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ABSTRACT

The auction rate bond market grew from inauspicious beginnings in 1985 to representing a significant fraction of the municipal bond market in 2007 with a total of 603 issuances that year raising more than $35 billion in capital. Since March of 2008 not a single auction rate bond has been issued. The last issuance coincided with a wave of "failures" of auction rate bond auctions during the early winter of 2008. Pundits have attributed the auction failures to a "frozen" market and hint that irrationality on the part of investors precipitated the auction failures. Missing from the headlines is that all auction rate bonds have interest rate caps that limit their yields. We find that, contrary to the impression given by news headlines, not all auctions failed and that investors rationally discriminated among bonds such that it was primarily those with low caps that experienced high failure rates. We further conclude that, in the absence of such caps, few if any, auctions would have failed.

Why Did Auction Rate Bond Auctions Fail During 2007-2008?[1]

The first auction rate bond (ARB) was issued in 1985 by Warrick County, Indiana, to finance the Southern Indiana Gas and Electric Company. The most recent ARB issuance, and perhaps the last, occurred in February 2008. Between the first and most recent issuance, the market grew steadily such that by February 2008, the total dollar amount of ARBs outstanding was estimated to be roughly $267 billion. Thus, from its inauspicious beginnings roughly 25 years ago, the market prospered - - at least until 2008. Consider that 2007 witnessed the issuance of 603 ARBs with a total face value of $35.7 billion. In comparison, through the first three months of 2008, only 12 bonds were issued with a total face value of $0.162 billion. Since that time, we have been unable to identify a single ARB issuance. In this article we investigate what happened to the ARB market during 2007 and 2008.

In part, the answer to the question of what happened to the ARB market is obvious and straightforward. To wit, the market experienced a wave of auction "failures" during late 2007 and the first half of 2008. In the wake of the auction failures, new issuances stopped. The failure of the auctions made headline news. The typical headline story attributed the auction failures to investors who "abandoned" the "frozen" market, and hinted that the investors, perhaps irrationally, were unwilling to bid for the securities at any price. Consider the following:

> The failure of a string of short-term funding auctions this week is a reminder that not only is the credit crunch not over — it's taken a further step into the realm of the irrational. (Barrett [February 13, 2008] Auctions fail on fear of fear itself, *Dow Jones Capital Markets Reports*, pp. 27-29).

And:

> Much of the $350 billion market for auction-rate securities... has been frozen since February, when auction failures became widespread. That has left many investors without the ability to sell. (Smith, Scannell, and Rappaport [July 16, 2008] UBS to buy back up to $3.5 billion in securities, *The Wall Street Journal*, p. C15).

In this article we investigate what factors, other than, perhaps, irrationality on the part of investors, contributed to the auction failures. Before doing so it is useful to offer a short primer on the way in which the auctions for ARBs work.

The coupon rate of interest paid on ARBs is reset at regular intervals through a Dutch auction in which buyers pay, and sellers receive, par value for the securities. Given that the securities must trade at par, potential buyers submit bids in terms of the coupon rate they require for holding the securities until the next auction. The auction agent allocates bonds moving upward from the lowest coupon rate bid until the dollar amount of bonds outstanding is fully allocated. All buyers receive the same “market clearing” coupon rate of interest on their bonds so that the market-clearing “price” for an issue is the lowest coupon rate at which the cumulative dollar amount of securities demanded at or below that rate equals the total dollar amount outstanding.

An auction “failure” occurs when there are not sufficient bids to clear the market. The failure of auctions during late 2007 and early 2008, therefore, gave rise to the inference that investors were unwilling to hold the bonds at any conceivable yield. One item omitted from the headline stories, however, is that, as with most floating rate securities, ARB periodic reset rates are capped by contractually specified maximum rates. With ARBs, because the securities trade at par, the maximum rates play a critical role in the market clearing process. In fact, an auction is deemed to have failed when there are not sufficient bids to clear the market at a rate less than a security’s maximum rate. In official parlance, the rate caps are “maximum auction rates.” As shorthand, we use the term “max rate” interchangeably with “maximum auction rate” throughout this article.

An alternative explanation to irrationality on the part of investors is that the failed auctions occurred because the market yields that investors required to hold the securities lay above their maximum auction rates. When this occurred, market participants rationally declined to bid at the auctions. Thus, the missing market participants were investors who quite reasonably decided not to bid.

As a preliminary analysis, we calculate the fraction of auctions that failed, by week, beginning with the first week of January 2003 and ending with the third week of July of 2008. Contrary to the impression given by news stories that refer to the frozen market, we find that, even at the peak of auction failures, not all auctions failed.[2] Indeed, at its peak, in our sample of 793 bonds, the overall auction failure rate was only 46%.

This observation gives rise to the question of whether auction failures can be explained by characteristics of the bonds that were being auctioned. We propose that failed auctions were systematically and negatively related to the level of the bonds’ maximum auction rates. To evaluate this proposition, we undertake three sets of analyses.

First, we estimate the parameters of a logistic model of auction failures. We find that the probability of auction failure is negatively and significantly related to the level of bonds’ maximum auction rates - - lower max rates are associated with a higher probability of auction failure.

Second, we observe that there are two generic types of maximum auction rates: fixed and floating. Because the levels of floating max auction rates are typically much lower than the levels of fixed max auction rates, the type of max auction rate can serve as a proxy for the levels of the rates and allows a natural dichotomization of the sample. When we classify ARBs by type of max rate, we find that auctions for those with floating max rates failed at a much higher frequency than did auctions for bonds with fixed max rates. For example, during the tumultuous second week of February 2008, when the rate of auction failures in our sample jumped from 18% to 41%, the rate of auction failures for bonds with floating maximum auction rates was 93%, while the rate of auction failures for bonds with fixed maximum auction rates was 13.1%. Using a logit model, we find that the probability of auction failure is significantly related to the type of maximum auction rate - - ARBs with floating max rates were significantly more likely to have experienced auction failures than were those with fixed max rates.

Third, using bonds with successful auctions, we estimate regression models of market clearing yields based on bond characteristics and market-wide data. For bonds with failed auctions, we compare the market clearing yields implied by the models with the bonds' maximum auction rates. We find that the market clearing yields implied by the models are significantly higher than the bonds' maximum auction rates.

Thus, the data solidly support the proposition that auction failures were directly related to the level of maximum auction rates. Rather than being irrational, investors appear to have prudently distinguished among ARBs and chose to bid on those for which the market required yields were less than their maximum auction rates.

We then investigate whether investors were "compensated" for the risk of auction failure. This question has its origins in the official inquiries and civil lawsuits that followed shortly on the heels of the failed auctions.[3] One of the focal points of the inquiries and lawsuits is the allegation that ARB investors were duped into buying securities that were “cash equivalents.” We investigate this allegation, albeit inferentially, by comparing ARB yields with yields of certain cash equivalent investment alternatives including treasury bills (T-bills), certificates of deposit (CDs), and money market funds (MMFs).

In a regression analysis that controls for various differences between ARBs and the benchmark alternatives, we find that ARBs provided average returns that were significantly greater than the various cash equivalent alternatives. For example, over the period January 2003 through the mid-January 2008, ARBs provided an average annual return of 26 basis points above the return of MMFs. Over the period of September 2007, when the auction first auction failure of 2007 occurred, through the second week of January 2008, the week just prior to the jump in auction failures of 2008, the spread between ARB yields and MMF yields increased to approximately 48 basis points.

We cannot answer the question of whether individual investors were duped into buying ARBs under the false impression that auctions would never fail. However, the data indicate that ARBs were not being priced by market participants as if the securities were cash equivalents.

Auction Rate Bonds

ARBs are long term floating rate bonds whose coupon interest rates are reset by market participants through periodic auctions. Buyers must pay face or par value for securities purchased at auction. In their bids, potential investors specify an amount at par value and a required periodic yield. At each auction, the market clearing bid is the lowest yield such that the cumulative dollar amount of bids with lower yields equals the total outstanding dollar amount of the issue at par value. The market clearing yield is the yield that all holders of the security earn over the interval until the subsequent auction.

Market participants who already hold a particular security may submit one of three types of bids. Those who wish to sell the security regardless of the market clearing yield can submit a sell order. Those who wish to maintain their positions regardless of the market clearing yield can submit a "hold at market" order. Those who wish to submit a specific bid at the auction can do so. If that bid is below the market clearing yield, the investor continues to hold his position. If that bid turns out to be above the market clearing yield, the bidder is deemed to have sold his position.

A market participant who does not hold the security and wishes to do so can submit a buy order that specifies a dollar amount and a yield. If the bid is less than or equal to the market clearing yield, the bidder receives the security. All market participants submit their bids to brokers who, in turn, submit the bids to the auction agent. It is the auction agent's responsibility to determine the market clearing yield by matching orders among holders and potential new investors.

In clearing the market, the auction agent is constrained by a maximum auction rate that limits the interest rate that the issuer can be required to pay on the bond. The maximum auction rates, which are specified in each bond indenture, come in one of two varieties: fixed rate or floating rate. As implied by their name, fixed maximum auction rates are straightforward, albeit, across securities, there is a wide range of observed fixed maximum auction rates with a low of 9% and a high of 25% for the bonds in our sample.

In contrast to the straightforward fixed max rates, floating max rates exhibit significant heterogeneity in their composition. To begin, each floating max rate is tied to a floating reference rate. The floating max rates are either tied to the reference rate as of the date of the auction or to a moving average of the reference rate over some pre-specified period of time prior to the auction. In either case, a floating max rate can be specified as the reference rate times some multiplier or the reference rate plus a spread. Additionally the magnitude of the multiplier or the additive spread depends on the credit rating of the security as of the date of the auction. Further, in some instances, the floating max rate is specified as the minimum of two rates, one of which is the reference rate times a multiplier and the other of which is the reference rate plus a spread.

Reference rates include the one-month London Interbank Offer Rate (LIBOR), the 30-day AA Non-Financial Commercial Paper rate, the 30-day AA Financial Commercial Paper rate, the Kenny S&P High Grade Municipal Bond Index, and the Securities Industry and Financial Market Association (SIFMA) Municipal Swap Index rate. Further, the reference rate multipliers vary significantly across ARBs ranging from a low of 125% to a high of 500%. Similar variability occurs in additive spreads that range from 1% to 3.5%.

One example of a floating max auction rate comes from the 2007 series C bond issued by the Michigan Housing Development Authority: if the rating of the issue is AAA- or higher as of the auction date, the max rate is 150% of the one-month LIBOR as of that date; if the rating of the bond is AA+ to AA- as of the auction date, the max rate is 175% of the one-month LIBOR; if the rating of the bond is A- to A+ as of the auction date, the max rate is 200% of the one-month LIBOR; if the rating is BBB- to BBB, the max rate is 225% of the one-month LIBOR; and if the rating is below BBB-, the max rate is 250% of the one-month LIBOR. The bond is tax exempt and is insured by Financial Security Assurance Incorporated.

A second example comes from the Student Loan Revenue Senior Bond issued by the Brazos Education Authority in 2006: if the rating of the issue is AA- or better as of the auction date, the max rate is one-month LIBOR as of that date plus 1.5%; if the rating of the issue is between A+ and A- as of the auction date, the max rate is one-month LIBOR plus 2.5%; and if the rating of the issue is below A-, the max rate is one-month LIBOR plus 3.5%. The bond is tax exempt and is guaranteed by the Brazos Education Authority, but has no other form of insurance.

The examples illustrate, but do not exhaust, the many variations in max rates across ARBs. The examples also illustrate that some bonds are tax exempt and others are not, and that some are self-insured while others are insured by third-party insurers.

A further characteristic of ARBs with floating max rates is that all of them also have fixed max rates. At each auction, the binding max rate is the minimum of the two as of the auction date. An auction succeeds when there are sufficient bids at or below the maximum auction rate such that the cumulative dollar amount bid is at least equal to the dollar amount outstanding at par value.

For our purposes, the more important outcome occurs when there are not sufficient bids to clear the market at a rate less than the bond's max rate. These are the failed auctions that were much in the headlines during the first six months of 2008. In the instance of a failed auction, current holders of the ARB continue to hold the security regardless of their orders. The problematic investor is the holder who wishes to extricate himself from his position. This investor is stuck, at least until the next auction, and possibly much longer. Indeed, this investor is stuck until the next successful auction and, in the meantime, receives the contractually specified maximum auction rate. Assuming that the bond's maximum auction rate is below the "market required" rate, investors are stuck with a security that is providing a below market return.

The Evolution and State of the Auction Rate Bond Market

As we noted, the first ARB was issued in 1985 by Warrick County (Indiana) to finance the Southern Indiana Gas and Electric Company. Seven ARBs were issued in 1985 with another 34 issued between 1986 and 1990. Issuances began to pick up in 1991 with 81 issues and another 129 in 1992. Over the following 16 years, the number of issuances of ARBs ebbed and flowed as capital market activity underwent cycles of expansion and contraction, but ARBs, with 603 issued in 2007, had remarkable staying power — at least until 2008.[4]

From their inception, it was recognized that ARB auction failures could occur. However, auction failures with any type of ARB were few and far between. According to *Moody's*, between 1984 (when the first auction rate preferred stock was issued) and the end of 2006, auction rate bonds and preferred stocks together experienced a total of only 13 auction failures out of over 100,000 auctions.[5] The landscape began to shift in the latter part of 2007 and erupted dramatically during the first quarter of 2008.

For the 793 ARS bonds in our sample, which we describe in greater detail below, the first auction failure of 2007 occurred in the first week of September. Another four occurred during the remainder of September and through the end of November for a total of five failures from over 13,000 auctions. December witnessed 22 auction failures. The level of auction failures picked up further during January 2008 and into the first week of

February, with 158 failures in January and 104 failures in the first week of February. It was during the second week of February that the auction failures surged along with the headline stories. Those stories paint a dire picture for the ARS market:

> Goldman, Lehman Brothers, Merrill Lynch and other banks have been telling investors the market for these securities [ARS] is frozen — and so is their cash. (Anderson and Bajaj [February 15, 2008] New trouble in auction-rate securities, *The New York Times*, p. 6).

And further:

> Auction rate securities are the latest corner of the debt market to lock up. Some investors can't sell because no one is bidding. (Maxey [February 20, 2008] Discount sales can be boon for investors, *The Wall Street Journal*, p. C3).

Thereafter, news stories regularly appeared at least through mid-July of 2008 describing the ARS market as "frozen" and telling the tale of investors who were holding securities for which there was no market.[6] One of the accompanying themes that is that market participants were acting "irrationally." A variation on that theme is that investors had abandoned the market and/or that investors were unwilling to bid at any price leading to a "frozen" market.[7]

A further well-reported set of events were the official government inquiries into the ARB auction failures and the related lawsuits filed by ARB investors. The most publicized of the official inquiries were those led by the Attorney General of the Commonwealth of Massachusetts and the Attorney General of the State of New York.[8] The most widely-reported of the civil lawsuits, but it was only one of many, is that by Maher Terminal Holdings, Inc.[9] A common allegation of the inquires and lawsuits is that investors were misled by their brokers and bankers into believing that ARS were "cash equivalents" that could readily be converted to cash at their par values at any time.

ARBs Data

Descriptive data for the entire ARBs market as of March 15, 2008 are given in Exhibit 1.[10] The Exhibit presents bonds by year of issuance from 1985 through March 2008. The total number of issues outstanding was 5,636 with an aggregate face amount of $266.5 billion, an average face amount of $47.3 million, and an average term to maturity of 27.2 years. When classified according to auction interval, roughly 40% reset every seven days, 20% reset every 28 days, and 40% reset with an interval of 35 days or longer. The remainder, a tiny 0.01%, reset daily.

As for tax status, 79% are exempt from federal taxation, 67% are exempt from the calculation of the alternative minimum tax, and 87% are exempt from state taxation for investors who reside in the home state of the issuer. Finally, 65% of the bonds are insured by one of the monoline insurers. All of the bonds are issued by some form of government-related entity.

Auction Failures

Exhibit 2 plots the fraction of auctions that failed by week over the time period from the first week of September 2007 (the week of the first auction failure in our sample) through the second week of July 2008 (the last week for which we have data as we undertake this study). The failure rate in our sample was minimal until December 2007. During December, 22 of the ARS in our sample experienced failures. In January, auctions began to fail in greater numbers. By the third week of January, the failure rate had reached 9.7% and by the fourth week of January it had grown to 18.2%. It was during the second week of February that the failure rate increased dramatically. In our sample, 40.5% of auctions failed during that week. The rate of failures remained at about that level throughout the remainder of the period of our analysis.

A key point is that even at its peak, the overall failure rate was less than 50%. This raises the question of whether there is a common factor that distinguishes the bonds with failed auctions from those with auctions that succeeded. We propose that auction failure is directly related to the bond's maximum auction rate. In our first analysis of this question, we estimate logistic regressions in which the dependent variable is an indicator of whether the auction failed.

To begin, we estimate a base case model that excludes the bonds' maximum auction rates. As independent variables, for each bond, we include the remaining term to maturity of the bond as of the auction date (Maturity), the dollar amount of the face value of the issue (Face Value), an indicator variable equal to one for issues rated less than AAA (Rating < AAA) as of the week of the auction, and an indicator variable equal to one if the bond is insured (Insured).

For each week, beginning with the third week of January 2008, we estimate a cross-sectional model. We report the average of the time series of the weekly coefficients of each variable in Column 1 of Exhibit 3 along with the corresponding t-statistics. We begin with the third week of January 2008 because that is the first week for which there is a sufficient number of auctions to estimate the model.[11] The average pseudo-$\overline{R}^2$ of the base case regressions is 10.3%.

As a first attempt to determine whether investors were rationally selecting among securities in their bidding decisions, we include in our regressions the level of the bonds' max rates (Max Rate) as an independent variable. The coefficients of this model are reported in Column 2 of Exhibit 3. The average estimated coefficient of Max Rate is negative and statistically significant, indicating an inverse relation between the probability of an auction failure and the maximum auction rate — the lower the max rate, the higher is the probability of auction failure. Additionally, the inclusion of Max Rate substantially increases the average pseudo-$\overline{R}^2$ of the model, from 10.3% to 57.2%.

To illustrate the economic importance of the maximum auction rates on the probability of auction failure, an increase in the level of the max rate by one standard deviation (5.0%) relative to the mean (9.1%) decreases the probability of auction failure from 31.1% to 2.1%. Clearly, the level of the maximum auction rate is not only statistically but also economically significant as a determinant of the likelihood of auction failure. These data are consistent with the proposition that auction participants rationally avoided auctions in which the maximum auction rates were below market-clearing yields.[12]

As a second analysis, we sort the bonds into two categories: those with only fixed max rates and those with both a floating and a fixed max rate. In our sample, 44% of the issues have only a fixed max rate. The fixed max rates tend to be high and the floating max rates tend to be low. As of the dates of the auctions in our sample, the average max rate for those bonds with only fixed max rates was 14.1%. In comparison, for those bonds with a floating max rate, the average max rate was 4.4%. Thus, the type of maximum auction rate provides a natural partition of the sample.

In the third specification of the model, we include an indicator variable that takes the value of one if the issue has a floating max rate and zero otherwise (Floating Max Rate). The estimated coefficient of this variable, reported in Column 3 of Exhibit 3 is positive and statistically significant. The average pseudo-$\overline{R}^2$ is essentially the same as when the level of the max rate is used, suggesting that partitioning by floating versus fixed max rate captures the same information as the level of the max rate. This result is particularly helpful because it allows us to classify the sample in a straightforward way and compare the fraction of auction failures of ARBs with high (i.e., fixed) max rates with the fraction of auction failures of ARBs with low (i.e., floating) max rates.

Exhibit 4 is a plot of the weekly fraction of failed auctions for the two groups. The rate of failures among the group of ARBs with fixed max rates exhibits an uptick in the second week of February but quickly subsides. Even at its peak, the fraction of failed auctions with a fixed max rate reaches only 13%. In comparison, the auction failure rate among ARBs with floating max rates reaches 90% in the second week of February and stays near or at that level through the second week of July 2008. Thus, these data, along with the regressions of Exhibit 3 are consistent with investors, and potential investors, rationally avoiding auctions with max rates less than market-clearing yields.

Of course, the market-clearing yields required by market participants for failed auctions are unobservable. When an auction fails, the yield is reset to the maximum auction rate regardless of whether that rate is above or below what the market-required yield would have been had the auction succeeded. That is, the market yield is truncated at the maximum auction rate.

To assess whether the market-clearing yields of failed auctions would have been above or below the bonds' maximum auction rates had the auctions succeeded, we estimate two models of ARB yields. The first is a cross-sectional model of weekly yields based on bond characteristics. The second is estimated using a panel of cross-sectional and time-series data of bond characteristics and marketwide data.

In both models, the dependent variable is the weekly market-clearing yield of ARBs with successful auctions. In the cross-sectional model, we estimate the coefficients each week, beginning with the first week of September 2007 and ending with the second week of July 2008, and use those to calculate the implied market yields of the bonds with failed auctions in each week. With the panel regression, we estimate one set of coefficients for the entire time period of September 2007 through July 2008 and use those to estimate the implied yields of ARBs with failed auctions over that interval. The virtue of the panel regression is that we can incorporate marketwide variables. The virtue of the cross-sectional model is that the coefficients of the model are allowed to vary each week of the analysis.

An extensive set of literature reports that municipal bond yields are related to the variables used in the regressions of Exhibit 3.[13] Thus, we include those as independent variables in both regression models. Both models also include tax indicators to capture the cross-sectional differences in the tax status of the bonds. We include an indicator variable set to one for bonds that are taxable at the federal level (Federal Taxable), an indicator variable set to one for bonds that are taxable at the state level for investors who reside in the state of issuance (State Taxable), and an indicator variable set to one for bonds that are subject to the alternative minimum tax calculation (AMT Taxable).

Additionally, ARBs have embedded in them a put option such that, at each failed auction, the bond is “put” to the investor at par value. To capture this optionality in ARB yields, we calculate the degree to which the option is in the money each week as the ratio of the market-clearing yield to the bond's maximum auction rate (Moneyness) for each bond with a successful auction. To capture volatility, for each week we include a forecast of the conditional volatility (Sigma) of the yield of each bond using a GARCH(1,1) model.

The panel regression includes each of the variables used in the cross-sectional regressions, along with the level of one-month LIBOR as of the week of the auction and the average spread of five-year credit default swaps for investment grade corporations as of the week of the auction (CDX Spread). We include LIBOR as a proxy for the marketwide level of interest rates. We include the CDX Spread as a proxy for the sensitivity of investors to the marketwide level of credit risk.

The first column of Exhibit 5 reports the averages of the time series of the weekly coefficients of the cross-sectional regressions along with their t-statistics. The coefficients of the variables have sensible signs and all but the coefficients of Face Value and Insured are statistically significant. Given that we are most concerned with the explanatory power of the models, the important statistic is the average adjusted $\overline{R}^2$ of the regressions — which is a highly reassuring 67.7%.

The second column of Exhibit 5 gives the coefficients of the panel regression. The coefficients of both LIBOR and CDX Spread are positive and significant. Thus, the higher the level of interest rates (as proxied by LIBOR), the higher is the level of the ARBs market-clearing yields; and the greater is the level of marketwide concern with credit risk (as proxied by CDX Spread), the higher are ARB market-clearing yields. In this model, at 80.6%, the adjusted $\overline{R}^2$ is also reassuringly high.

We use the coefficients of the two models to calculate implied market-clearing yields for ARBs with failed auctions. We then compare the implied market-clearing yields with the bonds' maximum auction rates for the week of the failed auction. Finally, we calculate the fraction of the bonds with failed auctions for which the implied market-clearing yield is above the bond's maximum auction rate. With the cross-sectional model, this fraction is 92%; with the panel regression, this fraction is 86%.

In Exhibit 6, we plot the fraction of failed auctions for each week for which the market-clearing yield implied by each model is above the bond's maximum auction rate. The asterisks represent the results using the panel regression; the crosses represent the results using the cross-sectional regressions. As the figure shows, with the exception of four weeks, the fraction of failures implied by the panel regression is at or above 80% each week. Likewise, with the exception of four weeks, the fraction of failures implied by the cross-sectional model is at or above 80% for each week. With both models, the fraction is often above 90%.

The results in Exhibit 6, coupled with those in Exhibits 3 and 4, strongly support the proposition that auction failures were directly linked to ARB max rates. Apparently, market participants rationally discriminated among ARBs and chose not to bid on those for which market-required yield lay above the bond's maximum auction rate.

Were ARB Yields Too Low?

A byproduct of the ARB auction failures were official inquiries undertaken by State Attorneys General and the accompanying civil lawsuits filed the by states and by individual investors. Major investment banks and brokerage firms were named as defendants in the lawsuits. One of the primary complaints was that the bankers and brokers misled investors into believing that ARBs were “cash equivalent” investment alternatives.[14] For example, from the lawsuit filed by the Attorney General of the State of New York:

> UBS financial advisers marketed auction rate securities to UBS retail clients and others as liquid, short term investments that were similar to money market instruments. Customers then received account statements that reinforced the misrepresentations, as statements identified auction rate securities as cash equivalent securities. (The People of the State of New York, by Andrew Cuomo, Attorney General of the State of New York, Plaintiff, against UBS Securities LLC and UBS Financial Services, Inc., Defendants, July 24, 2008)

Similarly, from the lawsuit filed by the Attorney General of the Commonwealth of Massachusetts:

> ...Merrill Lynch marketed ARS as safe, cash like, and liquid investments. It categorized ARS as “Other Cash” on customers statements, even after the market imploded. (Commonwealth of Massachusetts: In the matter of: Merrill Lynch, Pierce, Fenner & Smith, Incorporated, Respondent, Administrative Complaint, Docket No. 2008-0058)

Of course, we do not have any evidence as to whether any individual investor was duped into believing that ARBs were cash-equivalent investments or that auction failures could never occur. We can, however, provide certain inferential evidence by comparing ARB yields with contemporaneous yields of various cash-equivalent investment alternatives. We compare ARB yields with the seven-day average yields of a sample of tax-exempt MMFs, the yields of one-month constant-maturity T-bills, and the yields of seven-day CDs.

In our first analysis, we compare the yields of federally tax-exempt ARBs with the yields of federally tax-exempt MMFs. This comparison obviates the need to adjust yields for differences in the federal tax status of the bonds and the benchmark.

We estimate weekly cross-sectional regressions in which the dependent variable is the yield for that week of federally tax-exempt ARBs minus the contemporaneous average yield of federally tax-exempt MMFs for that week. We estimate the weekly regressions for each week for the interval beginning with the first week of January 2003 and ending with the second week of January 2008. We end with the second week of January 2008 because that is the week prior to the onset of the wave of auction failures in our sample. We drop failed auctions from the analysis.

As independent variables, the regressions include indicators to identify ARBs that are taxable at the state level (State Taxable), ARBs that are subject to the alternative minimum tax calculation (AMT Taxable), and indicators that summarize the ARB characteristics. These are Long v. Short (where the indicator is equal to one if the remaining term to maturity of the bond is greater than the average term to maturity of the bonds in our sample), Large v. Small (where the indicator is equal to one if the dollar amount of the issue is greater than the average dollar amount of the bonds in our sample), Rating < AAA (where the indicator is equal to one if the bond rating is lower than AAA), and Not Insured (where the indicator is equal to one if the bond is not insured).

In this regression, the intercept is interpreted as the conditional mean of the spread between the ARB yields and the benchmark yields after controlling for bond characteristics. Column 1 of Exhibit 7 gives the averages of the weekly coefficients. The average difference between ARB yields and MMF yields over the period from the first week of January 2003 through the second week of January 2008 is 26 basis points per year. This difference is statistically significant.

To compare ARB yields with the other cash-equivalent securities (i.e., T-bills and CDs), we adjust yields for federal taxes. If an ARB is taxable at the federal level, we multiply the yield by (1 – 0.35), where 0.35 is the statutory federal corporate tax rate. We also multiply the T-bill and CD yields by (1 – 0.35).[15] To capture any federal tax effect not picked up by this tax adjustment, we include an indicator to identify ARBs that are taxable at the federal level along with the indicators used in the regressions of Column 1.

As shown in Columns 2 and 3, adjusted for tax status and controlling for bond characteristics, ARBs provided statistically significantly higher returns than T-bills and CDs. The "excess returns" are also economically significant. ARBs provided an annual return of 25 basis points greater than T-bills and an annual return of 8 basis points greater than CDs.

We now consider only the period between the first auction failure in our sample, the first week of September 2007, through the second week of January 2008. We present the averages of the coefficients of the weekly cross-sectional regressions in Columns 4 –-6 of Exhibit 7. The average spread between ARB yields and the yields of the cash-equivalent alternatives widened considerably in the last four months of 2007 and into 2008. Of particular note, in the regression of Column 4, in which we include only tax-exempt ARBs and tax-exempt MMFs, the average spread is 48 basis points. This compares with a spread of 26 basis points in the parallel regression in Column 1. Apparently, investors became increasingly concerned about possible auction failures during the fall of 2007 and into January 2008 and, as a consequence, increased their required yields relative to those of various cash-equivalent alternatives.

Thus, according to our analyses, ARBs provided yields significantly above cash-equivalent alternatives. We cannot determine whether any individual investor was misled about the liquidity of ARBs. However, according to the results in Exhibits 7, regardless of whether we use MMF, T-bill, or CD yields as the benchmark, market participants were not pricing ARS as if they were cash-equivalent securities.

Conclusions

In this study we investigate the market for auction-rate securities prior to and during the wave of auction failures that occurred during the winter through the spring and into the summer of 2008. Headline stories have attributed these failures to "irrationality" on the part of investors and hint that market participants were unwilling to bid for the bonds at any price. We conjecture that market participants recognized that ARB yields are capped by maximum auction rates that limit the yield that the bonds can pay. Further, we conjecture that if the market-clearing yields of bonds that experienced auction failures had been observable, they would have been above the bonds' maximum auction rates. Thus, investors quite reasonably did not bid at these auctions.

Consistent with these propositions, we find, after controlling for other bond characteristics in a regression analysis, that the likelihood of auction failure was negatively and significantly related to the level of the bonds' maximum auction rates — the lower the maximum auction rate, the higher was the likelihood of auction failure. We then estimate regression models of market-clearing yields based on ARBs with successful auctions and use these to calculate implied market-clearing yields of ARBs with failed auctions. We find that in over 80% of the cases in which an auction failed, the implied market-clearing ARB yield was above the bond's maximum auction rate. This result is also consistent with our conjecture.

We then address the question of whether ARB yields compensated investors for bearing the risk of being "stuck" with an ARB because of an auction failure. Here we find, after controlling for bond characteristics, that ARBs did provide higher returns than money market funds, Treasury bills, and certificates of deposit. The implication is that market participants were pricing ARBs so as to be compensated for a possibility of auction failure.

Overall, the results of our analysis are reassuring for economists who are likely to be mystified by the idea that auctions can fail. After all, there must be some price at which investors are willing to buy any asset. In the case of failed ARB auctions, those prices were apparently unobservable in that they lay above the bonds' maximum auction rates. Our analysis suggests that in the absence of the bonds embedded maximum auction rates, most, if not all, auctions would have been successful.

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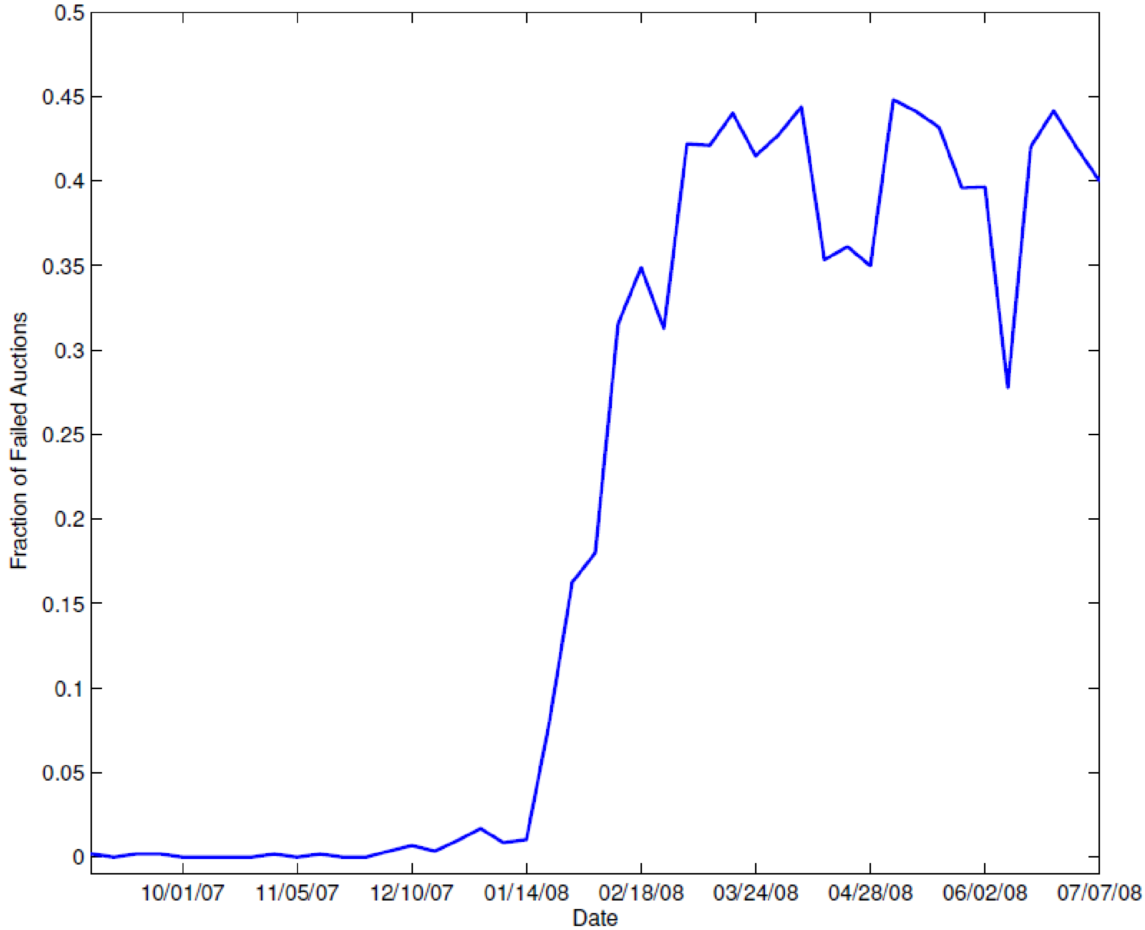
Exhibit 1
Descriptive Statistics for Auction Rate Bonds

Year	Number of Issues	Number of Issues by Auction Interval				Total Face Value (in Mil $)	Average Marturity (in Years)	Fraction of Tax-Exempt Issues	Fraction of Insured Issues
		1 day	7 days	28 days	35 days				
1985	7	1	4	0	2	397.3	35.0	1.000	0.857
1986	1	0	0	0	1	50.0	40.0	1.000	1.000
1987	3	0	0	0	3	119.0	40.0	1.000	1.000
1988	17	0	3	3	11	761.5	26.1	1.000	0.941
1989	5	0	0	0	5	176.5	30.2	1.000	0.600
1990	8	0	2	0	6	310.3	33.3	1.000	0.375
1991	81	2	1	3	75	1769.8	28.9	1.000	0.642
1992	129	1	12	6	110	2938.3	25.9	0.992	0.752
1993	277	5	10	4	258	3798.7	20.8	1.000	0.643
1994	134	4	21	10	98	3764.4	23.4	0.881	0.597
1995	116	0	20	17	79	4087.8	26.1	0.698	0.414
1996	88	0	8	15	65	2758.0	26.9	0.682	0.398
1997	107	0	20	21	66	4317.7	28.7	0.776	0.467
1998	161	6	25	42	88	6352.0	26.8	0.689	0.410
1999	206	9	57	49	91	8529.3	25.7	0.704	0.534
2000	287	3	104	90	90	12645.3	27.3	0.655	0.477
2001	316	5	99	101	111	14772.8	28.0	0.722	0.576
2002	497	6	156	146	189	26143.7	28.8	0.714	0.588
2003	732	8	256	168	300	38064.2	26.3	0.820	0.686
2004	755	5	351	167	232	39631.4	27.1	0.797	0.732
2005	563	5	338	88	132	29090.3	28.0	0.842	0.748
2006	531	2	317	116	96	30191.3	29.1	0.729	0.678
2007	603	8	418	93	84	35671.2	28.2	0.826	0.731
2008	12	0	12	0	0	162.0	14.9	0.917	0.417
Total/Average	5,636	70	2,234	1,139	2,192	266,502.8	27.2	0.793	0.646

Notes: This table presents selected descriptive data by year of issuance for auction rate bonds outstanding as of March 15, 2008.

Exhibit 2
Fraction of Failed Auctions



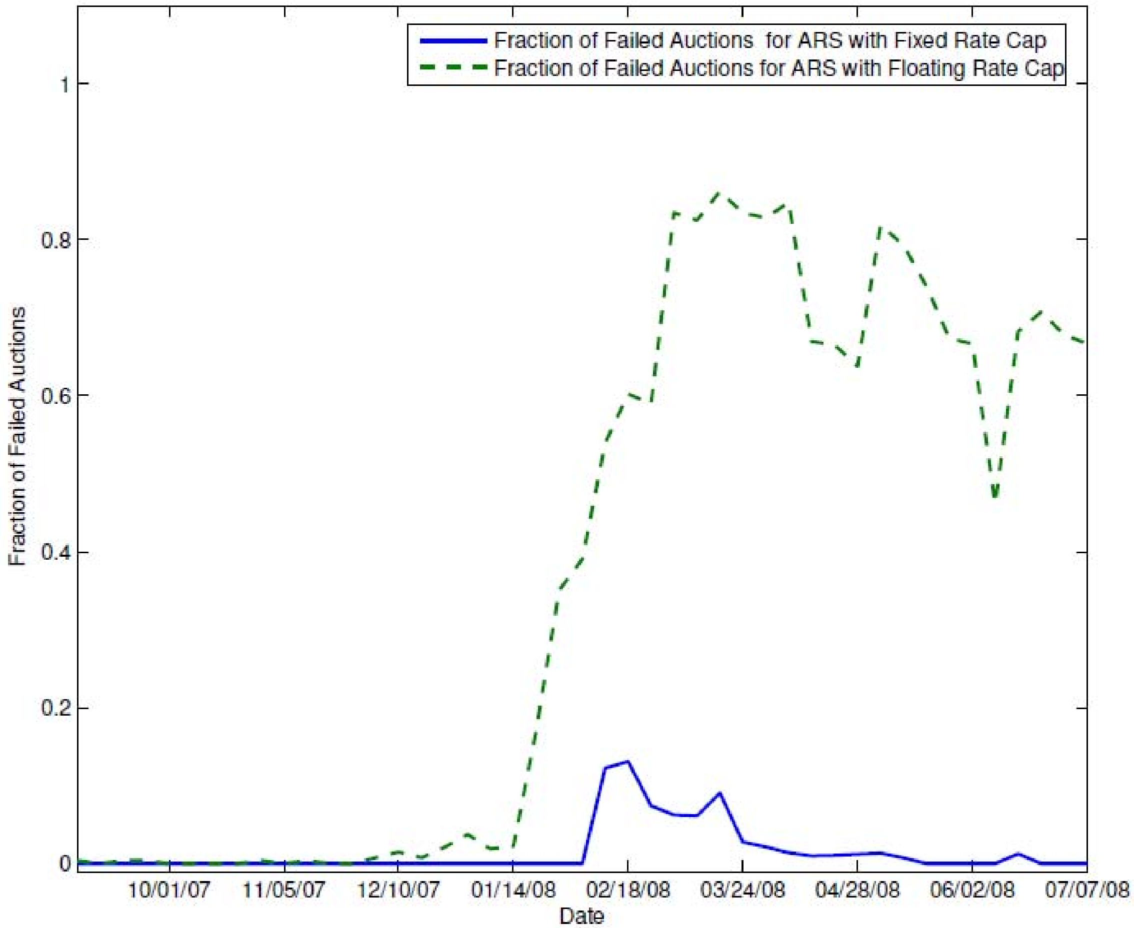
Notes: This figure plots the weekly fraction of failed auctions for the sample of 793 auction rate bonds from the first week of September 2007 through the second week of July 2008.

Exhibit 3
Coefficients of a Logit Model of Auction Rate Bond Auction Failures

	W3 Jan-08 - W2 Jul-08		
	(1)	(2)	(3)
Intercept	4.513	2.506	-5.811
	(6.21)	(6.81)	(-1.28)
Maturity	-1.237	0.804	-0.614
	(-5.87)	(6.09)	(-3.66)
Face Value	-0.593	-0.215	-0.669
	(-6.00)	(-1.73)	(-5.16)
Insured	0.867	0.419	2.932
	(1.79)	(1.27)	(1.02)
Rating < AAA	-0.071	-0.267	-0.469
	(-0.60)	(-1.56)	(-2.99)
Max Rate		-0.776	
		(-10.55)	
Floating Max Rate			8.690
			(5.09)
pseudo-R squared	0.103	0.572	0.552

Notes: This table presents estimated coefficients of an auction failure model for auction rate bonds. The conditional failure probability is modeled as a logistic distribution. For each week in the sample beginning with the third week of January 2008 (W3 Jan-08) and ending with the second week of July 2008 (W2 Jul-08), we run a cross-sectional logit model. Reported parameters are obtained by averaging the weekly estimated coefficients for each variable. The t-statistics are reported in parentheses. The sample is composed of 793 auction rate bonds for which we have the time series of credit ratings.

Exhibit 4
Fraction of Failed Auction Rate Bond Auctions by Type of Maximum Auction Rate



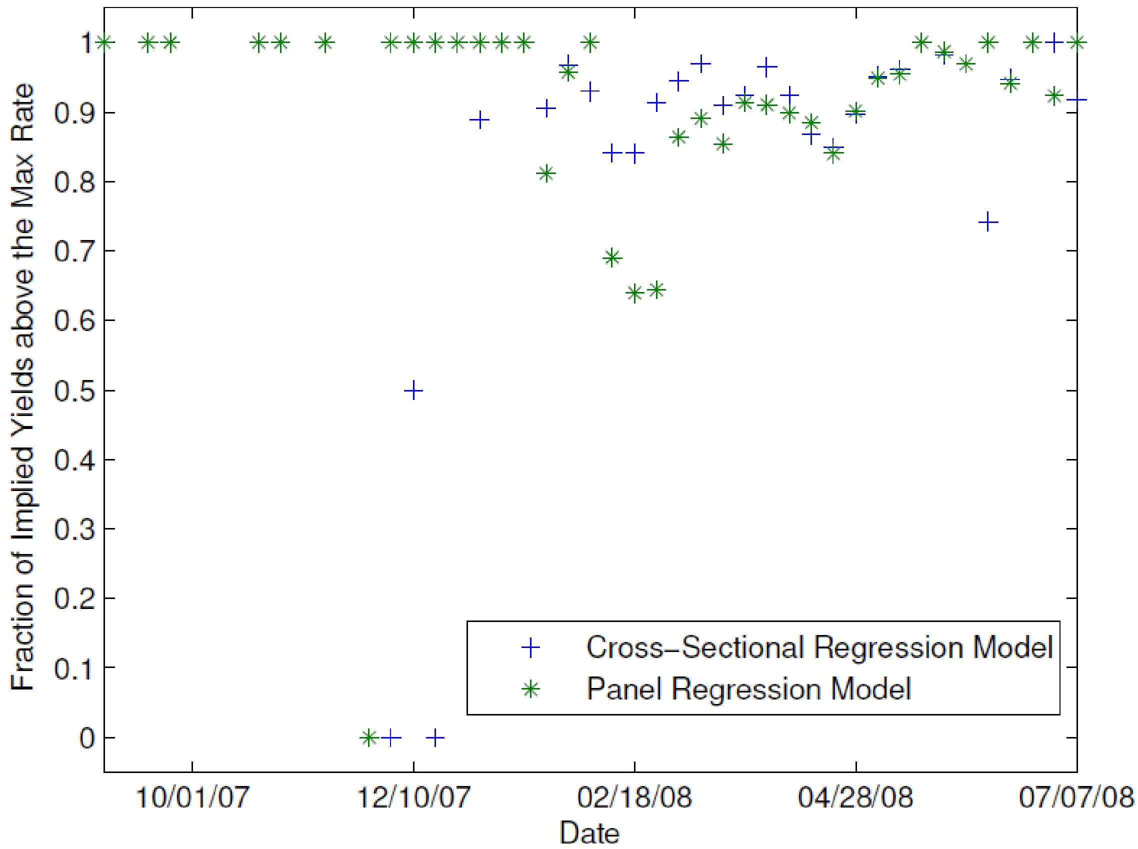
Notes: This figure plots the weekly fraction of failed auctions for the sample of 793 auction rate bonds from the first week of September 2007 through the second week of July 2008.

Exhibit 5
Regression Models of Auction Rate Bond Market-Clearing Yields

	W1 Sep-07 - W2 Jul-08	
	Cross-Sectional Regression	Panel Regression
	(1)	(2)
Intercept	1.565	-1.347
	(8.07)	(-4.70)
Maturity	0.228	0.210
	(9.72)	(4.07)
Face Value	0.001	0.017
	(0.11)	(0.52)
Federal Taxable	0.793	0.786
	(5.64)	(5.05)
State Taxable	0.322	0.262
	(6.31)	(2.70)
AMT Taxable	0.365	0.340
	(5.76)	(2.19)
Insured	-0.015	-0.197
	(-0.28)	(-1.40)
Rating < AAA	0.258	0.066
	(8.16)	(0.88)
Floating Max Rate	-2.231	-1.434
	(-8.53)	(-14.34)
Moneyness	4.659	4.271
	(9.96)	(13.53)
Sigma	0.037	0.051
	(4.10)	(29.67)
LIBOR		0.550
		(15.45)
CDX spread		0.960
		(11.10)
R squared	0.677	0.806

Notes: This table presents estimated coefficients of linear regression models of auction rate bond yields based on auction rate bond characteristics. We estimate two models: the first is a cross-sectional model that we re-estimate every week; the second is a panel regression model that we estimate using all available data. The dependent variable is the annualized yield of the auction rate bonds. Reported coefficients in Column 1 are the average of the weekly cross-sectional regression coefficients. The t-statistics are reported in parentheses. The sample is 793 auction rate bond issues for which we have the time series of credit ratings. The data used to obtain the estimates reported in this table encompass the first week of September 2007 (W1 Sept-07) through the second week of July 2008 (W2 Jul-08).

Exhibit 6
Fraction of Failed Auction Rate Bond Auctions Explained by the Models



Notes: This figure plots the fraction of failed auctions for each week for which the market-clearing yield implied by the models is above the bond's maximum auction rate over the time period from the first week of September 2007 through the second week of July 2008.

Exhibit 7
Regression Model of Auction Rate Bond Yields versus Yields of Cash-Equivalent Investment Alternatives

	W1 Jan-03 - W2 Jan-08			W1 Sep-07 - W2 Jan-08		
Cash Equivalent Investment Alternative:	MMF (1)	T-BILL (2)	CD (3)	MMF (4)	T-BILL (5)	CD (6)
Intercept	0.259	0.253	0.082	0.482	1.284	0.392
	(17.67)	(6.49)	(3.79)	(4.71)	(9.20)	(4.03)
Long vs. Short Maturity	0.016	0.011	0.012	0.087	0.086	0.089
	(3.98)	(2.33)	(2.40)	(7.96)	(7.17)	(8.29)
Small vs. Large Size	0.037	0.041	0.04	0.047	0.04	0.04
	(11.86)	(10.65)	(10.42)	(2.77)	(2.52)	(2.51)
Federal Taxable		-0.178	-0.178		-0.237	-0.247
		(-11.92)	(-11.98)		(-4.55)	(-4.67)
State Taxable	0.225	0.251	0.249	0.162	0.161	0.164
	(7.02)	(6.92)	(6.85)	(12.33)	(9.05)	(9.71)
AMT Taxable		0.258	0.258		0.561	0.561
		(12.12)	(12.07)		(4.37)	(4.30)
Not Insured	0.014	0.006	0.008	-0.226	-0.218	-0.214
	(1.56)	(0.63)	(0.91)	(-9.54)	(-9.84)	(-9.40)
Rating < AAA	0.105	0.104	0.106	0.601	0.602	0.598
	(6.53)	(6.52)	(6.69)	(16.64)	(16.60)	(16.06)
R squared	0.134	0.246	0.245	0.161	0.195	0.200

Notes: This table presents estimated coefficients of weekly cross-sectional regressions of the difference between auction rate bond yields and the yields of cash-equivalent investment alternatives against auction rate bond characteristics. The dependent variable is the difference between the yield of an auction rate bond and the yield of one of the short-term investment alternatives. The t-statistics are reported in parentheses. The data used encompass the time period from the first week of January 2002 (W1 Jan-02) through the second week of January 2008 (W2 Jan-08).

END NOTES

[1] This article is based on "Auction Failures and the Market for Auction Rate Securities," Journal of Financial Economics, Vol. 97, No. 3 (2010), p. 451.

[2] Kim and Anand [February 21, 2008].

[3] Scheer [January 18, 2008], Bajaj [April 18, 2008], and Morgenson [June 27, 2008].

[5] Special Report, Moody's Investors Service [February 20, 2008].

[6] Rappaport and Karmin [February 14, 2008], Maxey [February 20, 2008], Kim and Anand [February 21, 2008], and Cowen [March 23, 2008].

[7] Chasan (January 24, 2008), Norris [February 8, 2008], Rappaport and Scannell [February 22, 2008], and Forsyth [March, 3, 2008].

[8] Bajaj [April 18, 2008] and Story [(July 25, 2008].

[9] Scheer [January 18, 2008], Frank [February 14, 2008], and Henry [February 18, 2008].

[10] The bond data used in our analyses are from *Bloomberg* with all yields expressed in annualized terms. We obtain time series of credit ratings from *Standard & Poors* (*S&P*).

[11] We are unable to estimate a cross-sectional logit model for the weeks prior to the third week of January 2008. Because there are not enough auction failures during those weeks, the maximization algorithm does not converge.

[12] Similar results are reported by Han and Li [2010].

[13] Benson, Kidwell and Koch [1981], Buser and Hess [1986], and see, e.g., Chalmers [1998].

[14] Morgenson [March 9, 2008] and Kim [April 1, 2008].

[15] Because there is uncertainty about the magnitude of the marginal tax rate (see, e.g., Ang, Bhansali, and Xing [2008]), we conduct sensitivity analysis by varying the tax rate from 30% to 60%. The coefficients of the intercepts are similar to those reported in Exhibit 7.