Norwegian School of Economics



FIN 11: TRADING AND MARKET MICROSTRUCTURE

AUTUMN 2016

Number of words (excluding cover page, table of contents and references): 5,824

Number of pages: 21

Lars Bjørnerud - 163959

Kristoffer Bringslid - 157089

Sondre Tallaksen - 145135

Navpreet Kahlon - 145304

TABLE OF CONTENTS

1 - CASE AND INTRODUCTION *3*
2 – THE TURTLE TRADING SYSTEM *5*
2.1 – Markets: What to Buy and Sell 5
2.2 – Position Sizing: How Much to Buy or Sell 5
2.3 – Entries: When to Buy or Sell 7
2.4 – Stops: When to Get Out of Losing Position 8
2.5 – Exits: When to Get Out of Winning Position 8
2.6 – Tactics: How to Buy or Sell 9
3 – TESTING THE TURTLE TRADING SYSTEM *10*
3.1 - Methodology 10
3.1.1 – Data 10
3.1.2 – Assumptions and simplifications 11
3.2 - Results 12
3.3 - Analysis of the backtesting results 14
3.3.1 – Big wins, many losses 14
3.3.2 – Trading the right markets 15
4 – WAS THE TURTLE TRADING SYSTEM HIGHLY PROFITABLE? *17*
4.1 – Conclusion based on the backtesting 17
4.2 – Validity of our results 17
4.3 – Final thoughts 20
5 – Bibliography *21*

1 - CASE AND INTRODUCTION

"The Turtles made Richard Dennis over $200 million in profits" (former turtle trader Russell Sands, 2015)

The story about Richard Dennis and William Eckhardt's turtles in the 1980s is one of the great stock market legends. Richard Dennis is a well-known commodity trader, and had by the early 1980's turned an initial stake of less than 5,000 USD into more than 100 million USD. (Carr, 2016). Dennis and Eckhardt had frequent discussions about their success. Dennis believed that he could teach people to become great traders. Eckhardt on the other hand thought that genetics and aptitude were the determining factors.

To settle the discussion, Dennis created The Turtle Experiment. In 1983, Dennis picked out 23 people to join his program. His goal was to "grow traders just like they grow turtles in Singapore" (Angrist, 1989). Dennis started off the program with classroom trainings for two weeks, teaching the fundamentals of commodity trading and the principles behind his methods of trading (Angrist, 1989). When the classroom work ended, he gave each of the "turtles" between 500,000 USD and 2 million USD in capital to trade (originalturtles.org).

According to a Wall Street article (Angrist, 1989) a group of 14 turtle traders had an average annual compound rate of return of 80% over the first 4,5 years. As quoted from Sands (2015), the turtles made Dennis over 200 million USD in total profits. We are sceptical about these results, as the only sources are Dennis himself and his turtle traders. Dennis and the turtle traders obviously had strong incentives to present good results from the experiment. Imagine the profit you could make from selling a trading system that promises an annual return of 80%. Furthermore, we find it interesting that little is said about the other nine participants who were also part of the Turtle Experiment.

The Turtle Trading System is a form of technical analysis. Technical analysis is the forecasting of future price movements, based on an examination of past price movements (Edwards et al. 2012, p. 4). The efficiency of technical analysis has been widely discussed since it was first introduced. Theorists refer to the efficient market hypothesis (EMH), and claim that the market price is always correctly valued. Any past trading information is already reflected in the price of the stock and, therefore, any analysis that finds incorrectly valued securities is useless (Nath, 2015). However, many trading practitioners, including the turtle traders, have had great success using technical analysis.

Based on the claims from the turtles and scepticism related to their extraordinary results, we decided to backtest the Turtle Trading System. We used actual historical data, and simulated trades in accordance to the trading rules.

Our topic question is:

"Can we determine whether the Turtle Trading System was highly profitable?"

To answer the topic question, we will begin with presenting Turtle Trading Strategy in its entirety. Moreover, we will present our observations and trading results from our backtesting. Lastly, we will analyse the results and try to draw a conclusion on whether or not the Turtle Trading System was highly profitable.

2 – THE TURTLE TRADING SYSTEM

To describe the Turtle Trading System we have used the article *The Original Turtle Trading Rules*, written by Curtis Faith (2003, p 9-32).

The turtle trading system was a complete trading system, with the six following components:

1. Markets - what to buy and sell.
2. Position sizing - how much to buy or sell.
3. Entries - when to buy or sell.
4. Stops - when to get out of losing position.
5. Exits - when to get out of winning position.
6. Tactics - how to buy or sell.

In this chapter we will explain the six components of the turtle trading system in full detail. The objective of this chapter is to make sure the reader has a clear understanding of all the rules that the turtles were instructed to follow.

2.1 – Markets: What to Buy and Sell

The first component to the turtle trading system is the markets – what the turtles traded. The turtles were future traders, trading commodities and currencies. Furthermore, they were instructed to trade only in liquid markets[1]. The turtles traded almost all the liquid US markets. They could select from a total of 18 markets, in where nine were exchange markets and nine were commodity markets. However, the turtles were instructed to trade in markets with consistency, meaning they would stick to only a few markets for a long time.

2.2 – Position Sizing: How Much to Buy or Sell

The turtles used a position-sizing algorithm called *market volatility normalization*. We will explain the technicalities of this concept in the next paragraph, but the underlying principle of volatility normalization is simply to make sure that the risk of every trade you make is the same, regardless of the market. This leads to traders trading fewer contracts in highly volatile markets, and more contracts in less volatile markets.

The turtle trading system used the letter N to represent each market's underlying volatility. N is simply the 20-day exponential moving average of the true range, more commonly known as ATR. N represented the average range in price movement that a market made in a single day, accounting for opening gaps. The calculation of N, is based each day's *true range*. The true

[1] A marked is *liquid* when traders can trade without significant adverse effect on price. Markets with many standing limit orders and small bid/ask spreads are usually quite liquid. (Harris, 2003, p. 70)

range is simply the price difference between a day high and a day low price. However, accounting for opening gaps, it could also be the difference of the day high and previous day's close price, or the difference between the day low price and previous day's close price. The largest of these three ranges would be a day's true range. The formula for N works as shown in the formula below.

$$N = \frac{(19 \times PDN + TR)}{20}, where\ PDN = Previous\ day's\ N\ and$$
$$TR = The\ current\ day's true\ range$$

Formula 1 - Formula for calculating normalized market volatility

Since this formula requires a previous day's N value, you must start with a 20-day simple average of the true range for initial calculation of N. With the calculation of N, the turtles could now calculate every market's normalized volatility, making it easy to calculate the proper position size.

The next step in determining position size is calculating the *dollar volatility* for each market. The dollar volatility measures how much risk goes into the dollar of any given market, and is a product of the market's N and the market's *dollars per point.* The dollars per point shows how a 1-dollar price change of an asset changes the price of 1 future contract in that asset. For example, in the future market for crude oil, 1 contract represents 1,000 barrels. If the price of crude oil changed by 1 dollar, this would mean a 1,000-dollar change in value for the contract. Formula 2 shows how turtles calculated the underlying market's dollar volatility.

$$Dollar\ volatility = N \times dollars\ per\ point$$

Formula 2 - Formula for calculating dollar volatility

The last step used when calculating position size, is based on what the turtles called *units*. Units were sized so that 1 N represented 1% of the account equity. Thus, a unit for a given market or commodity could be calculated using the formula below:

$$Unit = \frac{1\ \%\ of\ account}{market\ \ dollar\ volatility}$$

Formula 3 - Formula for calculating Unit size

The Unit was both a measure of risk and position size. The turtles were given risk management rules that limited number of units they could maintain at any given time. The unit formula was based on the account equity size, and most turtles were given initial accounts ranging from 500,000 to 2,000,000 USD.

There will be times where markets don't trend for many months. Most of the turtles were given 1,000,000 USD for initial equity account. If one of the turtles lost 10 % of their initial equity, meaning 100,000 USD, they were restricted to trade with a notional account of 20 % for every 10 % they went in losses. This meant they could only trade with 800,000 USD, until they reached their initial equity of 1,000,000 USD.

2.3 – Entries: When to Buy or Sell

The turtles used a very simple system for when to enter a position. They were given two related but different *breakout systems*, called system 1 and system 2. A breakout is defined as the price exceeding the high or low of a particular number of preceding days, indicating the possibility of a trend. The turtles could allocate equity freely between the systems. However, it was common that turtles would prefer and only utilize one of the systems. System 1 was based on a 20-day breakout, and system 2 was based on a 55-day breakout.

System 1 would give a breakout signal if the price exceeded by a tick the high or low of the preceding 20 days. At a breakout signal, turtles could choose to enter position. However, if the last breakout signal in the respective market, in either long or short direction, was or would have been a winner, the rule was not initiate a position. Anyhow, given that previous breakout-signal was a loser, turtles could enter position if they wanted to. The system breakout signal would be either for a short or a long position. If the current price went below the preceding 20-day low, turtles would sell one unit to initiate short position. If price went higher than the preceding 20-day high, turtles would buy one unit to initiate long position. To sum up, the breakout signals were supposed to detect trends in the market.

System 2 was basically the same as system 1, except for two differences. The first one being that system 2 generated breakout signals when price exceeded the high or low of the preceding 55 days. The second difference was that system 2 turtles could enter position regardless of the previous breakout signal being a winner or loser.

Although the turtles initially entered positions with only one unit, they could add units to their positions if their account equity allowed it. Adding of units would be applied when the price changed by ½ N in the favourable direction for the respective position. This means that for

high volatility markets, the price development criteria for adding units would be stricter than for lower volatility markets. The calculation of ½ N in price development would be based on the previous order's actual fill price.

2.4 – Stops: When to Get Out of Losing Position

The turtle trading system made one thing very clear for the turtles; getting out of position in time was critical. When initiating a position in a market at a breakout, the turtles would always have a predefined stop price for when to get out of position. These stop prices would be defined so that a turtle could not lose more than 2 % of their account equity in a trade. For short positions, it would be a high price, and for long positions a low price. The stop-prices were non-negotiable exits.

No trade could incur more than 2 % risk. Since 1 N of price movement represented 1 % of account equity, the maximum stop that would allow 2 % risk would be 2 N of price movement. Turtle stops were set at 2 N below the entry price for a long position, and 2 N above the entry price for a short position. For example, if a turtle initiated a long position unit in the crude oil market at the price 25 USD, with N on the entry day being 0.5, the turtle would get out of position when the crude oil price hit 24 USD. Being based on N, volatile markets would have wider stops, but then the turtles would trade fewer units in these markets. This way, the turtle trading stop system resulted in good diversification and risk management.

The turtles had another stop strategy, called "the whipsaw". This strategy was more difficult to apply, and some of the turtles didn't use this strategy at all.

2.5 – Exits: When to Get Out of Winning Position

If turtles entered a position, and the respective market never hit its stop price, the turtles would stay in position until they received an exit signal. The turtle trading exit system was very simple. In system 1, turtles would exit long positions at a 10-day low price, and exit short positions at a 10-day high price. For system 2, turtles would exit positions on a 20-day high or 20-day low. Waiting for this 10-day high or 10-day low could often mean watching your profit drop severely, but turtles were instructed to never exit too early, and always follow the 10-day rule.

2.6 – Tactics: How to Buy or Sell

The last component to the turtle trading system is the tactics. As a main rule, the turtles were told to use *limit orders*[2] for their trades. This simply made sure that the trades were completed at their desired price. Furthermore, turtles wanted to have as much information as possible about their markets. They wanted to have long positions in the markets that were strong, and short positions in the markets that were weak. Lastly, the turtles were instructed to invariably follow the rules of the system, and to be confident in the fact that playing by the rules would pay off in the long run. Trading with this trend based trading system, the turtles could sometimes see their initial account equity drop by large amounts, and it could be very tough for the turtles to stick to the rules.

[2] A *limit order* is an instruction to trade at the best price available, but only if it is no worse than the *limit price* specified by the trader (Harris, 2003, p. 73).

3 – TESTING THE TURTLE TRADING SYSTEM

3.1 - Methodology

3.1.1 – Data

The dataset used in this assignment is from 1985. The reason for choosing 1985 is because according to multiple sources this was the year the turtles were supposedly most active in their trading. All the raw data is extracted from the Bloomberg terminal and was processed using Microsoft Excel. Finding precise historical data is a challenge and finding correct price movement was not possible. Therefore, we had to use the historical price data which was available and that was closing price, daily high and daily low. The optimal price data would be from second to second, but the data we used was sufficient for the backtesting.

Our analysis will be conducted on futures contracts of two commodities and one index. The commodity futures we chose were gold and crude oil. The choice fell particularly on gold and crude oil because they are characterized by high liquidity and at the same time are very important in the world market. The index we chose was the S&P 500, which was also traded by the turtles. Because the turtles did not trade any single share, we found it interesting to implement the mechanical system on an index. An index gives an indication of the general development of a stock market, especially an index future. Moreover, the S&P 500 is an index of 500 stocks seen as leading indicator of U.S. equities and is a market value weighted index. It is used as a common benchmark for the U.S. stock market. (2016, Investopedia)

In table 1 there are some random price observations from our data. The price of gold/crude/S&P in the table does not represent the price for a single future contract. The price of gold is per ounce, and the size of a future contract is 100 ounces. Therefore, the value of a future contract is the price per ounce multiplied with 100. It is the same case for crude oil, but the price of crude oil is per barrel and the size of the future contract is 1000 barrels. The value of a future contract S&P index is not measured the same way, but we have used the standard multiplier for S&P 500 (which gives the price of one future contract by taking the price and multiplying it with 250).

DATE	PRICE (CLOSE)	PRICE (CLOSE)	PRICE (CLOSE)
02.01.85	304,2	25,92	165,37
03.01.85	303,2	25,84	164,57
04.01.85	299,7	25,18	163,68
07.01.85	303,7	25,56	164,24
08.01.85	298	25,48	163,99
09.01.85	305,5	25,43	165,18
10.01.85	304,3	25,76	168,31
11.01.85	300,3	25,77	167,91
14.01.85	303,9	26,12	170,51

Table 1 - Crude oil, gold and S&P 500 futures prices

3.1.2 – Assumptions and simplifications

To achieve meaningful results from the backtesting without the process becoming too complex, we found it necessary to make certain simplifications and assumptions. However, we have tried to make these adjustments and simplifications only to the extent that our backtesting will still be valid.

Market assumptions

To simplify the entering and exiting positions, we assumed perfect liquidity in the market. This implies that the entries and exits are completed instantly when desired. In addition to this, we assumed that there were zero transaction costs.

In our analysis, we have used the daily prices, as found in the Bloomberg Terminal. This includes daily closing prices, highs and lows. However, the turtles were trend hunters and the minimal differences bear little impact on the final results.

Furthermore, we did not trade on margin. In the futures market, margin refers to the amount of capital one needs to post in order to control a futures contract. Trading on margin allows you to invest in futures without covering the entire cost of the contract (Wildau, 2015). In our analysis, only entire contracts were traded.

Simplifying the Turtle Trading System

We assumed that there was maximum 1 million USD disposable throughout the implementation of the system. Investments over 1 million USD would be adjusted down; to make sure we never exceeded the 1 million USD limit. This means that wins and losses would affect our account equity going into the next position. However, we summed up our profits and losses into an annual result. To sum up, before entering a position we would always have 1 million disposable to invest.

Regarding the entries, we decided to use only the 20-day breakout system. The 55-day breakout system was less fitting, given the one-year data. Additionally, regarding the stops, we exclusively applied the basic stop-strategy. As many of the turtles, we chose to stay away from the more complicated “whipsaw” method.

During the backtesting we did not add units to the positions, while the original turtle trading rules includes adding units at specific times. However, our decision to leave out the adding of units is highly related to the decision of not trading on margin. By trading entire contracts, which requires relatively high capital, there was not much room for entering with additional units.

3.2 - Results

In this part of the chapter we will present our results from implementing the Turtle Trading System on crude oil, gold and S&P 500 futures in 1985.

3.2.1 – Crude oil results

We can see from table 2 that the net profit from trading in crude oil in 1985 was 138,620 USD. This means the annual return rate from trading in the crude oil market this year was almost 14 %. In table 2 we can see that the annual win was primarily due to our final short position that lead to a profit of 320,000 USD. This big profit compensated for the many 20,000 USD stop losses.

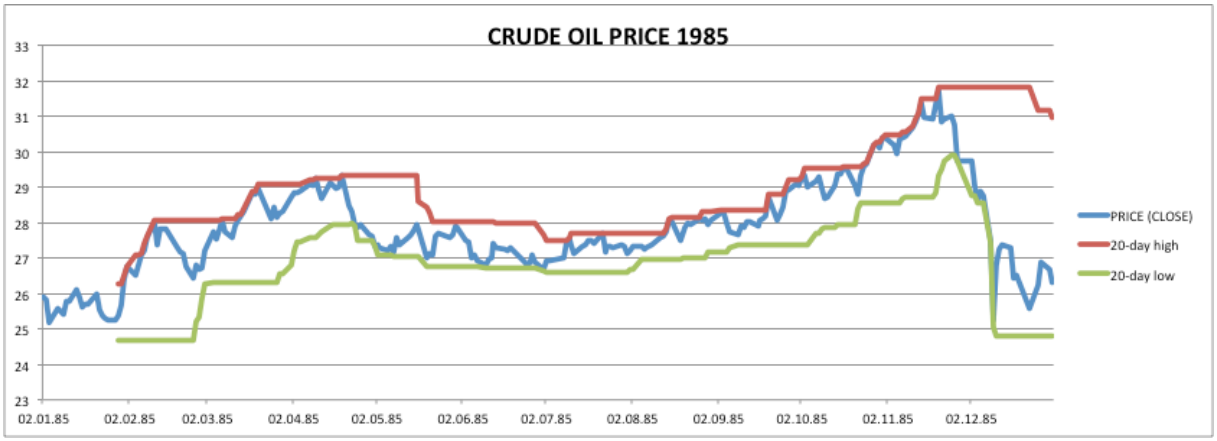


Figure 1 - Crude oil price 1985 with donchian channels

From figure 1 we can spot an upward trend in the price of crude oil in the first few months of 1985. Then, from April to October, the crude oil price fluctuated around 27-28 USD per barrel, with no significant trend for seven months. Then, at end of year, there was a big downtrend. This price development is visible in figure 1. The figure also shows a red and a green line, representing the current 20-day high and 20-day low respectively. These lines, surrounding the development in crude oil price, are known as a donchian channel. Whenever the crude oil price intersects with the 20-day low, it would be an opportunity for a short position. Equivalently, when the crude oil price intersects with the 20-day high, it would be an opportunity for a long position. The system will signal for an entry at all 20-day highs or lows, the majority of them being false breakouts and resulting in

Crude oil futures			
Position	Period	Direction	P&L
1	31.01 - 21.02	Long	$ 12 420
2	07.03 - 22.04	Long	$ 4 600
3	08.05 - 15.05	Short	$ -20 000
4	20.05 - 23.05	Short	$ -20 000
5	10.06 - 13.06	Short	$ -20 000
6	01.07 - 09.07	Short	$ -20 000
7	10.07 - 23.07	Long	$ -20 000
8	14.08 - 06.09	Long	$ -4 400
9	20.09 - 21.09	Long	$ -20 000
10	26.09 - 10.10	Long	$ -14 000
11	16.10 - 19.10	Long	$ -20 000
12	20.11 - 21.11	Long	$ -20 000
13	27.11 - 29.11	Short	$ -20 000
*14	04.12 -	Short	$ 320 000
Total Profit (Sum of positions)			$ 138 620

Table 2 - results from crude oil positions in 1985

a stop loss of 20,000 USD. This is what led to so many stop losses in the seven-month period from April to October.

Despite the system detecting many false breakouts, we should keep in mind that using the turtle trading system on crude oil this year ended in a 14 % annual return. The downtrend at the end of the year, continuing into 1986, compensated for all the losses, showing just how profitable the system can be in periods with significant trends. To sum up, there were two major trends this year that lead to positions making profit, the last one clearly being the most profitable.

3.2.2 – Gold results

In the year of 1985 gold did not have any significant trends. If we take a closer look at figure 2 below, the price fluctuates around $300 for the first three months. For the next nine months the price fluctuates around $320. Over the year we can point at three big changes in price. However, just one of the price movements (the price jump in mid-March) is profitable using the Turtle Trading System. When the price peaks or drops over a short amount of time, like the two other times (beginning of March, end of August), the 20-day breakout system is too slow to enter position in time.

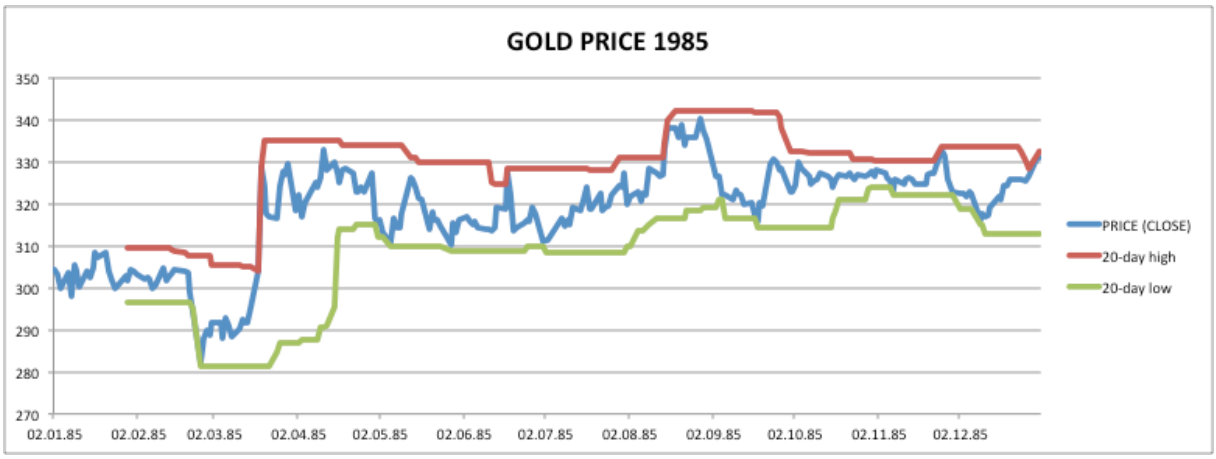


Figure 2 - Gold price in 1985 with donchian channels

As table 3 shows, 12 out of the 14 positions ended with a stop signal. That is the consequence of trading in a market with no trends. As the Turtle Trading System still registers many breakthroughs, but none of them lead to trends, we end up pulling out on the stop signals.

Gold futures			
Position	Period	Position	Profit/Loss
1	22.02-13.03	Short	$ -6 400
2	18.03-23.04	Long	$ 38 850
3	30.04-13.05	Short	$ -20 000
4	28.05-31.05	Short	$ -20 000
5	18.06-20.06	Long	$ -20 000
6	02.07-08.07	Short	$ -20 000
7	29.07-01.08	Long	$ -20 000
8	15.08-03.09	Long	$ -20 000
9	06.09-09.09	Short	$ -20 000
10	17.09-23.09	Short	$ -20 000
11	01.11-07.11	Long	$ -20 000
12	25.11-27.11	Long	$ -20 000
13	02.12-04.12	Short	$ -20 000
14	09.12-16.12	Short	$ -20 000
Total Profit (Sum of positions)			$ -207 550

Table 3 - results from gold positions in 1985

3.2.3 – S&P results

Our simulation in the S&P index futures resulted in four trades with profit, but only one of them led to a significant amount of money. At the end of the year the S&P index is in a long upward trend, which would make a large amount of profit from the long position taken 14th October. However, because the trend does not meet a 10-day low within 1985 we do not see an exit for this position.

Therefore, we calculated the profit based on the next year's data.

S&P 500 futures			
Position	Period	Direction	P&L
1	29.01 - 22.02	Long	$ 220
2	13.03 - 21.03	Short	$ -19 583
3	17.04 - 30.04	Long	$ -20 000
4	18.04 - 30.04	Long	$ -20 000
5	10.05 - 13.06	Long	$ 1 523
6	27.06 - 23.07	Long	$ 4 600
7	29.07 - 05.08	Short	$ -20 000
8	06.08 - 21.08	Short	$ -6 773
9	11.09 - 01.10	Short	$ -2 320
*10	14.10 -	Long	$ 187 558
Total Profit (Sum of positions)			$ 105 225

Tabell 4 - results from S&P 500 positions in 1985

3.3 - Analysis of the backtesting results

3.3.1 – Big wins, many losses

Based on our results from the backtesting, it appears that it was the substantial trends that essentially would make the turtles their profit. As we have seen, these trends could occur maybe only a few times a year, and sometimes not at all, e.g. the gold market in 1985. Therefore, it was important to jump on every opportunity. However, many of these entry signals did not result in profitable positions. Consequently, the majority of our positions ended in 20,000 USD stop losses.

The result is a bit surprising. Even though we expected more losses than wins, we found it surprising that 65 % of the positions ended in a stop loss. "The trend is your friend" is a common phrase in trading and entering a position in the opposite direction of a trend should always be done with caution. A 20-day high or low can definitely be characterized as a short trend. Although, if you take a look at e.g. gold you can clearly see that the short trends is clearly not your friend in 1985. Of the 14 positions we entered in total, twelve resulted in stop

losses due to false breakouts. However, the reason for these losses is the tight stops. The reason for the tight stop is because each trade should not have more than 2% risk, which in this case translates to a stop that ensures that the losses do not exceed $ 20 000.

On the other hand, the market for crude oil futures had a couple of short trends that resulted in profitable positions. Also, it shows that one short position can make up for a large number of losing trades. This emphasises the fact that taking every breakout is essential. Moreover, this proves that choosing a market that actually has trends and does not have many false breakouts is essential for the results.

As we have experienced, the Turtle Trading System is not necessarily profitable just from a large change in the market price. The price development must happen over just the right amount of time for the breakout system to benefit from it. A steady development in price (e.g. crude oil futures price in 1985) can be way more profitable than a rapid shift, due to the nature of the breakout system. This is why, for instance, the turtle system could not take advantage of the gold price moving from 290 to 325 USD during March 1985.

3.3.2 – Trading the right markets

Table 5 shows the overall profits implementing the Turtle Trading System in all three markets and the table 6 shows the overall profits in only crude oil and S&P futures.

Total Profits 1985				
Asset	Profit		Positions	
Gold	-USD	207 550		14
Crude Oil	USD	138 620		14
S&P 500	USD	105 225		10
SUM	**USD**	**36 295**		**38**
Average profit per position			**USD**	**955**

Table 5 - Profits in gold, crude oil and S&P 500 in 1985

Profits Without Trading Gold 1985				
Asset	Profit		Positions	
Crude Oil	USD	138 620		14
S&P 500	USD	105 225		10
SUM	**USD**	**243 845**		**24**
Average profit per position			**USD**	**10 160**

Table 6- Profits in crude oil and S&P 500 in 1985

As table 5 and 6 reveal, the choice of markets to trade could have a major impact on annual profits using the Turtle Trading System. If we exclude the positions from the gold futures

market, the annual return increases from 3.6 % to 24.4 %. Trading in the S&P 500 market proved superior to trading gold futures in 1985. The question that arises is: How do you pick the markets, which are going to maximize profits? The turtles were given 18 markets in which they could consistently trade. Which markets are better to trade, and how did they decide? It is likely that they based their choice on historical prices, news and information or diversification. However, for all we know, they could have selected the markets randomly.

4 – WAS THE TURTLE TRADING SYSTEM HIGHLY PROFITABLE?

4.1 – Conclusion based on the backtesting

Based on our backtesting, we conclude that the Turtle Trading System has the potential to be a well-working system in a trend-friendly market. However, the analysis also reveals that the success of the strategy strongly depends on substantial trends. This should be no surprise, as this was how Richard Dennis intended the system to work. The turtle system is a trend-following trading system, and will lose money when no trends occur. As seen in the gold futures market the system fails to create profit, and the losses increase over time. The problem is that the system detects and indicates an entry when the price has already reached the top or bottom of the trend, the result being a stop loss.

Through backtesting the Crude oil and S&P 500 futures markets of 1985, where trends were present, we discover the power of the strategy. Given a strong trend, the system will detect it, and the profit will be significant. However, predicting if a market will trend or not is very difficult, and losses and weak positions will be initiated as well. The few big profits from substantial trends are meant to outdo the more often occurring smaller losses. And this is how the turtles, simply explained, made their money.

4.2 – Validity of our results

Our backtesting results extensively differ from the claimed turtle trading results of 80 % return. Does this prove the turtle trading legend is a pure myth? Or does it imply that our backtesting was not sufficiently comprehensive? In this subsection we want discuss these questions.

4.2.1 - Statistical validity

Given that the turtles on average had 80 % annual return, the average return per position was 80%. This means that a turtle, with starting account equity of 1,000,000 USD, would on average make a profit of 800,000 USD in his first year. In order to compare this against our results, let us simply assume that the turtles also on average had 38 positions per year. This would mean their average position would result in a 21,000-dollar profit. As we know from table 5, our average profit per position was 955 USD. We wanted to see if average profit per trade being 21,000 USD could be justified against our actual position results. Our average profit per position being 955 USD, on a total of 38 positions, gives this test a p-value[3] of 3 %,

[3] P-value: The probability that, using a given statistical model, the statistical summary, would be the same as or more extreme than the actual observed results. (Ubøe, 2012, p. 196-197)

implying a high unlikelihood for the claim of 21,000-dollar average to be true. The probability of observing our results or more deviant from 21,000 USD, given that their claims are true, would be only 3 %. However, this test is based on the expected profit per positions being normally distributed, which is not the case. Out of a total of 38 positions, 25 resulted in stop losses of 20,000 USD. Then we had two large wins of respectively 320,000 and 188,000 USD. The remaining eleven positions were minor-impact losses and wins. Since our positions are far from normally distributed, the probability of the average profit per position being 21,000 USD is way higher than 3 %. To sum up, this statistical test indicates that the probability of their claims being true is low. However, we cannot statistically reject the legend to be true.

4.2.2 - Consequences of assumptions and simplifications

- Does the specific market selection weaken the reliability of our analysis?

The futures markets for gold, S&P 500 and crude oil are highly liquid markets. The three selected markets were markets preferred by the turtles. The main issue with our backtesting regarding the market is the sample size. On one hand, we used several observations from these three specific markets. On the other hand, we left out numbers and results for all the other turtle-markets.

- Does the one-year data limitation weaken the reliability of our analysis?

The one-year data limitation is possibly the weakest point of the analysis. The chosen limitation can rightfully receive criticism, for lacking realistic time perspective, especially given the rarity of substantial trends. As compared to the 8 years the turtles traded, we tested only one single year. For that very reason, we choose to discuss a 5-year perspective in the next subsection. Catching trends over a one-year period is hard; a big trend might not arise that specific year. Then again, a trend might not arise even during a five-year period either.

- Does the rule-simplifications weaken the reliability of our analysis?

The adjustments and simplifications of the rules were carefully analysed in order to retain credible results. We wanted to follow the rules and strategy as strictly as possible, as given by Richard Dennis.

Our evaluation of the system showed that there was room for removing the most complex aspects from the equation. The 55-day breakout system proved to give almost equal results as the 20-day one. The adding of units was also excluded from our backtesting. We realize that

adding of units most likely would have given better payoffs, which will also be discussed in the next subsection.

A bigger perspective

The results from our backtesting in the three separate markets show the importance of catching the big trends. There will be years where certain markets have no big trends, and it might result in losses. Other years, there will be trends, like the one in the crude oil market in 1986, which alone provides 30% return.

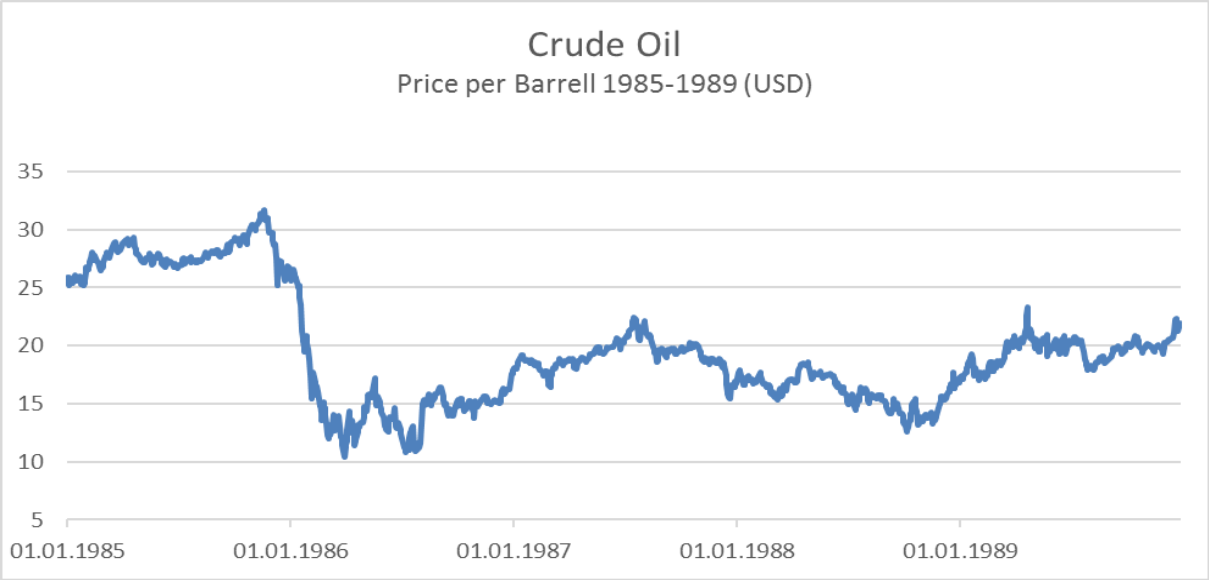


Figure 3 – Crude oil price from 1985-1989

To catch the big trends, it appears to be crucial to trade in several markets, and maybe even more important, to trade over several years. Therefore, let's take a look at the crude oil prices from 1985-1989. Based on our backtesting we can make certain assumptions about how the Turtle Trading System would perform during this period. Because of the substantial 4-month downtrend going into 1986, it is reasonable to assume that traders would profit from this 5-year period, simply due to the fact they caught this one trend. In other words, over the period of five years there is one crucial period of four months that makes your profit. Furthermore, this proves how rarely substantial trends might occur.

Adding units – would it make a difference?

As we excluded the concept of adding units from our backtesting, we found it interesting to explore whether utilizing this concept would make a significant difference in our results. Since position sizing supposedly was one of the most important aspects of the Turtle Trading System, we ran a quick test on this. However, it turned out that adding units would not be relevant to the backtesting of neither the gold nor the S&P 500 market in 1985. In the gold

market, it would not be relevant since the price development never called for adding of units. For the S&P 500 market it would not be possible to add units, because the initial call for contracts in this market would always exceed our account equity. However, it would be possible to apply for the crude oil positions, which we will discuss in the next paragraph.

As we remember from backtesting in the crude oil market in 1985, our last position of the year lasted well into 1986, on a massive downtrend. From this short position, with only one unit, we made 320,000 USD in profit. However, the initial position called for selling only 22 contracts, meaning we had remaining account equity of 371,900 USD. This means, we could have added contracts to our position if the system called for it. The system called for this only a few days after entering the initial position, meaning a turtle would have sold 13 more contracts. Total sales for this short position would then have been 996,325 USD. The first exit call for this position, with added contracts, would have resulted in total cover costs of 501,550 USD. The profit from the position would have then been 494,775 USD, as opposed to 320,000 USD profit from the position with only one unit.

4.3 – Final thoughts

As pointed out in the previous paragraphs, there are definitely some weaknesses to our backtesting results, regarding our simplifications and assumptions. However, we still believe there are validity to our results, and in our opinion, one still should be sceptic to the legend of the Turtle Trading System. Their claims of 80 % annual returns seem to be unrealistic, even if the backtesting of their system would have been performed perfectly. Then, one also have to wonder if the Turtle Trading System published, that we used for our backtesting, actually is the same one that the turtles used. All this being said, there is no way to conclude whether the Turtle Trading System was as profitable as claimed. However, we can conclude that our backtesting makes it seem highly unlikely.

5 – Bibliography

Russel Sands Original Turtle (2015). (2016, 28.11) From: http://www.russellsandsoriginalturtle.com

Stanley W. Angrist. (1989, 05.09). Winning Commodity Traders May Be Made, Not Born. *The Wall Street Journal*.

Carr, Michael. (2016, 28.06). *Turtle Trading: A Market Legend*. *Investopedia*. From: http://www.investopedia.com/articles/trading/08/turtle-trading.asp

Faith, C. (2003). *The Original Turtle Trading Rules*. *Originalturtles*. From http://www.metastocktools.com/downloads/turtlerules.pdf

Harris, L. (2003). *Trading Exchanges & Market Microstructure for Practitioners*. New York: Oxford University Press.

(2016, 10.11). *Standard & Poor's 500 index – S&P 500. From:* http://www.investopedia.com/terms/s/sp500.asp

(2016, 01.11) *Price data (close, high and low). From: Bloomberg terminal.*

Ubøe, J. (2012). *Statistikk for økonomifag.* Gyldendal Norsk Forlag AS, 3rd edition.

Gabriel Wildau (2015, 19.01) *Margin finance in China.* From: https://www.ft.com/content/7d667138-9fd3-11e4-aa89-00144feab7de

Edwards, Magee and Basetti (2012). *Technical Analysis of Stock Trends.* CRC Press, 10th edition.

Trevir Nath (2015, 15.10). *Investing basics: What is the Efficient Market Hypothesis, and What are its Shortcoming*. From: http://www.nasdaq.com/article/investing-basics-what-is-the-efficient-market-hypothesis-and-what-are-its-shortcomings-cm530860