Leveraged Municipal Bond Arbitrage: What Went Wrong?[1]

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The substantial losses suffered by several multi-billion dollar fixed income hedge funds have brought attention to the risks involved in an investment strategy known as leveraged municipal bond arbitrage. Municipal bond arbitrage is a complicated, risky strategy involving trades of municipal bonds, short term notes, and interest-rate derivatives. Investment banks marketed these funds to retail investors as high-yielding alternatives to money market funds or municipal bond funds with little, if any, additional risk. Not only was this strategy not an arbitrage, it had a lower expected return to investors and considerably more risk than a simple investment in the stock market.

In this article we explain what the leveraged municipal bond arbitrage strategy is and why it failed. The leveraged municipal bond arbitrage strategy was based on as assumed but non-existent market inefficiency. The strategy predictably produced returns with higher volatility than investing in Treasury securities, municipal bonds, or even common stocks.

I. Introduction

The leveraged municipal bond arbitrage (hereafter "municipal arbitrage") strategy is based on a misunderstanding of why the difference between the yield on long term and short term tax-exempt municipal bonds (the municipal "term spread") is typically larger than the difference between the after-tax yield on long term and short term Treasury securities (the taxable "term spread").

The municipal arbitrage strategy was the primary investment strategy for the dozens of hedge funds.[2] Advocates of the strategy believed that the difference in the municipal term spread and the taxable term spread was largely a market inefficiency that could be arbitraged away, thereby creating a sure profit with little risk. The municipal

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[2] Six highly leveraged municipal bond funds were marketed to investors by Citigroup under the ASTA and MAT brand names. Another set of Citigroup's hedge funds, Falcon Strategies funds, also employed municipal bond arbitrage, but included other investment strategies such as, mortgage-backed securities arbitrage, opportunistic mortgage-backed securities investments, banks loans, and relative value plays. *See,* Eric Dash, "Citigroup Acts to Bolster Hedge Funds," *New York Times* March 11, 2008 and David Enrich, "Inside Citi, A Hedge-Fund Push Blows Up," *The Wall Street Journal*, April 29, 2008. More than 35 similar leveraged municipal arbitrage funds were marketed including by Stone & Youngberg Municipal Advantage Fund, 1861 Capital Management, Gem Capital, Rockwater Hedge Fund, LLC, Blue River Asset Management Main Muni Fund and others.

arbitrage strategy sought to capture the difference in the term spreads by borrowing short term funds and investing in long term municipal bonds, and hedging the risk that the yield curve would shift using interest rate derivatives. Leverage was used to magnify the small incremental returns which could be earned from this strategy.

Published academic research on tax-exempt and taxable yield curves shows that the apparent market inefficiency underlying the municipal arbitrage strategy is not an inefficiency at all, but is a premium necessary to compensate investors for credit risk and liquidity risk incurred in the municipal market.[3] Treasury securities are free of default risk, while municipal bonds sometimes default, and the longer the bond's maturity, the higher the relative risk of default. In addition, the U.S. Treasury market is the most liquid bond market in the world, while the municipal bond market consists of millions of smaller bond issues, issued by over 50,000 different municipal authorities. Municipal bond investors are thus compensated for bearing the increased credit and liquidity risk from investing in long term municipal bonds with higher yields than earned on Treasury securities.

The municipal arbitrage strategy was exposed to the risk that the difference in the municipal term spread and the taxable term spread would decrease, either as a result of short term municipal yields increasing faster than short term Treasury yields and/or as a result of long term Treasury yields falling faster than long term municipal yields. This risk was imperfectly hedged using LIBOR swaps and swaptions.[4]

In August 2007, long term municipal yields and swap rates moved in opposite directions and the interest-rate hedges failed. As a result of the failure of the hedges, municipal arbitrage funds' Net Asset Values (NAVs) dropped significantly as their cost of funding increased without corresponding gains on the hedges. In some cases, the inability to reissue short term notes or margin calls led to partial liquidations of the municipal bond portfolios at large losses. These losses, exacerbated by the leverage used by the funds to magnify returns, ultimately resulted in the near or total failure of several municipal arbitrage funds.

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[3] See bibliography for literature.

[4] One interpretation of the strategy is that is was a bet on the relative credit quality of insured municipal bonds and AA-rated banks since the fund invested in long term insured municipal bonds and hedged with 20-year LIBOR.LIBOR is the London Interbank Offer Rate which is the interest rate banks charge each other for loans and is usually interpreted to be the interest rate paid by AA/A rated banks. An interest-rate swap is an agreement between two parties to swap the interest payments for a specified period of time. The swap rate is the fixed interest rate exchanged for floating interest rate payments in an interest rate swap; the floating rate is typically LIBOR. A term is specified for the swap, meaning that the fixed rate is paid in exchange for the floating rate for a specified number of years – the term of the swap. The fixed interest rate paid in exchange for LIBOR for various terms makes up the swap curve. If a swap is unwound the contract is cash settled with a payment of the market value of the net future cash flows. A swaption is an option giving a buyer a right to enter into a specified swap at a specified future date. For an accessible introduction to interest rate swaps see "Bond Basics: What are Interest Rate Swaps and How Do They Work?" available at www.pimco.com/LeftNav/Bond+Basics/2008/Interest+Rate+Swaps+Basics+1-08.htm

We conducted extensive simulations to test the relative riskiness of the municipal arbitrage strategy. The simulation results show that the strategy has much higher downside risk than investing in Treasury bonds, municipal bonds, or stocks.

II. Leveraged Municipal Bond Arbitrage Strategy in an Idealized Environment

Yield Curves

Yield curves are graphs that plot the relationship between yields-to-maturity and terms-to-maturity of a particular type of bond. The difference between the yields on long term and short term bonds of the same credit quality is referred to as the term spread. For example, on January 5, 2005 the yield on 20-year Treasury bonds was 5.0% and the yield on a 1-year Treasury note is 2.9%. Therefore the Treasury term spread on January 5, 2005 was 2.1%.[5] Table 1 reports this 2.1% term spread as well as the 1.4% after-tax Treasury term spread and the 2.3% AA-rated municipal term spread. [6]

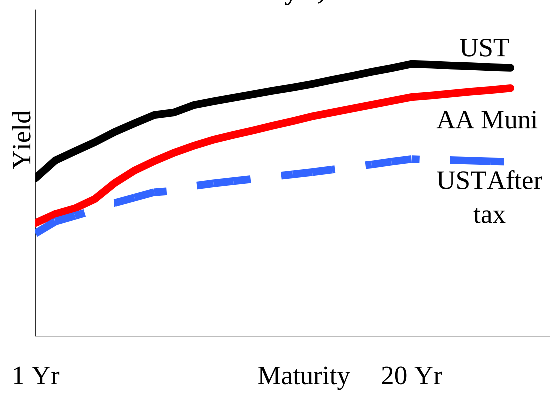
Table 1
Example Yields on January 5, 2005

Maturity	Treasury Securities	After-tax Treasury Securities	AA-Rated Municipal Bonds
20 Years	5.0%	3.3%	4.4%
1 Year	2.9%	1.9%	2.1%
Term spread (20Y-1Y)	2.1%	1.4%	2.3%

Since long term investments are more risky than short term investments, long term interest rates are usually higher than short term rates to compensate investors for taking the additional risk. That is, term spreads are typically positive as shown in Table 1 or equivalently yield curves typically slope upwards as shown in Figure 1.

Yield curves can also be drawn for different credit qualities of corporate bonds and municipal bonds. Figure 1 also plots the AA-rated municipal bond yield curve and the tax-adjusted Treasury yield curve on January 5, 2005. The tax-adjusted Treasury yield curve plots the after–tax yields on Treasury securities to make comparison to the yields on municipal bonds, which typically are not taxable, on an after-tax basis.

Figure 1
Treasury Yield Curve
January 5, 2005



[5] The term spread can be calculated between maturities besides the 20-year and 1-year maturities used in this example. It is important to specify which maturities are being used to calculate the term spread.
[6] The Treasury curve is shifted downward to reflect a tax rate of 35%.

The "Arbitrage Opportunity"

An arbitrage opportunity arises when the prices of the same asset in two markets differ by more than the trading costs of buying in the low price market and simultaneously selling in the high price market. For example, if Yahoo stock is being quoted in one market at $11.00 "bid", $11.25 "ask" in one market and at $11.50 bid, $11.75 ask in another market, investors who can simultaneously buy in the first market at $11.25 and sell in the second market at $11.50 will make a riskless profit of $0.25.[7] The order imbalance in the first market will push the price quotes up and the order imbalance in the second market will cause the price quotes to fall. Traders continue to arbitrage the difference in price quotes in the two markets for the same asset until the bid-ask spreads overlap – $11.25 bid, $11.50 ask in both markets, for example.

The municipal arbitrage strategy is based on the observation that the municipal term spread had been consistently greater than the after-tax Treasury term spread.[8] Table 1 and Figure 1 illustrated this relative steepness of the municipal yield curve compared to the Treasury yield curve; on January 5, 2005 the municipal term spread was 2.3% and the after-tax Treasury term spread was only 1.4%. This difference between the term spreads was sold by Citigroup and other investment firms to investors as "inefficiency" in the municipal bond market creating an arbitrage opportunity.

Figure 2
Muni - After-Tax Treasury Term Spread
January 2001 to June 2008

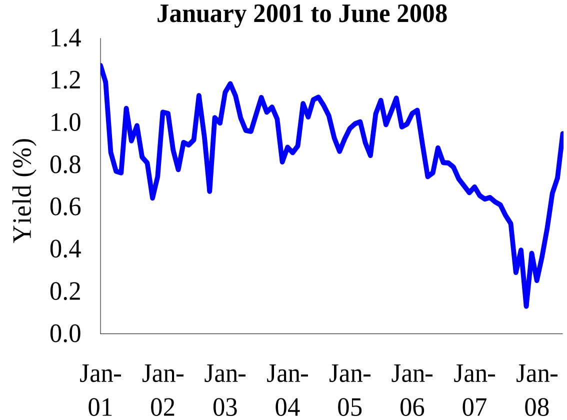


Figure 2 plots the difference between the term spread for municipal bonds and the term spread for Treasury bonds.[9] The municipal term spread is greater than the Treasury term spread throughout the period plotted in Figure 2 although there is considerable variation over time. This difference in term spreads is the claimed arbitrage opportunity that hedge fund managers sought to exploit.

The Arbitrage Strategy

Consider an example of how an investor might implement the strategy by entering into transactions to capture the difference in term spreads illustrated in Figure 2. Assume that the yields on municipal securities and Treasury securities are as listed in Table 2.

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[7] Of course, the market makers or other professional investors have an incentive to capture the potential arbitrage profit in this example so retail investors are unlikely to ever observe an arbitrage opportunity.
[8] Alternatively, at short maturities, the municipal yield is closer to the after-tax Treasury yield than at longer maturities.
[9] Source: Bloomberg, MMAI and C082, 20-year and 1-year data series.

The municipal term spread is 2.3% (4.4% - 2.1%) and the Treasury term spread is 1.4% (3.3% - 1.9%). A fund manager could make the following four transactions to capture the 0.9% (2.3% - 1.4%) difference in term spreads.

1. Buy $100 million AA-rate 10-year municipal bonds yielding 4.4%.
2. Short (issue or borrow and sell) $100 million of short term notes paying 2.1%.
3. Short $100 million of 10-year Treasury bonds yielding 5.0% pre-tax, 3.3% after-tax.
4. Buy $100 million of Treasury bills yielding 2.9% pre-tax, 1.9% after-tax.

Table 2
Stylized Difference in Term Spreads

	Yield	Term Spread
20-year AA-rated municipal bond	4.4%	
1-year AA-rated municipal note	2.1%.	2.3%
20-year Treasury bond	3.3%	
1-year Treasury bill	1.9%	1.4%
Difference in Term Spreads		0.9%

The profit is small but fund managers can increase the return by leveraging up the portfolio. For example, by leveraging the equity investment 10 times, the portfolio could provide a tax-exempt annual return of 9.8% over 10 years. *See* Table 3.

Table 3
Stylized Leveraged Municipal Arbitrage
Generates Annualized 9.8% Risk-Free Return[10]

Municipal	Initial Value	Annual Return	Value After 10 Years
Buy long term bonds	$100.00	4.4%	$153.82
Issue notes	$(90.00)	2.1%	$(110.79)
Treasury			
Short sell long term bonds	$(100.00)	3.3%	$(138.36)
Buy notes	$100.00	1.9%	$120.71
Net Asset Value	$10.00	9.8%	$25.38

This strategy is conceptually simple. Long term municipal bonds paid more than short term bonds. By investing long term and borrowing short term the hedge funds banks a positive cash flow. The viability of the leveraged investment was protected against interest rate risk imperfectly by hedging in the taxable market. Some but not all of the positive net cash flow on the municipal bonds was given up in the hedging transactions. So long as the imperfect hedges didn't fail, the positive cash flow – the "carry" – generated high returns.

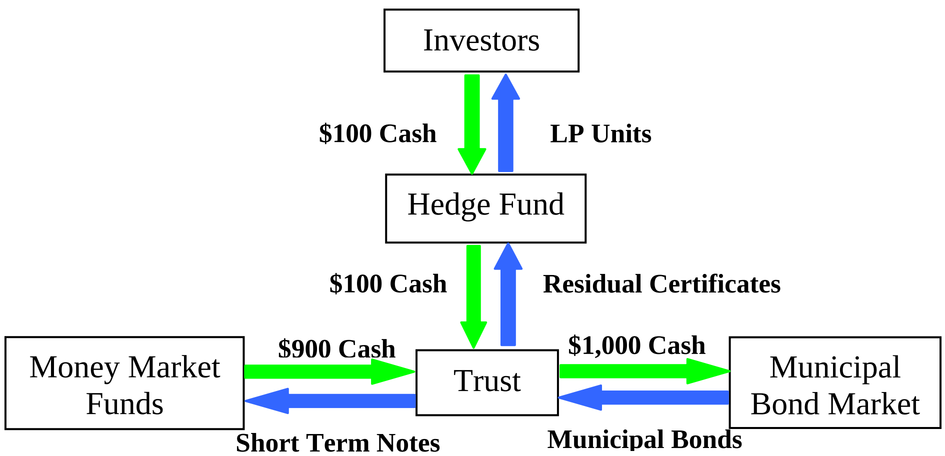
[10] This example treats the notes and bonds as zero-coupon securities and ignores transaction costs and management fees to simplify the analysis.

III. The Leveraged Municipal Strategy as Implemented

a) The Leveraged Strategy is Hedged With an Interest Rate Swap

The municipal arbitrage strategy was not typically implemented using Treasury securities as illustrated in Table 3. Instead, the hedge fund manager invests the investors' contributed capital in high-quality assets pledged as collateral to a dealer who forms a trust and issues two classes of securities: senior short term floating-rate notes, known as variable-rate demand obligations (VRDOs), and junior notes called residual certificates. The proceeds from the sale of the short term notes are used to purchase additional long term municipal bonds thus leveraging the residual certificate holders' exposure to the long term municipal bonds held in the trust.[11] Figure 4 illustrates the cash flows at initiation.

Figure 4
Cash Flow at Initiation
(Green is cash, Blue is securities)



The interest rate paid by the trust on the short term notes to the money market funds is reset weekly, based on a market-determined spread to a short term municipal yield benchmark rate. The short term notes also include a put option which allows the holders of the notes to put their bonds back to the trust at par on any reset date. The junior residual certificates are retained by the hedge fund and pay an interest rate equal to the difference between the interest rate on the underlying long term municipal bonds and the interest paid to the short term, senior note holders, less the trust's expenses. These residual certificates are the only source of value for hedge fund investors. [12]

At this point in our example, the portfolio manager has leveraged up the investors' capital 10-to-1 - investing $1,000 in long term municipal bonds, financed with short term debt - and is therefore exposed to tremendous interest rate risk.[13] If the

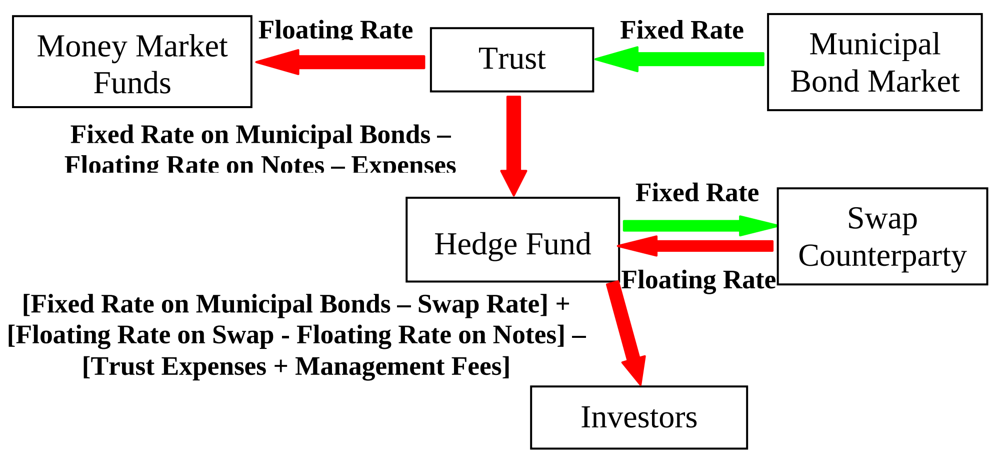
[11] The dealer is typically a large investment bank like Citigroup, JP Morgan or Morgan Stanley.
[12] In some instances, hedge funds purchase residual certificates from Tender Option Bond programs in which the hedge funds do not own the underlying collateral.
[13] This is the classic S&L problem: borrowing short term at variable rates to fund long term, fixed-rate investments.

municipal yield curve shifts up, long term municipal bond yields will increase and the value of the municipal bonds held in the portfolio will fall. At the same time, as short term borrowing rates increase the net interest received will decline or become negative. The portfolio manager may have to liquidate bonds at a loss to pay these increased borrowing costs. The net asset value of the portfolio might even drop close to zero, at which point the portfolio manager will not be able to continue to borrow to support the portfolio holdings.

Most municipal arbitrage hedge funds, including Citigroup's funds, claimed to use interest-rate swaps to hedge both the long term and short term interest-rate risk. Since the hedge fund in our example has financed a leveraged, long term investment (the fixed-rate municipal bonds) with a series of short term floating-rate notes, it will enter into an interest rate swap, attempting to take a position in the swap market that has the opposite risks of the position already taken in the municipal bond market. That is, the hedge fund will want to recieve a short term floating interest rate in exchange for paying a long term fixed interest rate.

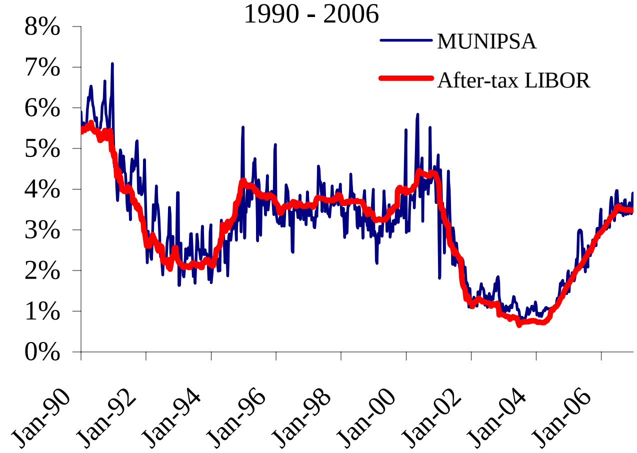
Ideally, the hedge fund would pay a fixed rate that is slightly less than (but perfectly correlated with) the yield on the municipal bond portfolio and receive a floating interest rate that is slightly higher than (but perfectly correlated with) the interest rate paid on the floating rate notes sold to the money market funds for a term equal to the average maturity of the municipal bonds held. If the hedge fund could enter into such an idealized swap it would be very close to the pure arbitrage examples above; the hedge fund would receive positive net cash flows and any change in the market value of the leveraged municipal bond portfolio would be exactly offset by changes in the mark-to-market value of the interest rate swap. Figure 5 illustrates the periodic cash flows resulting from the strategy.

Figure 5
Periodic Cash Flows
(Green is Fixed Payments, Red is Floating Payments)



In the practice, the hedge fund enters into a swap agreeing to pay a fixed-rate of interest, such as the 20-year swap rate or a percentage of the 20-year swap rate, to the counterparty in exchange for receiving floating-rate cash flows, usually at a rate of 3-month LIBOR, some percentage of 3-month LIBOR, or possibly the BMA swap rate.[14] This swap hedges the risk of rising short term interest rates that might otherwise wipe out the positive periodic net cash flows of the municipal arbitrage strategy so long as the floating interest rate payments are highly correlated with interest rate paid on the short term notes sold to money market funds.

Figure 6
MUNIPSA v LIBOR
1990 - 2006



b) The Interest Rate Swap Was An Imperfect Hedge

Figure 6 plots the BMA/SIFMA short term borrowing cost index and 3-month LIBOR from January 1990 to December 2006.**[15]** The short term borrowing costs track the 3-month LIBOR received under the interest rate swaps although there is a great deal more variation in the short term borrowing costs than in LIBOR. The relationship pictured in Figure 6 continued in 2007 and early 2008. That is, the floating rate payments received under the interest rate swap did not drop significantly below the interest payments required on the VRDOs issued to money market funds.

The interest rate swap was also designed to protect the NAV of the hedge fund investors' limited partnership interests if the swap (fixed) rate paid is highly correlated with the yield on the long term municipal bonds. That is, this swap is a useful hedge for the interest rate risk arising out of the funding mismatch in the portfolio to the extent that LIBOR is correlated with borrowing costs and swap rates are correlated with long term municipal bond rates.

Figure 7
20-Year Muni Yields v Swap Rates
1994 - 2006

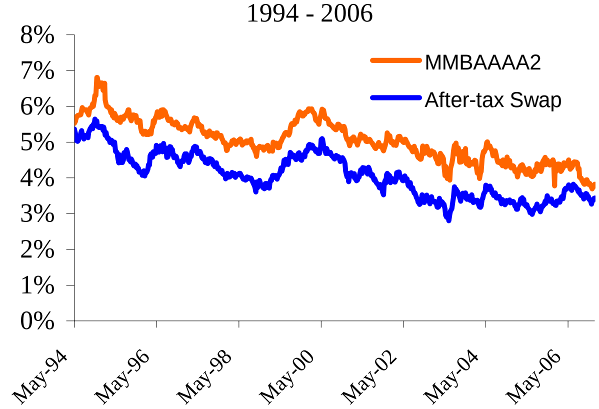


Figure 7 plots 20-year municipal bond yields versus after-tax 20-year swap

[14] The BMA swap rate is the Securities Industry and Financial Markets Association swap index, which is a 7-day high-grade market index comprised of tax-exempt VRDOs compiled by Municipal Market Data.
[15] Source: Bloomberg, US0003M and MUNIPSA indices.

rates from 1994 to 2006.[16] Historically, interest-rate movements in the swap market closely track, in both magnitude and direction, interest-rates in the municipal market. But the correlation was not nearly perfect and there were periods of time when yields on municipal bonds would increase more than the 20-year swap rates used to hedge the NAV of the leveraged municipal bond portfolio.

Although Figure 6 and Figure 7 show that the key rates involved in the leveraged municipal bond arbitrage strategy generally move together, the figures also show that the relationships are not perfect. The leverage used in the strategy made the NAV extremely sensitive to differences in the yield on the long term municipal bonds and the after-tax swap rates. Because the duration of the portfolios was between 10 years and 20 years and the portfolios were leveraged as much as 10-to-1, if this difference between the long term municipal bond yields and the swap rates increased by 0.50%, the NAV could drop 30% or more.

Figure 8
20-Year Municipal Yield - After-Tax Swap Rate
1994-2008

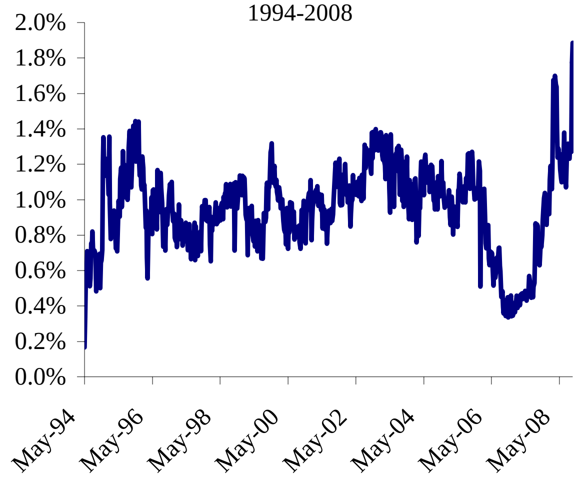


Figure 8 plots the difference between the yield on the long term municipal bonds and the after-tax swap rates from 1994 to 2008. The funds' NAVs dropped significantly in 2007 as the difference in these rates started to increase. The sharp increase in yields at the end of Figure 8 occurred in 2008 after the leveraged municipal bond funds had effectively collapsed. Although the information necessary to completely evaluate the strategies is not yet public, it appears that a 0.25% increase in the spread was all that was required to cause the strategy to lose more than 50% of its value. As seen in Figure 8, such an increase in the spreads had been observed many times in the past.

In fact, the spreads pictured in Figure 8 increased 0.4% within 6 months almost 15% of the time between 1994 and 2006. Thus if this strategy had been implemented perfectly with virtually no costs there was a 15% chance that a leveraged long term municipal bond portfolio would lose 50% or more of its value.

IV. Risks of Leveraged Municipal Arbitrage Strategy

A. Assumption of Municipal Market "Inefficiency"

Citigroup and other firms marketing municipal bond arbitrage funds claimed that the larger after-tax term spread in the municipal market than in the Treasury market was an inefficiency that presented an arbitrage opportunity from which investors could earn risk-free profits. Several academic studies, however, show that the difference in term

[16] Source: Bloomberg, USSW20 and MMBAAAA2 indices.

spreads is reward for the credit risk and illiquidity investors are exposed to in the municipal market.

Municipal bonds are not risk-free, and as such, they contain some credit risk. The credit risk of municipal bonds increases with maturity thus should provide investors with some compensation (higher interest rate) for taking on this higher risk. Also, the municipal bond market is less liquid and more fragmented than the Treasury market. Municipal bonds are very thinly traded because issue sizes are relatively small when compared to the U.S. Treasury market. There are over 2 million unique municipal bonds outstanding totaling $1.7 trillion issued by over 50,000 different state and local government entities, with an estimated daily trading volume of $11 billion.[17] Many long term municipal bonds only trade a few times after they are issued because they often are bought by large institutional investors such as mutual funds, insurance companies and commercial banks, and held until they mature. Since investors bear the risk that they might have difficulty liquidating positions in municipal bonds in the future, there is usually a liquidity premium included in the yield.

Empirical evidence shows that credit risk and liquidity and the tax effect explain most of the difference in the municipal term spread and the after-tax Treasury term spread.[18] Since the difference in term spreads is not a market "inefficiency," there is no arbitrage opportunity and any attempt to arbitrage the difference in term spreads will increase risk and lower expected returns.

V. What Brokerage Firms Said Went Wrong with ASTA and MAT V

The brokerage firms claim that the municipal bond arbitrage strategy followed by Citigroup's ASTA and MAT V funds and other hedge funds failed as a result of unprecedented conditions that affected the bond markets in 2007: credit quality concerns, divergence of municipal bond yields and the swap rates, problems with mono-line bond insurers, and illiquidity in the market for short term municipal notes. These market conditions were either not unprecedented and/or did not cause the losses suffered by investors.

Figure 9
2-Year Correlation Muni Yields and Swap Rates
1994-2006

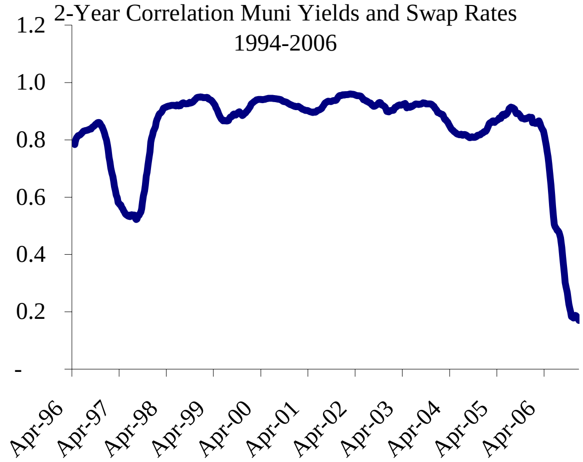


Figure 9 shows that the historic correlation between municipal yields and swap rates had started to decline well before the huge losses in the leveraged municipal bond funds. In fact, during 2005 and 2006

[17] SIFMA's www.investinginbonds.com.
[18] Wang, Wu, and Zhang (2005) developed a model to explain the yield difference between municipal bonds and Treasury bonds using default risk and liquidity risk and found that the tax rates implied in their model are very close to the marginal statutory tax rate of high-income individuals and corporations after controlling for the default and liquidity risk.

the correlation dropped to 0.20. This decline in the correlation made the strategy predictably much riskier before the losses were suffered.

As hedge funds and leveraged municipal bond mutual funds experienced losses, they had to liquidate much of their holdings, leading to further increases in yields on long term municipal bonds. As bond insurer problems worsened, money market mutual funds became unwilling to hold short term notes insured by guarantors who lost their top-tier credit rating or were under review for a possible downgrade. The losses in these funds were thus caused by illiquidity and credit risk in the municipal bond markets which had been well documented in the scientific literature.

In summary, the municipal arbitrage strategy was dependent on hedging large, leveraged, long term municipal bond positions with taxable interest rate swaps. As long term municipal yields increased more rapidly than the swap market over many months, the hedging strategy failed. In February 2008, the municipal bond prices fell further and leveraged municipal bond portfolios were liquidated. Much of the losses though had occurred earlier during relatively routine interest rate environments.

VII. Conclusion

The leveraged municipal arbitrage strategy has been marketed by many brokers as a low-risk and high-yielding alternative to money market funds or municipal bonds. Our analysis of the strategy shows that it is based on a flawed concept of market inefficiency and a tenuous arbitrage opportunity. The strategy introduced additional risk by leveraging in an attempt to generate enough gross returns from the perceived arbitrage opportunity to cover the banker's fees and to net a marketable return to investors. The combination of basis risk and leverage makes the strategy a highly risky investment strategy when compared to directly investing in the municipal market, the Treasury market, or the stock market.

In addition to the inherent riskiness of this strategy, the strategy locked investors up for one or two years even if it turned out to be riskier than the investors expected or wanted. A less complex investment would have allowed these investors to exit before the catastrophic losses occurred.

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