis and Milyo (2016) document problems with the official corruption conviction measures commonly used in economics and finance research (including those used in Butler et al., 2009 and Glaeser and Saks, 2006). Although reported by the Public Integrity Section of the Department of Justice, the commonly used conviction data is based upon retrospective surveys of U.S. District Attorneys and contain many convictions of public employees not contemporaneously coded as official corruption.[22]

We instead employ data drawn directly from administrative records of contemporaneous court filings compiled via FOIA requests by the Transactional Records Access Clearinghouse (TRAC).[23] From these reports, we calculate the number of convictions and prosecutions per million persons for official corruption for each year and federal judicial district. Rather than aggregating these districts to the state level, we exploit the extra granularity provided and map each issuer to their geographic county and then map these counties to federal judicial districts.[24] Finally, following Butler et al. (2009), we compute dummy variables (High

[21] The SEC (2017) Office of Compliance Inspections and Examinations released a risk alert based on its Observations From Municipal Advisor Examinations. During examinations, SEC staff frequently observed deficiencies including the failure to monitor gifts, travel, and entertainment expenses. To the extent that municipal advisors solicit business for third-parties, such gifts, travel, and entertainment expenses could very well extend beyond advisors to municipal officials.

[22] Cordis and Milyo (2016) note that the state-year correlation between the survey-based traditional measure and one based on the actual court administrative data is .29.

[23] TRAC is a nonpartisan data gathering, data research, and data distribution organization associated with Syracuse University.

[24] We are grateful to Zihan Ye for providing us with the geographic mapping data.

Convictions and High Prosecutions) if the bond issue is in a county within a federal judicial district that has population-adjusted conviction or prosecution rates above the 25th percentile of the cross-sectional distribution of rates in that year. The former variable proxies for the degree of corruption whereas the latter variable indicates the strictness of enforcement.

Table 11 Columns (1) and (2) present a regression of the "money left on the table" measure on these variables and their interaction, controlling for bond characteristics, ratings dummies, year effects, and state dummies.[25] Higher corruption (as measured by conviction rates) is associated with more "money left on the table" whereas more aggressive prosecutions – serving as deterrence to official misconduct – are associated with less. Including the effects of the interaction of the two concepts conveys additional insight. High convictions and low prosecutions, perhaps most indicative of a corrupt environment, are associated with significantly higher economic losses (more money left on the table). In contrast, those municipalities with high prosecutions and high convictions (presumably those with the most effective deterrence) have significantly lower economic losses. Our results thus support the hypothesis that the "money left on the table" – an indicator of municipal underperformance in the bond issuance market – is linked to the quality of municipal governance.

6.2 Fulfillment of Fiduciary Duties of Advisors and Underwriters

As explained above, the incentive structure and aptitude in the municipal advisor market is a matter of policy concern. Municipal advisors give advice on bond issuance, the investment of proceeds, escrow management, derivatives use and they solicit business for third parties. However, prior to the Dodd Frank Act of 2011, municipal advisors faced little regulatory oversight or expertise requirements and no fiduciary duty to the municipalities they advise. Moreover, compliance rates with recent MSRB rule changes to address these concerns appear low; see SEC (2017) and Bergstresser and Luby (2018).[26]

[25] We use as state dummies all states with more than one federal judicial district for these regressions.

[26] The recent MSRB Rule G-42 imposes fiduciary duty of care and duty of loyalty, MSRB Rules G-20 and 37 impose the first pay-to-play restrictions and restrictions on gifts and gratuities, and MSRB Rules G-2 and 3 impose professional qualification standards.

Although the advising and underwriting functions for any particular bond issuance were statutorily separated in 2014, some advisors are affiliated with broker-dealers that also provide underwriting services.[27] Because issuers do not observe the yields associated with the counterfactual issuance without insurance, advisors and underwriters face classic moral hazard incentives to recommend insurance, especially when underwriters hold much of the issue in inventory. We further hypothesize that advisor and underwriter influence increases with their market share, which we proxy by deal volume.[28]

To test whether influential advisors and underwriters are more associated with economic losses for issuers, we form dummy variables for Top Advisors or Top Underwriters indicating the advisor or underwriter is in the top decile of advisory business or underwriting by volume in that year. We then regress the "money left on the table" measure on the top advisor and top underwriter dummies and report the results in Columns (3) and (4) of Table 11. We find some support for our conjecture that issuers leaving more money on the table are advised by influential advisors or working with influential underwriters. The effect is stronger when influential advisors are combined with small underwriters, or vice versa. When both advisors and underwriters are in the top decile – likely indicative of the most sophisticated issuers – we find no significant effect. These results indicate that issuers who employ an influential advisor or underwriter (but not both) tend to leave more money on the table in the decision to purchase bond insurance.

7 Conclusion

Our contributions to the literature are as follows. We provide an explanation (downgrade and bankruptcy of the monolines) for the municipal bond yield inversion previously documented in the secondary market during the financial crisis. We find that insurance remains valuable to investors, during the crisis and since, provided insurers maintain credit ratings

[27]Registration of Municipal Advisors; Temporary Stay of Final Rule, Release No. 34-71288 (January 13, 2014), 79 FR 2777 (January 16, 2014), available at http://www.sec.gov/rules/final/2014/34-71288.pdf

[28]For an example of suboptimal advice by one of the largest municipal advisors (regarding the use of derivative contracts), see https://www.centredaily.com/news/article42817461.html

higher than the underlying bonds they insure. Because most municipal bonds have ratings as high (or higher) than the bond insurers since 2008, the observed yield inversion obtains, on average, in the full cross-section of bonds. We also test whether insurance improves bond liquidity and find that the economic magnitude of this benefit is negligible. Overall, the secondary market evidence for insurance value to investors is limited in the post-crisis period.

We further examine the direct benefit of insurance to the issuers (taxpayers) paying the premiums. Here we find that insurance provides an average nine basis points of gross value across our broad sample of issuers in the pre-crisis period (1985–2007) when the monoline insurers were universally rated Aaa. However, in the post-crisis period when Aaa coverage is no longer available, we find that insurance provides no value for the overwhelming majority of issuers with credit ratings that are close to their insurers' ratings.

The post-crisis yield inversion we document in the primary market could result from some correlated risk variable omitted from our analysis. However, such an omitted variable would have to be (1) unimportant in the decades preceding the 2008 financial crisis, (2) suddenly significant in the post-crisis period, (3) known and observable to the (primarily retail) investors in these bonds, (4) known and observable to the municipal officials issuing and insuring bonds, (5) unknown or unobservable to the credit rating agencies, and (6) uncorrelated with macroeconomic variables for which we can obtain data. Given our comprehensive set of publicly and commercially available data, we believe it is unlikely that we omit important credit risk factors that are observable to the (primarily retail) investors in these markets.

Overall, we conclude that highly-rated issuers appear to be subsidizing the lower-quality issuers for whom insurance continues to provide positive gross value. We also conclude that the money left on the table is influenced by the potential conflict of interest among municipal advisors, underwriters, and lower quality governments. Our results commend additional regulatory efforts to enforce municipal advisor standards and educate municipal issuers.

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Table 1: Value of insurance in secondary market trading of municipal GO bonds

The table shows the estimated value of insurance in the secondary market trading of municipal GO bonds, based on cross-sectional regressions of trade yields using the specification proposed in Bergstresser et al. (2010), i.e., $y_i = I_{buy}(\beta_1 + \beta_2\text{LnTradeSize}) + I_{sell}(\beta_3 + \beta_4\text{LnTradeSize}) + \beta_5\text{MAT} + \beta_6\text{MAT}^2 + \beta_7\text{LnIssueSize} + \beta_8\text{LnBondSize} + \beta_9 I_{insured}$. The regressions are run separately for each month and each category of underlying credit quality. β_9 captures the difference in trade yields between insured and uninsured bonds, holding all else constant, and reflects the value of insurance. Panel A reports the time-series average of β_9 estimates for the pre-crisis period, and Panel B reports that for the 2008–2018 period. t-statistics are computed as the time-series averages divided by the corresponding time-series standard errors. *Nobs* is the average number of bonds in a monthly regression for the given underlying rating category. Bond characteristics are from the Mergent Municipal FISD database, and trade data are from the MSRB. Rating data are collected from various sources as described in the text. The underlying credit rating is contemporaneous at the time of trade.

Panel A: Pre-crisis Period (2005–2007)

Underlying Rating	Estimate	t-stat	Nobs
Aa	-0.102	-23.03	18,383
A	-0.184	-32.10	16,032
Baa	-0.174	-26.94	2,689
Unrated	-0.197	-26.45	7,050
Number of monthly regressions: 36			

Panel B: Crisis and Post-Crisis Period (2008–2018)

Underlying Rating	Estimate	t-stat	Nobs
Aa	0.603	15.46	22,872
A	0.325	13.56	9,104
Baa	-0.660	-8.68	2,119
Unrated	0.347	13.77	9,871
Number of monthly regressions: 132			

Table 2: Post-crisis value of insurance by insurance rating

The table shows the estimated value of insurance for different insurance ratings in the secondary market trading of municipal GO bonds from the following regression model of the yield on trade j of bond i: $y_{i,j} = I_{buy}(\beta_1 + \beta_2 \text{LnTradeSize}_{i,j}) + I_{sell}(\beta_3 + \beta_4 \text{LnTradeSize}_{i,j}) + \beta_5 \text{Mat}_i + \beta_6 \text{Mat}_i^2 + \beta_7 \text{LnIssueSize}_i + \beta_8 \text{LnBondSize}_i + \beta_{Aaa} I_{Aaa} + \beta_{Aa} I_{Aa} + \beta_A I_A + \beta_{Baa} I_{Baa} + \epsilon_{i,j}$. The regressions are run separately for each month and each category of underlying credit quality. I_{Aaa}, I_{Aa}, I_A, and I_{Baa} are dummies indicating whether the bond is insured by a *Aaa*-rated, *Aa*-rated, *A*-rated, and *Baa*-rated insurer at the time of trade, respectively. Reported in this table are the time-series average of β_{Aaa}, β_{Aa}, β_A, and β_{Baa} coefficients in the 2008–2018 period. t-statistics are computed as the time-series averages divided by the corresponding time-series standard errors. *Nregs* is the number of monthly regressions from which the value of insurance of the given rating class is estimable. Bond characteristics are from the Mergent Municipal FISD database, and trade data are from the MSRB. Rating data are collected from various sources as described in the text. Both the underlying and insurance credit rating are contemporaneous at the time of trade.

	Insurance Rating											
	Aaa			Aa			A			Baa		
Underlying Rating	Estimate	t-stat	Nregs	Estimate	t-stat	Nregs	Estimate	t-stat	Nregs	Estimate	t-stat	Nregs
Aa	-0.091	-8.74	11	0.177	9.15	127	0.798	17.34	82	0.261	9.34	132
A	-0.140	-4.53	16	-0.106	-5.88	131	0.157	6.64	84	0.299	7.71	132
Baa	-0.213	-8.95	11	-0.607	-13.28	132	-0.828	-6.88	86	-0.234	-3.92	132
Unrated	-0.200	-13.30	11	-0.100	-6.09	132	0.456	14.41	86	0.176	7.14	132

Table 3: Differences in Variables Over Time

The table presents t-tests for differences in variables between bonds issued with insurance and without insurance. The raw means by insurance status are presented in the columns headed by "Uninsured" or "Insured". Yields and coupons are in percent, maturity is expressed in years and rating is numerically encoded in a scale where Aaa is 21 and Ba1 is 11. Differences that are significantly different from zero are flagged with ***,**, or * corresponding to 1%, 5%, and 10% significance level (two-sided).

Full Period: 1985-2016

	N(Ins.)	Insured	N(Unins.)	UnInsured	Diff.	Std. Error
Offering Yield	212,079	3.98	268,631	3.50	0.48***	0.0040
Coupon	212,079	4.41	268,631	4.15	0.26***	0.0037
Maturity	212,079	10.54	268,631	10.05	0.48***	0.0176
Bond Rating	212,079	16.16	268,631	18.44	-2.28***	0.0057
LN(Issue Amount)	212,061	16.04	268,415	16.25	-0.21***	0.0040
LN(Bond Amount)	212,079	12.98	268,631	13.29	-0.31***	0.0041
Num. of Agents	211,923	5.49	268,201	5.88	-0.39***	0.0071

Pre 2000 Period: 1985-1999

	N(Ins.)	Insured	N(Unins.)	UnInsured	Diff.	Std. Error
Offering Yield	47,171	5.01	63,262	5.21	-0.21***	0.0060
Coupon	47,171	5.37	63,262	5.59	-0.22***	0.0068
Maturity	47,171	10.40	63,262	10.47	-0.07*	0.0362
Bond Rating	47,171	15.64	63,262	17.79	-2.15***	0.0124
LN(Issue Amount)	47,153	15.90	63,046	16.06	-0.16***	0.0089
LN(Bond Amount)	47,171	12.88	63,262	13.04	-0.16***	0.0091
Num. of Agents	47,032	4.78	62,872	5.01	-0.23***	0.0145

Pre-Crisis Period: 2000-2007

	N(Ins.)	Insured	N(Unins.)	UnInsured	Diff.	Std. Error
Offering Yield	129,697	3.86	72,169	3.96	-0.10***	0.0041
Coupon	129,697	4.26	72,169	4.35	-0.09***	0.0039
Maturity	129,697	10.54	72,169	9.93	0.60***	0.0279
Bond Rating	129,697	16.43	72,169	18.65	-2.22***	0.0092
LN(Issue Amount)	129,697	16.17	72,169	16.31	-0.14***	0.0063
LN(Bond Amount)	129,697	13.09	72,169	13.32	-0.23***	0.0065
Num. of Agents	129,680	5.65	72,150	6.13	-0.47***	0.0108

Post-Crisis Period: 2008-2016

	N(Ins.)	Insured	N(Unins.)	UnInsured	Diff.	Std. Error
Offering Yield	35,211	3.06	133,200	2.43	0.63***	0.0071
Coupon	35,211	3.68	133,200	3.36	0.32***	0.0066
Maturity	35,211	10.71	133,200	9.92	0.80***	0.0371
Bond Rating	35,211	15.87	133,200	18.64	-2.76***	0.0104
LN(Issue Amount)	35,211	15.77	133,200	16.31	-0.55***	0.0081
LN(Bond Amount)	35,211	12.72	133,200	13.40	-0.68***	0.0083
Num. of Agents	35,211	5.84	133,179	6.16	-0.32***	0.0150

Table 4: Determinants of Offering Yield

This table reports the determinants of offering yields over the entire period using a pooled OLS regression, with standard errors clustered by issue. Variable definitions are in the text.

Variable	Full Period	1985–1999	2000–2007	2008–2016
Insured (Y/N)	-0.0576***	-0.128***	-0.0439***	0.0182
	(-12.62)	(-12.44)	(-7.70)	(1.66)
Call Dummy	0.226***	0.0833***	0.192***	0.353***
	(79.55)	(12.60)	(70.90)	(85.30)
LN(Bond Amount)	-0.0171***	-0.0109**	-0.0192***	-0.0116***
	(-9.03)	(-2.98)	(-7.80)	(-3.98)
LN(Issue Amount)	0.0193***	0.0294***	0.0165***	-0.00605
	(8.06)	(5.70)	(5.25)	(-1.60)
CAstate	0.0379***	-0.0251	-0.0399***	0.152***
	(5.32)	(-1.57)	(-5.60)	(11.86)
TXstate	0.108***	0.0697***	0.0636***	0.0262**
	(19.07)	(7.23)	(10.19)	(2.62)
NYstate	-0.0213***	0.0293**	-0.0618***	-0.0153
	(-3.87)	(2.90)	(-10.35)	(-1.37)
ILstate	0.152***	0.0631***	0.0646***	0.286***
	(16.31)	(4.32)	(6.60)	(15.71)
LN(Bond Maturity)	0.826***	0.665***	0.736***	1.020***
	(295.19)	(130.38)	(169.94)	(283.94)
Ba1 rated	0.0133	-0.234**	-0.464**	0.989***
	(0.16)	(-2.86)	(-3.14)	(20.71)
Baa2 rated	-0.0937	-0.0976	-0.559***	0.749***
	(-1.12)	(-1.22)	(-3.80)	(21.35)
Baa1 rated	-0.162	-0.135	-0.572***	0.674***
	(-1.95)	(-1.69)	(-3.89)	(20.09)
A3 rated	-0.266**	-0.280***	-0.595***	0.346***
	(-3.21)	(-3.53)	(-4.05)	(17.97)
A2 rated	-0.265**	-0.243**	-0.597***	0.296***
	(-3.21)	(-3.08)	(-4.07)	(18.04)
A1 rated	-0.297***	-0.270***	-0.625***	0.223***
	(-3.59)	(-3.42)	(-4.26)	(15.81)
Aa3 rated	-0.351***	-0.376***	-0.634***	0.146***
	(-4.24)	(-4.72)	(-4.32)	(11.69)
Aa2 rated	-0.402***	-0.390***	-0.644***	0.0797***
	(-4.86)	(-4.90)	(-4.38)	(6.90)
Aa1 rated	-0.443***	-0.426***	-0.647***	0.00794
	(-5.34)	(-5.34)	(-4.40)	(0.66)
Aaa rated	-0.484***	-0.456***	-0.676***	-0.0493***
	(-5.84)	(-5.71)	(-4.60)	(-3.99)
Bank Qualified	-0.0976***	-0.0760***	-0.0696***	-0.198***
	(-22.66)	(-9.27)	(-13.76)	(-24.37)
Macro Controls?	Yes	Yes	Yes	Yes
Adjusted R^2	0.914	0.896	0.830	0.889
Observations	480,199	109,994	201,796	168,409

Table 5: Actual Yield - Fitted Yield for Insured Bonds By Year

This table reports the mean difference between offering yields and predicted yields for insured bonds tabulated by year. Yields for insured bonds are predicted using coefficients obtained from yearly OLS cross-sectional models that regress offering yields on bond characteristics and macro-variables for uninsured bonds issued in that year using the specification in Equation 4. Negative values represent a lower cost of borrowing to issuers. N is the number of insured bonds in that year and Insured represents the dollar value of the insured bonds in millions. Dollar loss is the present value of difference in yield paid as an annuity over the life of the bond and discounted at the riskfree rate at issuance expressed in millions and the Loss as % divides the Dollar Loss by the total insured (.495 = 49.5 bps). S.A. = Simple Average; W.A. = Weighted Average.

Year	N	Diff. Yield (%, S.A.)	Diff. Yield (% W.A.)	Insured ($ million)	Dollar Loss ($ million)	% Loss
1985	117	0.065	0.100	44	0.2	0.480
1986	230	-0.116	-0.244	125	-2.4	-1.926
1987	103	-0.217	0.051	182	1.0	0.557
1988	432	-0.147	-0.174	223	-2.7	-1.200
1989	574	-0.201	-0.075	477	-1.3	-0.268
1990	1,195	-0.180	-0.228	1,607	-27.5	-1.708
1991	2,762	-0.320	-0.367	2,024	-56.7	-2.800
1992	2,537	-0.123	-0.136	3,353	-59.0	-1.761
1993	2,219	-0.150	-0.138	2,259	-38.0	-1.681
1994	4,224	-0.102	-0.063	4,800	-20.3	-0.423
1995	3,788	-0.132	-0.115	4,002	-37.2	-0.928
1996	5,500	-0.103	-0.074	5,752	-22.7	-0.394
1997	6,886	-0.090	-0.007	10,061	15.3	0.152
1998	7,565	-0.020	0.058	9,414	81.0	0.861
1999	8,620	-0.080	-0.000	9,350	25.5	0.273
2000	10,196	-0.044	0.029	12,040	66.4	0.552
2001	13,475	-0.019	0.030	15,752	90.2	0.572
2002	15,187	-0.098	-0.006	20,139	9.3	0.046
2003	19,037	-0.122	-0.075	24,571	-240.0	-0.977
2004	21,199	-0.086	-0.032	28,932	-107.5	-0.372
2005	18,424	-0.034	0.008	22,700	66.6	0.293
2006	16,516	-0.026	0.041	23,296	137.0	0.588
2007	15,594	-0.035	0.020	23,351	106.3	0.455
2008	8,913	-0.089	-0.077	8,704	-75.1	-0.863
2009	5,742	-0.172	-0.016	4,904	8.9	0.182
2010	2,179	-0.114	0.024	1,260	4.6	0.362
2011	1,976	-0.187	0.019	1,284	8.7	0.676
2012	1,518	0.089	0.259	1,152	62.0	5.383
2013	2,656	0.117	0.190	1,743	71.0	4.074
2014	3,581	0.142	0.155	2,042	56.1	2.746
2015	5,497	0.114	0.158	3,503	90.9	2.593
2016	3,149	0.097	0.150	1,814	45.9	2.530
Total	211,591	-0.063	-0.008	250,861	256.6	0.102

Table 6: Actual Yield - Fitted Yield for Insured Bonds By Rating

This table reports the mean difference between offering yields and predicted yields for insured bonds tabulated by rating. Yields for insured bonds are predicted using coefficients obtained from yearly OLS cross-sectional models that regress offering yields on bond characteristics and macro-variables for uninsured bonds issued in that year using the specification in Equation 4. Negative values represent a lower cost of borrowing to issuers. N is the number of insured bonds in that year and Insured represents the dollar value of the insured bonds in millions. Dollar loss is the present value of difference in yield paid as an annuity over the life of the bond and discounted at the riskfree rate at issuance expressed in millions and the Loss as % divides the Dollar Loss by the total insured (.495 = 49.5 bps). S.A. = Simple Average; W.A. = Weighted Average.

Rating	N	Diff. Yield (%, S.A.)	Diff. Yield (%, W.A.)	Insured ($ million)	Dollar Loss ($ million)	% Loss
Aaa	578	0.086	0.224	1,724	53.9	3.129
Aa1	3,250	0.003	0.044	7,964	45.5	0.571
Aa2	13,394	-0.005	0.040	32,850	203.5	0.619
Aa3	24,834	-0.007	0.043	55,746	332.6	0.597
A1	51,789	-0.027	-0.006	57,124	105.7	0.185
A2	54,099	-0.071	-0.046	43,623	-159.5	-0.366
A3	27,909	-0.036	-0.007	21,648	7.1	0.033
Baa1	17,995	-0.192	-0.128	18,946	-202.4	-1.068
Baa2	12,348	-0.158	-0.110	8,155	-54.2	-0.665
Baa3	5,281	-0.280	-0.244	2,431	-65.2	-2.681
Ba1	114	-0.336	-0.182	651	-10.5	-1.608
Total	211,591	-0.063	-0.008	250,861	256.6	0.102

Table 7: Actual Yield - Fitted Yield for Insured Bonds By Year (Expanded Model)

This table reports the mean difference between offering yields and predicted yields for insured bonds tabulated by year. Yields for insured bonds are predicted using coefficients obtained from yearly OLS cross-sectional models that regress offering yields on bond characteristics and macro-variables for uninsured bonds issued in that year using the specification in Equation 5. Negative values represent a lower cost of borrowing to issuers. N is the number of insured bonds in that year and Insured represents the dollar value of the insured bonds in millions. Dollar loss is the present value of difference in yield paid as an annuity over the life of the bond and discounted at the riskfree rate at issuance expressed in millions and the Loss as % divides the Dollar Loss by the total insured (.123 = 12.3 bps). S.A. = Simple Average; W.A. = Weighted Average.

Year	N	Diff. Yield (%, S.A.)	Diff. Yield (% W.A.)	Insured ($ million)	Dollar Loss ($ million)	% Loss
1985	117	-0.421	-0.584	44	-1.3	-2.841
1986	223	-1.611	-1.691	125	-20.8	-16.692
1987	85	1.511	0.090	182	0.3	0.160
1988	390	-0.058	-0.028	223	-0.3	-0.155
1989	541	-0.156	-0.066	477	-1.4	-0.284
1990	1,089	-0.172	-0.305	1,607	-36.9	-2.296
1991	2,604	-0.320	-0.389	2,024	-57.0	-2.815
1992	2,366	-0.151	-0.091	3,353	-18.6	-0.556
1993	2,083	-0.159	-0.119	2,259	-23.0	-1.016
1994	4,124	-0.100	-0.045	4,800	-8.9	-0.185
1995	3,645	-0.146	-0.137	4,002	-52.3	-1.307
1996	5,293	-0.113	-0.102	5,752	-36.2	-0.629
1997	6,647	-0.085	-0.064	10,061	-55.1	-0.548
1998	7,447	-0.015	0.027	9,414	34.3	0.365
1999	8,479	-0.078	-0.005	9,350	10.5	0.112
2000	10,147	-0.053	-0.043	12,040	-47.3	-0.392
2001	13,417	-0.016	0.011	15,752	50.3	0.320
2002	15,061	-0.106	-0.040	20,139	-79.4	-0.394
2003	18,817	-0.157	-0.112	24,571	-306.8	-1.249
2004	18,729	-0.099	-0.028	28,932	-61.2	-0.212
2005	18,356	-0.040	-0.011	22,700	-10.6	-0.047
2006	16,501	-0.032	0.012	23,296	37.9	0.163
2007	15,594	-0.051	-0.020	23,351	-34.1	-0.146
2008	8,913	-0.097	-0.063	8,704	-36.6	-0.420
2009	5,742	-0.189	0.001	4,904	53.6	1.093
2010	2,179	-0.138	0.010	1,260	5.4	0.429
2011	1,976	-0.219	-0.045	1,284	-5.5	-0.428
2012	1,518	0.043	0.197	1,152	45.3	3.932
2013	2,656	0.104	0.126	1,743	40.9	2.348
2014	3,581	0.090	0.100	2,042	37.5	1.836
2015	5,488	0.079	0.122	3,503	65.1	1.857
2016	3,149	0.071	0.085	1,814	16.4	0.904
Total	206,957	-0.075	-0.033	250,861	-495.6	-0.198

Table 8: Actual Yield - Fitted Yield for Insured Bonds By Rating (Expanded Model)

This table reports the mean difference between offering yields and predicted yields for insured bonds tabulated by rating. Yields for insured bonds are predicted using coefficients obtained from yearly OLS cross-sectional models that regress offering yields on bond characteristics and macro-variables for uninsured bonds issued in that year using the specification in Equation 5. Negative values represent a lower cost of borrowing to issuers. N is the number of insured bonds in that year and Insured represents the dollar value of the insured bonds in millions. Dollar loss is the present value of difference in yield paid as an annuity over the life of the bond and discounted at the riskfree rate at issuance expressed in millions and the Loss as % divides the Dollar Loss by the total insured (.123 = 12.3 bps). S.A. = Simple Average; W.A. = Weighted Average.

Rating	N	Diff. Yield (%, S.A.)	Diff. Yield (%, W.A.)	Insured ($ million)	Dollar Loss ($ million)	% Loss
Aaa	574	0.048	0.226	1,724	60.2	3.490
Aa1	3,129	-0.010	0.048	7,964	77.5	0.973
Aa2	13,000	-0.019	-0.010	32,850	-23.5	-0.071
Aa3	24,437	-0.023	0.011	55,746	69.3	0.124
A1	50,779	-0.038	-0.017	57,124	46.0	0.081
A2	52,711	-0.089	-0.071	43,623	-265.1	-0.608
A3	27,301	-0.049	-0.023	21,648	-18.3	-0.084
Baa1	17,612	-0.181	-0.152	18,946	-264.6	-1.397
Baa2	12,084	-0.175	-0.140	8,155	-89.8	-1.102
Baa3	5,216	-0.274	-0.232	2,431	-66.1	-2.717
Ba1	114	-0.386	-0.321	651	-21.2	-3.256
Total	206,957	-0.075	-0.033	250,861	-495.6	-0.198

Table 9: Marginal Effects of Selection Model

This table reports the marginal effects from the probit selection models for estimating propensity scores. Each coefficient represents the percentage increase in the probability of insurance from a unit change in the coefficient. Monthly macroeconomic controls for inflation, constant-maturity 10yr yield, credit spread, and treasury slope are included in all models but not tabulated. McFadden pseudo R^2 are displayed as well as the percentage of insured and uninsured issues correctly classified by the model.

Variable	Full Period	1985–1999	2000–2007	2008–2016
Maturity	0.007***	0.011***	0.012***	0.003***
Maturity sq.	-0.000***	-0.000***	-0.000***	-0.000***
LN(Issue Amount)	0.015***	0.035***	0.017***	-0.009**
Under. Decile	-0.007***	-0.007***	-0.013***	-0.000
Num. of Agents	-0.003*	-0.011***	-0.010***	-0.005**
Comp. Offering	0.006	-0.036*	0.026**	0.102
Neg. Offering	-0.010	-0.071	0.022	0.113
Bank Qualified	-0.051***	-0.055***	-0.025**	0.004
Call Dummy	0.018***	-0.019*	-0.001	-0.002
Ratings				
Ba2 rated	-0.282**	-0.051	-0.549***	0.000
Ba1 rated	0.133***	0.063	0.021	0.019
Baa2 rated	0.107***	0.049	0.028	0.137***
Baa1 rated	0.104***	0.126***	0.038*	0.032
A3 rated	0.129***	0.058*	-0.005	0.039
A2 rated	0.073***	0.082***	0.027*	0.031
(A1 rating base)	0.000	0.000	0.000	0.000
Aa3 rated	-0.238***	-0.441***	-0.109***	-0.308***
Aa2 rated	-0.424***	-0.519***	-0.220***	-0.364***
Aa1 rated	-0.511***	-0.553***	-0.474***	-0.379***
Aaa rated	-0.587***	-0.578***	-0.686***	-0.373***
Proceeds				
General	0.002	0.025	-0.012	-0.003
OtherEd	0.046**	0.009	0.024	0.039
PrimaryEd	-0.006	0.044*	0.008	-0.006
Water	0.117***	0.014	0.089***	0.111***
LowPre2000			-0.105***	
MedPre2000			0.012	
HighPre2000			0.096***	
PriorIssuance				
LowPreCrisis				-0.091***
MedPreCrisis				-0.021*
HighPreCrisis				0.025**
Observations	469,910	104,361	197,212	168,330
Pseudo R^2	33.33	38.30	40.16	49.38
% Insured Correct	78.78	81.13	92.03	69.90
% UnInsured Correct	77.21	78.09	65.14	93.67

Table 10: Average Value of Insurance: Selection Models Expanded

This table reports estimates of insurance value (in bps) from empirical specifications that control for selection of insurance by issuers. Panel A reports the mean predicted yields and average treatment effects of insurance using a propensity score matching procedure which predicts the choice of insurance. The insurance choice model is fit using a probit specification including controls for issue size, maturity, issuer rating, bank qualified status, number of agents, underwriter activity, and monthly macroeconomic controls. Insured bonds are matched with replacement to their 3 nearest neighbors by propensity score. Negative values for the average treatment effect (ATE) indicate that insured bonds have lower yields than comparable (control) uninsured bonds. Standard errors of the ATE estimates are in parentheses. Panel B reports the mean predicted yields and average treatment effects for uninsured and insured bonds using an inverse probability weighted regression adjustment model to control for insurance selection. The insurance selection model is fit using a probit specification including controls for issuer rating, underwriter activity, issue size and maturity, and the augmented weighted outcome regression on offering yield includes issuer ratings, size and maturity variables, as well as monthly macroeconomic controls. Robust standard errors of the ATE estimates are in parentheses. For the propensity score matched models, errors are calculated according to Abadie and Imbens (2016).

Panel A: Propensity Score Matched Models

	1985–2016	1985–1999	2000–2007	2008–2016
Uninsured	3.872	5.208	3.944	2.651
Insured	3.843	5.055	3.868	2.894
Avg. Treatment Effect	-0.028***	-0.154***	-0.076***	0.243***
	(0.004)	(0.016)	(0.006)	(0.015)
Observations	417,451	95,372	175,138	146,931

Panel B: Inverse-Probability Weighted Regression Models

	1985–2016	1985–1999	2000–2007	2008–2016
Uninsured	3.779	5.195	3.960	2.623
Insured	3.725	5.102	3.874	2.663
Avg. Treatment Effect	-0.054***	-0.093***	-0.086***	0.039*
	(0.002)	(0.003)	(0.004)	(0.017)
Observations	417,451	95,372	175,138	146,934

Table 11: Cross-Sectional Determinants of Money Left On The Table

This table reports a regression of the money left on the table measure described in the text on the corruption measures and advisor/underwriter sizes, with standard errors clustered by issue. High Conviction and Prosecution indicate bonds issued in counties contained in federal judicial districts with above 25th percentile per capita official corruption convictions or prosecutions. Top advisors and underwriters refer to an underwriter or advisor who was in the top decile of total volume of municipal GO bonds advised or underwritten during the year of issue. Bond controls include coupon, issue size, time to maturity, and dummies for bank qualified, competitive, negotiated, and callable issues. State dummies in conviction regressions are all states with more than one federal judicial district and all states in advisor regressions. Coefficients that are significantly different from zero at 1%, 5%, and 10% significance levels are flagged with ***,**, or *.

Variable	(1)	(2)	(3)	(4)
High Conviction	11.16**	35.14***		
	(2.37)	(4.78)		
High Prosecution	-22.18***	2.449		
	(-4.81)	(0.33)		
High Conviction x High Prosecution		-37.45***		
		(-3.97)		
Top Advisor			18.70*	18.10*
			(1.83)	(1.76)
Top Underwriter			20.07**	19.61**
			(2.22)	(2.12)
Top Advisor x Top Underwriter				6.176
				(0.15)
Bond Controls?	Yes	Yes	Yes	Yes
Rating Dummies?	Yes	Yes	Yes	Yes
Year Effects?	Yes	Yes	Yes	Yes
State Dummies?	Yes	Yes	Yes	Yes
Adjusted R^2	0.192	0.193	0.216	0.216
Observations	167,845	167,845	101,751	101,751

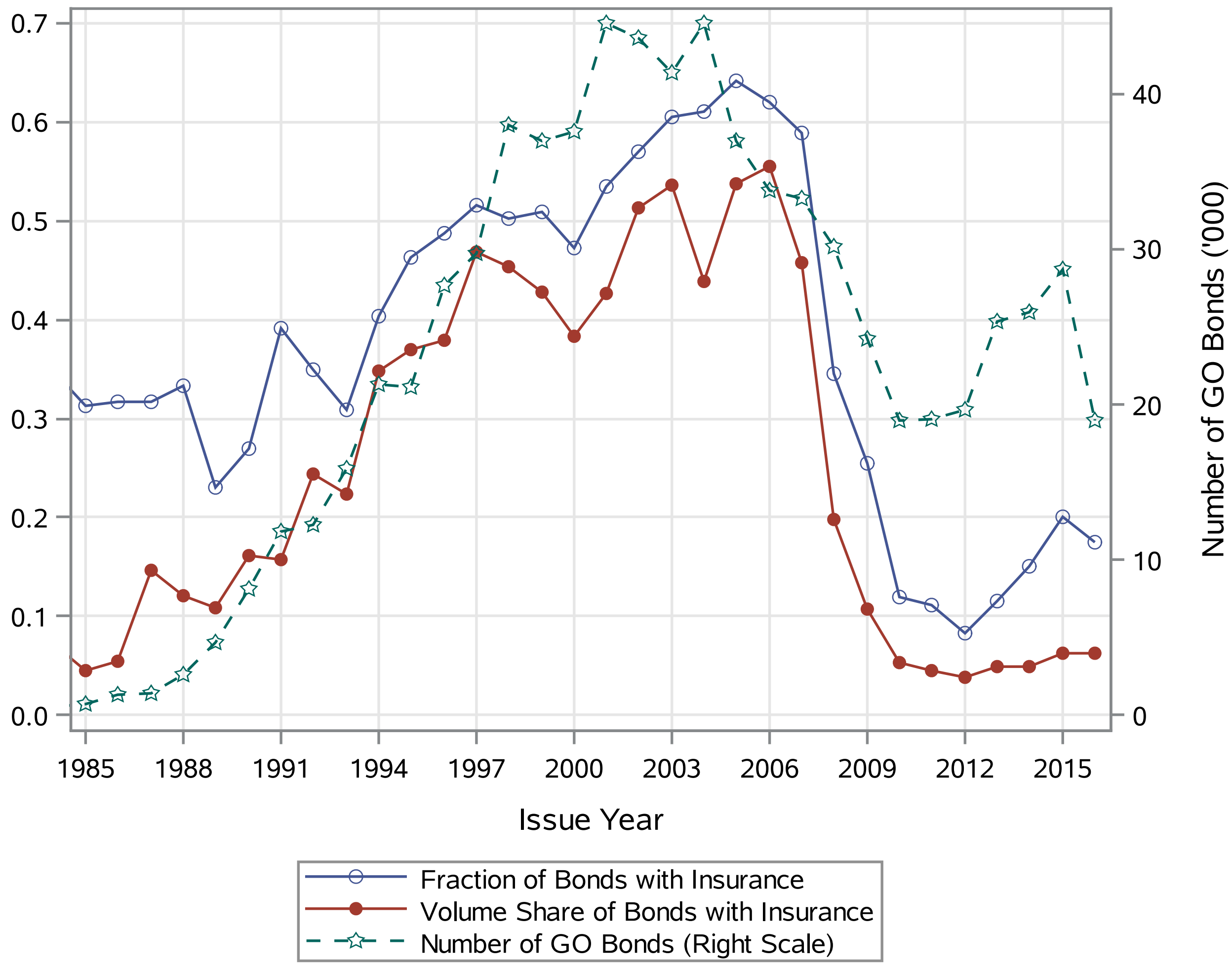

Figure 1: Trend in municipal general obligation bond issuance and use of bond insurance

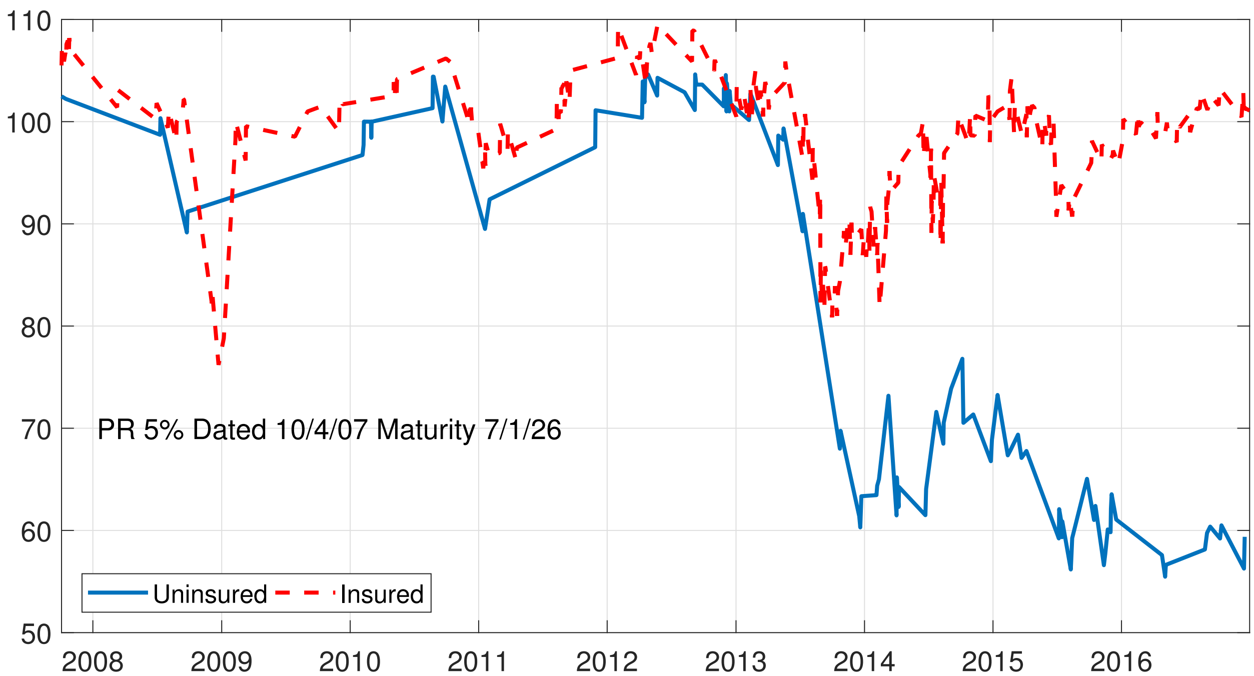

Figure 2: The Value of Insurance in Secondary Market Trading

This figure plots the volume-weighted daily average price of two Puerto Rico GO bonds issued on 10/4/2007 with a coupon rate of 5% and maturity date of 07/01/2026. The offering size of the uninsured bond is $18.35 million, $7 million of which is subsequently insured in the secondary insurance market. Trade data are from MSRB.

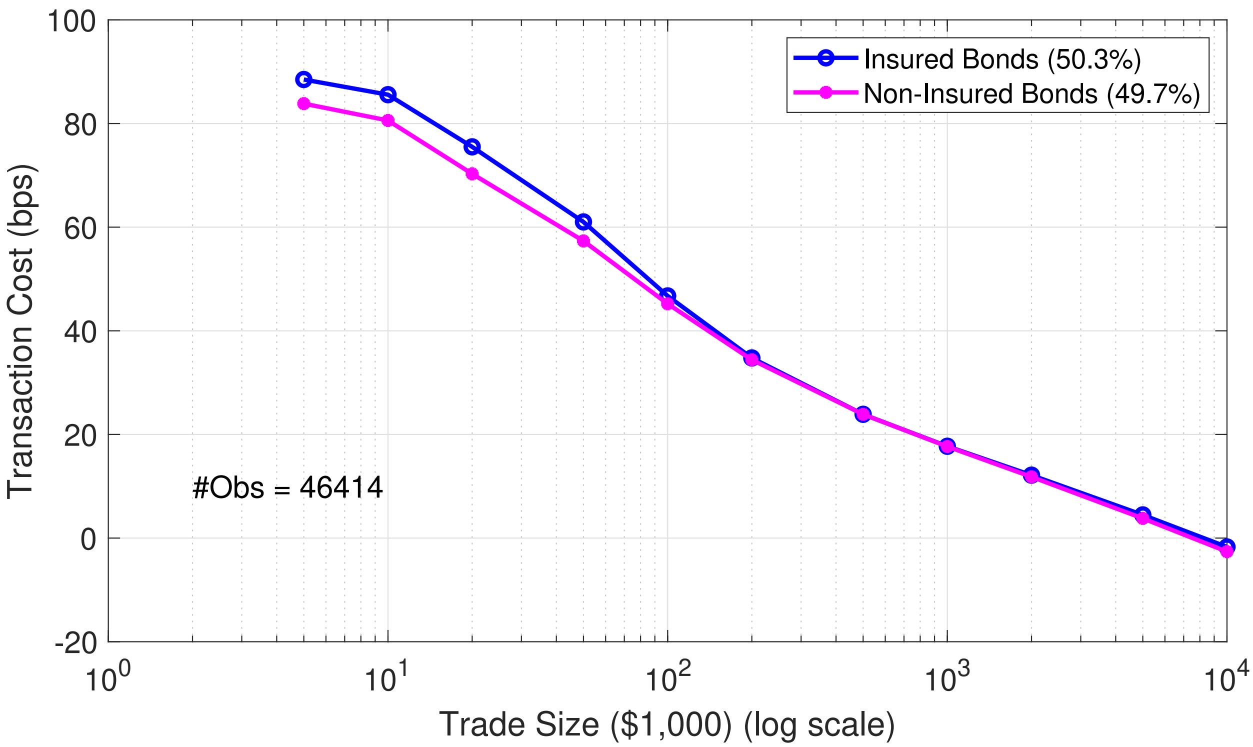

Figure 3: Transaction Costs of Insured versus Non-Insured Bonds for 2005-2016 Period

This figure shows the transaction cost functions for insured bonds versus non-insured bonds. Estimation is based on MSRB municipal bond trade database for the 2005-2016 period. Bond insurance status is from Mergent FISD Municipal Bonds database.

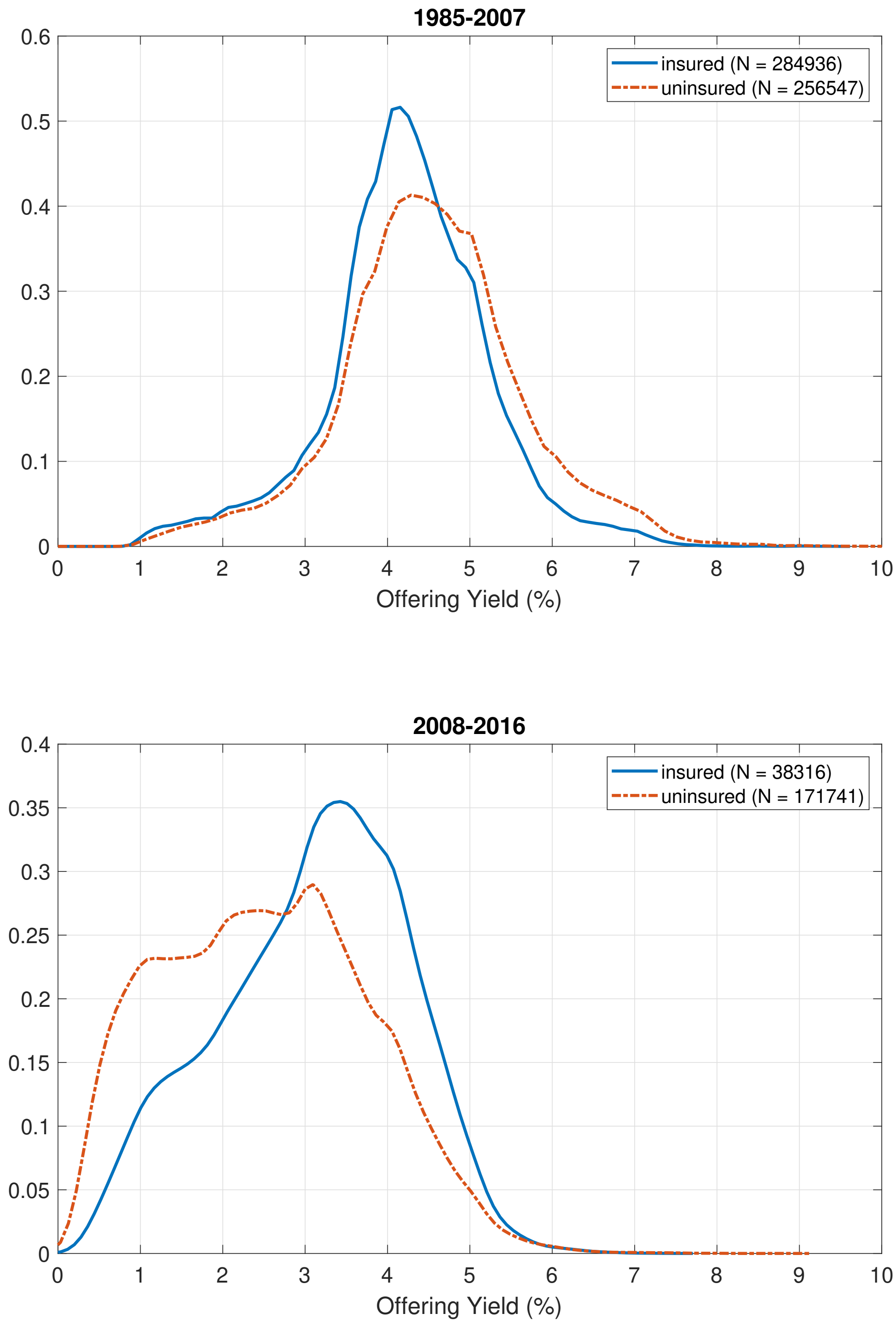

Figure 4: Distribution of Offering Yields of Insured and Uninsured Bonds

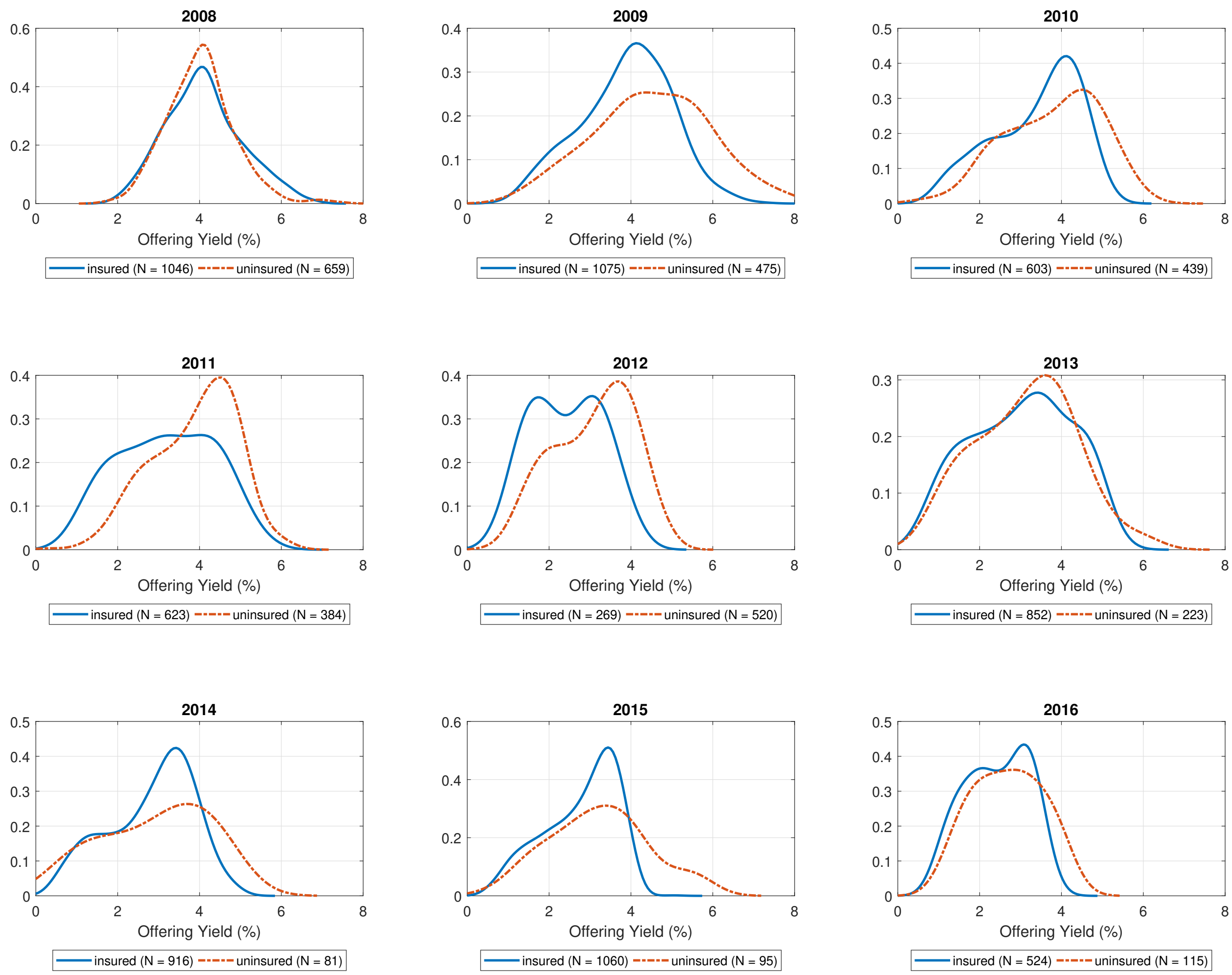

Figure 5: Post-crisis distribution of offering yields of Baa bonds

This figure shows the distribution of offering yields of bonds with Baa ratings and lower over the 2008-2016 period.