White Paper: Overview of High Frequency Trading - What's Driving the Markets?
by Larson Gunness, June 2010

Introduction to High Frequency Trading

I've been trying to better understand HFT, since that's what's driving markets. I've read several articles and have been taking notes. When TD posted that exceptional interview with Themis, I thought I'd organize my notes and post them. Basically, here are some key points about HFT as I understand it. This all may be old news to you (or arguable), but I nonetheless want to offer this to the mix. I believe most investors, whether institutional or retail, don't know much about HFT.

HFT Defined

Robert Iati, a partner at TABB Group, defines high frequency trading as "...fully automated trading strategies that seek to benefit from market liquidity imbalances or other short-term pricing inefficiencies. And that goes across asset classes, extending from equities and derivatives into currencies and a little into fixed income."

Basically, HFT is: using super powerful computers (i.e., on the order of milliseconds or less) and math PHd geeks to develop and implement equity trading strategies. This approach grew out of the algorithm, quant, and program traders of the 1980s. But it really come into its own in recent years. The strategy began in exchanges such as NASDAQ and only recently, due to regulatory changes (read, unintended consequences of government intervention), has it come to NYSE. HFT has found a fertile landscape in NYSE listed stocks, given the features present for most blue chip type equities (such as high number of shares available, liquidity, etc. more on this later).

HFT platforms are owned and operated by the large broker/dealers, independent HFT firms, and to a smaller extent by hedge funds. There is also a great deal of cross-ownership between various exchange platforms, HFT firms, B/Ds and funds. They use several different fields of math in order to build their models. For example, linear regression analysis, game theory, pattern recognition, and neural network analysis are used.

Currently, according to a TABB Group study, HFT trading accounts for over 70% of US equity trading volume. Who knows if this number is accurate. For any of us who watch the markets, it is clear that the impact of HFT is a (if not the) dominant force driving equity markets in 2010.

HFT Profitability Model

This sector is based on tiny margins from incremental asset gains/losses and rebates, so extremely large volume is required to make money real money. Volume can be on the order of millions of shares traded, essentially immediately. Also, high levels of leverage are required to amplify those margins. 10X to 30X leverage is not uncommon.

HFTs see themselves as not managing high levels of risk because the norm is that they finish flat each day (i.e., don't carry positions overnight).

Trading Strategies Used

Several math-based strategies are common among HFTs. Here are some categories I've read about:

- **Market Making:** They place, and rapidly edit, limit orders just outside the bid/ask spread of stocks in order to arb these disparities. Remember they do these edits and adjustments many times per millisecond.
- **Statistical Arbitrage:** Many traders are familiar with convergence trades, where two securities deviate from their historical pattern and as the deviation corrects itself, money can be made by shorting the one that is likely to come down and going long the one that's likely to revert up. Statistical arbitrage is the same, except they do it with 4 or more variables, at the speed of light.
- **Low-latency Trading:** Provide bids/asks to their own algorithmic trading platforms much much faster than anyone else. Kind of like a first-mover advantage, where milliseconds matter.
- **Liquidity Detection:** This one pisses a lot of people off, and may be regulated out. They sniff out the potential for large blocks coming behind small trades. Nothing new or wrong about that, except that there is evidence that the HFTs have access to superior data (and get it earlier) than is more broadly available. So, by pinging immediate fill or cancel orders (often in dark pool trading exchanges that most people don't have access to), they can identify when a big seller, say a mutual fund, is making a move. Then they can immediately buy up all offered shares for that, and resell them at a higher price than would have been available if they weren't there. Some say that specialists have done this for years, but the fact that it's now done at speed of light seems to make an unfair practice borderline criminal (sorry for editorializing...).
- **Flash Orders:** Apparently, (according to Themis) HFTs have superior access to data streams provided by exchanges. Because of this, they can act accordingly, milliseconds before anyone else... which is all the time they need. This is a hotly contested area, though regulators do not seem to understand or have appetite to address it.

Assumptions/Requirements

For these HFT models to operate, they assume that:

- There is enough liquidity in the market to meet their trading volume.
- Correlations must hold, or at least be predictable enough to be added to and updated in timely fashion.
- Data availability. HFTs need to capture, cleanse, store, and analyze data on an intraday (real time?) basis. Algo trading firms often use end of day data such as variable weighted average price (VWAP).
- Colocation is a big issue. Because data transmission can get bogged down as it goes through servers and routers, they locate their servers as close as possible to exchanges.

- Regulatory environment continues to provide advantage climate for operation (such as, rebates aren't adjusted).
- Number of competing firms doesn't get so large that available margins disappear.

Issues/Questions

- Is there a bullish bias in these activities? If so, what does that mean for strong bear markets (flash crashes)?
- Speaking of the "flash crash" of early May, was that an anomaly or a tremor along a fault line?
- It appears that all of this activity has in large part scared away both the retail and institutional investor. Doesn't this undermine one of the key fundamental assumptions of HFTs, namely availability of liquidity?
- Isn't there likely a high regulatory risk, given that so few investors, let alone politicians, understand HFT?
- What happens then the correlations cease to hold? Or, when something exogenous (and unforeseen) becomes the primary variable driving things?
- I assume (though I don't know this) that HFT models are based more heavily on technical market analysis, than on fundamental analysis. It seems to me that technical analysis offers the type of data that would fit perfectly into mathematical models. *Judgement*, so common in fundamental analysis, can't be programmed.

My Own Takeaway

When I think about Iati's definition of HFT, it surely sounds accurate. But the overall self-conception of the HFT industry seems to leave out a key consideration. I look at this from a dynamic systems perspective. HFT tools have been applied to an existing system, in order to "benefit from market liquidity imbalances or other short-term pricing inefficiencies... across [all tradable, my addition] asset classes...." By all accounts, HFTs have been hugely successful at their task.

But, I believe we have entered a moment when the HFTs *themselves* are the exogenous factor that they didn't build into their model. They are such a large player in the markets that they are the ones driving the relationships between various securities.

This seems unsustainable. It also ties with the observations of many market watchers. Most people seem to have a sense that this is unconnected to fundamentals and cannot go on forever. HFT firms driving prices up higher because other HFT activities have caused prices to approach various technical thresholds, and so on.

Sources

Sorry I didn't put these in Chicago Manual of Style bibliography format...

- Vimeo: "High Frequency Trading" (this is an excellent introductory video)
- Advanced Trading: "Breaking it Down; An Overview of HFT" (An excellent overview)
- Kate Welling's interview with Themis (so in formative! TD posted last night on ZH)
- Wikipedia: "High Frequency Trading" (there's a ton on that site...)
- Automated Trader: "High Frequency Data Analysis (more techie focused, but helpful)