Valuation and trading, fundamental vs. technical analysis, and standard vs. behavioural finance[1]

Reading this chapter you will be introduced to the following key concepts:

- The different types of analysis used: Fundamental, technical, and quantitative
- The models used for valuation based on these types of analysis
- The theoretical foundation for the use of these methods
- Some evidence against the profitability of the methods and some recent advances

Introduction

It goes without saying that to make money in financial markets one needs to "buy low and sell high" or alternatively to "sell (short) high and buy (back) low". However, while this is simple enough to understand the trick is, of course, to pick the appropriate investment and the appropriate time for investing. In order to achieve this goal a method for assigning a value to an asset either in absolute terms or relative to some benchmark is needed. This is called valuation which we formally define as:

> **Definition:** Valuation is the process of estimating the potential market value of a financial asset or liability either in absolute terms or relative to some benchmark.

While many techniques for gauging this value exist, and we will go through the most important ones here, there is no uniformly optimal way of doing this. In fact, the existence of such a universal method would be quite counterintuitive. Investors should ask the question: "if this is a winning strategy then why do you tell me?" Moreover, even if some benevolent "power" would give advice for free or even at a price different form zero, the incremental value of this advice should equal the cost, as investors invest according to the advice (although this clearly depends on markets being efficient).

So, not only are there several methods for valuation, but their applicability may also differ from market to market. For example, one of the classical questions is what type of fundamental analysis could be applicable in the foreign exchange markets. Let us consider the price of CAD

[1] This document has been prepared for the class "Trading in Financial Markets" by Lars Stentoft, Associate Professor, Department of Finance, HEC Montréal.

quoted in USD – just another type of asset. Suppose that your analysis shows that CAD will appreciate continuously against the USD. You will then have to ask yourself if this is really something you could imagine happening over the next 10-20 years leading to an exchange rate of 100's of USD for one CAD. For this reason technical analysis is often used in this market.

Although many types of valuation attempts to arrive at a final "fair" price this is not always the case. Sometimes all that can be hoped for is some sort of idea about an asset's relative value either compared to its long run value or compared to an ensemble of comparable assets. In fact this may be as vague as statements about the asset being either overvalued or undervalued! However, when it comes to trading this is strictly speaking enough, as long as the analysis can be repeated at a later time and can be used to decide when the asset goes from being overvalued to being fairly valued or undervalued, or vice versa. If this is possible, the strategy of buying low and selling high can be implemented with few problems.

In general, the first step in any valuation is the analysis step, in which the important or fundamental variables which determines the value of the asset and their respective values are determined. Once this is done, valuation oftentimes proceeds by assuming a specific type of model, and this then is used to calculate a fair value either absolutely or in relative terms or to assess whether the asset is overvalued, undervalued, or fairly valued. This last step may rely on particular assumptions about how markets and investors behave either explicitly or implicitly through the choice of a particular model. In the following sections we will go through each of these steps. We will use the generic example of common stock, but attempt to make comparison to e.g. fixed income instruments or other types of assets whenever possible.

Types of analysis used for valuation

When it comes to valuation three different types of analysis are generally used: fundamental analysis, technical analysis, and/or quantitative analysis. Each one of these offers a different paradigm and focuses on different variables. In this section we describe each of them in detail. We will consider their differences as well as their similarities. The obvious question then is which one to choose? A fundamental property is that, under optimal conditions, they should in fact lead to the same conclusions.

Fundamental analysis

When it comes to analyzing e.g. common stocks fundamental analysis refers to the analysis of the issuing company's financial statements and health, its management and competitive advantages, and its competitors and markets. The analysis uses historical as well as current data with the goal of making forecasts of important financial variables. Although the objective of the analysis may be different from that of actual valuation we will limit attention to this specific use here. That said the financial variables of interest are e.g. dividends, earnings, or cash flows, future growth rates, and the level of risk for the company. However, any other variable which the investor considers might influence the firm's future value, and which is therefore one of the

fundamentals of the firm, can be the object of the analysis. Formally, we may define fundamental analysis as:

> **Definition:** Fundamental analysis is the discipline of using earnings and dividends prospects, expectations for future interest rates, risk evaluations of the firm etc. to determine asset value.

Fundamental analysts can use either a top-down or a bottom-up approach. The first of these is the one most commonly used and to a certain extent also the most structured approach. Specifically, the top-down analyst starts by performing an economic analysis, which is followed by an industry analysis, and finishes up with the analysis of the specific company. An important part of the company analysis is the analysis of the financial statements.

Once finished the fundamental analysis proceeds to value the share, and by comparing this value to the current market price sell or buy recommendations are issued. The actual valuation is performed using either discounted cash flow models like the Gordon model or by using simple ratios, like the PE ratio, which has the benefit that they may require making fewer assumptions about the future evolution of the firm fundamentals.

Technical analysis

In its purest form technical analysis considers only the actual price behaviour and volume of trades of the asset under consideration. Thus, technical analysts stand in stark contrast to the fundamental analysts as they often completely ignore the nature of the company and its financial standing as well as its market conditions. Notice that while fundamental analysis generally has to be adapted to the specific types of asset under consideration, this is not the case for technical analysis which is an additional important difference between the two.

Although it is hard to define precisely what technical analysis is in general terms it encompasses the search for price patterns and trends. In particular, technicians would argue that all the relevant information used for valuation is already reflected in the observable prices. We will use the following definition for technical analysis:

Anecdotes about Technical Analysts:

Burton Malkiel tells a story about a technical analyst, or technician as they are often called, in his book *A Random Walk Down Wall Street* who worked out of an office in a basement with cardboard covering all of the windows. The story goes that the technician would argue that this prevented him from being influenced by and making excessively optimistic predictions because of a day being particularly sunny or warm.

Also, because technical analysis is based only on patterns in prices and volumes, some technicians would in fact prefer not knowing what type of asset they are looking at. This way they are sure not to be influenced by personal sentiments about a particular stock or industry.

Source: Malkiel (2003)

> **Definition:** Technical analysis is the discipline of studying past market data, primarily price and volume, in order to forecast the future direction of price changes and potentially the size of this change.

While technicians use various methods and tools the study of price charts is "fundamental". Because of this the term "chartist" was previously often used for proponents of this type of analysis. Technicians will search for archetypical patterns, which historically have been shown to predict a particular future behaviour of the asset, and use these to make predictions about the future asset value. Once observed, the technician will use the patterns to decide to sell or buy the asset being considered and as history repeats itself positive returns are realized.

Fundamental analysis versus Technical analysis

Although these two techniques are often seen as completely opposite and supporter of either one of the techniques frown upon the proponents of the alternative, these can be and are in fact used together. Thus, fundamental investors may choose to use technical indicators for deciding exactly when to enter or leave the market. Likewise, technical investors may use fundamentals such as PE ratios to limit the potential investment universe to what is considered fundamentally "good" companies.

Quantitative analysis

Recently, the term quantitative analyst has been used to refer to a person who uses (advanced) numerical and mathematical techniques in finance to determine the value of an asset or its future movement. This is the definition we will use here.

> **Definition:** Quantitative analysis is the discipline of using advanced numerical and mathematical techniques to predict the direction of price changes and potentially the size of this change.

The analyst is often referred to as a quant. Broadly speaking any use of the portfolio selection theory developed by Harry Markowitz in his Ph.D. thesis back in 1952 as well as the option pricing framework developed independently by Robert Merton and Fischer Black and Myron Scholes in 1973 falls within the category of quantitative analysis. However, nowadays quants use many other and oftentimes much more advanced techniques.

Sometimes a distinction is made between numerical quants and statistical quants. The first of these use advanced numerical methods for pricing and managing the risk associated with complex derivative products, whereas the latter will use statistical methods to calculate which assets are expensive, potentially relative to some other assets. A classical example of the latter is pair(s) trading which is essentially a spread trade between historically highly correlated assets, which have recently moved in opposite directions. Oftentimes, though, quants will do both. As an example, take the valuation of collateralized debt obligations (CDO's) which are complex derivatives but for which statistical input is needed about e.g. the correlation of defaults within the pool of mortgages.

Quantitative analysis versus fundamental and technical analysis respectively

Although we have mentioned quantitative analysis as being distinct from fundamental and technical analysis often the lines are blurred. First of all, in fundamental analysis oftentimes predictions about e.g. future growth rates are required. While the current growth together with a thorough analysis of the financial statements will help the analyst so too could a statistical analysis of the historical growth or variables of importance for estimating this. Also, if the fundamental analyst performs a scenario analysis to examine the sensitivity of the results to changes in the predictions this is borderline quantitative analysis.

Second of all, although we have stated that technicians often use charts, they also use indicators based on historical movements. These may be more or less statistically founded, and thus essentially bordering the field of quantitative analysis. This is particular so when considering the technicians using systematic trading rules.

Models used for valuation

Are investors really rational and do they only care about future cash flows? And what about the trend – is it really my friend? In this section we explain how either of the types of analysis combined with assumptions about the behaviour of investors can lead to an actual valuation, i.e. the calculation of the value of an asset.

Valuation based on fundamental analysis

As such, fundamental analysis tells the investor nothing about the fair value of the asset under consideration. And this is so even after having found, by conducting a thorough analysis of the financial statements, that the company is in huge problems as this may already be reflected in the market price. Thus, in order to proceed with the valuation step, further assumptions are needed about investor behaviour, and often this leads to the specification of a particular valuation model. Depending on the principle used for valuation, the fundamental analysis, that has to be performed, may have to change.

Relative valuation using simple ratios

Arguably the simplest possible way of using the results of a fundamental analysis for valuation is to calculate simple ratios, of which the Price to Earnings, or PE, ratio is among the simplest possible. In fact the only thing needed from the fundamental analysis is a prediction about the next period's earnings. To be specific, assume that this is denoted E_{t+1} and that the current price is denoted P_t, then the PE ratio at time t is simply calculated from the formula

$$\frac{P_t}{E_{t+1}}$$

This ratio is easily interpreted as the $ amount which is paid per $ of future earnings. It seems "obvious" to state that stocks with low PE ratios are cheap relative to stocks with high PE ratios. However, as innocuous as this statement is this in fact does rely on a particular assumption about the valuation model. Note that the inverse, or reciprocal, of the PE ratio, the earnings

yield, corresponds to the current yield used in the fixed income market. This is a measure, although a very simple one, of the yield on a bond investment.

So what can the PE ratio be used for? In principle it can be used for comparison to historical values, to a comparable company, to the overall level in the industry, to the market in general, or even between countries. Malkiel explains that the pros play the biggest game in town by applying the following three steps:

1. Chose a firm and a group of comparables
2. Calculate the multiple for the firm and the group of comparables
3. Adjust the multiple of the firm under consideration "appropriately" and compare it to the ratio for the group of comparables

It is clear that in this "highly scientific" method the adjustment could mean the difference between financial life and death when it comes to investing.

The main problem with the PE ratio is that it neglects future differences in growth if say two stocks are compared. Thus, often people will report the PE to growth, or PEG, ratio. This is simply the PE ratio divided by the growth in percentage taken on an annual basis. This correction, which once again depends on a particular model, will work well if the relationship between growth and PE is linear. This however is unfortunately not guaranteed even in the simplest possible models used for valuation.[2] In spite of this Peter Lynch is quoted for the following statement, which is now known as the "Peter Lynch Rule":

> "The PE ratio of any company that's fairly priced will equal its growth rate…. If the PE ratio of Coca Cola is 15, you'd expect the company to be growing at about 15% per year, etc. But if the PE ratio is less than the growth rate, you may have found yourself a bargain."

Although many other ratios exist many of them suffer from the same type of problems.

Relative valuation between markets: the FED Model

The use of the relative valuation principle is not limited to the comparison between assets of equal type. A particular example is what is referred to as the Fed model, which is sometimes used to compare the yield on long-term treasury notes and the expected return on equities. This model is in no way endorsed by the Fed, i.e. the Federal Reserve System in the United States, though. The model simply states that in equilibrium the yield on the 10 year U.S. Treasury notes should be similar to the earnings yield on the Standard & Poor's 500 stock index, where the latter is defined as the estimated future dividends divided by the current level of the index.

Although very simple, the model is often used "on the street" and on January 19, 2008, Tom Lauricella wrote the following in the Wall Street Journal:

[2] This may be analysed using e.g. the Gordon dividend model, which we return to in the next section, with constant growth when examining the theoretical PE ratio and PEG ratio.

> "With the past week's downturn, stocks in the Standard & Poor's 500 stock index are trading at 13 times their expected earnings for 2008. Last June, when the S&P index was 12% higher than it is now, stocks were priced at 14.2 times this year's earnings. Meanwhile, with a U.S. recession now widely expected and the Federal Reserve thought likely to cut short-term rates further, U.S. Treasury yields have fallen sharply. The 10-year Treasury note is yielding 3.64%, its lowest level since July 2003, and down from 3.81% a week ago."

Since the implied PE for the 10 year U.S. Treasury notes is 1/3.64%=27.5, the S&P 500 with a PE of 13 is considered cheap according to the FED model.

Absolute valuation using relatively simple models

While the relative valuation method above essentially makes claims about the relative over- or undervaluation of a stock compared either to the historical value, the ratio of a group of comparables, or some other benchmark, absolute valuation calculates directly the fair value of a particular stock. This then can be compared directly to the actual price observed in the market. If the fair value is below the currently observed value the asset should be sold, whereas if the fair value exceeds the observed value the investor should buy the asset. This way, once the market realizes it has mispriced the asset under consideration and hence the observed price converges to the fair value the investor stands to make money.

One very famous and relatively simple model is the Gordon Model which assumes that dividends paid out grows at a constant rate g. If we further assume that the appropriate rate used for discounting is k some simple manipulations gives the following formula for the intrinsic or fair value, V_0, of the asset at the present time:

Having performed the appropriate fundamental analysis yielding estimates of g and k and observing the current value of the dividend payments this simple formula gives a fair value.[3] Once again, if this value is above current market prices the investor has found a good deal and should invest in the asset, and vice versa. In addition to the Gordon model, models exist with two stages of growth and it is also possible to use more flexible models.

Making money on Fundamental analysis

As we have seen above, the relative valuation step following a fundamental analysis determines which assets are currently relatively undervalued or overvalued. Likewise the absolute valuation step yields a fair price based on the expected value of the cash flow stream investors will get. Comparing this to the observed price indicates to the investor whether the asset is currently undervalued, i.e. if $P_0<V_0$, overvalued, i.e. $P_0>V_0$, or correctly valued when P_0 is close to V_0.

[3] The rate used for discounting should take into consideration the relative risk associated with the asset. Oftentimes, this rate is derived using the Capital Asset Pricing Model.

Trading strategies based on either of these types of information are clear and follow the paradigm of "buy low and sell high". Thus, the cunning investor should buy any undervalued asset and keep it until the market has adjusted the price such that it has become correctly valued. Alternatively, investors should (short) sell overvalued asset and buy them back when the market has lowered the price appropriately. This is very simple so why is it so hard consistently making money in the financial markets? There are several reasons for this.

The first reason is that the profitability of the above strategy relies heavily on having obtained the correct predictions about say the future dividend growth rates. That is to say that although the analysis today has shown that an asset is undervalued if new information shows that the future growth is lower than expected this will lower the fair value and thus the asset may in fact be correctly valued in the end. This, of course, will lead to less interesting outcomes or even to a loss of money.

However, an even bigger problem with the above strategy is that in order to obtain a final positive outcome, even if the fundamental analysis is correct, the market has to adjust the price of the asset keeping everything else constant. Thus, when using the Gordon model the market has to realize that you were right and the market itself wrong about the assumed dividend growth rate and the appropriate discount rate to be used. However, as John Maynard Keynes is quoted for saying:

"The market can stay irrational longer than you can stay solvent."

In the sense that this indicates that the market may decide consistently to misprice an asset, trading strategies based on fundamental analysis may turn out to be quite disappointing.

Trading based on technical analysis

As it was the case with the fundamental analysis technical analysis per se does not tell investors how to trade. For this to be possible, further assumptions are needed. Technicians in general refer to these as **basic principles** and there are at least three of these:

1. The market has discounted all relevant information
2. Prices move in trends
3. History tends to repeat itself

The immediate implication of the first of these principles is, that it is sufficient to analyse the price movement of the asset under consideration. Thus, analysing any other variable in order to obtain information about future movements in prices is, according to the technician, a waste of time. This goes for growth rates, earnings, or even the risk exposures i.e. all of the variables considered important for fundamental analysis. The most basic type of analysis is graphical but the professional technician will also use indicators and oscillators calculated based on the historical price movements. Oftentimes volume is used in conjunction with the price data to validate predictions.

Prices move in trends

The favourite mantra of technicians is “the trend is your friend”. Technicians believe that prices trend, which may be up, down, or sideways. Such movements can be exploited to make predictions about future movements. In order to implement a trading strategy based on this, technicians will claim that one should always go in the direction of the trend.

To establish a trend technicians talk about support lines and resistance lines. A support line is a line which the price does not penetrate through downwards. A resistance line is a line which the price does not penetrate through upwards. Both of these lines can be downward or upward sloping, or even flat. Moreover, both lines may be present and this case the pattern is called a channel. The trend lines constitute the basic figure used by technicians.

Consider an upward sloping support line, which intuitively indicates a bullish trend. The implication of this is that, whenever the current price is close to this line, it is close to its relative minimum. This, on the other hand, means that there is a high probability that it will increase in the future. Next, consider a downward sloping resistance line, which indicates a bearish trend. The implication of this is that, whenever the current price is close to this line, it is close to its relative maximum. This, on the other hand, means that there is a high probability that it will decrease in the future. The more times the prices have reflected off the lines the more credible they become.

You should note that both of these situations allow the investor to implement strategies which “go with the trend”. In the case of the bullish trend, indicating rising prices, a profitable strategy is to buy whenever the asset is close to the support line. This is a bullish investment; the investor is bullish on the asset, and thus in line with the trend. The argument is that since the price cannot penetrate this line, it is ensured to increase, and hence a positive profit is guaranteed. Likewise, for the bearish trend a profitable strategy is to sell the asset once it gets close to the resistance line. This is a bearish investment; the investor is bearish on the asset, and thus in line with the trend. Since the price cannot penetrate this line, it is ensured to decrease, and hence a positive profit is guaranteed on the short position.

It is important to realise that the same type of trading strategies cannot be implemented using either an upward sloping resistance line or a downward sloping support line. In particular, although one might think that it would constitute a winning strategy if one sells at the resistance line or buys at the support this goes against the trend and should be avoided. Contrary to this, if these lines are established as a part of a channel, they may indicate appropriate times to close the position instead. The classical example of this is when both lines are horizontal in which case the asset is in a trading range as illustrated in Figure 1. The profitable strategy to implement in this situation is to buy at the support and sell at the resistance.

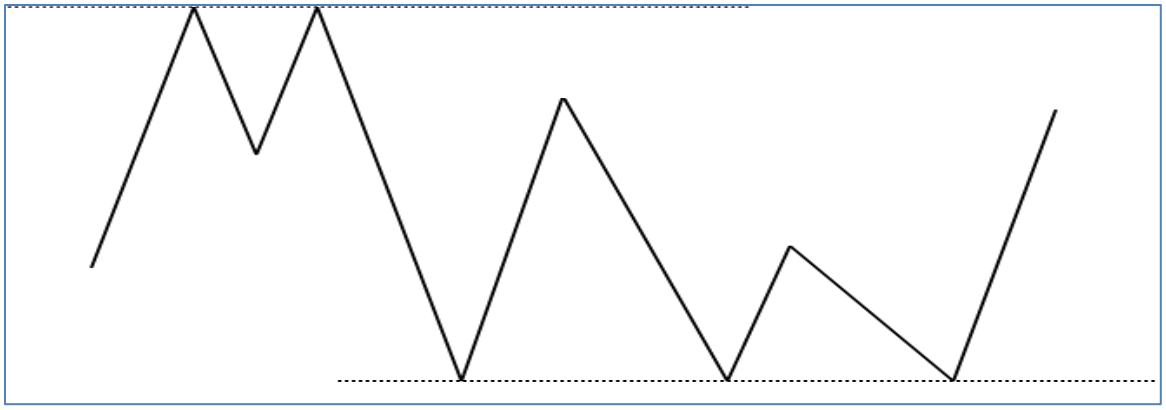


Figure 1: This figure shows a security which is currently in a trading range. The dashed line at the top identifies the resistance line and the one at the bottom the support line.

Mathematical indicators

In addition to establishing actual trend lines technicians may chose to use mathematical indicators such as the moving average, or MA, which is calculated based on a historical subset of variable length of the actually observed prices. Formally, the simple equally weighted MA at time t with a length of k is given by the following formula:

$$\_$$

In a bullish trend two appropriate trading strategies are the following:

1. Buy when the market penetrates the MA to the upside and sell again when the market penetrates to the downside
2. Buy when the short term MA crosses the long term MA towards the upside and sell again when the short term MA crosses the long term MA towards the downside

However, note that for these strategies to be in line with the technical analysis the trend has to be established up front.

Another type of indicators is called oscillators which are used to indicate overbought or oversold regions. Often, such indicators may help the investor to decide on the appropriate point to invest. The most important of these indicators is the relative strength index, the RSI. The RSI based on length k is given by

$$\_\_\_\_\_ \qquad \_\_\_\_\_$$

When the RSI is below 30 this indicates that the asset is oversold when it is above 70 it indicates that the asset is overbought. According to technical analysis the investor should buy when the indicator exits from the oversold area.

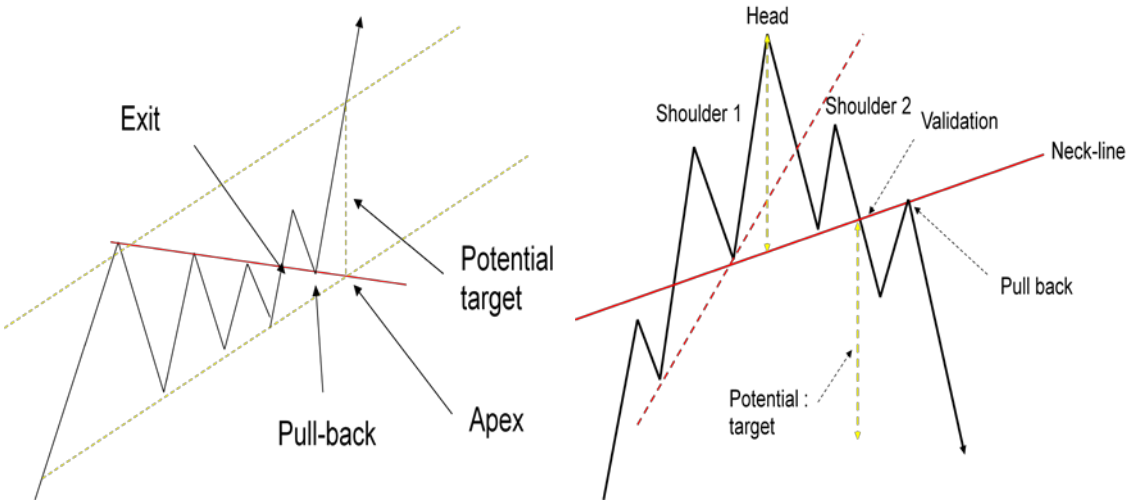
History tends to repeat itself

Technical analysts believe that, collectively investor behaviour repeats itself and that of previous investors. Thus, if last week's prices have been moving in a particular pattern, which is similar to that in which it moved one month ago, what happens next week should also correspond to what happened during the following week one month ago. Although this may seem somewhat loose, years of "research" into technical analysis allows us to be more concrete in a number of special cases.

Although establishing trends to an extent hinges on history repeating itself, most of the technical analysis deals with examining the effect of an apparent breach of the prevailing trend. In the jargon of technical analysis this is called a (potential) trend reversal. The analysis following an apparent trend reversal essentially deals with the effect on the future price movements of having penetrated well established trend lines. Basically two things can materialize:

1. The market can consolidate before resuming its preceding trend
2. The market can confirm the trend reversal

Whether point 1 or 2 above is likely to happen is based on detecting patterns which have been observed previously and on making conjectures about future movements based on the idea that history repeats itself. Thus, specific patterns like flags and triangles are thought to be consolidating patters, whereas (inverse) head-and-shoulders and double or triple top or bottom are signs of a trend reversal. Moreover, in some cases these patterns will not only give information about the direction of the future price movement but also on its magnitude. The following two figures show examples of a triangle to the left and a head-and-shoulders pattern to the right.



When it comes to detecting trend reversals the technician may also use mathematical indicators. These are the so called counter trend indicators or oscillators. The RSI from above is

actually such an indicator. A divergence is indicated when the market and the oscillating indicator are in contradiction. As an example, a bullish divergence is observed when the market is hitting new lows in a bearish trend, potentially touching the support line of the chanel, while the indicator is not hitting new lows. The divergence is an alarm telling the technician that the current trend may end soon!

Potential problems when investing according to the predictions from technical analysis

Whether technical analysis works is a matter of great controversy and empirical evidence is not conclusive. Malkiel notes in his book that of the technicians he knows most have holes in their shoes. Moreover, the methods vary greatly and may even produce contradictory predictions when applied to the same data and thus internal consistency is not guaranteed.

When it comes to making money of technical analysis one of the main problems is that these patterns are always easy to see after they appeared. The difficult thing is to distinguish them in time and before anybody else. Specifically in the case of trend reversals it should be clear that, for this strategy to be profitable, the actual point of reversal has to be identified as quickly as possible. Another more general problem is that as profitable strategies are determined, they are simultaneously destructed by overuse, and the patterns discovered should vanish.

A final problem, although potentially less significant, is that at times the technical analysis tells investors nothing about the potential profit compared to the assumed risk. This is e.g. the case for the trend based strategies, which are purely directional. That is, the support line in a bullish trend may tell you when to buy, but the analysis may be silent about when to close out the position.

Theoretical foundations for the use of fundamental versus technical analysis

As we have already seen fundamental and technical analysis is based on very different methods. Therefore it should come as no surprise that the theoretical foundations are very different also. In this section we discuss these underpinnings in turn for fundamental and technical analysis. What about quantitative analysis you may ask. Well, by definition there is very little theoretical foundation for the use of this type of analysis on its own. However, as mentioned above oftentimes this type of analysis in one form or another is a part of either of the two other types of analysis.

Theoretical foundations for using fundamental analysis for trading

Although it may seem that fundamental analysis and it use for valuation is theory free, since it simply relies on discounting future dividends, this is by far the case. First of all, by focusing on future dividends only, we have implicitly assumed that this is all the investors care about. This may not be realistic. The reason is that shareholders have a “right” to a share in the assets of the company and hence the entire cash flow generated by these assets to the company after

meeting all financial obligations and covering capital expenditures and not just the dividends paid out. This has lead to the use of free cash flow models in which measures of future cash flows and not just dividends are discounted.

While free cash flow models may provide more realistic valuation, the underlying assumption remains that it is only cash flows that investors care about. However, for some investors non-monetary elements may yield value also, and if this is the case an asset's price is not simply the discounted future monetary cash flows. Some examples of this are what is termed ethical or socially responsible investing as well as environmentally investing. While this may not change the value of an asset to an individual investor over a short time span it still could potentially affect the return on such an investment. To see this simply note that if for some reason an asset is considered a socially responsible investment its value will, everything else equal, be higher than what is estimated from say the Gordon model. However, this does not mean that short selling the stock is guaranteed to yield a profit. The reason is that the price will remain relatively high as long as the company remains socially responsible.

Finally, the application of the valuation model requires the investor to decide upon a required discount rate. While one may use the prevailing interest rate this would neglect the risk associated with investments in e.g. common stocks. In fact, unless you are indifferent to risk, or risk neutral, the risk free rate is not the appropriate rate to use when discounting uncertain future cash flows. Specifically, if investors disapprove of risk a higher rate is needed, which would lower the objective fair value, compared to that obtained using the simple interest rate. This is in some way similar to the addition of the spread based on credit rating when calculating the value of corporate bonds. Although a similar credit spread could be added to the Gordon model this is in general not the way investors apply the models. Instead, well known standard finance concepts such as the modern portfolio theory and the capital asset pricing model are used.

Modern portfolio theory

The modern portfolio theory, or MPT, is a theory for how rational investors will optimize their portfolio choice, and as a corollary also for how risky assets should be priced considering this. Important elements of the theory are investor's preferences for risk and return, the benefit of diversification, and the concepts of efficient frontiers, capital allocations lines, and the capital market line.

Briefly, the MPT states that by diversifying their portfolios in search for the highest returns given the level of risk, investors, who like return but dislikes risk, will realize that the optimal trade off is found by combining the market portfolio and the risk free asset.[4] The graphical illustration of this is as the optimal capital allocation line, or CAL, which is then referred to as the capital market line, or CML. These concepts are illustrated in Figure 2.

[4] To be specific, it is necessary that investor's utility can be described by a quadratic utility function.

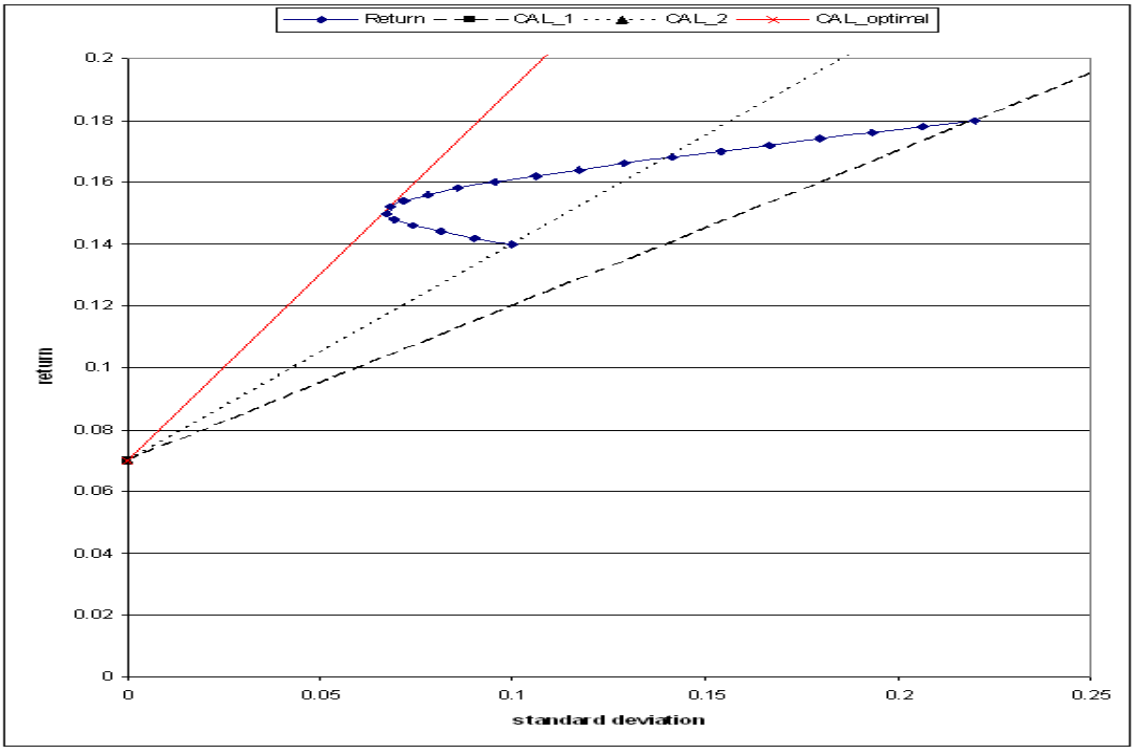


Figure 2: This figure illustrates the principles of the capital allocation line and the capital market line. On the x-axis in the figure the standard deviation is shown and on the y-axis the return is shown. A fundamental assumption is that investors prefer more return for a given level of risk, measured by the standard deviation.

Mathematically, the CML states that the expected return on any combination of portfolios, or efficient portfolios, should be given by

$$\bar{r} = r_f + \frac{\bar{r}_M - r_f}{\sigma_M}\sigma_C$$

where r_f is the risk free rate, and σ_C and σ_M are the standard deviation of returns on the combination of portfolios and the market portfolio.

Capital asset pricing model

While the MPT provides the theoretical foundation for portfolio formation it says little about how to price existing or newly issued individual stocks since these are not efficient portfolios. The capital asset pricing model, or CAPM, can be used for this purpose as it determines a theoretically appropriate required rate of return of a risky asset. This is achieved by posing additional assumptions on the behaviour of individual investors and markets. Among other things, investors are assumed to be identical, single period planners which share the same beliefs about the state of the economy. Moreover, the financial markets, on which all risky assets are publicly traded, are assumed to be large such that investors can be assume to be small and act as price takers.

Because financial markets are large and due to the effect of diversification it can be shown that the relevant measure of risk for individual stocks is the covariance with the market portfolio relative to the market standard deviation. This should hold for all assets and we obtain the following

where is the covariance between the asset i and the market portfolio. Not only does the above hold for individual assets it also holds for efficient portfolios, leading to the CML, and for the market portfolio.

However, for the market portfolio . Based on this it is possible to derive the security market line, or SML, which is the mathematical representation of the CAPM model. This is given by

where β_i is specified as

The CAPM thus yields a formal relationship between the sensitivity of the asset returns to market returns and the required expected return. With this expression, investors can now use the calculated required return as the discounting factor in e.g. the Gordon model to calculate fair prices.

Potential problems when investing according to the valuation from fundamental analysis

After having established, at least partially, how to value asset based on fundamental analysis and the underlying assumptions this method builds upon it is clear that there are numerous reasons for why this may fail. The most obvious reason is the lack of power to predict the future value of the necessary variables. This was discussed already above and it remains problematic irrespective of which additional assumptions are made.

However, even if it is possible to predict these variables the profitability of the investment strategy relies on all the assumptions needed for the MPT and the CAPM since this is often used to calculate the required rate of return. In particular, one of the critical underlying assumptions is that investors care only about the risk and return and that risk can be measured by the standard error of the returns alone. Finally, a potentially problematic assumption is that investors have access to the same information, agree about actual estimates of the risk and the return, and agree on the true distribution of future returns. This latter assumption is widely questioned in the field of behavioural finance.

Theoretical foundation for using technical analysis for trading – introduction to behavioural finance

Proponents of other types of analysis, specifically fundamental analysis, will argue that technical analysis lacks theoretical foundation. Technicians will reply that the theory of behavioural finance offers exactly this theoretical basis. But then again the fundamental analyst might retort that, behavioural finance is nothing but a collection of more or less well founded models for human behaviour, which can be manipulated to explain any and every possible type of investor behaviour. Therefore, behavioural finance lacks the rigor one expects of an actual theory, they argue. Who is winning this debate is still an open question.

Behavioural finance is primarily concerned with the bounds of rationality of economic agents. Thus, whereas standard finance builds on the assumption that agents are rational and maximize expected utility behavioural finance recognizes that investors can and do behave irrational. These "irrationalities" may come from two sources: first, investors do not process information about future movements of the stocks correctly and therefore they consistently make biased predictions; and second, even given the correct predictions, investors make inconsistent and suboptimal decisions. In addition to this, "behaviouralists" will argue that several factors limit the efficiency of markets. Thus, there are three main themes in behavioural finance:

1. Information processing and the use of heuristics: The fact the people often make decisions based on rules of thumb and do not perform a strictly rational analysis.
2. Behavioural biases and the effect of framing: The fact that the same problem posed in two different ways may lead to different conclusions.
3. Market inefficiencies: The fact that observed market outcomes are contrary to the assumptions of rational expectations and market efficiency. Oftentimes it is argued that this may be caused by limits to arbitrage.

Prospect theory

A well known theory which may be used to explain a number of the behavioural biases is the prospect theory. This theory was developed by Daniel Kahneman, a professor at Princeton University's Department of Psychology, and Amos Tversky in 1979 as a psychologically realistic alternative to expected utility theory, which is the fundament of the MPT and the CAPM. Note that this is meant to be a descriptive theory of human behaviour and is not meant to be a theory for optimal behaviour.

Formally, prospect theory states that when investors make choices they seek to maximize their "utility" U given by

where are potential outcomes and are their respective probabilities. The function w is called a probability weighting function and expresses that people tend to overreact to small probability events, but underreact to medium and large probabilities. The function v is a value function, which passes through the reference point, is potentially s-shaped, and may be

asymmetric. It should be noted that the expected utility theory is a special case of the prospect theory which obtains if the w function is the identity function, the reference point used is zero, and v is a proper utility function.

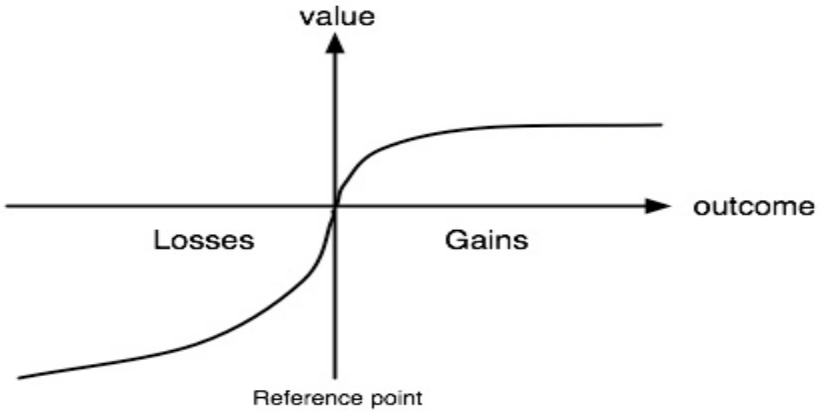


Figure 3: This figure shows the functional form of the value function used in Prospect Theory.

The value function v is often taken to have a form similar to that shown in Figure 3. The first thing to notice is that while concave in gains the value function is convex in losses and hence s-shaped. Moreover, a loss will have larger effect on the value then a gain of similar size. This asymmetry implies that given the same variation in absolute value, there is a bigger impact of losses than of gains. This is also referred to as loss aversion. Finally, in contrast to expected utility theory, the value function measures losses and gains compared to a reference point and not necessarily absolute wealth. This feature can reflect the framing effect, i.e. the fact that the same choices presented in different ways can lead to different choices by investors.

Comparing behavioural finance to standard finance

It should be clear from the above that the theoretical foundations used in the different types of analysis are fundamentally different. Because of this they will also imply very different investor behaviour. In Table 1 the most important differences between the investor's behaviour implied by classical finance and behavioural finance are summarized.

Table 1: This table shows the main differences between standard finance and behavioural finance in terms of investor's behaviour.

Standard Finance:	Behavioural Finance:
Investors are risk averse	Investors are loss averse
Investors have rational expectations about the investment choice	Investors have biased expectations about the investment choice
Investors construct their portfolio taking account of the interaction between assets	Investors construct their portfolio considering each asset in isolation

For the actual choices made by investors an implication of the behavioural finance is that these are made based on the interaction of economic and fundamental variables as well as individual preferences. The immediate result of this is that the portfolios constructed are made based on a succession of individual investments, each of which corresponds to a specific objective. Thus, the resulting portfolio is not considered in its "globality".

Evidence against the profitability of fundamental, technical, and quantitative analysis

In spite of the significant amount of research into the validity of both fundamental and technical analysis it is still somewhat of an open question whether or not it is possible to make money of either of these. The same holds for quantitative finance. In particular, the value of each one of these types of analysis is questioned by two well known hypotheses; the efficient market hypothesis and the random walk hypothesis.

The efficient market hypothesis

The Efficient Market Hypothesis, or EMH, asserts that the prices of financial assets already reflect all known information and will change rapidly to reflect any new information arriving to the market place. An important implication of the EMH is that it is virtually impossible to outperform the market by using any information already available to the market participants. All that counts is luck, or perhaps some information that nobody else has access to! Thus, in its strongest form this means that there is no way to make money using fundamental, technical, or quantitative analysis.

There are three commonly accepted forms of the EMH: strong-form efficiency, semi-strong form efficiency, and weak-form efficiency. Each of these use different information sets as Figure 4 illustrates. Because of this they will also have different implications for how markets work. In particular, note that if strong-form efficiency holds this implies semi-strong form efficiency which in terms implies weak-form efficiency.

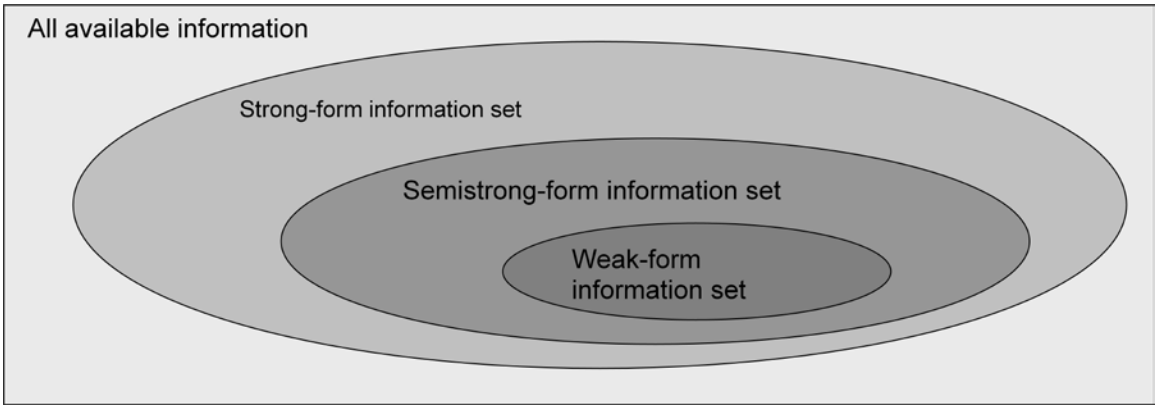


Figure 4: This figure illustrates the information sets used in each of the forms for the efficient market hypothesis.

If all the available information was included in current asset prices, in principle at least, these would never change! This of course stands in stark contrast to what is observed in the markets and based on this **strong-form efficiency** supposes that share prices reflect all currently available information, public as well as private. Thus, no single market participant can earn excess returns based on this information. One implication is that, there should be no value to using insider information and therefore no problem with profitability of insider trading. The strong-form information set differs from the entire information set by e.g. not including future realizations of important variables like growth. Thus, it is implicitly implied that prices only move when news arrive. Moreover, when news arrives the adjustment happens instantaneously.

In **semi-strong form efficiency**, it is implied that current asset prices reflect and adjust to publicly available new information. This happens so quickly and in such a way that no excess returns can be earned by trading on that information. Thus, semi-strong form efficiency implies that neither basic fundamental nor technical analysis can be profitable since only information which is truly new would change prices. Under the semi-strong form efficiency only analysts with a unique insight, or unique information, will be rewarded. Thus, there may be room for some types of fundamental analysis.

Finally, in its "weakest" form, the **weak-form efficiency**, the EMH claims that future price behaviour cannot be predicted from past behaviour. That is to say that, it is impossible to use available price data to continuously beat the market. In other words, technical analysis is useless, whereas there may be some benefit to analysing fundamental variables, and therefore fundamental analysis may have value. An implication of the weak-form efficiency is that future price movements cannot be predicted using historical data and this in terms means that future returns are unpredictable.

The random walk hypothesis

The fact that under weak-form efficiency it is useless to use of historical data for predicting future price movements provides a link between the EMH and the other hypothesis mentioned above, the random walk hypothesis. The random walk hypothesis states that asset prices follow a random walk process. This process is the simplest possible stochastic processes and is given by

where y_t is the stock price at time t and ε_t is a shock to the price also referred to as an error term. The error term has an expected value of zero and does not depend on previous data, i.e. it has no serial correlation. In Figure 5 an example is shown were at each time the stock price either moves up by one dollar or down with one dollar.

Thus, when looking at the specification or at the stock price path which the model generates like the one in Figure 5 it is seen that given today's price, y_t, tomorrow's price is completely unpredictable. For technicians this is obviously completely nonsense but for Burton Malkiel it makes sense according to the title of his famous book which popularized this term for stock markets. In fact, Malkiel explains in his book that he once took the results of an experience such

as the one in Figure 5 to a chartist, who upon seeing the graphic told Malkiel that they needed to immediately buy the stock. When Malkiel told him it was based purely on flipping a coin, the chartist was very unhappy.

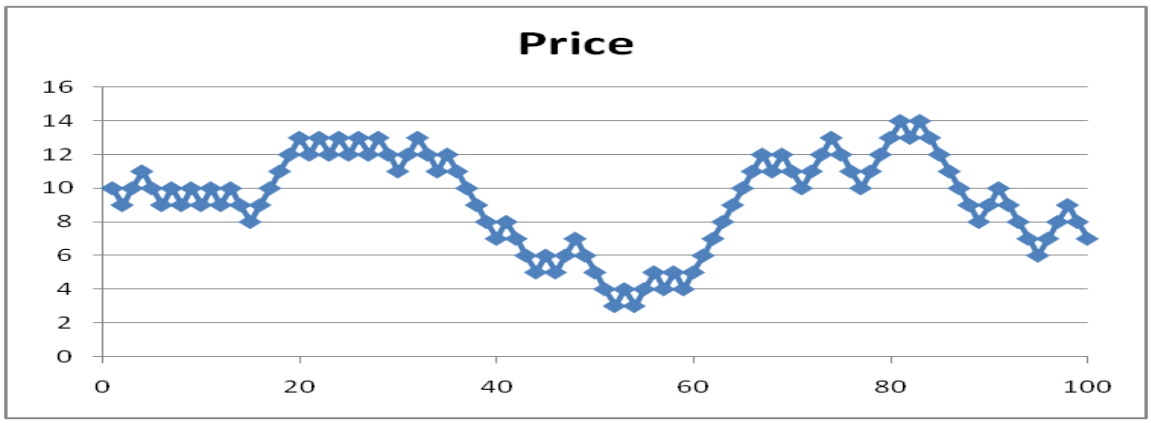


Figure 5: This figure illustrates a potential price path for a stock which has a price described by a random walk.

Although the example with the chartist can by no means be considered conclusive evidence it does confirm that under the random walk hypothesis technical as well as fundamental analysis is at best useless. Moreover, under the random walk hypothesis quantitative analysis is useless. The reason is that no matter how advanced a technique is used by the quant the future movements remain completely unpredictable.

Recent advances – non-random walks and the adaptive market hypothesis

In spite of the popularity of the EMH and the random walk hypothesis recently these theories have been challenged. In particular, this has been the case for the random walk specification. The first reason for this is, of course, that it may seem completely counterintuitive some would argue.

Non-random walks

One of the advantages of the specification of the random walk above is that it can potentially easily be tested. That is, the random walk gives us a very simple relationship between today's price and the price tomorrow and looking at data for various types of assets we can test if this is a plausible description. In fact, we could easily use any of the advanced quantitative methods quants use and test if these provide a better description. If so, we would reject the random walk hypothesis.

A major contribution in this area is the work of Professors Andrew W. Lo and Archie Craig MacKinlay and is collected in their book *A Non-Random Walk Down Wall Street*. This book goes through a number of tests and studies that try to prove there are trends in the stock market and that they are somewhat predictable. A very simple alternative they propose is that stock prices are governed by the following process instead

where μ is termed a drift parameter. If this drift is important then the random walk hypothesis is rejected.

Although this test seems very simple it is by no means trivial to reject the random walk hypothesis. The reason is that often times the changes found are very small or put differently statistically not significant. Moreover, even if it is possible to find an interesting positive drift from the point of view of a potential investor the question is if this is sufficient to compensate for the additional risk. This is not a statistical question though, and it may therefore be difficult to answer simply using a quantitative approach. The same results are often found even when using much more complicated models, and the predictability of stock prices and stock returns remains a very active area of research to this day.

The adaptive market hypothesis

Essentially the EMH relies on the assumption that market prices incorporate all information rationally and instantaneously. The first element would imply that investors are rational also whereas the second is more related to the absence of arbitrage. However, these assumptions have been challenged by the discipline of behavioural finance. The Adaptive Market Hypothesis, or AMH, as proposed by Andrew Lo, is a new framework that reconciles theories that imply that the markets are efficient with behavioural alternatives.

The theory applies the basic principles of evolution, i.e. competition, adaptation, and natural selection, to financial interactions, and claims that the traditional models of modern financial economics can coexist alongside behavioural models in an intellectually consistent manner. In fact under the AMH much of what behaviouralists cite as counterexamples to economic rationality, i.e. loss aversion, overconfidence, overreaction, are consistent with an evolutionary model of individuals adapting to a changing environment using simple heuristics.

According to Lo, the AMH can be viewed as a new version of the efficient market hypothesis, derived from evolutionary principles where prices reflect as much information as dictated by the combination of environmental conditions and the number and nature of "species" in the economy. By species, he means distinct groups of market participants, each behaving in a common manner. This could be pension funds, retail investors, market makers, and hedge-fund managers for example. If multiple members of a single group are competing for a scarce resources within a single market, that market is likely to be highly efficient. This would be the case for the market for 10-Year US Treasury Notes, which reflects most relevant information very quickly indeed. If, on the other hand, a small number of species are competing for rather abundant resources in a given market, that market will be less efficient. Shortly stated, the degree of market efficiency is related to environmental factors characterizing market ecology such as the number of competitors in the market, the magnitude of profit opportunities available, and the adaptability of the market participants.

Summary

It has been argued that proponents of the random walk hypothesis in general and academics like Burton Malkiel in particular would claim that there is no value to fundamental as well as technical analysis. However, this may not be entirely correct. In particular, much of this is geared towards the average informed investor and maybe not to the Peter Lynch's and Warren Buffet's of tomorrow with their greater access to information. That said there is generally little empirical information that investors can continuously beat the market without having some sort of incremental information. The trick then is to acquire this information, see the patterns before they materialize, or be able to treat the information quicker or more precisely than any of the other market participants. This, at last, may seem to be the only method which is sure to beat the market!

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