Enhancing the Liquidity of Bond Trading

Charles W. Polk[1] and Evan Schulman[2]

A Chapter Taken from:

The Handbook of Fixed Income Technology

Summit Group Press, ©2000, New York, NY

[1] Charles Polk is the president of Net Exchange (www.nex.com), a California Corporation spun out of the California Institute of Technology in 1994 for the purpose of commercializing combined value auction technologies. Net Exchange has produced combined value trading systems for wholesale transport contracts, air quality permits, and, most recently, bonds.

[2] Evan Schulman is the founder of Lattice Trading and a consultant to State Street Bank in Boston Massachusetts. His interests include the quantitative analysis of securities and systems applications for the management and trading of equity and debt securities. He is the author of articles for several publications, including the Journal of Portfolio Management, the Financial Analysts Journal, The Canadian Investment Review and the Encyclopedia of Investments. His work has been the subject of three case studies at the Graduate School of Business at Harvard University; his career is the subject matter of Chapter 9 of Alan Reubenfeld's *Super Traders*, Probus Press, 1992. Evan is a New Englander by choice, having emigrated from Canada. He has adopted the New England tradition early and enthusiastically, becoming a cranberry farmer in the process.

Enhancing the Liquidity of Bond Trading

Charles W. Polk[3] and Evan Schulman[4]

A bond is a loan. Bonds, like loans, have less risk than equity (if there is a bankruptcy, the debt holders get preferred treatment) and less reward on the upside: that is, the most that debt holders can receive is the agreed upon interest payments and the principal returned at maturity.[5] But, loans to corporations and governments are substantial in size. A total loan would bulk large in most portfolios: and loan instruments are difficult to transfer. By dividing a loan into small pieces and establishing easy transferability, bonds are designed to increase investors' willingness to purchase loans. The design has been popular -- in the U.S., the amount of bonds in circulation is roughly double the amount of publicly traded equity. Bonds are now a crucial element of the financial system, facilitating capital formation and accommodating the borrowing needs of both public entities and private individuals (through the mortgage-backed markets).

The Secondary Market Should be Active and Characterized By Narrow Spreads

[3] Charles Polk is the president of Net Exchange (www.nex.com), a California Corporation spun out of the California Institute of Technology in 1994 for the purpose of commercializing combined value auction technologies. Net Exchange has produced combined value trading systems for wholesale transport contracts, air quality permits, and, most recently, bonds.

[4] Evan Schulman is the founder of Lattice Trading and a consultant to State Street Bank in Boston Massachusetts. His interests include the quantitative analysis of securities and systems applications for the management and trading of equity and debt securities. He is the author of articles for several publications, including the Journal of Portfolio Management, the Financial Analysts Journal, The Canadian Investment Review and the Encyclopedia of Investments. His work has been the subject of three case studies at the Graduate School of Business at Harvard University; his career is the subject matter of Chapter 9 of Alan Reubenfeld's *Super Traders,* Probus Press, 1992. Evan is a New Englander by choice, having emigrated from Canada. He has adopted the New England tradition early and enthusiastically, becoming a cranberry farmer in the process.

[5] Ignoring the equity inducements of warrants and conversion features that may be attached to the debt instrument, the only other contractual payment debt holders may receive is a premium if the debtor prepays the loan.

Trading activity is generated because, unattended, portfolios of bonds move one day closer to maturity every day of the year, weekends and holidays included. Portfolio managers must always trade to maintain their desired duration, yield and maturity profile. Narrow spreads should occur because bond investors tend to hold a common set of information: there is little chance of any of us having private information. (What can I know about general economic conditions that you do not? Once classified as investment grade, what can we know about the ability of firms to meet their obligations that our competition does not?) Since there is less risk of misjudging prices, trading should be driven almost solely by investors' portfolio idiosyncratic values, and the bid/ask spreads should be smaller than in riskier markets.

On the face of it then, we expect liquid bond markets characterized by narrow spreads as investors, with common information sets, continually trade in the market to counter the effects of their portfolio's always shrinking maturity. The evidence is contrary to our expectations.

The Test -- Since equity is a residual claimant on the firm's income stream, we may view the resources backing the equity claim as a non-maturing cushion that supports payment to the bond holders. Thus the equity of a particular firm, say, IBM, should be riskier that the debt of the same firm. Riskier, long-lived securities should have larger bid/ask spreads than less risky, shorter term securities of the same firm. If we look at the bid/ask spread of IBM 10 year bonds, it varies from 0.2% to 0.4%, versus that of IBM common stock of 0.07% to 0.15%.[6] Since the IBM bonds have less risk (the equity cushion) and have shorter maturities than the equity, the difference must be due to lack of liquidity. Given the above, it is hard to trace the lack of liquidity to the design of the security. Accordingly, we argue that the cause of the illiquidity is the secondary market for bonds; the trading system itself.[7]

---

[6] The equity spread measurement was taken at the market open on Thursday the 30th of October 1997. The market was in some turmoil. The specialist took 12 minutes to open the stock and it was up more than $2.00 from its previous close.

[7] Larger spreads are also a function of the interval between trades. If the interval between trades is large, risk accumulates and the spread widens.

The remainder of this chapter outlines the variables that give value to bonds within a portfolio, caricatures the current trading system and then establishes a design for a better trading system. This is not an academic exercise. By the time this chapter is published, a consortium of State Street Bank, Bridge and Net Exchange will have built a trading system for fixed income securities which embodies the characteristics described below. This system will be operated under the supervision of the Boston Stock Exchange.

How an Investor Values Bonds in the Secondary Market

Before the inefficiencies of existing bond trading systems can be identified and more efficient alternatives examined, the motivations governing bond investing must be understood.

The rate of return demanded by a particular investor from a particular debt issue, i, for a particular maturity, m, is composed of the following elements:

$$R_{i,m} = r_{UST,m} + r_{i,risk} + r_{i,port}$$

where $r_{UST,m}$ is the return from a United States Treasury issue with the same maturity, $r_{i,risk}$ is the risk premium attached to the issue, and $r_{i,port}$ is the premium based on how the issue 'fits' into the investor's portfolio of other issues (maturity mix, sector weights, etc...).[8] Note that $r_{i,risk}$ will be greater than zero for all but tax exempt municipal bonds and that $r_{i,port}$ can be negative or positive depending on the investor's desire to buy or sell the issue.

When secondary market trading is the concern, Equation 1 must be thought of over time. Over time, $r_{UST,m}$ may increase or decrease due to changes in market perceptions of the time value of money (e.g., inflation, equity alternatives, etc...). Over time, $r_{i,risk}$ can change if the likelihood of issuer default changes

[8] Equation 1 is not technically correct. The correct way to evaluate a bond is to view it as a time series of zero-coupon bonds where the yield from each zero-coupon bond is a modification from the rate on a zero-coupon U.S. Treasury instrument of the same maturity (the U.S. Treasury spot rate). Equation 1 is an approximation, but it does correctly convey how an investor evaluates a bond from a basis in risk free Treasuries. For a discussion of correctly valuing a bond, see Fabozzi, F. J., "Bond Market Analysis and Strategies, 3rd Edition," Chapter 5.

due to fundamental shifts in the issuer's financial condition. The value of holding any amount of an issue relative to portfolio holdings of other issues will change as the quantities and risk ratings of the other issues change.

No investor, nor any bond issuer, can affect $r_{UST,m}$; thus, the return from any bond is often thought of as a spread off of a comparable Treasury. Normalized in this manner, the value of holding a specific bond depends on its risk premium, which is summarized by a quality rating, and its placement in an investor's portfolio, which is an investor idiosyncratic assessment.

Quality ratings group bonds into classes. For bonds and stocks from the same issuer, bonds have lower downside risk and lower upside potential, which results in the return variance of the bonds being much lower on average than that of the stocks. Bonds in the same class with equivalent risk premiums at one point in time will dependably tend to have equivalent risk premiums at other points in time so long as both remain in the same class. Portfolio values for an investor can be described in terms of $r_{i,port}$ alone because of the commonly held assessments of risk premiums and zero risk bases – in this manner, Table 1 describes the portfolio values for a hypothetical investor. For every bond of interest, an investor can evaluate his reservation portfolio spreads; those spreads, off of any zero risk Treasury and risk premium, at which he would be equally willing to sell or buy a bond.

Table 1. Reservation Portfolio Spreads, $r_{i,port}$, for Mixes of Quality and Maturity, Basis Points

Quality Rating	Maturity, Semi-Annual Periods from the Present						
	1	**2**	**3**	**4**	**5**	**6**	...
AAA	0	-2	-9	-13	11	8	...
AA	4	-8	0	10	0	-11	...
A	0	9	3	0	-13	0	...
BBB	10	6	0	-12	0	-15	...
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮

Two observations are immediate from Table 1:

1. The portfolio spread of each quality/maturity cell applies to any of several bonds.[9]

2. The spreads in each cell are valid only for relatively small volumes of buys or sells -- the validity of each spread depends on the magnitude of individual bonds traded and on the outcome of all trades attempted across all cells.

Observation 1 defines the property of false fractionalization; essentially, the same item is broken up into numerous designations -- that two or more distinct items can amount to the same thing is far more likely if the items are bonds than if they are stocks. Observation 2 is common across all types of investments and is a property that lies behind all portfolio strategies – nothing is valued unto itself.

Clash between Investor Values and Trading System

False fractionalization creates thinness if the trading system used forces investors to treat equivalent bonds as distinct items. Limited by such a system, investors must decide to commit to one of several equivalent bond orders. These artificially constrained decisions result in tradable contra parties only through lucky coincidence or as a consequence of laborious intermediation, both of which increase the cost of trading while decreasing the liquidity of each bond issue.[10]

If the items traded in a particular trading system are traded thickly, then concern for investors' combined valuations within portfolios need not bear heavily on the design or operation of the trading system. In a thick market an investor can, with high accuracy, determine what trades are likely to occur,

[9] It might be argued that there should be a third dimension to Table 1 for specific bond identification so that industry type or multiple bond risk spreading could be indicated. For an established portfolio, such concerns, if they exist, should be independent of the intent to distribute debt quality across time.

[10] To sell bonds in the secondary market, prices must be lowered sufficiently to attract the contra side AND to pay for the dealer's search services (investors) and the use of his (borrowed) capital. Bond managers react to illiquid markets in two ways: 1.) they implement buy and hold strategies such as "portfolio immunization" and 2.) they satisfy their purchase requirements in the new issue market. Both of these strategies compound the thinness of bond markets.

and, thus, what set of individual orders should be placed to address his portfolio requirements. A trading system that does not ameliorate the effects of false fractionalization is unnecessarily thin, implying that if its design and operation are not sensitive to investors' combined values then trading will be thinner still.

The traditional brokered bond market deals poorly with false fractionalization -- dealers and their customers spend time and effort negotiating the price at which a specific security will change hands without adequately considering equivalent alternatives. The traditional market does have an understanding of the combinatorial nature of securities in that a large proportion of bond trades are swaps of one bond for another; however, combinatorial values need not be limited to sub-portfolios of two bonds. The rich information potential of distributed electronic trading suggests a way out of inefficient bond haggling, yet most electronic bond trading systems tried to-date are copies of successful electronic equity systems; thus, they do not address the thinness of bond markets and miss totally the combinatorial nature of portfolio transactions.

Bringing Practical Liquidity closer to Theoretical Liquidity

If the worth to an investor of an individual trade depends on the outcome of other trades, then the investor has combined value for the trades. Combined values are the building blocks that justify valuing one portfolio over another.

A combined value order can be thought of as a number of individual orders with AND logic tying them together into one package order. Each individual order, or element, will be a buy or sell. In this fashion, portfolio buys, sells, and swaps can be expressed. This may be a theoretically appealing concept of an order that addresses portfolio concerns, but it offers little practical value if used in the context of an already thin spot market -- a package order is more difficult to match than is a single element order. Further, the public revelation of an investor's portfolio values that would result from his placement of a non-hedged package order into a spot market would put the investor at a disadvantage. Fortunately, a properly implemented call market can avoid spot market shortcomings; allowing the theoretical benefits of combined value orders to be realized in practice.

In a call market, orders are submitted over a period of time and allowed to accumulate; which is to say that possible trades among the orders are not consummated when received. Once the market is called, order submission ceases and trades among the orders are determined.

There are a number of guiding principles that can be used to match orders in a call market; for example, volume maximization or gains from trade maximization (the summed dollar value between all bids and asks that trade). Gains from trade maximization assures that the investors in the call who have indicated the highest value for the trade are the most likely to trade -- a very attractive feature if a trading system wishes to attract and keep business. Maximization of gains from trade does not imply that the gains should be taken by the trading system. Such a commissions policy would discourage investors from submitting truthful offers which would undermine the attractive attribute of aligning true willingness to trade with the likelihood of trading.

To illustrate a call market approach with package orders and a gains from trade maximization rule, consider the orders of Table 2 for the hypothetical bonds X and Y. The package order, Buy 3 (B3), has been expressed with individual offers; however, it should be apparent that the act of packaging the bonds into a single order with the word "AND" implies that the investor who submitted B3 has a combined value for the bonds (i.e., $2,004,000 for 1,000 of X and 1,000 of Y). When individual bond offers are compared without modification, order B3 cannot trade because only its bond Y element can add gains from trade; therefore, only orders B1, B2, S1, and part of S2 can trade. However, the combined designation of order B3 allows its elemental unit offers to be adjusted, as in Figure 1, increasing the overall gains from trade and, incidentally, the volume of trade. Here as described in the next paragraph, B3 pays $2,003,000, or $1,000 less than the budgeted $2,004,000 for the two bonds. The system used some of the gains from Bond Y to capture a position in Bond X.

Table 2. Sample Orders

Order	Bond X		Bond Y	
	#	offer	#	offer
Sell 1	1,500	99.9		
Buy 1	1,500	100.2		
Sell 2			1,500	100.2
Buy 2			500	100.4
Sell 3			500	100.5
Buy 3	1,000	99.8	1,000	100.6
Sell 4	1,000	100.0		

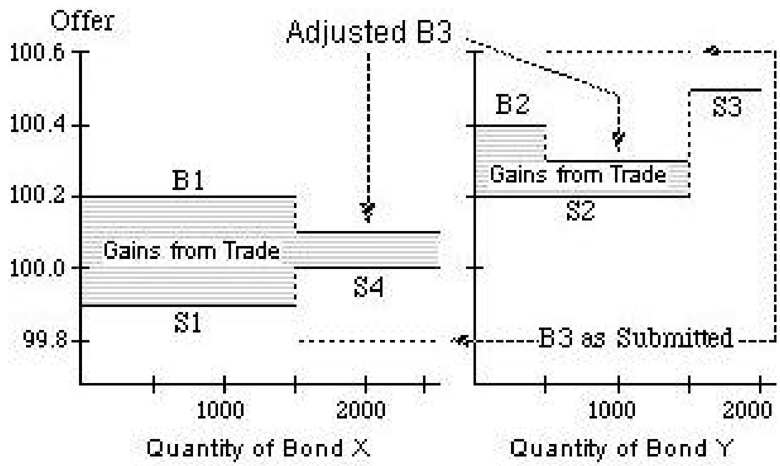

Figure 1. Trades among the orders of Table 2

If the pricing policy were to charge at bid and pay at ask, then investors would hedge their offers relative to their expectations of what the 'Market Price' of the bonds will be -- an investor will not offer at his true valuation if he knows that he will have to pay it; rather, it would be in his interest to guess what the market will accept. Referring back to Figure 1, an incentive compatible pricing rule is to set clearing prices for each bond based on the marginal trades in each bond. A simple example of such a rule is to set clearing prices at the mid-point of the marginal trades, splitting gains from trade 'at the margin.' In the example of Figure 1, this mid-point pricing rule would set the bond X price at 100.05 and the bond Y price at 100.25.

In a call market, once the order submission round is called, an investor does not get to change his mind based on pricing information that may be apparent from the submitted orders. Instead, the investor must submit strategies that reflect his willingness to trade different groups of orders under different potential price environments. Such strategies embed contingencies -- one group of orders under one pricing environment OR a second group under a second pricing environment OR so on and so forth. Prices are then the outcomes of the orders that trade from among the strategies placed across all investors.[11]

The use of OR logic between orders suggests the use of OR logic within an order to help overcome the problem of false fractionalization. If an investor feels that a degree of equivalency exists between two or more bonds, then he should be able to express a mix of possible trading outcomes among these bonds that would be acceptable. In such a formulation, each possible trading outcome is ORed with all other outcomes in the investor's acceptable mix. Figure 2 illustrates an OR formulation between two bonds, X and Y, within a single combined value order.[12] Any one of the specific quantity combinations in the shaded area has been designated by the investor as an acceptable trade. If the shaded area is narrowed to a single line, then a combined value order without OR logic is formed. If the shaded area is widened to a box that includes the axes, then the investor is indicating a complete indifference between bonds X and Y.

[11] A 'Chicken and Egg' dilemma seems apparent -- the winning set of trades is contingent on prices that can only be known once the winning set of trades is known. This dilemma can be solved through the proper mix of order formation tools and order processing routines. It is beyond the purview of this chapter to describe such a solution; however, such problems have been solved and are in commercial operation (the interested reader might wish to examine the Web address, www.nex.com).

[12] The principles generalize to any number of bonds.

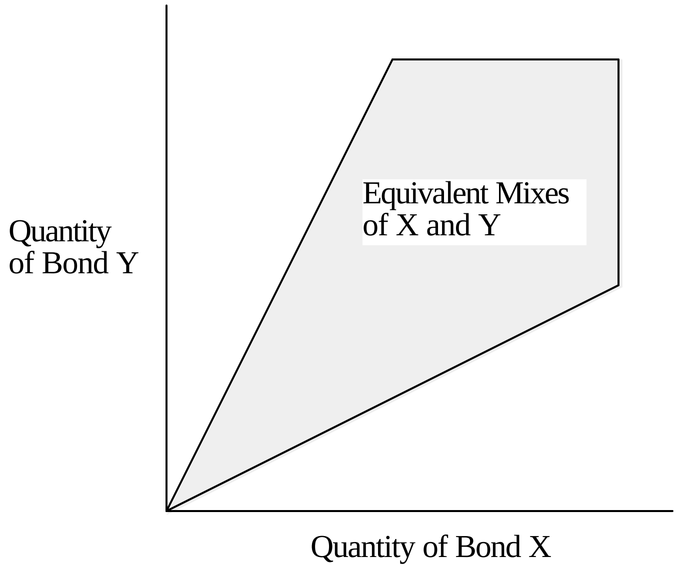

Figure 2. OR-Logic within a Combined Value Order

The basic formulation of Figure 2 can be made more useful by allowing the investor to specify minimum individual quantities, minimum and maximum summed total quantities, and minimum and maximum budgets. To further the realization of combined value trading, this sort of order can be comprised of all buy offers, all sell offers, or a mix of buy and sell offers, while different orders can be grouped into trading strategies using OR logic. Trading strategies can be aggressive -- pay for size (volume), or defensive -- trade more, but at a better price.

The practical liquidity of a bond trading system can be increased through the accumulative property of a call market, the incentive compatibility of a clearing price rule, and the proper use of AND and OR logic in a combined value order format. In principle, all of this is rather apparent. In practice, the trick is in the implementation.

Implementing a Combined Value Call Market for Bond Trading

There are tens of thousands of bonds currently available for trading. There are potentially thousands of investors in such bonds who might want to participate in the sort of call market that has been described.

Manual processing of the order volume that would accumulate in a combined value call market is unimaginable. Since the required high speed computational methods are now available, there exists the opportunity for a distributed, or virtual market -- no trading floor is necessary.

State Street Bank and Trust has identified that basic research in combined value auction methods conducted at the California Institute of Technology is relevant to secondary market bond trading. These pioneering methods have been 'spun out' for commercial use into the California firm Net Exchange. State Street and Net Exchange have developed an order formulation and high speed processing approach which brings the merits of combined value call markets to the secondary market for bonds. State Street and Bridge have developed a client/server system that operates as part of Bridge's widely installed Bridge Station® suite of financial applications. The operation of this trading system will be supervised by the Boston Stock Exchange. Together, these efforts have produced Bond Connect which will debut commercially in mid-1999.