MODULE 3 UNIT 2
Rules, trading, and accounting for risk

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Learning outcomes:

LO4: Identify the origins of trading rules and the importance of futures in algorithmic trading.

LO5: Interpret the risks associated with algorithmic trading at the management and programming levels.

1. Introduction

What would you consider to be a rule in the context of this programme? There is certainly a range of possibilities. They can range from very high-level rules such as the two sets of four rules presented by Professor Vulkan, all the way to a single line of code in your trading system. In the case of the former, these rules come from extensive experience working in the algorithmic trading industry, while those in the latter case often come from some underlying principle or economic assumption.

It is important to understand the origin of trading rules, which will help you understand how these systems are put together. It is also important to understand how different asset classes work and which key concerns should be kept in mind when engaging with each one individually. Only once you understand the nature of each asset class can you see how these classes would work when you combine them, and only then can you understand the interaction between them.

This set of notes looks at the different types of asset classes with a specific focus on futures. Algorithmic funds primarily focus on trading futures, as they are highly liquid and allow for scalability. As an algorithmic trader, you want to be able to make trades when you want (liquidity) and, if the strategy is very profitable, increase the amount of assets you can allocate to it (scalability).

2. Origin of rules

In practice, these rules often come from complex mathematical principles, even if what they are targeting is simple. This complex research will hopefully provide you with better, more advanced rules that can be incorporated into a trading system. There are lots of rules from complex mathematical subjects being used in algo trading, and this had led to a significant number of people from the scientific community being hired to work in the finance industry.

This programme is not intended to serve as a set of instructions for practically coding a trading system. The intention is to take a more high-level view that will provide you with the tools needed to understand the industry as a whole. However, it is still necessary to engage in a discussion about where the rules that these systems trade on come from. To this end, the sections that follow include basic introductions to certain concepts, with extra readings suggested for those with a technical background or those wanting to dig deeper into the subject. These extra readings are not required for the completion of this programme.

In Module 4, you will discuss model optimisation, but what are you really optimising? You are optimising a set of rules with origins in mathematics. In Unit 1's notes, you heard briefly about candidate predictors. These are essentially the first step in creating rules for your system to follow. Consider any trend model, for example. The model sees an upcoming trend and expects it to continue. This can be captured using a simple moving average.

2.1 Simple and exponential moving average

The moving average is the average stock price of a security over a specific amount of time. It is considered "moving" because the average is calculated as new information comes in. This metric is very easy to construct and is widely used as part of trading strategies. There are two common forms of the moving average that are used in trading systems: the simple moving average (SMA) and exponential moving average (EMA). While the SMA places importance on the average price of a security over a specified (and usually longer) period, the EMA focuses on more recent security prices (on the order of days).

2.1.1 Applying the moving average in trading systems

The moving average can be used to help predict a trend and to inform your system on what trades to make. One way in which this is achieved is through a crossover of two or more moving average trend lines.

To implement a moving average crossover strategy, you might set up a trading system that monitors the movement of a short- and long-term SMA of a particular security (for example, a 50- and 200-day SMA). A buy signal is initiated when the shorter SMA crosses above the longer SMA, indicating a trend upwards in the security price. Conversely, if the shorter SMA crosses below the longer SMA, a sell signal – indicating a downward trend in the security price – is initiated. While this is a simple example of how to apply a moving average to a trading strategy, there are many more complex uses, including the crossover of three moving averages and the use of EMA-based strategies.

Further reading:

If you have a technical background and are proficient in coding, you can extend your learning by beginning to translate the logic of the moving average into a simple systematic trading system.

2.2 Mean reversion and pairs trading

The concepts of mean reversion and pairs trading are also highly relevant. These are relative rules, meaning that they look at a large number of markets. Mean reversion says one market seems to be moving out of sync and will adjust. It sees a trend and thinks it cannot continue. Your system would have rules programmed that would allow it to make trade decisions based on this information.

One such rule is the relative strength index (RSI), which measures the speed and size of market movements over a specified period. It is typically accepted that an RSI value that exceeds 70 represents a market that is overvalued (or overbought), whereas a value below 30 represents a market that is undervalued (or underbought). Therefore, it is conceivable

that you might set up a system that trades based on the value of the RSI. If the RSI value exceeds 70, it is likely that the market will revert to the mean or fair value. This would trigger a sell signal, as a downward trend is likely imminent. On the other hand, if the RSI value is well below 30, you might expect the price to increase towards fair value. This would trigger a buy signal, as an upward trend is likely imminent.

Further reading:

Constructing a mean reversion strategy involves considering the model's targets, its markets, and determining its performance.

Pairs trading looks at two different markets and asserts that these markets always move together (if one market has moved in a particular direction, the other must follow soon) and bases trade decisions on this view. For example, if markets A and B are closely correlated, and B crashes, the model would expect A to crash as well. You would thus formulate a rule for the model to sell market A under these conditions.

Further reading:

Considering the dual market dynamic, a trader can make good profits from pairs trading. For those interested in more detail on pairs trading strategies, how profitability is diminished as more traders adopt pairs trading, and how profitability might be increased, explore the following article on whether simple pairs trading can still be profitable.

2.3 Volume-based rules

Some traders place significant importance on volume as a driver and predictor for market movements. One such rule that captures trading volume is on-balance volume (OBV). Essentially, OBV captures crowd sentiment, since it is thought that a dramatic change in trading volume often reflects the market's attitude towards a particular security.

In line with this, it is feasible to assume that positive sentiment may drive the security price higher, whereas negative sentiment may drive the security price lower. With this knowledge, a trading system might be developed to exploit sudden and dramatic changes in trading volume, with buy and sell signals initiated following either an uptick (increased OBV) or downtick (decreased OBV) in trading volume.

2.4 Polarised fractal efficiency (PFE)

As you'll learn throughout this programme, algorithmic trading combines the expertise of multiple fields, including economics, mathematics, and physics. This is often reflected in trading rules, such as polarised fractal efficiency (PFE), which uses fractal geometry to measure price movement efficiency.

Fundamentally, the PFE provides an indication of the strength of either a bullish or bearish trend and can range in value between −100 and +100. The more positive the PFE, the greater the strength of an upward trend. In contrast, the more negative the PFE, the greater

the strength of a downward trend. It's feasible, then, to develop an algo model that monitors when the PFE crosses above or below chosen threshold values in order to buy or sell a security. This is the chosen strategy for testing an algo model, which is discussed further in the next module.

2.5 Important considerations for selecting trading rules

The most important takeaway here is that there are many rules available when developing a trading system. The few discussed in this section are mathematical concepts expressing the ideas of either trend, mean reversion, pairs trading, or volume.

There is a lot more to consider beyond the selection of rules, such as how these rules are constructed. Many models include a large number of rules; two models may use the same or similar rules, but how they are put together will vary. Another point is that, if you want to learn the behaviour of one market and apply it to another market, there is a high degree of mathematics and logic required.

For example, in the case of developing a moving average crossover strategy, you would need to give due consideration to the following:

- What market(s) or securities will you be trading?
- What is your trading hypothesis? Is your system trading based on a particular economic condition, market trend, or some form of market inefficiency? Recall from Unit 1 the different types of biases that might manifest in the market. Is your strategy aiming to exploit one or several of these biases? Is your strategy attempting to manage risk?
- Will you use the simple or exponential moving average? What time period(s) will you employ?
- Will you be monitoring the crossover of two or more moving averages?
- How far should the shorter moving average cross above the longer moving average before executing a trade? In other words, what is your entry signal?
- Will you use a unique (a single technical indicator) or hybrid (several technical indicators) approach?
- When will you exit the trade? Will this be based on a different indicator or set of rules?
- What is the volume of securities to be traded when you enter?

This type of questioning can be applied to the development of any trading system. It also highlights that creating a successful system involves more than simply selecting relevant trading rules. Rather, it involves a holistic approach that monitors a trade through its life cycle – from hypothesis to entry to exit. Recall that rigorous academic research is often required to formulate innovative and profitable trading rules and systems.

With this in mind, it is important to understand that producing a functional trading system requires a lot more than what is covered here. These notes focus only on covering the most important considerations for you to get a more comprehensive overview of the processes involved in the construction of an algo model. Next, you will look at some of the actual asset classes that algo models trade.

3. Futures

Futures is a special focus here because it is the primary asset class traded by algorithmic models. The primacy of futures in algo trading is due to it being a very liquid market that allows for rapid scaling. This allows you as a trader to trade as much as you like and, should your strategy do particularly well, increase your volume.

“Futures are standardised contracts used for the purchase and sale of financial instruments or physical commodities for future delivery on a regulated commodity futures exchange” (CME Group, 2013). Like forward contracts, futures contracts are an agreement to buy or sell an asset on a specific date for a specific price. A key difference is that forward contracts are private agreements between two parties, while futures contracts are traded on an exchange and can therefore change ownership. Futures can be bought and sold, which means you could buy the right to receive, for example, 500kg of grain next January.

3.1 Trading futures

Now that you know what futures are, the next step is to look at the considerations around trading them. The focus of this section is on how algorithmic funds would engage in futures trading. However, remember that these are not the only entities that trade in futures.

The following all commonly trade in futures:

- Hedgers
- Hedge funds
- Individual traders
- Portfolio managers
- Proprietary trading firms
- Market makers

You have already learnt about hedge funds and market markers in Module 2. Think back to Professor Zohren’s video in that module, where he discussed market makers and how important liquidity is to them. As mentioned earlier, the market for futures is highly liquid and allows for these funds to effectively implement strategies that require constant trading. The other primary concern for funds is scalability. In other words, can they ramp up the volume of trades if their model does well? Futures allow for this.

3.2 The risks of trading futures

Trading futures involves speculating on the future price of an asset (normally a commodity). Essential to this is the issue of risk. The following are some of the risk considerations when trading futures:

- **Unlimited liability:** You can lose more money than the amount you originally invested if the underlying asset moves strongly against your position and continues to do so. For example, if you were to sell the right to buy oranges at £1 for 1kg, you would be required to sell Xkg of oranges at £1 at a predetermined time in the future. If, for some reason, the price of oranges increases to £30, your loss would be £29 multiplied by X.

- **Leveraging:** Debt can greatly improve your return on your invested capital, but at the same time, it will also multiply your losses. For example, if you pay £6 for a contract on a £60 asset (10 times leverage) and the price goes down by £6, you lose 100% of your initial capital amount, while the underlying asset only fell by 10%.

- **Daily settlement:** A key feature of futures is that profits and losses are settled daily. This means that any profits your position makes during trading will be paid at the end of the day. However, losses you make must also be paid on that day.

4. Other asset classes

Futures are not the only type of security that funds trade in. This section briefly looks at the other asset classes but will not cover the risks for each. However, later in this set of notes, you will hear from Susi Gorbey and Terri Duhon on risks associated with algo trading. It is more important for you to be aware of the wider algo trading risks than those associated with each individual asset class.

4.1 Equities

Equities are also known as stocks. They represent a share of ownership in a company and are traded on stock exchanges around the world. They are great for making money in a growing economy since growth in the economy means growth in corporate earnings. As with futures, a key benefit to trading equities is the liquidity they offer. They are easy to buy and sell; however, they do not have the same unlimited liability problems that futures have. A disadvantage is that stockholders are paid last if the company goes bankrupt (preferred stockholders and bondholders get paid first). This contributes to the additional risk buyers of equity take on in exchange for a higher return (Prudential Investment Managers, 2016).

From a systematic point of view, a larger percentage of equity market is being traded electronically than by human traders today, which has led to a large and growing pool of data for algorithmic traders to use. This is not the case in the fixed-income markets.

4.2 Bonds

Bonds (i.e. fixed-income securities) are essentially debt instruments where borrowers pay a fixed level of interest based on their level of risk. These securities provide investors with a lower level of volatility, and thus risk, than other asset classes, which is why the rate on Treasury bonds is often used as the risk-free rate.

Bonds are fairly easy for an institution to trade in large volumes without affecting the price much. The owners of bonds have a certain degree of legal protection as well. If a company goes bankrupt, the owners of the bonds attached to the company will receive some money back, whereas the company's equity could possibly end up with no value.

4.3 Real estate

Property has traditionally done well in providing financial returns above inflation. This applies to both commercial and residential property. Funds wishing to invest in this asset class can do so by either buying physical property or buying shares in a property development or real estate firm. Many people invest in rental properties because they provide an ongoing, monthly income that is mostly passive and can be used for reinvestment (Lumsden, 2012).

4.4 Commodities

The commodities traded on the global commodity market vary extensively. The range includes:

- Oil and gas;
- Precious metals (for example, silver and gold);
- Industrial metals (for example, iron and copper); and
- Agricultural commodities (for example, wheat, rice, and lettuce).

(Lumsden, 2012)

Similar to shares and bonds, funds can exploit changes in commodity prices as they rise and fall in response to supply and demand (think back to Professor Zohren's video on market microstructure). Commodities also have exposure to different growth opportunities. Between 2008 and 2010, the growth in China's economy led to an increase in demand for iron ore, causing its price to more than triple over this period.

A key feature of this asset class is its diversification benefits. As mentioned, most futures contracts are based off commodities, and commodities have often shown a low or negative correlation with stocks and bonds. So, if you are interested in producing uncorrelated returns, then trading in a financial instrument based off an asset class that is typically uncorrelated to the market is a good place to start.

4.5 Currencies

Currency provides a useful benchmark for all investments. Currencies can be utilised to balance a portfolio that has a large portion of its value in one country's currency. For example, if you have a portfolio made up primarily of securities denominated in US dollars and you expect some future volatility in the dollar's value, you can balance this risk by buying other currencies.

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The asset classes covered in these sections behave in different ways. Consequently, generalisation is challenging since each asset class will, at times, do well or do poorly, and all classes are vulnerable to large market events, such as bubbles or crashes (Lumsden, 2012).

Now that you have looked at each of these asset classes, it is time to look at a common consideration. Regardless of asset class, it is essential to account for risk around your trades. However, before continuing, engage with Poll 1 to see how your peers' risk appetite compares to yours.

Poll 1: Identify the asset classes you would trade. (Access this set of notes on the Online Campus to engage with this poll.)

If you were to begin creating an algo model, which asset class(es) would you trade based on the level of risk you are willing to take?
Futures
Equities
Bonds
Real estate
Commodities
Currencies

A combination of the above

5. Accounting for risk

Any form of investment carries some form of risk. Some risks may be common across asset classes, while others may be unique. To manage your portfolio effectively, you should have an idea of how to mitigate or account for the different types of risk your investments face. Here are some of the primary considerations for risk-mitigation strategies:

- Identify your or your investors' preference for risk.
- Identify the time frame for investment.
- Consider the objective of the investment (e.g. saving for retirement vs holiday).
- Think about risk of ruin (or at least how much capital you can afford to put at risk).
- Ensure you have an exit plan in place.
- Consider using leverage to mitigate potential losses.
- Use algorithms to mitigate the risks of emotion and human error.
- Consider a diversified approach (across asset classes, countries, etc.) to eliminate the risk of concentrating on one asset class or region.

This list covers broad risk considerations. In the following video, Susi Gorbey from Tudor Investment Corporation provides key insights into more specific risk considerations and controls that must be in place when engaging in algo trading.

Video 1: Risk and controls. (Access this set of notes on the Online Campus to engage with this video and download its transcript.)

In the next video, you will hear from Terri Duhon. She is a lecturer at Saïd Business School, University of Oxford and is a board member at Morgan Stanley International where she chairs the risk committee. She discusses more high-level risk considerations around algo trading.

Video 2: Special risk considerations for algo funds. (Access this set of notes on the Online Campus to engage with this video and download its transcript.)

These two videos show not only the different risks, but the different levels of risk. Some are down to the level of actually writing the code for the algorithm, while others are considered at board level. It is important to have sight of this during the development of a trading model.

5.1 Risk of trade assumptions

Something that is important specifically for algo trading is the concept of slippage. As covered in the Unit 1 notes, slippage is the difference between what a trader expects to pay for a trade and what they actually pay. You must ask the question, “How sensitive is my model to slippage?” This should be answered numerically, so that you can make an informed decision about your model.

There are various causes of slippage, but transaction costs are a primary cause of slippage for new developers who have not done their modelling correctly. The process is fairly intuitive. If your model does not trade very often, then it stands to reason that it would not be very sensitive to transaction costs. An example of this is a trend model. These may only trade once a week, or even once a month, depending on market movements. So even when your transaction costs are double what they were expected to be, the impact on your model will be minimal.

On the other hand, high-frequency trading strategies are highly sensitive to transaction costs. Since they are executing huge amounts of trades each day, a small incremental increase in the costs to trade can have dire consequences. This should be looked at numerically as well. If you have read and understood the Unit 1 notes, you should now be familiar with the Sharpe ratio. The Sharpe ratio is a good tool for gauging how sensitive your model is to slippage. For example, a model should still perform well with a 10–20% increase in slippage costs. Ideally, the model should still be viable even after a 100% increase in slippage costs.

6. Conclusion

Now that you have heard about the origins of rules, you should be thinking about where the rules you intend to follow will come from. This applies broadly, but the focus here is on the rules you will use to engage with the algorithmic trading industry. This not only depends on your background, but also on the level of engagement you intend to have with the industry.

You have seen how trade rules are based on certain mathematical concepts. Clearly, this topic has many different aspects and considerations. As mentioned, it is important that you are aware of this, as it will enable you to have a more informed understanding of the industry. Those of you with technical skills are encouraged to dig further. Keep in mind the discussions of risk by the guest speakers as you develop your model.

7. Bibliography

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