

Price Discovery in a Market Under Stress: The U.S. Treasury Market in Autumn 1998*

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We analyze price discovery in the interdealer market for U.S. Treasury securities during stressful days in autumn 1998. Long-Term Capital Management (LTCM) had found itself with losing short positions in on-the-run Treasury securities, and yields on these securities were particularly volatile. Trading activity was intense, with durations between transactions shorter than usual.

Using tick-by-tick data on interdealer transactions in the on-the-run two-year, five-year, and ten-year notes, we find that during such periods of intense trading, the effect of trade flows on price movements became stronger, a phenomenon Dufour and Engle (2000) have documented for the stock market. We also find that during times of stress, depth was asymmetric between buy and sell sides, and this asymmetry affected the importance of trade flows for price movements. Moreover, market-makers seemed exceptionally reluctant to take risks. After identifying ten particularly stressful days for each on-the-run security, we find that the effect of trade flows on prices was significantly stronger on these days, even after accounting for the intensity of trading and the asymmetry in depth.

In the market-microstructure literature, order flow affects prices because it conveys private information regarding the value of the underlying asset. In Glosten and Milgrom (1985), for example, market-makers set a positive bid-ask spread as compensation for trades made with counterparties with superior information. As a sequence of sell orders arrive, market-makers lower bid prices, incorporating the probability that the order flow implies that better-informed investors believe the previous price was too high. In a very general empirical framework, Hasbrouck (1991) documents the

* For complete paper, see conference draft version.

positive relationship between order flow and price changes, using a sample of eighty New York Stock Exchange and American Stock Exchange stocks.

The literature has since been extended to determine *when* order flow is expected to have the greatest impact on prices. In Admati and Pfleiderer (1988), discretionary liquidity traders try to avoid losing money to the better informed by clustering their trading at around the same time. Thus, the observation of multiple transactions occurring together suggests the presence of predominantly uninformed traders. Order flow would then not be expected to have a large impact on prices. Contrast this intuition with that modelled by Easley and O'Hara (1992). In their model, they explicitly allow for the possibility that no new information exists. As a result, an increase in trading volume indicates that news has occurred and, therefore, order flow is more informative when transactions are occurring rapidly.

The empirical evidence on when order flow is important has provided mixed results. In foreign exchange markets, Lyons (1996) documents that trades are less informative if they occur when transaction intensity is high, a finding consistent with the theoretical result of Admati and Pfleiderer. Lyons describes it as hot-potato trading, whereby foreign exchange dealers rapidly and repeatedly lay off unwanted inventory in response to an initial potentially informed trade. By contrast, in equity markets, Dufour and Engle (2000) explicitly incorporate the role of inter-transaction time in the empirical framework of Hasbrouck (1991) and find that when equity markets are most active, i.e., inter-transaction times are short, the impact of order flow on prices is enhanced. Thus, the empirical literature has found opposite relationships between inter-transaction times and the price impact of trading, depending on the market being examined.

Our paper makes two contributions to the understanding of when order flow exerts a stronger influence on prices. First, we replicate the analysis of Dufour and Engle with transaction-level data on the U.S. Treasury market. Thus, we learn whether the busy periods of Treasury market trading are characterized more by the hot-potato view or by more information-based trading. Second, and perhaps more significantly, we examine whether or not the price impact of trading changes during a period of unusual financial stress. We closely examine the market during autumn of 1998, a particularly turbulent time for the market.

“The Johnson Report” (see Committee on the Global Financial System 1999) suggests three reasons why the Treasury market on certain days in autumn 1998 may be considered to have been fundamentally different from other days. First, some dealers became more reluctant to make markets during this period. Many dealers had already incurred grievous trading losses in August. Some of them were also counterparties of LTCM and were

concerned about the possibility of a default of the hedge fund. Thus, dealers began to withdraw from risk-taking, including reducing their market-making activity. Second, the market tended to be asymmetric. In particular, depth was reduced for trades perceived as being in the same direction as LTCM's unwinding of positions. Moreover, market participants were seen as trading on the anticipation that LTCM might be forced to close out its positions. Third, there was an unusual degree of uncertainty about what was going on. The Johnson Report, for example, states, "In this situation of great uncertainty, rumours were rife and often fed upon themselves" (p. 15).

To examine whether there were fundamental changes to the U.S. Treasury market in autumn of 1998, we use data from GovPX. This data set consolidates each tick (e.g., change in quoted spread, depth, or transaction increment) from five of six interdealer brokers, accounting for perhaps half of all transactions in the market. The data include the best bid and offer quotes for each security, the depths for both ask and bid quotes, the price and size of each trade, and an indicator for whether the trade was buyer- or seller-initiated.

Summary statistics indicate two notable changes in Treasury market activity during the crisis of 1998. First, trading volume in the U.S. Treasury market increased dramatically. The implication of higher volume is that average inter-transaction times fell accordingly. Second, the typical quoted depth in the market changed in two ways. Depth size declined, consistent with a period of greater uncertainty. In addition, the decline in depth during the crisis period was more acute on the ask side of the market. This asymmetry in depth is particularly striking, because we presume that during normal times the interdealer market tends to be deeper on the ask side, since dealers would be expected to be in the process of unwinding long positions in on-the-run securities in preparation for the next auction. Put another way, market participants during stressful times in 1998 became less willing to commit to being ready to sell a given quantity at quoted prices. This is consistent with less liquidity in the same direction of a close-out of an LTCM-type position.

We then employ a more formal empirical test of whether the dynamics of price adjustment changed during the crisis period. Our framework builds upon the work of Hasbrouck (1991), Dufour and Engle (2000), and Cohen and Shin (2002). In particular, it explicitly allows for different market dynamics during the crisis period of 1998, as might be suggested by the time-series plots presented in Fleming (2001). We follow Dufour and Engle's approach of explicitly incorporating inter-transaction time into Hasbrouck's vector-autoregression model of prices and trades. In addition, we explore the effects of stress over and above that of trading intensity. We

examine these effects in two ways, by measuring the effect of asymmetric depth and by distinguishing the most stressful days from other days. We also conduct analysis on the two-, five-, and ten-year on-the-run security.

In general, the dynamics of trading in the Treasury market are much like those found in other markets. In particular, returns are negatively autocorrelated, trades are positively autocorrelated, and order flow moves prices in the expected direction. During periods of intense trading, the effect of trade flows on price movements in the Treasury securities market becomes stronger, the phenomenon Dufour and Engle (2000) have documented for the stock market. Using, for example, our results for the on-the-run five-year Treasury note, we can quantify the relationship between the time between trades and the price impact of a trade. During busy times, defined as the 10th percentile in the inter-transaction time distribution (2 seconds), 10 trades in the same direction are expected to move prices by 2.7 basis points. Ten trades arriving at the median inter-transaction time (32 seconds) would move prices by only 2.0 basis points.

Times of stress do seem to impose their own special dynamics on the market. First, we find evidence on the importance of asymmetric depth on the price impact of a trade. Trades where depth is shallower had significantly more impact on prices than trades on the opposite side. Second, the crisis period of 1998 witnessed a dramatic increase in the price impact of a given trade. Even after controlling for the compression of inter-transaction times and for asymmetric depth, trading during the crisis moved prices much more than trading during the more normal times of 1998. For instance, on a stressful day, 10 trades of the same sign would have led to a 3.9 basis points price move in the five-year on-the-run Treasury note, even if these transactions arrive at the median inter-transaction time.

Our results suggest that in the U.S. Treasury market, busy times are times of more informative trading. Furthermore, asymmetry in depth matters, since trades in the direction of lower depth move prices more than trades in the opposite direction. Finally, market stress reduces liquidity, as measured by the price impact of trading. Even after controlling for an increased rate of trading, the price impact of trading during a crisis period is higher than during normal times.

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