Systems and Technology

for Municipal Bond Trading and Portfolio Management

Dan diBartolomeo

Northfield Information Services, Inc.

Author's Note: Unlike most chapters in this book, this section deals extensively with specific technology product offerings from a variety of firms. The reader should note that the author is a principal in a firm that supplies investment analytical technology and hence may have a biased view. The author takes complete responsibility for any inaccuracies in characterizing such products and for any omissions of products or firms. Paul Chudnofsky of Ernst & Young should also be acknowledged for inspiring many of the ideas in the "build versus buy" section.

General Considerations

For participants in the municipal bond market, the unusual features of the municipal market make the issues of computer systems and technology both of great importance and of substantial complexity. It has also created sufficient impediments to technology adoption that the level of rigor in analytical methodology has lagged behind comparable efforts in corporate bonds and mortgage-backed securities.

The minimum technological needs of a fixed income market participant include the ability to receive aggregate market information during the trading day and to analyze and value individual bond issues. For trading desks it is also imperative to monitor and potentially to hedge the risk

characteristics of the total firm position at any moment in time. Portfolio management firms require the additional capability to maintain detailed accounting and analysis of each individual portfolio under their control.

Foremost among the special problems associated with systems for the municipal bond market is the vast number of issues outstanding. Current municipal bond databases include more than 1.2 million different bond issues. In addition, the number of bond issuers, each of which requires separate credit analysis, is larger by several orders of magnitude than in the corporate bond market. High levels of issue complexity comprise another feature of the market. Complex call provisions, sinking funds, "super sinkers", pre-refundings, and the special aspects of housing bonds all represent bond characteristics that are very common in the municipal marketplace. Just trying to keep up with the vast flow of this data has been described as akin to getting a drink of water from a fire hose. To date, the only solution has been the maintenance of huge centralized databases by a few specialized vendors. This lack of locally accessible data has been the primary limiting factor in the development of analytical systems oriented toward municipal market participants.

The Build versus Buy Decision

While all market participants will be buying some technology such as subscriptions to real time news terminals, municipal market participants have had a greater tendency to do in-house systems development than their counterparts in other fixed income markets. This tendency arises as a consequence of the more limited number of municipal systems offerings from vendors. Perhaps the most critical decision regarding technology for municipal bond firms is finding an appropriate

position in a spectrum that ranges from buying a turn-key system from a vendor to building a custom system for themselves entirely from the ground up.

In making technology decisions the first consideration dealt with by most firms is cost. There is little doubt that buying systems is almost always less expensive than developing an in-house system. This is simply because the vendor is able to spread the cost of systems development over however many customers they are able to obtain for their product. System vendors also have on-going maintenance and enhancement efforts that can further reduce the long-term costs relative to a custom system.

Another crucial issue is the amount of time available for development and installation. Building systems from scratch can produce all sorts of unanticipated problems. The consistent inability of our country's largest software companies to release new versions of their mass market products on time is indicative of how hard it is to keep a software development effort on a tight time schedule. Presumably, purchased systems are ready to go, and have been largely "debugged" at the cost of aggravation to prior, rather than current, purchasers. However, in most cases, some customization of turn-key systems is needed. The willingness and ability of vendors to perform such customization in a timely fashion can be a critical element in the success of a systems development effort.

Building entirely custom in-house systems is generally justifiable only for a firm that is determined to be a market leader in its particular form of participation in the municipal bond market. Proprietary systems and technology are likely to be important if a firm is to distinguish itself meaningfully from its competitors on a continuing basis. The mere existence of such proprietary

systems is also an advantage in the marketing of underwriting and portfolio management services. They are also often necessary in the case of underwriting and trading of municipal bonds with exotic features, where the volume of such activity has not been sufficient for a vendor to develop suitable tools.

Any firm considering systems development work must determine whether such efforts should be undertaken by internal staff or outside contractors. Often this decision is rendered moot by the lack of available internal resources. It is often much easier for firms to commit money to a systems development effort than it is to commit personnel who are often fully occupied. One of the great dangers of developing systems internally is that as projects get into difficulty, more and more of an investment firm's intellectual horsepower is drawn into the systems effort to the detriment of the core business of trading, underwriting or managing municipal bonds.

Another key consideration is to identify the range of users of such a system and deal with the often discordant needs of different users. Given the hectic pace of a trading desk, systems used there must be very user friendly, requiring a minimum number of keystrokes (or mouse clicks) to accomplish a particular task. At the same time, underwriting and portfolio management personnel often have substantial interaction with marketing staff and clients. For them, attractive graphical presentation may be crucial to any analytical or reporting function. Often, the majority of time expended in a systems development project is devoted to the issues of user friendliness and presentation output, rather than to the portion of a system that performs the actual direct functions.

A middle of the road position in the build or buy spectrum arises from the increasing availability of "toolkits". A small number of vendors now make the more complex portions of fixed income

systems (for example, the calculation engine for option-adjusted spread analysis) available as prepackaged computer program libraries that can be integrated into an in-house system in a relatively painless fashion. Many of the less complex needs can be met with libraries of spreadsheet "add-ins".

What we know, what we think we know and what we believe

In any information technology project the most conceptually challenging aspect is to maintain proper separations among information that is certain, information that is believed to be certain but may contain errors, and information that is uncertain and may be affected by errors, subjective inputs or misinterpretation of the presented result. Given the volatile nature of the financial markets, it must be admitted that the vast majority of important information falls into the last category.

In using a system, we must be aware of the implicit assumption that the system we are using was constructed with the same belief set that we hold. For example, we "know" that the calculation methods for most traditional bond calculations (yield-to-maturity, accrued interest, etc.) have been codified by groups such as the Securities Industry Association and Public Securities Association. In buying or building a system it should be verified that the system complies fully with all such standards.

The second category, things "we think we know" involves items such as issue data that might come from a vendor database of issue description information. While we must presume that vendors make every effort to keep correct information, some rate of error is inevitable given the vastness of

the data needed for the municipal bond market. While there are no readily available published studies on error rates in municipal bond databases, such a study was published regarding stock price databases in 1974. Publishing in the *Journal of Finance*, Barr Rosenberg and Michel Houglet found significant error rates in the stock price database of S&P Compustat and the database of the Center for Research in Securities Prices (University of Chicago). While data collection methods have improved in the intervening years, anecdotal evidence from market participants suggests this problem is ongoing in the municipal bond area.

A more subtle but pervasive problem is reliance on matrix pricing. Vendors of municipal bond prices cannot be expected to update 1.2 million issues with actual bids and offers on a daily basis. The preponderance of bond prices are generated from a pricing matrix where the basis of the matrix is a survey of actual bids and offers on a sample set of municipal bond issues. To the extent that pricing matrices do not take generally take into account the issue-specific contingent claims aspects of bonds, such as call and sinking fund features, the estimated prices for bonds not in the survey sample are of questionable accuracy. All calculated items, such as yield and duration that use such prices as inputs, are hence tainted.

Option Adjusted Spreads

As an example of "what we believe", let us consider the valuation of bonds using the technique known as option-adjusted spreads (OAS), a method to which a substantial portion of this entire book is devoted. As this analysis method is based on the forecast relative likelihood of various future events (bond call and sinking fund redemptions), there is no right or wrong answer. There are merely sets of beliefs and procedures which are presumed reasonable by the user of the

analysis. In this regard, it may prove instructive to examine some of the alternative belief sets that could be incorporated into an OAS analysis system.

The mathematical architecture for OAS models generally falls into two categories: one that discounts bond cash flows through a binomial tree of possible future interest rates, and a second, which uses Monte Carlo simulation to sample the space spanned by the range of possible future interest rates. Several commercial systems use the latter technique. However, some theoreticians argue that Monte Carlo simulation cannot be accurate for callable coupon bonds because of an analytical problem known as "optimal exercise". They argue that Monte Carlo methods are suitable only for securities such as housing bonds where prepayments may be externally forecast. For more information on the optimal exercise issue, see "A Simplified Model for Valuing Debt Options", by Ravi Dattatreya and Frank J. Fabozzi, *Journal of Portfolio Management* (Spring 1989). Systems that use Black-Scholes option modeling for embedded options are clearly flawed and are to be avoided. The Black-Scholes approach to option pricing assumes fixed short interest rates, an assumption that makes this approach inappropriate for embedded options.

Other assumption options embedded in OAS systems relate to the shape of the probability distribution of future interest rates. Some systems use a log-normal representation of rates while others assume a normal distribution. One consequence of an assumption of a normal distribution is that interest rates are presumed able to become negative. The log-normal assumption often results in an upper tail of the future rate distribution with interest rates far higher than have ever been observed in the United States, although this possibility seems somewhat less offensive to basic economic common sense than negative interest rates.

Some systems incorporate the assumption that interest rates are mean-reverting as a way of explaining the lack of historical observations of either very high or negative interest rates. However, the primary statistical trait one would observe in a mean-reverting series is a first-order
autocorrelation coefficient that is negative and statistically significant. Most bond index time series have first order autocorrelation coefficients that are positive.

Of particular interest to municipal market participants in regard to OAS analysis is the way in which the "spot" curve for municipal issues is derived. Some systems take the taxable Treasury yield curve and do an after-tax transformation while others take the AAA municipal yield curve and try to derive a municipal "spot" curve. This issue remains controversial among theoreticians.

One input to OAS analysis that must be supplied by the user is the expected volatility of short-term interest rates. Many systems supply a default value that is based on some historical average. Other systems try to be more forward looking, deriving the implied volatility from the prices of options of futures. Unfortunately for municipal market participants, the futures contracts traded on municipal bond indices reflect long-term, rather than short-term, maturity bonds.

A final assumption that is built into OAS analysis is the concept of risk-neutrality. Central to the typical methodology of OAS is the assumption that the probable range of future interest rates (forward rates) can be unambiguously derived from only two data inputs, a volatility forecast and the current yield curve. To make this assumption reasonable, it must be assumed that bond investors are indifferent to the possibility of achieving the same total return over a period of time,

irrespective of whether they do so by holding a single bond to maturity or by holding a succession of short-term bonds. Put another way, investors must be assumed to be indifferent to price risk.

All of the above issues and many more are dealt with in an OAS analysis. It is imperative for users of such systems to confirm that all the assumptions of their particular system are in keeping with their own views on these matters.

Sources and Resources

Numerous on-line systems deliver real time news and market information that may be of considerable interest to municipal bond market participants. Systems from Telerate, Knight-Ridder, Reuters, and Bloomberg all provide access to a variety of basic and optional services. Special note should be given to the Bloomberg system which has considerable internal analytical capabilities (including OAS) for analyzing bonds and bond swaps. The other vendors have countered Bloomberg with user friendly interfaces operating in Microsoft Windows. The Windows operating system allows for market data to be fed in real time through DDE (Dynamic Data Exchange) to most Windows based analytical applications or spreadsheets.

There are also a number of market information vendors to the municipal bond marketplace that have made electronic delivery of their information available. Included in this group are Bond Buyer and Municipal Market Data. The information available ranges from on-line delivery of official statements to daily technical analysis of municipal bond market conditions. One interesting such product is Munitrac from H.F. Pearson. This service is a database that tracks institutional holdings of municipal bonds.

Extensive databases of municipal bond issue information are provided by Kenny S&P, Muller Data, Interactive Data Corp. (IDSI), and Security Data Corp. Data from these databases can be delivered in bulk on magnetic tapes or can be queried issue by issue via telephone modem. It is anticipated that one or more of these databases will soon become available on CD-ROM so as to facilitate the usage of analytical software at user sites.

The only portfolio management system currently available specifically for the municipal bond market is that from InvestorTool. It includes a variety of analytical, accounting and reporting functions oriented toward the municipal market. InvestorTool uses telephone modem access to the Kennybase database for issue information. The BondEdge system from Capital Management Sciences also provides capabilities suitable for municipal bond portfolio management but users must supply much of their own issue description data. BondEdge does provide reports that meet much of the specialized reporting needed for presentations to bank regulators. BARRA and Global Advanced Technologies also provide extensive fixed income analysis systems that could be utilized by municipal bond portfolio managers. Suppliers of fixed income analytical and accounting "toolkits" include Intex and Northfield Information Services. The Spreadsheet Solutions Company provides a number of spreadsheet "add-ins" that are compatible with real-time systems operating under Windows or UNIX.

Good resources for anyone contemplating a change in their systems or investment technology are industry guidebooks such as *Nelson's Tech Resources* and the annual product digest from *Wall Street & Technology* magazine.

The Future

As the complexities of municipal bond issues increase, technological superiority will be of key importance for market participants. While the vast data requirements of the municipal bond market have slowed the propagation of some technology-based improvements in industry practices, the municipal market is clearly catching up to the taxable markets in sophistication. One aspect of municipal bond portfolio management that lags rather badly behind other markets is the availability of systems that assist in the construction of portfolios of bonds to meet specific investor needs. Such "portfolio optimization" systems have been broadly discussed but rarely implemented. For a good discussion, see chapter 14 of *Applied Mathematical Programming*, by Stephen Bradley, Arnoldo Hax and Thomas Magnanti, published by Addison Wesley in 1977.