

Eurex Exchange releases results of proprietary HFT research

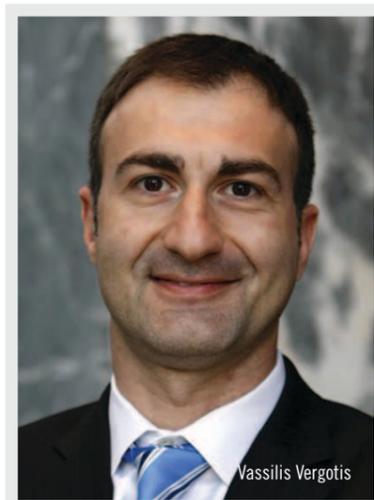
By Vassilis Vergotis, Dr. Randolph Roth and Bernard Hosman

Eurex Exchange is the first exchange in Europe to share part of its proprietary quantitative research on high-frequency trading (HFT) with the public. Key findings of this research include:

- (a) HFT participants played an important and beneficial role during one of the most extreme market situations Eurex Exchange has seen in recent years,*
- (b) HFT participants play a unique and indispensable role in the recovery of market quality right after large trades, and*
- (c) Eurex Exchange did not find evidence of abusive HFT activity.*

Background

Eurex Group continuously invests in deepening its understanding of the structure and dynamics of the markets it operates. Its proprietary data contains a wealth of information on each individual order, down to the level of trader ID and microsecond granularity timestamps. This data uniquely allows the exchange to conduct extremely granular research, which is more important than ever considering the public debate. The analysis is a contribution to much needed empirics in the discussion on HFT.



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Defining HFT

Key to the credibility of any research on HFT activity is a solid process to identify which order flow is - and which is not - of HFT origin. Eurex Group argues that HFT is a technologically advanced implementation of a great variety of trading strategies - some of which already existed prior to the existence of electronic trading platforms. Therefore, the exchange's HFT selection process is based on the technical (instead of functional) characteristics of its participants' order flow. More specifically, the exchange's research looks at the inter-arrival time of messages, measured by the number of microseconds between any two consecutive messages from any two different participants.

To understand the underlying logic of the research, imagine a world wherein participants in a market place would not react on the exact same events when making investment decisions. In this world, the speed with which one reacts on any opportunity would generally not matter; there is no other participant hunting for the

same opportunity. Therefore, from a system perspective, transaction arrival at the central exchange system would be uncorrelated. There would be a predictable number of observations with a small inter-arrival time and a somewhat smaller number of observations with a higher inter-arrival time. The expected number of observations for any inter-arrival time would be given by a Poisson distribution. In reality, trading activity is partly correlated and, since the rise of HFT, especially on a micro-second time frame. Therefore, there are observations in excess of what might be expected based on the Poisson distribution, particularly in the 0-100 microsecond time frame. These excess observations for very short inter-arrival times serve as a proxy for the 'HFT-ness' of a participant.

HFT participants provide important liquidity during periods of extreme market volatility

On 25 August 2011, Eurex Exchange experienced one of the most challenging market situations in its history. An institutional investor (not an HFT participant) offloaded a 6,000 contract DAX® Futures position in a 20 minute period, causing tremendous price pressure. For comparison, the average turnover increased from 300 contracts per minute to more than 1,700 contracts per minute. As a result, the market in DAX® Futures briefly lost more than four percent of its value, making the event look much like the U.S. 'Flash Crash'. However the situation was different in two very important respects.



Dr. Randolph Roth

Firstly, although liquidity became more expensive, it did not dry up. Spreads widened and the number of available contracts declined, but these are natural consequences of increased demand. Arbitrage (against e.g. EURO STOXX 50® Index Futures, SMI® Futures, etc.) allowed participants to transfer liquidity from correlated instruments to DAX® Futures and vice versa. Trading continued in an orderly fashion, and the volatility interruption that halts trading when prices move too fast was not triggered.

Secondly, HFTs continued to be an important source of liquidity throughout the event, supplying 30 to 50 percent of the contracts available at the best bid and offer. Contrary to what one might expect, their aggregate participation was not skewed to one side or the other. Of course, only an execution proves the relevance of an order. Therefore, it is also important to note that the HFT share of passive executions remained stable and high. Furthermore, contrary to popular belief, the majority of the aggressive side of those executions were not HFT participants. Last, but not least, HFT liquidity was spread out over several price levels at all times, reducing the price impact for large aggressive orders.

HFTs increase their participation in liquidity provision after large trades

Eurex Exchange keeps close contact with end users of its trading system, such as buy side investment firms. Discussions with traders at these firms have proven to be invaluable input for decisions regarding market structure and trading system design. The exchange takes their concerns about market structure very seriously and investigates specific issues wherever possible. An often heard criticism is that HFT liquidity is spurious; "Whenever I try to hit it, it's gone before my order reaches the exchange".

To verify or falsify this claim, Eurex Exchange took all add, modify and delete orders and rebuilt the historical order book in EURO STOXX 50® Index Futures for several days from 2012. The exchange defined "large trades" as trades that were 10 to 20 times the 10-minute moving average trade size. In EURO STOXX 50® Index Futures, such trades occur between 400 and 500 times per day. For each 100 milliseconds (ms) in the two seconds around these trades, Eurex Exchange analysed the contracts available at the best price

level on the side of the order book that was affected. Based on that, it was possible to calculate the share of contracts provided by HFTs and by non-HFTs respectively (adding up to 100 percent).

The results can be found in the figure below. The grey lines represent the combined market share of the exchange's top 40 HFT participants, whereas the blue line is the average of the grey lines. Remarkably, instead of reducing their participation, it can be seen that on average, HFTs significantly increase their share of contracts on the best price level of the side of the order book where a large trade occurs. Furthermore, it can be seen that the participation of HFT users does not change in the second prior to the execution of the large order. Therefore, the claim that HFT participants revoke their liquidity before a large trade hits the order book does not, in general, hold true. ▶

Each grey lines depict the daily average market share of HFTs on the relevant side of the BBO before and after a large trade (10 times the trailing 10 minute average) in the front month Eurostoxx future. The blue line is the average of these averages. The graph shows that HFTs do not reduce their participation right before large trades and increase (rather than reduce) their market share of the relevant side of the BBO after large trades.



Passive HFT activity development around liquidity gaps



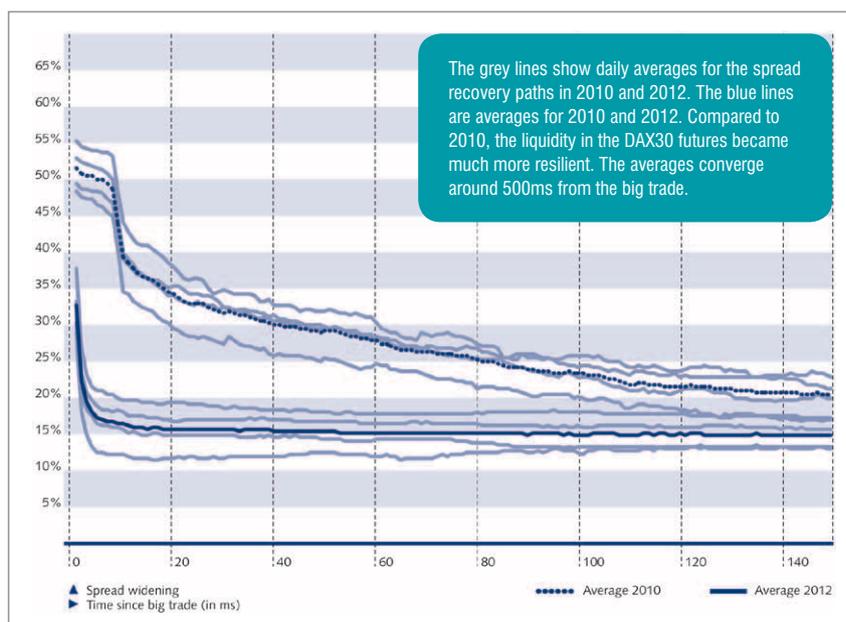
Bernard Hosman

Strong competition among HFTs yields remarkable improvement in market quality resilience at Eurex

Over the past few years Eurex Exchange has seen a substantial increase in HFT activity. The exchange wanted to quantify the effect of increased competition among liquidity providing HFT participants on market quality. One of the areas it expected to see market structural changes was the resilience of the market; in other words: How fast does the market recover after a large trade? What happens after large trades hit the order book is extremely important as most trading is highly correlated; a slow recovery means unnecessary sub-optimal executions.

To quantify the recovery process of market quality, the exchange measured the spread (in ticks) for each millisecond in the two seconds before and after the large trades that caused the spread to widen. Such events happen several hundred times a day in the front-month DAX Futures. Based on these measurements the exchange calculated daily averages for eight similarly volatile days in 2010 and 2012 (grey lines in the graph above).

The chart shows the recovery paths relative to the average pre-trade



Spread resilience

spread to account for the effect of differences in intra-day volatility; a spread recovery of four ticks is more significant if the initial spread was one tick than if the initial spread was ten ticks. The top blue line is the average of the spread recovery paths in 2010 and the bottom blue line represents those paths in 2012. The most obvious difference between 2010 and 2012 is the significant improvement in the speed of the recovery that took place. Another observation is the fact that the recovery process in 2010 only started after 5-10 ms whereas in 2012 a much faster reaction can be observed. The exchange's working hypothesis, supported by some early findings, is that these 5-10 ms was the minimum reaction time of some exchange participants, which - at that time - provided the lion's share of the liquidity in DAX® Futures.

Continuing research

According to the study, high-frequency trading activity is an important positive contributor to overall market quality and stability. The exchange will continue to analyse HFT activity and will share the findings with the industry. In response to customer requests, Eurex Exchange has posted three videos on its website that detail its analysis of HFT. These include:

- HFT and non-HFT participation during an extreme market situation
- A three dimensional representation of HFT activity
- Zooming into HFT participation during micro shocks

The videos can be viewed at: www.eurexexchange.com > Technology > High-frequency trading

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