Fin Mkts Portfolio Mgmt (2006) 20:19–32
DOI 10.1007/s11408-006-0001-y

Stock and bond liquidity and its effect on prices and financial policies

Yakov Amihud · Haim Mendelson

Published online: 23 March 2006

Abstract An asset is liquid if it can be traded at the prevailing market price quickly and at low cost. We show that in addition to risk, liquidity affects asset prices and returns. Theories of asset pricing suggest that the expected return of an asset is increasing in its risk, because risk-averse investors require compensation for bearing more risk. Because investors are also averse to the costs of illiquidity and want to be compensated for bearing them, *asset returns are increasing in illiquidity*. Thus, asset prices should depend on two asset characteristics: risk and liquidity. This paper surveys research on the effects of liquidity on asset prices and returns, showing that liquidity is an important factor in capital asset pricing.

Keywords Market efficiency · Liquidity risk premia · Asset prices
JEL Classification: G12, G14

Y. Amihud(✉)
Ira Leon Rennert professor of Entrepreneurial Finance,
Leonard N. Stern Graduate School of Business,
New York University, New York, USA
E-mail: yamihud@stern.nyu.edu

H. Mendelson
The Kleiner, Perkins, Caufield & Byers Professor of Electronic Business and Commerce, and Management, Graduate School of Business,
Stanford University, Stanford, CA 94305, USA
E-mail: Haim@stanford.edu

1 What are illiquidity costs?

Illiquidity reflects the costs of executing a transaction in the capital markets. These costs include three components:

(a) *Price-impact costs* reflect the price concession that a buyer or a seller of a security makes when trading: a discount when selling or a premium when buying. For small orders, the market impact is confined to the *bid-ask spread*, which is the difference between the buying and selling price quoted by dealers, market-makers and investors who supply liquidity to the market by standing ready to buy and sell at the quoted prices. The bid-ask spread represents a cost to investors because a simultaneous "round trip" buy and sell transaction costs the full bid-ask spread. For larger orders, the price impact exceeds the bid-ask spread and increases in the order size. *Depth* is the order size at the best quoted price, which is the largest size that does not incur a price impact cost above the bid-ask spread. [1]

(b) *Search and delay costs* are incurred when a trader looks for better prices than those quoted in the market or wishes to reduce the price impact of his order. This often occurs with block orders, where traders search for a counterparty rather than "dump" an order on the market. While saving on price-impact costs [component (a)], the trader bears search and delay costs resulting from the fact that the trade is not executed immediately. In particular, the trader incurs opportunity costs and risk as the order awaits execution. For example, if a trader wishes to sell a security, the stock price may decline while he is searching for a counterparty. The trader then trades off the benefit of a lower price-impact cost against the risk of the market turning against him.

(c) *Direct trading costs* include exchange fees, taxes and brokerage commissions. These are also subject to tradeoffs: for example, a trader may ask a dealer to liquidate a block, with the dealer bearing the search and delay cost while the trader pays a larger commission.

The three components of transaction costs are highly correlated: assets with high price impact costs or high bid-ask spread often have high search and delay costs and high brokerage commissions. Other measures of liquidity are also correlated with the above three components. For example, stocks with greater depth are more liquid. Another liquidity measure,

[1] Each security has a characteristic depth which may change over time. It is much larger for liquid stocks than for illiquid stocks, and it is much larger for most U.S. Treasury securities than for stocks.

resilience, is the extent of bearing large-order flow in one direction without affecting the market price. Greater depth, greater resilience and smaller price impact cost go together.

2 How does liquidity affect asset prices?

We have developed a model that shows how liquidity affects asset prices (Amihud and Mendelson 1986). The model characterizes assets by their transaction costs, and investors—by their investment horizons. Investors maximize the expected present value of the cash flows their assets generate, including the costs of transacting. In equilibrium, the return on an asset is an increasing function of its transaction cost because investors require compensation for bearing these costs. The relation between illiquidity and return is increasing and concave, i.e., it increases less for less liquid assets, which are held by investors with longer investment horizons who can depreciate their transaction costs over a longer period. The illiquidity effect is more prominent for liquid assets, which trade – and hence bear the transaction costs – more frequently.

While the illiquidity costs of a single transaction are low relative to the asset price (for most publicly traded securities, it is a fraction of a percent), their *cumulative* effect on value is large because they are incurred repeatedly over the security's life. Thus, the impact of illiquidity costs should equal *at least* the present value of all costs incurred currently and in the future. A stock, for example, has an infinite life, resulting in an infinite series of transaction costs whose present value can be substantial relative to the stock's value. As pointed out above, traders avoid investment in illiquid securities unless they are adequately compensated. Consequently, the price of illiquid securities must fall sufficiently to attract investors.

We present below empirical evidence on the effect of illiquidity on asset prices and expected returns. The bottom line is that for stocks, bonds and other financial instruments, the higher the illiquidity – the higher the return or the lower is the price after controlling for other characteristics, such as risk. The evidence also shows that risk-averse investors price illiquidity risk.

2.1 Liquidity and stock returns

We tested the return-illiquidity relationship on NYSE-AMEX stocks during 1960–1980 (Amihud and Mendelson 1986, 1988). Stocks were divided into seven portfolios by their bid-ask spread, which is a measure of their

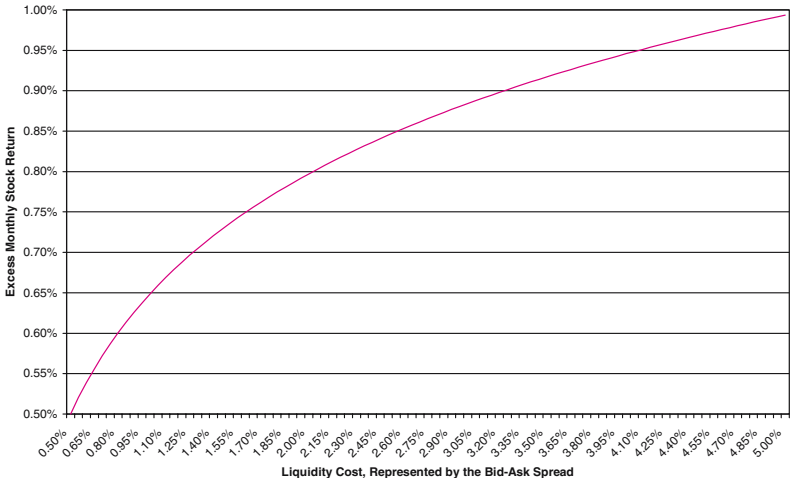


Fig. 1 The effect of stock illiquidity (bid-ask spread) on stock expected return, NYSE, 1961–1980

illiquidity, and within each – into seven portfolios ranked by β coefficient, the CAPM-based measure of risk, a total of 49 (7×7) portfolios. Then, in a cross-sectional estimation of the average return on each portfolio as a function of the bid-ask spread as well as of firm size and the unsystematic volatility, we obtained that the average portfolio return was significantly higher for stocks with higher spread. The function was increasing and concave, as predicted by the model. A summary of the results can be obtained from the following formula and also shown in Fig. 1

$$R_j = 0.0065 + 0.0010\beta_j + 0.0021\ln(S_j). \tag{1}$$

Here, R_j is the return on stock portfolio j and S_j is the bid-ask spread (as a fraction of the stock price. This relationship is depicted in Fig. 1.

Subsequent studies support the theory that higher illiquidity entails higher expected return, after controlling for risk and other characteristics, using a number of alternative measures of liquidity. Brennan and Subrahmanyam (1996) use each stock's price impact cost (per unit of order size) as well as the fixed costs, associated with the bid-ask spread, and estimated the effect of these measures of illiquidity on stock returns. They obtain a strong positive relationship between average stock return and both measures of illiquidity costs. Datar et al. (1998) measure liquidity using stock turnover (the ratio of trading volume to shares outstanding), and Brennan et al. (1998) use trading volume to measure stock liquidity. Both find that the higher the liquidity of a stock, the lower its return after controlling for

risk and other characteristics. This relationship, which is consistent with the theory, is found to be very robust.

Using data from the Swiss stock market, a recent study by Loderer and Roth (2005) strongly supports the theory. They estimate the effect of stock illiquidity, measured by the bid-ask spread, on stock prices. Effectively, they use the stocks' P/E (Price/Earnings) ratio, controlling for firm growth, dividend, risk and size. They find that the larger the bid-ask spread, the lower the P/E ratio. Using volume as a measure of liquidity, they obtain similar results: the lower the volume (the more illiquid is the stock), the lower the P/E ratio. The illiquidity effect is large, with an economically significant price discount of 12% for a median-spread stock compared to a zero-spread stock for the median year in the sample. Loderer and Roth replicate this methodology for Nasdaq stocks, examining the price discount as a result of illiquidity. The median price discount there due to illiquidity is 28% for the median year.

That illiquidity exacts a toll in terms of price discounts is clearly seen from the evidence on restricted stock. Some companies whose stock is publicly traded issue stock which is identical in all rights to the publicly traded one except that it cannot be traded in public markets for a limited period, and its sale is subject to restrictions under SEC Rule 144. Thus we observe two securities – the publicly traded stock and the restricted stock issued by the same company – with the only difference between them being in their liquidity. Consistent with the theory, Silber (1991) finds that on average, the price of the restricted stock is 34% lower than the price of the publicly traded stock of the same company. A similar discount is applied in court cases which determine the values of restricted stock. Silber finds that this illiquidity discount is decreasing in the size and earnings of the company, and is also lower when there is a special relationship between the restricted stockholders and the company, implying better monitoring. The results suggest that liquidity is more important in riskier investments.

2.2 Liquidity and bond yields

We tested our theory on the liquidity effect by examining the differences in liquidity and yields of the U.S. Treasury bills and notes with less than 6 months to maturity (Amihud and Mendelson 1991a). For these maturities, both securities are discount instruments and when maturities are matched, the two securities are completely identical, except that Treasury bills are much more liquid than notes. The average bid-ask spread on bills in our sample is 0.00775% compared to 0.0303% for notes. The brokerage fees

are $12.5 to $25 per $1,000,000 value for bills and $78.125 per $1,000,000 for notes. Also, the price impact on bills is smaller than on notes and consequently they can be traded in larger quantities. Because notes are less liquid than bills, our theory predicts that their yields should be higher than those of bills with the same maturity. We test the liquidity effect for 37 randomly-selected days between April and November of 1987, matching notes with bills so that they have the same maturities. As predicted by the theory, we find that the annual yield to maturity on notes is 0.43% higher than that on bills with the same maturity. Kamara (1994), who obtains similar results, finds that the note-bill yield differential holds after controlling for a number of additional security characteristics. A similar pattern is observed in the bond market in the yield differential between on-the-run bonds, which are most recently issued, and their less liquid off-the-run counterparts, whose maturity is only slightly shorter since they were issued earlier[2]. A number of studies document a lower yield to maturity for on-the-run bonds compared to their off-the-run counterpart (see, e.g., Warga 1992; Krishnamourthy 2002).

Corporate bonds are known to have, on average, higher yield than similar-maturity Government bonds, and within corporate bonds, lower-rated bonds have higher yield. This yield differential has traditionally been attributed to differences in the risk of default which is surely higher for corporate bonds and higher for lower-rated bonds. However, if illiquidity costs are higher on corporate bonds and on riskier bonds, part of the yield differential is due to illiquidity costs. The effect of liquidity on corporate bond yields is studied by Chen et al. (2006). They estimate the illiquidity cost of corporate bonds and find that it generally increases as the bond rating declines. Then, they estimate the effect of illiquidity costs on bond yields across bonds, controlling for bond risk, issuing firm characteristics and the bond's special features. They find that illiquidity has a strong positive and robust effect on bond yields. Further, *changes* in bonds' illiquidity costs lead to changes in bond yields, as predicted. In the U.S., Rule 144A bonds, which are less liquid corporate bonds whose trading is restricted to "qualified investors," exhibit a significant discount. Chaplinsky and Ramchand (2004) find that the yield on Rule 144A bonds is 0.49% higher than on unrestricted bonds with similar characteristics. The differential is particularly large for investment-grade bonds.

[2] In fact, bills – which are issued frequently with short maturity – are effectively the on-the-run counterparts of notes with the same maturity that have been issued in the past.

2.3 Liquidity changes over time and liquidity risk

Just as liquidity affects asset prices across securities, it affects changes in their prices over time. One example is the 19th of October, 1987 stock market crash in U.S. Amihud et al. (1990) propose that the crash resulted partly from a decline in investors' perception of overall market liquidity compared to the pre-crash level. Consequently, investors priced securities lower, which led to the crash. Studying NYSE stocks included in the S&P 500 list, they find that on 19th October the dollar bid-ask spread increased by more than 63% compared to its pre-crash level, and the quote size (the amount which dealers are willing to execute at the quoted prices) also showed a dramatic decline. A similar decline in liquidity was also found in London, where the bid-ask spread of the most liquid stocks increased from 1.2% prior to the crash to 3.4% on the crash day and remained at about 3% through November. The sharp decline in market liquidity came after a period when investors had believed that the market was having the capacity to process sufficiently large flow of orders with a very small effect on prices. The study found that across stocks, those that declined the most on the crash day were those with the greatest deterioration in liquidity, and those which recovered most by the end of October 1987 were those whose liquidity recovered the most.

Stock liquidity also changes when the market's trading system is improved. In Europe and the rest of the world, markets have been moving from call-auction markets which were relatively illiquid to continuous trading which provides greater liquidity. Amihud et al. (1997) study the effect of moving stocks in the Israeli stock market from once-a-day call auction to a more continuous trading. They find that stocks that were moved to the better trading system enjoyed greater liquidity (greater turnover and lower volatility-to-volume ratio) as well as a sharp increase in value of at least 6%. Subsequent studies obtain similar results for other markets that improved their trading systems and became more liquid.

Market liquidity changes not only in response to singular events but also over time for economic reasons. The question that arises is whether this affects stock prices over time. Amihud (2002) find that when market illiquidity rises unexpectedly, stock prices fall and subsequent expected return rises, consistent with Amihud and Mendelson (1986) predictions. The effect is particularly strong for small, illiquid stocks. Because in these times there is a "flight to liquidity," large stocks are less vulnerable to liquidity shocks.

It follows that a security's exposure to liquidity shocks should affect its price and expected return because it adds an additional dimension of risk,

a liquidity risk. Pastor and Stambaugh (2003) and Acharya and Pedersen (2005) find that stocks whose return is more sensitive to overall illiquidity shocks have, on an average, higher average return (controlling for other stock characteristics). In addition, Acharya and Pedersen find that greater sensitivity of stock illiquidity to market illiquidity, as well as higher (absolute) sensitivity of the stock illiquidity to the market return, also bring about higher stock return. That is, systematic liquidity [3] risk is priced.

3 Some investment implications

The theory and empirical results suggest that liquidity is priced in the market: for any given level of risk, more illiquid securities have lower price or higher expected return or yield. Risk, too, lowers securities prices, but there is a big difference between what investors can do to mitigate the costs of risk and illiquidity. To reduce risk, investors can diversify their holdings. Since most of securities' risk is idiosyncratic (uncorrelated across securities), a diversified portfolio enables investors to remove most of the risk. Investors are then exposed only to systematic, undiversifyable risk. However, part of this risk, too, can be hedged by some investors. Surely, the total economy's risk is not diversifiable, but an individual investment manager can hedge the market risk by using appropriate market instruments (e.g., derivatives). In contrast, the cost of illiquidity cannot be diversified away. It is additive, that is, a portfolio of illiquid stock remains illiquid. Still, illiquidity can be managed. For example, just as a fund manager diversifies risk by holding different securities with different levels of risk, he can hold different securities with different liquidity, ranging from cash-equivalent securities (the most liquid) to small, infrequently-traded stocks and bonds. The objective is to reduce the frequency of trading in the least-liquid securities, thus enjoying their higher return while not bearing the full cost. When a market shock calls for redemption of fund's units, the manager can easily liquidate the most liquid securities and thus reduce the fund's illiquidity cost. Surely, such a policy takes a toll on performance since, as we have seen above, more liquid instruments yield, on average, lower return. Thus, the fund manager needs to continuously manage the trade-off between liquidity, risk and return. Further, since an investment fund is subject to both inflows and outflows of cash, the fund manager needs to optimize the fund's investments, given the current fund's state of liquidity and risk as well as the likelihood of withdrawals and inflows.

[3] Acharya and Pedersen (2005) use liquidity betas to measure systematic liquidity risk, and show these betas are priced.

Another important way to manage liquidity costs is skillful trading. Money managers usually focus on stock selection and market timing. However, a fund's performance can be improved by trading skillfully to minimize illiquidity costs. For example, suppose a fund wants to sell a position in a security. Dumping the entire quantity in a single transaction would obviously lead to a large price impact. Selling the entire quantity in a negotiated block transaction can reduce the cost but it, too, is costly due to commissions, search and delay costs. A third alternative is to split the order and sell it in pieces. Here, it is possible to construct a model which takes as input the quantity to be sold, the price impact per unit of quantity and the time within which the position is to be sold. The model would provide an optimal, cost-minimizing way to sell the position. If an investor is concerned about the risk which results from the delay in execution, a risk-reducing objective can be added to the model to produce an optimal sale quantity. Finally, if the fund wishes to sell a position in a number of securities whose returns are correlated, a further complication ensues, which can be worked into the model. The bottom line is that skilled buying and selling of securities, aimed at minimizing illiquidity costs, is an important consideration for enhancing investment performance.

Because systematic liquidity risk (betas) is also priced in addition to the ordinary CAPM beta, portfolio optimization must take this risk into account. Since transaction costs affect the *net return* on stocks, reducing the risk of net portfolio return calls for a reduction in exposure of the stock's liquidity attributes to the market return and illiquidity. Portfolio strategies should take this into account in addition to the ordinary strategies of portfolio construction which focus on managing the risk of *gross* return, ignoring the role of liquidity risk.

Investments in hedge funds are growing now in an important way. Funds strategies include taking a long position in a low-priced instrument and hedging the risk by shorting a higher-priced instrument with the same cash flow pattern. Fund managers often expect that the valuation gap will close, in which case they unwind the position. Implicit in this strategy is the belief that the valuation gap is transitory, perhaps resulting from investors' valuation errors. However, if the low-priced instrument is also less liquid, the valuation gap may not close unless liquidity changes, and this may not happen, at least not in the short run. Moreover, transaction costs in building the position may eat up the potential gain. And, if the position becomes profitable, trying to unwind it may be too costly. For example, in our study of the note-bill yield spread, suppose an investor shorts bills and longs notes with the same maturity. This position is riskless if held to maturity, and by our findings it would have yielded 0.43% on the size of the

position. However, we calculated that after including all the relevant costs of constructing the position, there is no profit to be had. And, even if the position were profitable and the investor wanted to unwind it before maturity, it would be very costly: while the short position in bills would be easy to close, selling the less-liquid notes would be more costly. More broadly, if a position is taken in a seemingly underpriced asset which is illiquid, selling it would exact heavy cost. It should be recognized that not all strategies that seem profitable are indeed so when the liquidity consequences are considered.

4 Some corporate finance implications

We have shown that higher liquidity reduces the return required by investors. For a company that issues stocks and bonds, lower required return means lower cost of capital. Consequently, a company can increase its market value by enhancing the liquidity of its stocks and bonds, since a lower cost of capital means higher valuation for any given cash flows that the company generates.

We suggested (Amihud and Mendelson 1988, 1991b,c) a number of strategies that companies can employ to increase the liquidity of their securities. Below are some liquidity-enhancing measures.

(a) Increasing the company's investor base, especially by adding small individual investors, increases liquidity and raises the stock price. Amihud et al. (1999) find that when companies in Japan made their stocks more accessible to small investors by reducing the minimum trading unit, the investor base increased, resulting in an increase in stock liquidity and price. In general, the investor base can be increased by making it easier to trade the company's stocks and bonds (e.g., inducing more dealers to make a market in the company's bonds), and advertising the company so individual investors are familiar with it and are more willing to invest in it. Indeed, advertising has been shown to increase stock liquidity.

(b) Providing voluntarily more information about the company reduces the asymmetry of information about its value and thus increases stock liquidity. A company should apply transparent financial reporting, voluntarily make prompt announcements of new information and pay for services that provide information to the public, such as those of analysts. This is particularly valuable for small companies about which less information is generated and disseminated, a fact that may explain the small stocks' higher expected return and lower price. Of course,

given the cost associated with the provision of information, the final decision should consider these costs versus the benefits of enhanced liquidity.

(c) Refrain from fragmentation in the Stocks and bonds issues. Amihud et al. (2003) find that when two identical securities of the same company are traded in the market – in that case, stock and deep-in-the-money warrants – the stock's value rises when the warrant is exercised, since this eliminates the fragmentation that existed beforehand and makes the stock more liquid as its outstanding value is larger. In general, the larger the stock or bond issue, the greater is its liquidity and the higher its value. Many companies split their stock into two or more classes, and they issue bonds in small series. While there are economic reasons for doing so (for example, having two classes of voting stocks), corporate managers should realize that this reduces liquidity and consequently raises the corporate cost of capital.

(d) Listing the securities for trading on an exchange that would make them most liquid. Yet, while the NYSE, for example, is more liquid in general than a number of national markets in the world, trading may be less intensive there if the security is foreign and the information is generated mostly in the local market.

Increasing the liquidity of a company's securities presents a tradeoff between costs and benefits. The cost of increasing liquidity is likely to be lower for low-liquidity securities. However, the holders of such securities are usually long-term investors who are less sensitive to illiquidity. The benefits of increasing liquidity may be larger for liquid securities, which are held by investors who are sensitive to illiquidity. But as pointed out, the cost of doing so may be higher. At the end, the company should determine the optimal level of its securities' liquidity in a way that maximizes its overall value.

5 Concluding remarks

We have shown that expected asset returns depend on their liquidity (or marketability) in addition to their risk. For both bonds and stocks, the less liquid the asset, the higher its return (after controlling for risk). Further, the effects of liquidity on asset values and returns are larger than one would naively expect because the costs of illiquidity are incurred repeatedly, whenever the asset is traded.

These results have important implications for investments, corporate financial decisions and public policy. Securities analysis should consider,

in addition to cash flows and risk considerations, the liquidity of the security and possible changes in it. In issuing new securities, attention should be given to their liquidity in order to increase their price. And companies should employ strategies that make their publicly-traded securities more liquid. Finally, this paper suggests that there is value in public policy that increases securities markets liquidity, because this would reduce required returns and corporate cost of capital and increase stock and bond prices.

References

Acharya, V.V., Pedersen, L.H.: Asset pricing with liquidity risk. J Financ Econ **77**, 375–410 (2005)

Amihud, Y.: Illiquidity and stock returns: cross-section and time series effects. J Financ Mark **5**, 31–56 (2002)

Amihud, Y., Lauterbach, B., Mendelson, H.: The value of trading consolidation: evidence from the exercise of warrants. J Financ Quanti Anal **38**, 829–846 (2003)

Amihud, Y., Mendelson, H.: Asset pricing and the bid-ask spread. J Financ Econ **17**, 223–249 (1986)

Amihud, Y., Mendelson, H.: Liquidity and asset prices: financial management implications. Financ Manage **17**(Spring), 5–15 (1988)

Amihud, Y., Mendelson, H.: Liquidity, maturity and the yields on U.S. government securities. J Financ **46**, 1411–1426 (1991a)

Amihud, Y., Mendelson, H.: Liquidity, asset prices and financial policy. Financ Anal J **47**, 56–66 (1991b)

Amihud, Y., Mendelson, H.: Liquidity and Asset Prices. Financ Mark Portf Manage **5**, 235–240 (1991c)

Amihud, Y., Mendelson, H., Lauterbach, B.: Market microstructure and securities values: evidence from the Tel Aviv Exchange. J Financ Econ **45**, 365–390 (1997)

Amihud, Y., Mendelson, H., Uno, J.: Number of shareholders and stock prices: Evidence from Japan. J Finance **54**, 1169–1184 (1999)

Amihud, Y., Mendelson, H., Wood, R.: Liquidity and the 1987 stock market crash. J Portf Manage **16**, 65–69 (1990)

Brennan, M.J., Subrahmanyam, A.: Market microstructure and asset pricing: On the compensation for illiquidity in stock returns. J Financ Econ **41**, 441–464 (1996)

Brennan, M.J., Chordia, T., Subrahmanyam, A.: Alternative factor specifications, security characteristics, and the cross-section of expected stock returns. J Financ Econ **49**, 345–373 (1998)

Chaplinsky, S., Ramchand, L.: The borrowing costs of international issuers: SEC Rule 144A. J Bus **77**, 1073–1097 (2004)

Chen, L., Lesmond, D.A., Wei, J.Z.: Corporate yield spreads and bond liquidity. J Financ in press (2006)

Datar, V.T., Naik, N.Y., Radcliffe R.: Liquidity and stock returns: An alternative test. J Financ Mark **1**, 205–219 (1998)

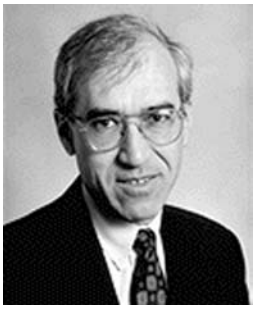
Kamara, A.: Liquidity, taxes, and short-term treasury yields. J Financ Quant Anal **29**, 403–416 (1994)

Krishnamurthi, A.: The bond/old-bond spread. J Financ Economics **66**, 463–506 (2002)

Loderer, C., Roth, L.: The pricing discount for limited liquidity: evidence from SWX Swiss Exchange and the Nasdaq. J Empir Finance **12**, 239–268 (2005)
Pastor, L., Stambaugh, R.: Liquidity risk and expected stock returns. J Pol Econ **111**, 642–685 (2003)
Silber, W.L.: Discounts on restricted stock: The impact of illiquidity on stock prices. Financ Anal J **47**, 60–64 (July-August 1991)
Warga, A.: Bond returns, liquidity, and missing data. J Financ Quant Anal **27**, 605–617 (1992)

About the Authors

Yakov Amihud is Ira Rennert Professor of Entrepreneurial Finance at the Stern School of Business, New York University. His research includes the effects of securities liquidity on their returns and values, and the design and evaluation of securities markets' trading methods and systems. He has also advised the NYSE, AMEX, CBOE, CBOT and other securities markets. His research also includes the evaluation of corporate financial policies and mergers and acquisitions. He has published more than eighty research articles in professional journals and in books, and edited and co-edited five books.



Haim Mendelson is the Kleiner, Perkins, Caufield and Byers Professor of Electronic Business and Commerce, and Management, at the Stanford Business School. His research interests include securities market microstructure, electronic networks, network effects, and the effects of information technologies on markets, firms, industries, and value chains, and he has published about one hundred research articles, thirty case studies and a book in these areas. Professor Mendelson has advised leading

stock exchanges, high-technology companies and financial services firms on issues related to liquidity, information technology and management.