finance 101

Financial Instruments

At Jane Street, we trade many different financial instruments. For this competition, we will focus on a few basic types.

Bonds

A bond is a form of debt. The buyer supplies some capital to the seller, and in exchange the seller agrees to pay back that amount plus interest at a fixed time in the future.

Stocks

A share of stock is a financial instrument that represents the partial ownership of the company that issued it. The buyer supplies capital to the company, and in exchange receives ownership of a small fraction of the company. The buyer hopes that the company will pay out dividends to its shareholders and/or that the company's share value will increase so that they can sell the shares at a higher price than they bought them.

ADRs

Investors may want to invest in foreign companies without having to trade on foreign exchanges. An ADR (American Depository Receipt) is a receipt issued by a US bank that trades on a US exchange but represents a share in a foreign stock. An investor can pay the ADR issuer a fee to convert between the ADR and the corresponding foreign stock. An ADR can be thought of as a special case of an ETF (explained below) with only one component.

ETFs

Investors may want to invest in a market as a whole instead of in a single stock. For example, one might want to invest in the S&P 500, an index of the 500 biggest US companies. However, for the average investor, going out and buying 500 different stocks would be expensive and time consuming. ETFs (Exchange Traded Funds) provide an easier and cheaper alternative. An ETF trades on the market like an ordinary stock, but it represents a basket of instruments. For instance, the SPDR S&P 500 ETF has an underlying basket made up of the 500 stocks in the S&P 500, so an easy way to invest in the US market as a whole is to buy this ETF. Just like for ADRs, an investor can pay the ETF issuer a fee to convert between the ETF and its corresponding basket.

The actions of converting to and from an ETF are called “creating the ETF” and “redeeming the ETF” respectively.

Orders

In the most basic sense, trading consists of buying and selling securities. An order is an instruction sent to an exchange to buy or sell a security, with certain constraints. The most common kind of order is a “limit” order, which places a limit on the price at which you are willing to buy or sell.

The parameters that specify a limit order are:

- The name of the security you want to trade
- Whether you want to buy or sell it
- The “limit” price, i.e. the “worst” price you’re willing to trade at (i.e. the highest price if you’re buying, or the lowest price if you’re selling)
- How many shares / contracts of the security you want to trade

A “bid” price is the limit price specified by a buy order, and an “offer” or “ask” price is the limit price specified by a sell order.

Stock Exchanges

A lot of our trading occurs on exchanges, which are highly regulated electronic marketplaces that match up buyers and sellers in the following way:

Suppose you’re the first person to send an order that day. You send an order to buy 10 BOND for $995. No-one is willing to trade against you right now, so the exchange just enters your order into the “book” and it sits there. This is called a “resting order”.

	bids	offers
10	$995	

Let’s say someone else comes along and also sends an order to buy 100 BOND for $995. They can’t trade with you – you both want to buy. So now the book looks like this:

	bids	offers
110	$995	

Note that the exchange displays the sum of all of the orders at a given price point and doesn’t divide it up into the individual orders.

A few more people come in and send: an order to sell 500 BOND at $1001, an order to sell 50 BOND at $1002, and an order to sell 3000

BOND at $1005. There is still no trading – the most anyone is willing to buy for is $995, but the least anyone is willing to sell at is $1001. At this point, we say “the market in BOND is $995 at $1001”, meaning the “best” (i.e. highest) bid is $995 and the “best” (i.e. lowest) offer is $1001.

	bids	offers	
110	$995	$1001	500
		$1002	50
		$1005	3000

Finally, someone comes along and sends an order to sell 30 BOND at $995. This can trade with the buy orders. Which orders get “filled”? First the 10-contract buy order gets fully filled, as it was on the exchange first (this is called “price-time priority”: the orders are sorted first by price, and then by age). The owner of the buy order gets a message from the exchange telling them how many of their contracts traded (all 10 in this case). Now there are 20 contracts left from the 30-contract sell order. Next, the 100-contract buy order gets partially filled with the remaining 20 contracts. The owner of this buy order gets a message from the exchange as well, telling them 20 of their contracts traded. And of course, the owner of the sell order also gets a message (or possibly multiple messages) about their fills.

After that’s all done, the book looks like this:

	bids	offers	
80	$995	$1001	500
		$1002	50
		$1005	3000

Price improvement

Any given trade is always between an order that was previously on the book (the resting order), and one that comes in and never gets entered into the book.

The price of a trade is always that of the *resting* order. For example, if there is a resting order to buy for $80, and someone sends an order to sell at $70, a trade happens at $80.

The business of market making

Market making is one way that firms participate on the financial markets. The purpose of market making is to act as an intermediary for other people’s trading. For example, suppose Alice wants to buy some shares, and Bob wants to sell some. It seems good for them to trade

with each other, but if we require that they meet at the exchange at the same time, this is not likely to be efficient. If this were really how markets worked, you might be afraid to invest. Who knows whether you'd be lucky enough to find a buyer when you wanted to sell? And if you did find a counterparty, how would you agree on a fair price?

Market makers are always willing to buy and always willing to sell. They have some conception of how much a security is worth right now (its "fair value"), but no long term interest in owning the security. Market makers are always willing to buy for slightly below the fair value and sell at slightly above it. You can think of market making a bit like running a supermarket: you are simply the link between the sellers of goods (wholesale producers) and the buyers (shoppers). You charge some premium on your wholesale purchase price in order to make a profit.

Unlike a supermarket however, a market maker can sell a security that they don't currently own, called "short selling", and end up with a negative "position" (quantity that they own) in that security. You should try to keep your position close to 0 in order to limit your exposure to large price moves, on which you don't really have a long-term opinion.

Note that it's wrong to think of trading as strictly a zero-sum game. In particular, there will be other participants in the etc market beyond the bots you create. Some of these might act like "investors" – people just wishing to buy (or sell) securities, who want to hold that position for a long time, putting capital at risk in order to earn a return. They're not very sensitive to the price, since they mostly just trust that the market has the fair price for the security right now. So they're likely to buy or sell on whatever market they see. Other participants are competing with you – they have a rough idea of what they think the security is worth, and they'll try to buy below that and sell above it.

Some basic trading strategies

The basic strategy is:

- Have some idea of a fair value for each security
- Attempt to buy the security for less than fair, and sell it at more than fair

Fair values

How might you come up with a fair value in the first place? Since markets (both in the real world and in this competition) tend to be fairly efficient most of the time, a good starting assumption is that the fair value is probably between the best bid and best offer; half-way between these (the "mid") is usually a good starting guess.

There are some classes of securities for which coming up with a better fair is relatively straightfoward. For example, as mentioned above, ETFs represent a basket of other securities. If there is an ETF called

FRED, and one share of FRED contains 0.5 shares of HENRY and 4 shares of EMMA, then it should be fairly clear what the fair value for FRED is given a fair values for HENRY and EMMA.

For non-ETF securities, it is less obvious what you might do. In general, predicting whether a stock will go up or down is hard, so it is unlikely you will be able to make money by betting on a stock going up or down. That said, it can still be possible to make money by providing liquidity in these stocks, but we will give no further hints in this section :)

Trading from your fair value

It may seem that all the trickery is in coming up with a fair, and indeed it is possible to do some very complex things in that space. But it's also not obvious how to trade around it. Let's look at some basic ideas.

If you think a financial security is worth exactly $100, it is impossible to make money by sending buy or sell orders at exactly $100. Obviously, you'll want to send buy orders below $100 and sell orders above $100. The difference between the price of your order or fill and your fair value is called the edge. More precisely:

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edge = dir_sign * (fair value - order price)
where dir_sign = 1 for buying and -1 for selling
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The way to think about edge is that it is the profit you earn by completing that trade.

So given a fair value, where should you send orders? Let's look at two ideas:

Pennying

You want to earn the most edge you can. Pennying is the idea of looking at the current best bid and offer, and sending orders the minimum amount "inside" that, i.e. sending a buy order for current best bid + 1 and/or a sell order at current best offer - 1.

This kind of strategy is an example of "providing liquidity". You place orders on the book, and when price-insensitive investors come along to trade, they find your orders already sitting there, and trade against them.

Taking

On rare occasions, you might believe that the fair value is outside the current best bid and offer, in which case you might want to trade with the current market. For example, if you think fair value > current best offer, you might send a buy order at current best offer to trade with the offer.

This kind of strategy is often referred to as “taking liquidity”.

WARNING: You generally need to have a good idea of fair value to make money by taking liquidity! Remember markets are generally fairly efficient most of the time!