MODULE 2 UNIT 3
Notes Video 1 Transcript

IN COLLABORATION WITH getsmarter™

Module 2 Unit 3 Notes Video 1 Transcript

NIR VULKAN: With an academic background in theoretical physics, probability theory, and in statistics, Stefan Zohren brings a unique insight to his views and his approach to algo trading. Stefan is a quantitative strategist, machine learning researcher, and a member of faculty at the Machine Learning Group, and of the Oxford-Man Institute for Quantitative Finance. He's an expert in the field of machine learning applied to market microstructure, and high-frequency trading. And in this video, he will speak about the ways that market microstructures, order flows, and statistical physics come together in high-frequency trading firms.

STEFAN ZOHREN: My name is Stefan Zohren. I'm an Associate Professor here at the Oxford-Man Institute for Quantitative Finance.

I wanted to talk a little bit about the industry of high-frequency trading. Prices of financial instruments are usually determined by supply and demand, and to facilitate liquidity, exchanges usually are specialised firms to constantly offer to buy and sell those securities. Those companies are called "market makers", and many of the high-frequency firms actually are engaged in market-making, and one of the big challenges those firms face, is that of adverse selection, because those firms can be trading with other, potentially more informed counterparties, such as hedge funds or a similar trading companies. So, to be competitive, they need a very good infrastructure and generally they need to be fast, and to understand that a little bit better, we have to understand what is known as "market microstructure".

Let's just dive a little bit more into market microstructure. So, most of us are familiar with just price charts, standard time series, but we've just said that those prices of financial instruments are determined by supply and demand, and that is represented usually by the limit order book, which represents the resting orders of buy and sell orders at an exchange.

So, let's just zoom in at this time series at a given point of time, now. Here, we see a limit order book. On the vertical axis, we see price, and each of these little blocks is an individual limit order of a given size and at a given price. At the higher prices, we have sell orders, and at the lower price, we have buy orders.

The levels of orders to sell are also called "ask" levels, whereas the levels of orders to buy are also called "bid" orders. The lowest level of the ask is called the "best ask", and the highest level to buy is called the "best bid", and the mid price is nothing else than the price in between the best ask and the best bid.

All those orders you see in the order book are considered passive orders. They won't trade until another order comes in and crosses the spread, or until someone cancels those orders. Those orders which cross the spread and then match are called "liquidity taking orders". Let's just look what happens if one order to sell comes in at the best bid.

Here we see the order coming in is at a slightly larger quantity than the quantity sitting on the best bid. In this case, the order will match the quantity available and the remainder will stay in the order book. This has to do with the order we used here, which was itself a limit order. If you would have used a market order, the order would have drilled further through the book until completely matched. As a result, we see that the new best ask has moved

down and so has the mid price. So, prices are really just an emerging quantity of supply and demand, and we have just seen in detail how that works. So, to give a little analogy, this is very similar to physics where, for example, thermodynamic quantities, such as temperature or volume of a gas, are really just emerging quantities of the underlying dynamics of the gas atoms, as described by statistical mechanics.

So, we have just seen that for every single instrument, at every point in time, we do have a limit order book. The limit order books, we have just seen on the previous slide, are usually not communicated by this, by the exchanges. Instead, the exchange sends us streams of placements of orders, cancels of orders, or matches where trade happens.

What the electronic trading companies do is then recombine all this data on the fly to build up order books as they are needed for the mathematical modelling, and because many financial instruments are correlated, we cannot just look at a single instrument at one time. We probably have to look at a big amount of instruments, and we consume data for many different exchanges.

This means that we are consuming vast amounts of data, and a lot of advanced techniques from data-driven modelling are needed to find insights in those data. Let me give you a small example of such an insight. In the order book here, on the right, you can see that on the ask-side, there are many more orders than on the bid. That is sometimes also referred to as “asymmetry” or “order book pressure”. It is very likely that this order book pressure will eventually push down the price. So, being able to see those patterns early, might help you to build models which can predict future price moves.

From what we have just seen, gaining insights of such vast amounts of data requires knowledge from quantitative modelling, data science, and machine learning. Not only that, but to then actually operate and deploy strategies in a real-time fashion, you need a very scalable and robust infrastructure. In that sense, those electronic trading companies are very similar to other tech companies, not only in the technology they employ, but also in the people they are hiring.

From what we have just learned, we can already understand, a little bit, the challenges the industry is facing. One big obstacle is the low volatility we have seen in recent years. Why this is a problem, we can already understand using a very simple example: imagine a stock which has a constant upward drift with very small volatility. On average, there will be more people wanting to buy this name, than there will be people wanting to sell this instrument. So, as a market maker, you’re most likely to be actually selling, and so you’re getting shorter and shorter while the price is moving up, resulting in a loss for yourself.

On the other hand, if you have a situation with larger volatility, even though if there’s a constant upwards trend, there will be many points where we could try to sell securities, and buy and sell. This is why high volatility is usually considered to be good for market makers, while low volatility is bad. This period of lower volatility we have seen in recent years has put a lot of pressure on revenues of those high-frequency trading firms. At the same time, the need for fast connections, co-location, and expensive data streams, has gone up every year. So, profits have been going down at the same time. This has led to a consolidation of the industry in which many companies have gone out of business and others have merged to form larger companies, which can operate at reduced cost.

Given the recent changes we have seen with slightly increased levels of volatility, as well as regulatory changes here in Europe, it is very interesting to see where the industry is heading next.

VULKAN: Did you understand all the concepts in this video? If you would like to review any of the questions, click on the corresponding button.