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Liquidity and the 1987 stock market crash

The price decline reflected, in part, a reassessment of market liquidity.

Yakov Amihud, Haim Mendelson, and Robert A. Wood

The Crash of October 1987 was a puzzling event — puzzling not only for what happened on October 19, but also for what subsequently did not happen. In spite of the magnitude and momentum of the crash, its effect was limited primarily to the financial markets, while the economy as a whole did not change its course. And, although the "bad news" that was supposed to be predicted by the crash has apparently not materialized, the market suffered a lasting decline after October of 1987.

This article advances a liquidity theory of the crash, proposing that the price decline in October 1987 reflects, at least in part, a revision of investors' expectations about the liquidity of the equity markets. Amihud and Mendelson [1986a, 1986b, 1989] have shown that the market price of stocks is positively associated with their liquidity (after controlling for risk). Given this relationship, when the liquidity of assets turns out to be less than had been expected, their price should decline.

We suggest that the main news that caused the prolonged decline in stock prices was the crash itself — that is, the realization that financial markets are not as liquid as previously assumed. Investors recognized that stock prices should reflect a larger discount for the costs of illiquidity, which turned out to be much higher than had been expected before the crash. Partial recovery following the crash reflects an upward reevaluation of the liquidity of the markets — that is, investors recognized that while the markets are not as liquid as had been assumed prior to the crash, they are also not as illiquid as when there was the possibility of closing the markets altogether.

These illiquidity problems, reflected in wider spreads between the quoted bid and ask prices, have persisted long after the crash, and market impact estimates have stayed significantly larger than they had been prior to the crash.[1] Thus, the crash and subsequent events have produced new information about the markets themselves rather than fundamental news about the economy.

Part of the liquidity-related price decline on October 19, 1987, was temporary. Unexpected sale pressure, even absent any negative information, can generate a temporary negative price impact, as we sometimes observe in block sales. But much of the effect was permanent. Investors realized that they may well have to pay a larger discount when they wish to sell stocks in a hurry. These illiquidity costs result in a stream of future cash outflows that translate into a loss of value.[2]

In general, illiquidity reflects the difficulty of converting cash into assets and assets into cash, or the costs of trading an asset in the market. Some of the costs of illiquidity are explicit and easy to measure, while others are more subtle. These costs include the bid–ask spread, market-impact costs, delay and search costs, and brokerage commissions and fees. These components of illiquidity cost are highly correlated: Stocks that have high bid–ask spreads also have high transaction fees and high search and market-impact costs, and are thinly traded (McInish and Wood [1989]). When the bid–ask spread widens, it signals that immediacy of execution is more costly,

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that is, asset liquidity is lower.

THE 1987 CRASH

We suggest that recognition that the market is less liquid than had been previously thought contributed to the decline of stock prices. Before that time, investors believed that the market was extremely liquid. Portfolio insurers assumed that in the event of a decline the market would absorb large sale quantities with only a minimal price impact. [3] Investors believed that when orders (buy or sell) arrived on the trading floor, the market would provide the needed liquidity to execute them without a significant price change.[4] This turned out not to be the case.

The crash was preceded by a few days of unusual price declines that culminated in a large selling pressure on Monday, October 19. This selling pressure was a test of the assumptions of unlimited liquidity. As we know, the markets failed this test: The price impact triggered by the sale orders was much larger than had been anticipated. To some extent, the reason was technological — the arrival of orders on one side of the market was faster than on the other. Normally, rational, value-motivated traders would step in to buy when large unexpected sell orders reach the market. The technology of market operation, however, made this impossible (Amihud and Mendelson [1988b]).

A number of operational problems exacerbated market illiquidity. Orders could not be executed, and information on market conditions and on order execution was delayed. Consequently, much of the burden of responding to the unexpected order flow fell on the exchange specialists, market makers, and other traders with immediate access to the trading floor. Such access was largely infeasible for outside investors who could have entered the market and traded against the mechanically-generated sell orders.

Those with immediate access to trading could not, however, provide the necessary liquidity because the capital that they could commit at short notice was small relative to market volume. Market depth was reduced, and quoted bid–ask spreads increased to unprecedented levels. All this meant lower liquidity.

The opening transaction, which is usually the largest of the day (Amihud and Mendelson [1987]), was delayed (in some large stocks — for two hours), meaning these stocks became virtually illiquid. There were even worse indications of illiquidity: "As the 19th wore on, investors witnessed symptoms of market failure and were frightened by the rumors that the NYSE would close" (Leland and Rubinstein [1988, p. 46]). The closing of the stock exchange is the ultimate in illiquidity!

After the crash, the decline in liquidity lingered. Press reports indicated that the markets suffered continuous liquidity problems: "Blocks of 25,000 shares can now move prices as much as 100,000-share blocks did before the crash" (Wallace [1987]). Seven months after the crash, liquidity indicators that measure price impact showed that the order quantity needed to effect a given change in stock prices had declined by about a third compared to the 1986 level, which was, in turn, four to six times higher than the 1981 level. According to Wallace [1988]:

> In reaction to these conditions, some money managers and traders now calculate a "liquidity discount" for their portfolios; that is, the extra amount it would cost to bail out of their stocks in such a thin market. . . . The discount on a $2 million portfolio has jumped to 3 percent or 4 percent of its total value, from 1 percent before October.

Applying the Amihud–Mendelson theory of the liquidity–price relationship, investors' expectations about market liquidity imply a certain level of prices for any given state of the fundamental values. If the liquidity of the market turns out to be substantially lower, we should expect a significant decline in stock prices even without any change in the fundamentals — or, put differently, liquidity is another fundamental factor that must be taken into account in stock pricing. We suggest that, in essence, what happened was a revision in investors' assessment of the liquidity of the market, and subsequently the market experienced a decline in value.

EMPIRICAL TEST

This section presents evidence linking the decline in stock prices to increased illiquidity. Our sample consists of 451 stocks included in the S&P 500 index and traded on the New York Stock Exchange for which we had complete data over the test periods. The sample data, every trade and quote for these stocks during the test periods, were provided by the Institute for the Study of Securities Markets.

We compare three periods:

Period I: The week of October 5–October 9, 1987.
Period II: October 19, 1987.
Period III: October 30, 1987.

Period I, before the crash, is taken as the "normal" benchmark, before the unusual price declines that preceded the crash. Period II is the crash day, and Period III is an arbitrary postcrash date.

For each stock, we calculated the return and the quoted bid–ask spreads, as presented in Table 1. The summary statistics show a sizable increase in the dollar bid–ask spread between Periods I and II; even in Period III, about two weeks after the crash, the spreads remained high. The relative (percentage) bid–ask spread on the day of the crash more than doubled

on average compared to the relative spreads of Period I. In Period III it still remained substantially higher than in Period I. These data suggest a sizable decrease in market liquidity on the day of the crash, which prevailed even after the unusual price shocks had subsided.

Table 1 shows that increases in the bid–ask spread, which measure an increase in illiquidity, were associated with a decline in prices, so that when the spread increased, prices fell. If illiquidity indeed contributed to the crash, we should observe a greater price decline for stocks that suffered from greater liquidity problems. That is, across stocks there should be greater price declines for stocks whose bid–ask spread increased more relative to its pre-crash level. Our estimation model is

$$R^i_{21} - \beta^i \cdot R^m_{21} = \alpha_0 + \alpha_1 \cdot DSP^i_{21} + \alpha_2 \cdot PERSPI^i + \epsilon^i,$$

where $DSP^i_{21} = SP2^i/SP1^i - 1$ is the percentage change in the dollar spread for stock i, and PERSPI is the relative (percent) spread for stock i in period I; stocks with lower PERSPI can be considered as more liquid.

The left-hand side of the equation is the "abnormal" price change for stock i, obtained by subtracting from the actual stock return the expected return for that stock given the market return between Periods I and II. The beta coefficients β^i were obtained from Standard & Poor's estimates, which use sixty months of return data up to the end of 1986, and R^m_{21} is the average return on the sample between Periods I and II. (The beta coefficients were adjusted to average 1.0 for the sample.)

On the right-hand side of the equation, the explanatory variables are the relative change in the dollar bid–ask spread for each stock i and the initial stock spread in the "benchmark" period. We use the change in the dollar spread rather than in the relative spread, because the change in relative spread includes the change in relative prices, which is the dependent (left-hand side) variable. The economically meaningful variable is the relative spread, so the equation actually is biased against our hypothesis.

We also estimated the equation with the period subscript 21 replaced by 32, that is, comparing Period III to Period II. Between these periods, there was a modest recovery in prices (5.45% on average); bid–ask spreads declined from their highs during the crash, but still stayed above their pre-crash levels (see Table 1). Again, we expect that the greater the decline in the bid–ask spread from Period II to Period III, the greater the associated increase in price.

We first estimated the equation by setting $\alpha_2 = 0$ (i.e., ignoring the dependence of the price change on the initial level of liquidity), correcting the standard errors to obtain heteroscedastic-consistent estimates. The results, presented in Table 2, columns A-1 and A-2, strongly support our hypothesis on the cross-sectional relationship between liquidity differentials and price differentials during the crash. Stocks that experienced a greater increase in their bid–ask spread suffered a greater price decline during the crash, after controlling for the market effect. Column A-2 of Table 2 shows the results for the "recovery" period. Again, α_1 is negative and significant, i.e., stocks whose bid–ask spreads shrunk relative to their crash levels enjoyed a greater recovery than stocks that remained illiquid.

Next, we examined whether the *initial* level of liquidity (in addition to *changes* in liquidity) of the sample stocks played a role in the crash and in the subsequent recovery, by estimating α_2 in the equation. The results appear in Table 2, columns B-1 and B-2. The variable PERSPI is insignificant in the crash, but has a negative and significant coefficient in the postcrash period. This captures the so-called flight to quality, which we suggest should be interpreted as a flight to liquidity. Investors fearing another liquidity-related crash reallocated assets toward high-liquidity stocks, which explains the greater price recovery of these stocks. As the October 19–October 30 period

TABLE 1

Summary Statistics for the Variables Studied

Variable	Mean	Standard Deviation
R_{21} = P1019/P1009 − 1	−0.2688	0.0825
R_{32} = P1030/P1019 − 1	0.0545	0.1450
SP1	0.2710	0.0849
SP2	0.4422	0.2164
SP3	0.3757	0.1797
SP1/P1009	0.788%	0.5510
SP2/P1019	1.715%	1.2090
SP3/P1030	1.405%	0.9630

Note: P1009, P1019, and P1030 are the closing prices for October 9, 19, and 30, respectively. The ratios are calculated for each stock. SP1, SP2, and SP3 are the average quoted bid–ask spreads in dollars during Periods I, II, and III, respectively. All prices are closing NYSE prices for the indicated period. The average spreads are calculated from all quotes during the period.

TABLE 2

Estimation of the Effects of Changes in the Bid–Ask Spread (α_1), the Initial Spread (α_2), and the Change in Quote Size (α_3) on the Change in Stock Prices

	"Crash" (Period II vs. I)			"Recovery" (Period III vs. II)		
	A-1	B-1	C-1	A-2	B-2	C-2
α_0	0.0376	0.0247	0.0011	−0.0104	0.0323	0.0339
	(5.12)	(1.73)	(0.07)	(1.40)	(2.04)	(1.92)
α_1	−0.0599	−0.0555	−0.0470	−0.0828	−0.0804	−0.0836
	(7.18)	(6.21)	(5.09)	(2.62)	(2.61)	(2.59)
α_2		1.3160	1.4694		−5.5361	−5.5049
		(0.95)	(1.08)		(2.94)	(2.93)
α_3			0.0283			−0.0010
			(3.13)			(0.19)

(t-values in parentheses)

provided no news to indicate a forthcoming change in the cash flows that these firms generate, the relative increase in the price of high-liquidity stocks implies a decline in their expected returns relative to those of low-liquidity (high PERSPI) stocks, consistent with Amihud and Mendelson [1986a, 1986b].

Our hypothesis on illiquidity as a factor in the crash is corroborated by the report of the Quality of Markets Committee of the International Stock Exchange (ISE) in London: "A key test of the effectiveness of a market is how well liquidity is maintained under pressure. We have commented . . . on the improvement in liquidity . . . over the past year" (Kamphuis et al. [1989], p. 281).

On the crash day (October 20), however, there was a dramatic increase in measures of illiquidity: the relative (percentage) bid–ask spreads for the group of most liquid stocks, which averaged 1.2% before the crash, rose and peaked at 3.4%, remaining at about 3% through early November 1987. The bid–ask spreads of the second most liquid group of stocks rose from 2.5% to 5.5% on the crash day and to 6.5% through early November. As the average price decline on the day of the crash was 22%, the increase in the relative bid–ask spread reflects mostly an increase in the spread in pence.

The data for three stocks analyzed by the market quality committee show this clearly: For Shell T&T, the spread increased from 6 pence to 20 pence on the day of the crash; for Amstrad it increased from 4.5 to 9.5 pence; and for Jaguar it rose from 5 to 15 pence on the crash day. By the end of 1987, the committee found that the spreads had narrowed somewhat, but still remained higher than before October. Correspondingly, the London market remained depressed.

Another measure of illiquidity that the committee analyzed is market depth, that is, the size of market makers' quotes. Quote size is usually reduced under extreme market conditions, implying an increased impact of a given size order on price. The maximum quote size for the group of the most liquid ISE stocks fell from 64,000 (average per stock) to 34,000. For the second liquidity group, the maximum quote size had fallen from 50,000 to 12,000 shares per stock. Although by year-end the quote size had recovered, it made up hardly half of the decline.

We tested the effect of the quote size on price changes across stocks in our sample. As for the ISE, the quote size fell substantially on the crash day, but it quickly recovered. We reestimated our model, adding a new variable, DQTSZ, the change in quote size (the number of shares for which the quote applies). We defined our depth variables $MQTSZ_i$ as the sum of the median quantities quoted on the bid and the ask sides in the respective estimation period (I, II, or III).[5] Then, we formed the depth ratios $DQTSZ_{21} = MQTSZ_2/MQTSZ_1$ and $DQTSZ_{32} = MQTSZ_3/MQTSZ_2$.

Adding DQTSZ to the equation, and denoting its coefficient by α_3, we obtained the results in Table 2, columns C-1 and C-2. They show that the change in quote size had a significant effect on the crash day. Across stocks, the greater the decline in the quote size, the greater the decline in the stock price relative to the expected decline (given the market decline). By October 30, 1987, however, the increase in the quote size did not play a significant role across stocks.

CONCLUDING REMARKS

We have suggested that the stock market crash of October 1987 can be interpreted in light of the relationship between liquidity and stock prices. Our theory is that the problems in stock trading and the sharp decline in liquidity, hitherto unexpected, contributed significantly to the decline in stock prices. Although the illiquidity problem prevailed only during the crash and for a number of months afterward, it had a lasting impact on stock prices because investors factor into the price the expected additional concessions they will incur when selling their stocks. Thus, the main news that led to the prolonged decline in stock prices was the crash itself, which changed investor perceptions of the liquidity of the market.[6]

Naturally, our measures of illiquidity cannot capture the fact that trading in some stocks was infeasible either because of extreme imbalances (e.g., they opened hours late) or because the trading floor was practically inaccessible to many traders. Nor can we directly capture the effect of the rumors about possible trading halts or market closing, which imply sharply lower liquidity. Ex post, we know that trading was not halted (except for a brief period on October 20) and, with the benefit of hindsight, trader assessment of the illiquidity of the market on October 19 and 20 was probably exaggerated just as judgments that preceded October 19, 1987, were too optimistic. These conclusions are consistent with the patterns of price behavior over these periods.[7]

The illiquidity problem encountered during the crash was international in nature. In Britain, for example, all measures of illiquidity soared on October 20, 1987, while prices declined. In the Tokyo Stock Exchange, the morning trading session did not take place. In general, the news of the liquidity failure of the United States markets made investors reassess the liquidity of markets around the world. Indeed, Roll [1988] found that price declines in the world's leading stock markets were associated with the trading mechanism employed in those markets. This corroborates our position on the relationship between market microstructure and the crash.

Taking a liquidity perspective toward the events of October 1987 suggests a simple criterion for the evaluation of policy options: They are beneficial if, and only if, they enhance market liquidity. From this perspective, proposed solutions such as circuit breakers resulting in lengthy trading halts, an increase in margin requirements, or institution of a sales tax on stocks are unsound because they are likely to reduce market liquidity and hence depress stock prices. Malkiel [1988] studies the recommendations of the Brady Commission in this spirit. See also Ferguson [1988].

We suggest elsewhere that improvements in trading mechanisms and the proper use of information technology have a greater potential than regulation.[8] The challenge is to find solutions that increase the liquidity of the market without hampering its efficiency (Bernstein [1987]).

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[1] More recently, market liquidity has increased — and so have stock prices.

[2] An important attribute of the costs of illiquidity is that they are incurred *repeatedly* throughout the life of the stock. Hence, an apparently small increase in illiquidity costs may have a sizable impact on value. See Amihud and Mendelson [1988a].

[3] See Treynor [1988]. Recognizing this problem, Ferguson and O'Brien [1988] propose stabilizing forward contracts for portfolio insurers to help resolve the liquidity issue and "discourage excessive growth based on unrealistically optimistic estimates of liquidity."

[4] The liquidity of the market increased continually in the 1980s. Looking at market "depth," the average stock showed no price change or a $1/8 change in 1000 shares of volume 89.2% of the time, up from 80.4% in 1980. Gammill and Perold [1989, p. 13] point out that the liquidity of the market had peaked before the crash: "Stock market volume was never greater and spreads never narrower, at least until October 1987."

[5] As the Exchange reports 999 round lots (of 100 shares) as the highest number of shares quoted, we used the medians of quote sizes.

[6] Indeed, Shiller [1988] found in a survey that immediately after the crash, investors indicated that they responded to the news of the crash itself rather than to specific economic fundamentals.

[7] Another factor that contributed to the crash was volatility (see Wood [1989]). Shiller [1988] argues that the increase in volatility during the crash was due not to fundamental factors, but rather to market psychology, and that it did not persist.

[8] Amihud and Mendelson [1985, 1988b] propose an integrated computerized trading system (ICTS) to increase market liquidity.