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Master's Thesis

Technical Analysis of Crude Oil Trading

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Objectives of thesis

The objective of this diploma thesis is to perform technical analysis for crude oil prices and formulate a profitable trading strategy. Specifically, prices of WTI crude are used which is traded on CME.
Other Objectives:
a. To determine indicators for formulating trading strategies.
b. To determine factors influencing the selected indicators

Methodology

Technical analysis of daily prices of crude oil (WTI) is done by charting line, bar, and candlestick graphs. Indicators used are moving average, relative strength indicator (RSI) and moving average convergence divergence (MACD). Trends are identified to formulate entry and exit positions. Data series used from year 2016 to 2020.

The proposed extent of the thesis

60-80

Keywords

commodities, crude oil, trading system, technical analysis, trend, moving average, Relative Strength Index, MACD, strategy formulation

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Recommended information sources

Carley Garner. A Trader's First Book on Commodities: An Introduction to the World's Fastest Growing Market . 2nd. United States of America: Pearson Education, 2013, pp. 19-38. ISBN 13: 978-0-13-324783-1

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Prague on 30. 03. 2022

Declaration

I declare that I have worked on my master's thesis titled "Technical Analysis of Crude Oil Trading" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the master's thesis, I declare that the thesis does not break any copyrights.

In Prague on 30.03.2022 _____

Acknowledgment

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Technical Analysis of Crude Oil Trading

Abstract

The main aim of this diploma thesis is to do a technical analysis of crude oil prices (WTI) and formulate a profitable trading strategy and test it using five-year historical data from 2016-2020. West Texas Intermediate (WTI) is a light, sweet crude oil which is traded on the CME market and serves as a benchmark for US crude oil future prices. It is one of the most actively trading commodities in the market. The theoretical part of the thesis analyses the concepts like commodity market and its evolution, commodity trading platforms, exchange markets. It further describes types of financial derivatives and methods of technical analysis. For the practical part of the thesis, the daily close price of WTI futures contracts is used. Technical tools applied are moving average, relative strength indicator, and moving average convergence divergence (MACD) to determine entry and exit positions with the motive of generating profits. Firstly, the contract details are specified with the initial and maintenance margin. The optimum risk percentage is decided to stop loss. Trading strategies are formulated using the indicators- Moving average, RSI, and MACD. The formulated strategies are applied on historical data from 2016 to 2020 and profitability for each strategy is calculated.

Keywords: Commodities, crude oil, financial market, trading system, technical analysis, trend, moving average, relative strength indicator, MACD, strategy formulation.

Technická analýza obchodování s ropou

Abstrakt

Hlavním cílem této diplomové práce je provést technickou analýzu cen ropy (WTI) a formulovat ziskovou obchodní strategii a otestovat ji na pětiletých historických datech z let 2016-2020. West Texas Intermediate (WTI) je lehká sladká ropa, která se obchoduje na trhu CME a slouží jako benchmark pro budoucí ceny ropy v USA. Je to jedna z nejaktivněji obchodovaných komodit na trhu. Teoretická část práce analyzuje pojmy jako komoditní trh a jeho vývoj, platformy pro obchodování s komoditami, burzovní trhy. Dále popisuje druhy finančních derivátů a metody technické analýzy. Pro praktickou část práce je použita denní zavírací cena WTI futures kontraktů. Používanými technickými nástroji jsou klouzavý průměr, ukazatel relativní síly a klouzavý průměr konvergence divergence (MACD) k určení vstupních a výstupních pozic s motivem generování zisků. Nejprve jsou specifikovány podrobnosti smlouvy s počáteční a údržbovou marží. Optimální procento rizika je rozhodnuto zastavit ztrátu. Obchodní strategie jsou formulovány pomocí ukazatelů – klouzavý průměr, RSI a MACD. Formulované strategie jsou aplikovány na historická data od roku 2016 do roku 2020 a je vypočítána ziskovost pro každou strategii.

Klíčováslova : Komodity, ropa, finanční trh, obchodní systém, technická analýza, trend, klouzavý průměr, ukazatel relativní síly, MACD, formulace strategie.

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1 Introduction

The financial markets play a vital role in a country's economy. They provide the liquidity to run enterprises and businesses in the country so it can grow economically. They also play an important role to connect the global markets. Commodities are a crucial part of any economy and their trading has gained wide popularity amongst traders.

Commodities are important factors not only for companies that produce products for direct consumption but also for investment. The commodity derivatives market, especially the futures is one of the most liquid markets and offers huge opportunities for traders to gain money.

In this work, I have given a basic overview of commodities, their classification, foundation, evolution, factors affecting commodity prices, trading platform, etc. Then I mentioned the market of crude oil, its extraction, transportation, types, trading, etc. Later, I mentioned various financial instruments present to trade in the commodities market such as futures, options, swaps, indices, Commodity Exchange Traded Funds (ETF), Exchange Traded Notes (ETN), trading types, etc. Then I described the Exchange markets such as spot market, forward market, Future market. Further, I described fundamental analysis means to predict the price of underlying assets through the basic rule of demand and supply through the study of economic forces. Also, explained two basic fundamental analysis approaches first top-down Investing approach and the second bottom-up Investing approach.

In the practical part, I have used the acquired knowledge and applied technical analysis tools to create a trading system that could generate profits. The formulated strategy is applied to the historical data from 2016-2020 with the help of trackntrade software to find out signals for entry and exit positions. Three combinations of technical indicators are used a. Moving average with RSI, b. Moving average with MACD, and c. RSI with MACD. Strategy is applied on all three combinations and the profitability of each system is calculated.

2 Objectives and Methodology

2.1 Objectives

The objective of this diploma thesis is to perform technical analysis for crude oil prices and formulate a profitable trading strategy. Specifically, prices of WTI crude are used which is traded on CME.

Other Objectives

a. To determine indicators for formulating trading strategies.
b. To determine factors influencing the selected indicators.

2.2 Methodology

In the first part of the diploma thesis, theoretical concepts and literature regarding commodities, financial markets, crude oil trading, derivatives, and futures are discussed. Moreover, the concept of technical analysis, its principles, and its indicators are described.
In the second part, the knowledge is applied to simulate trading strategies on real data. For this purpose quantitative approach is used to develop trading strategies using existing actual data from the Track 'n Trade EOD 5.0 trading platform. The same platform is used for processing the data as well. The closing prices of crude oil futures, WTI, traded on the CME market are used. Data series is used from the year 2016 to 2020.

The daily price movement using candlestick charts is tracked and trends received from technical analysis indicators – moving average crossover, RSI, and MACD are applied on the data series under observation to find out entry and exit signals. The trades are simulated using the trading strategy drafted by taking long and short positions as the signals are received from the technical tools.

Three strategies are made using combinations of the indicators as below

a. Moving average crossover with RSI
b. Moving average crossover with MACD
c. RSI with MACD

The results obtained from all three combinations are then accessed and compared for profitability.

Moving Averages are simple average calculations of a definite time series. They smooth out the fluctuations in the data series and provide an overall view of the latest trend series. Moving averages can be calculated for any time period (Rockefeller, 2011). A 10-day moving average is calculated by taking the sum of last 10 entries and then dividing it by 10.

$$SMA(n) = \frac{P1+P2.....+Pn}{n} \quad (1)$$

Where,

SMA(n) - n days simple moving average

Pn - Price on nth day of series

The crossover signals from 10 and 20 day moving averages for this thesis. 10 and 20 days moving average is calculated using equation 1. These are plotted with daily price series for the observed period. Signals are generated when the two averages crossover each other. When the shorter time average, here 10 day SMA, crosses the longer-term average, here 20 day SMA, from the bottom up it gives a buy signal. And when it crosses the long-term average from the top-down it is an indication of a sell signal. The crossover moving averages are highly used by trend analysts and effective in predicting trend reversals (Murphy, 1999).

Relative Strength Indicator (RSI): This indicator was developed by J. Welles Wilder in 1978. It is a momentum indicator that evaluates the extent of the change in the price of the underlying asset.

RSI is calculated by using the formula:

$$RSI = 100 - \frac{100}{1+Realtive\ Strength} \quad (2)$$

Where,

$$Relative\ Strength = \frac{Average\ Price\ gains\ over\ n\ periods}{Average\ Price\ Decrease\ over\ n\ periods} \quad (3)$$

According to Wilder, the standard interval period is 14 days. It is denoted as a line graph below the price chart of the studied asset and moves between a range of 0 to 100. This is used to find out oversold and overbought positions and thereby help the investor to find entry and exit points. The values above 70 on the RSI graph are an indication that the asset is in an overbought position and signals a reversal in trend and the values equal to or below 30 indicates an oversold market and that prices are likely to go up (Thomsett, 2014).

Moving Average Convergence Divergence (MACD): It is also a momentum indicator and is calculated by using different durations of exponential moving averages. The MACD graph is also plotted below the price chart of the asset under study. It indicates the bullish or bearish trend of the market and provides signal to investors for short and long positions. MACD is calculated by subtracting the 26 days EMA from 12 days EMA. The graph so obtained is called as MACD line. Also, a 9 day EMA is plotted called a signal line. The signals are generated when the MACD line crosses the signal line. The third part of the MACD graph is the difference between the MACD line and the signal line. This is represented by a histogram and shows the convergence and divergence between the two values. The market trend is bullish when the MACD line crosses over the signal line from below and the trend is bearish when the MACD line cross over the signal line from above (Thomsett, 2014).

The formula for MACD calculation is:

EMA = Closing price x multiplier + EMA (previous day) x (1-multiplier) (4)

Where,

$$Multiplier = \frac{2}{number\ of\ observations} \quad (5)$$

Using the above three indicators, charts are plotted, and trade is made as the signals are received. Stop loss is pegged at 5% of the capital amount to hedge from the high fluctuation in prices. Take-profit levels are marked at USD 5000, 7500, and 9500.

Assessment of trading strategy

The three trading strategies are compared for profitability using the following parameters:

a. Total number of trades- One trade is counted from a position opened till closed.
b. Gross profit: Total amount in USD from profitable trades
c. Gross Loss: Total amount in USD from loss-making trades
d. Profitable trade: Number of trades in which profit is earned
e. Loss trades: Number of trades in which loss is incurred
f. Average profit per trade: Gross profit divided by total trades
g. The average loss per trade: Gross profit divided by total trades
h. Net Profit: Gross profit minus gross loss
i. Profit factor: Ration of gross profit to gross loss

3 Literature Review

3.1 Commodities

Commodities are natural raw materials or livestock which can be processed into finished goods for individual and/or industrial consumption. These are the physical goods that are being traded since a very long time in history. People used to trade the goods they have for the services or goods they require. For example, a farmer trading wheat in lieu of cattle. With time it took the form of a market and the trading at local and small markets eventually lead to the establishment of a commodity market. Commodity markets were formed way before the financial markets came into existence. This trading of commodities has now developed into a full-fledged market where several commodities are being bought and sold every day between buyers and sellers all over the world (Garner,2013).

3.1.1 Commodity Classification

Commodities are generally categorized into the following four categories (Hartill, 2021)

a. **Agriculture commodities**: It includes edible as well as non-edible agricultural crops. For example grains, wheat, soybean, corn, cocoa sugar (edible); cotton, palm oil, rubber (non-edible).
b. **Energy commodities:** It includes crude oil, natural gas, coal, and ethanol. In recent years, it had also added forms of renewable energy, like wind power and solar power to its portfolio.
c. **Livestock commodities:** It includes live animals that are raised in agriculture settings for their milk, eggs, leather, wool, and other purposes. For example, cattle and hogs.
d. **Metals commodities:** It includes precious and non-precious metals. Precious metals include gold, silver, palladium, and platinum; and industrial metals include iron ores, tin, copper, aluminum, and zinc.

Commodities can also be classified based on their form of availability into

a. **Hard Commodities:** These are the commodities that are naturally available in their raw form like Metals, Minerals, oil, which are then extracted and can be refined for further use.

b. **Soft Commodities:** are those that are to be grown and harvested like crops and livestock.

3.1.2 Factor Affecting Commodity Prices

The price of commodities does not simply follow the demand and supply rule of the market. But it is considerably influenced by other factors like weather changes, global and local market situation, currency exchange rates, and economic and political situations also as the commodities natural, resource-based goods of basic need (Bharadwaj et al., 2020).
For example:

a. A bad harvest due to unfavorable weather conditions in one part of the world can adversely affect the prices of the commodity in the market all over the world.

b. If the currency of the producing country is depreciated the exports will become cheaper, thereby reducing the price of the commodity. It makes the commodity market more risk-prone.

3.1.3 Commodity Market: Foundation and Evolution

Commodities are the basic source of living. Since ancient times, people used to trade a commodity at their disposal in lieu of some other goods or services. In ancient times, urban development used to be directly associated with the trade in goods/commodities. The oldest record of commodity trading dates to 4500BC using clay tokens indicating the volume of the commodity to be delivered. The commodity market is believed to have its roots incorporated in the mid of 16th century when speculation of prices of grains, tulips,

spices, and whale-oil used to be done by the people in an open market of Amsterdam, Netherlands (Stringham,2003). The 18th century, Dojima Rice market, in Osaka, Japan, where rice was traded, is known as the first formal commodity market. In the 1840s, Chicago became a market center for agricultural commodities, where farmers used to meet prospective buyers of their crops. But lack of storage and traveling constraints created difficulties, especially during winters. As a result, the supply used to be in the abundance in harvest season but due to limited storage facilities and transportation means people face undersupply and scarcity during the alternate seasons. Farmers also had to face huge losses as they had to sell their goods at discounted prices. To come out of this situation a few traders came together and created an organized stock exchange known as the Chicago Board of Trade (CBOT) in 1848. It was established for trading in Grain future contracts (Bharadwaj et al., 2020).

The transformation of commodity trade into a market became a type of investment opportunity giving promising returns to the investors. It provides diversification from investments in bonds, stocks and for arbitrage opportunities available due to fluctuation in the prices. One more major benefit for which investors likes to diversify their investments in the commodity market is for protection from inflation in prices of raw materials as if inflation is going up, the commodity prices will also increase while that of stocks and bond can fluctuate in a negative direction. It provides investors with coverage against long-term increases in prices.

The Chicago Board of Trade (CBOT)

In Chicago, few intelligent grain traders establish the new formalized location and operation that attracts rich investors. These wealthy investors build the silos that help to store the grain throughout the year. It helps in the stability of grain price too. Gradually, CBOT becomes one of the largest futures trading organizations. In 1874, a new competitor emerged: The Chicago Mercantile Exchange.

The Chicago Mercantile Exchange (CME)

The success of CBOT encouraged investors to invest money into commodities other than grain.CME was founded in 1898 as the Chicago Butter and Egg Board. It developed the standardized contracts known as "futures" for buyers and sellers to formalize the trading of grain (CMEgroup, 2021).

The New York Mercantile Exchange (NYMEX)

NYMEX was founded in 1882 in Manhattan, New York city by a few butter and cheese farmers and used to trade in poultry products and dry fruits initially. With the merger of several small exchanges in Newyork like COMEX, it formed NYMEX. In addition to the previous commodities, it expanded trading in energy-related commodities such as coal, crude oil, natural gas, gasoline, electricity, etc. (CMEgroup, 2021).

The CME Group

The CBOT and the CME were merged on July 12, 2007, and created the CME Group. After the acquisition of NYMEX in 2008, the CME group became the largest derivatives market in the world. CBOT division of CME group controls the agriculture products such as corn, soybeans, and wheat. CME division of CME group responsible for the trading of contracts such as cattle, hogs, stock index and currency futures, and short-term interest rates. The CME division also offers weather and real estate derivatives. The NYMEX division of the CME group takes care of crude oil, gasoline, and natural gas (Garner,2013)

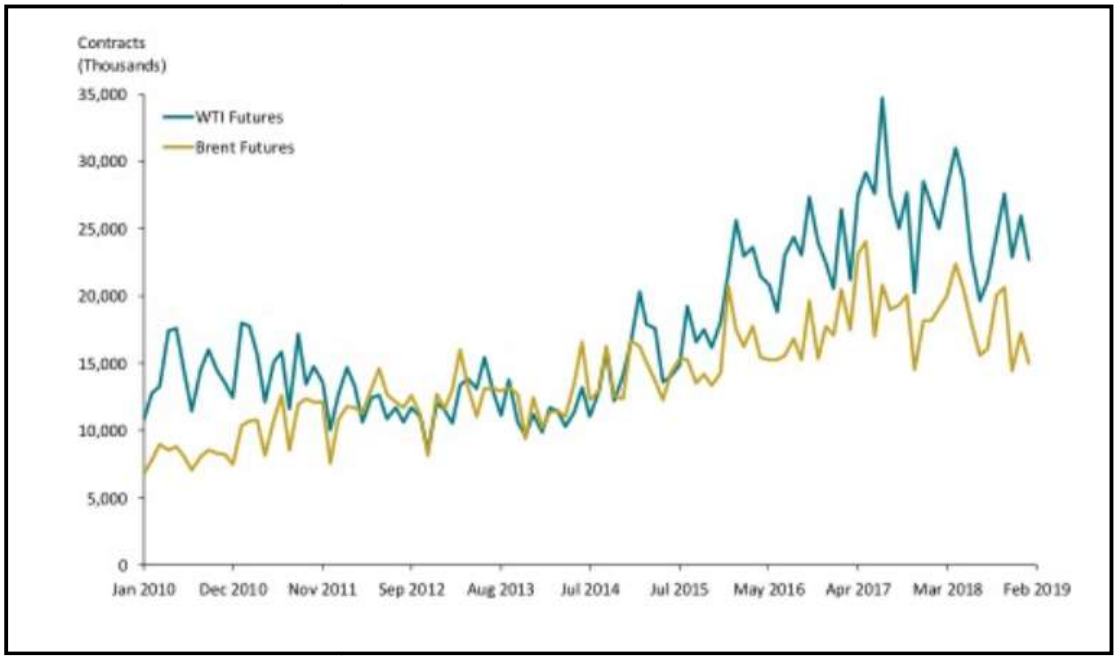
3.1.4 Commodity Trading Platforms

Commodities are traded on various dedicated markets and exchanges which offer more than 50 types of commodities to the investors present worldwide. There are several commodity exchanges present in different countries but the main ones influencing the direction of price movement of these commodities include Chicago Mercantile Exchange (CME), New York Mercantile Exchange (NYMEX), London Metal Exchange, and Tokyo Commodity Exchange.

Chicago Board of Trade (CBOT) is one of the oldest exchanges which is now affiliated with the CME group and not only deals in futures and options of agriculture, metal, and energy commodities but also stock indices and foreign exchange market.

For trading in the futures and options of crude oil, one of the most prominent markets is NYMEX, which is now a part of the CME group. The most-traded future here is WTI (West Texas Intermediate) futures and ICE futures Europe -for Brent brand (Garner, 2013).

Figure 1. Monthly Volume Comparison of ICE Brent and CME WTI Futures

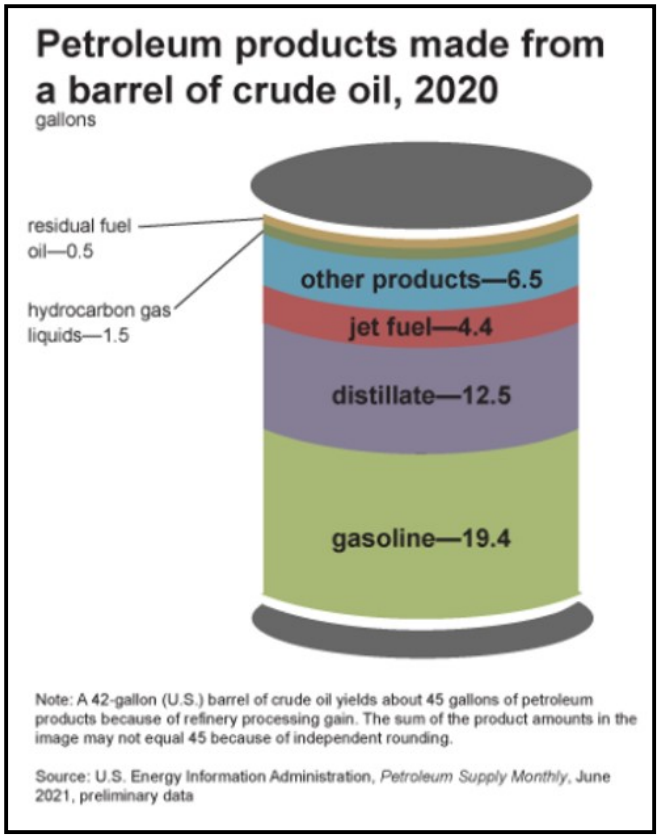


Source: cmegroup.com, 2021

3.2 Crude Oil

Crude oil is a fossil fuel and is composed of unrefined hydrocarbon deposits buried underground for millions of years at natural pressure and temperature. It is a non-renewable source of energy. It is also known as “black gold” for its color, rarity, and utility. Crude oil is refined to obtain fuels like diesel, kerosene, biofuels, and other petrochemicals through the process of distillation. Apart from its conventional use as an energy resource, it is also used in the manufacturing of a range of other goods like plastic and pesticides. Petroleum reagents are vastly used in the pharmaceutical industry. According to the statics available on, around 97,103,871 barrels (1 barrel=158.99Liters) of crude oil is consumed per day globally and it is estimated that the present crude oil reserves will exhaust in the next 47 years. This dependency on crude oil and its scarcity gives the countries, rich in oil reserves, economic and political advantage (EIA,2021). Figure 2 indicates the the products and their quatity extracted from a barrel of crude oil.

Figure 2. Petroleum Products made from a barrel of Crude Oil



Source: EIA, 2021

3.2.1 Crude Oil Market

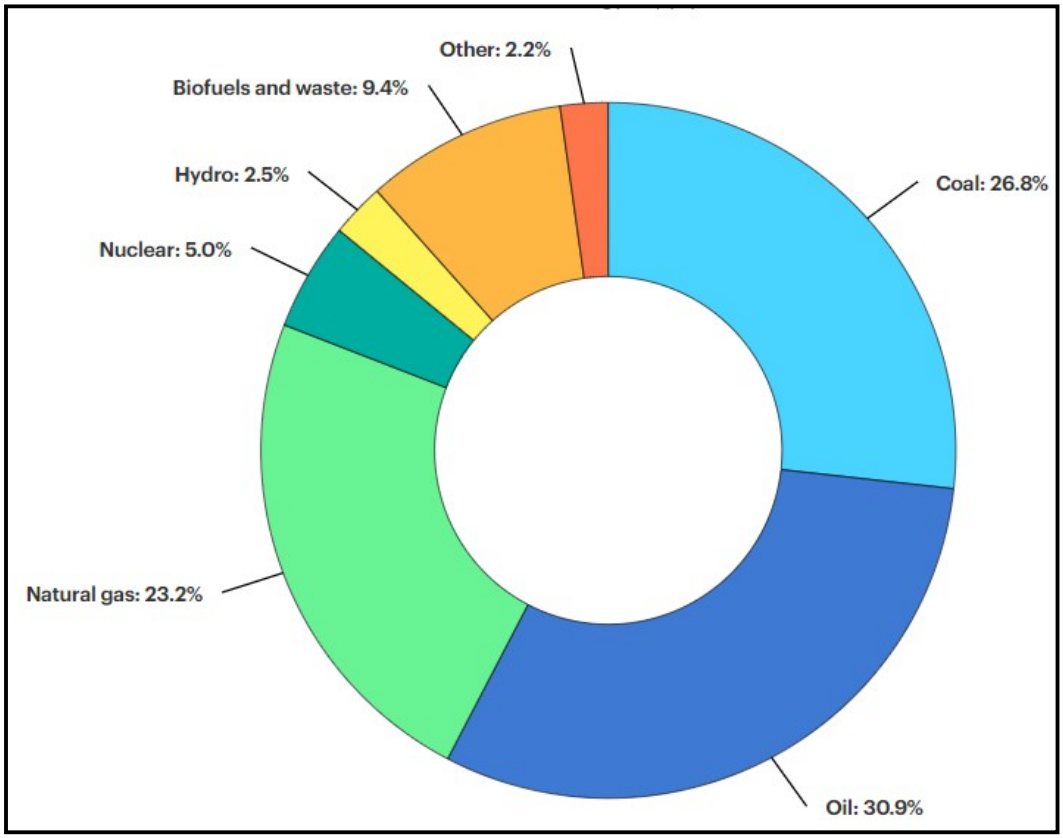
Over the past fifty years, crude oil has dominated the world energy sector (Zhang et al., 2015).

Crude oil has contributed around 30.9 percent to the total primary energy supply of the world, in 2019, which is also the maximum share compared to others (IEA, 2021).

An increase in year-on-year consumption of crude oil is likely to continue to play a major role in global energy needs for the next two decades. However, as per IEA estimates, with this rate of global consumption, the crude oil supply is limited to only 50 years. Crude oil is considered the main energy source for any country thus it influences the economic, political, and military strategies of the countries.

Crude oil's high demand and monopoly of a few crude oil extraction countries make oil prices extremely volatile (Byrne et al., in press).

Figure 3. World Total Energy Supply, 2020



Source: EIA, World Energy Balances, 2021.

3.2.2 Extraction and Transportation

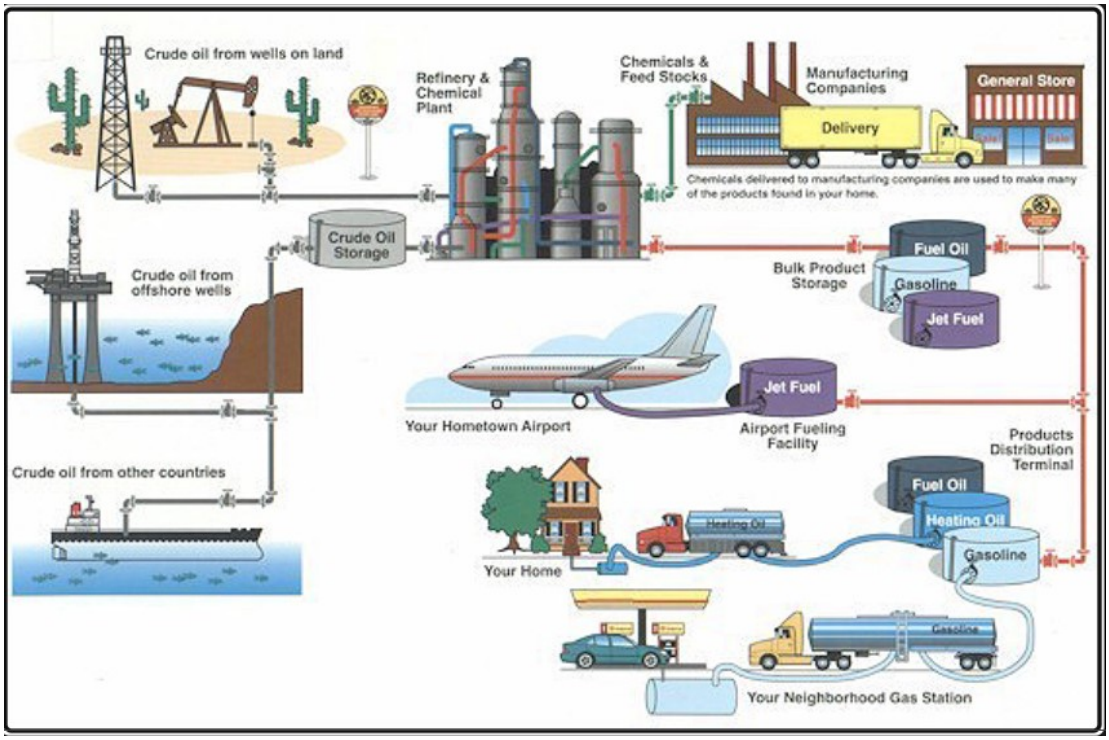
Most of the world's crude oil is extracted only by a few countries, and often the extraction takes place at remote locations such as seabed's, deserts, arctic, etc. As usual, these places are far from the point of consumption so need to be transported to the required destination by various means. Also, crude oil is refined through the process of fractional distillation. And obtained fuels such as gasoline, diesel, LPG, kerosene, biofuels, and other petrochemicals are transported to different countries (Luong, et al., 2021)

There are usually two suitable ways for the transportation of international crude oil:

1) Water ways
2) Inland pipelines

Around 80 percent of the crude oil is transported in huge tankers through waterways and the rest, through inland pipelines.

Figure 4. Extraction and Transportation Process of Crude Oil



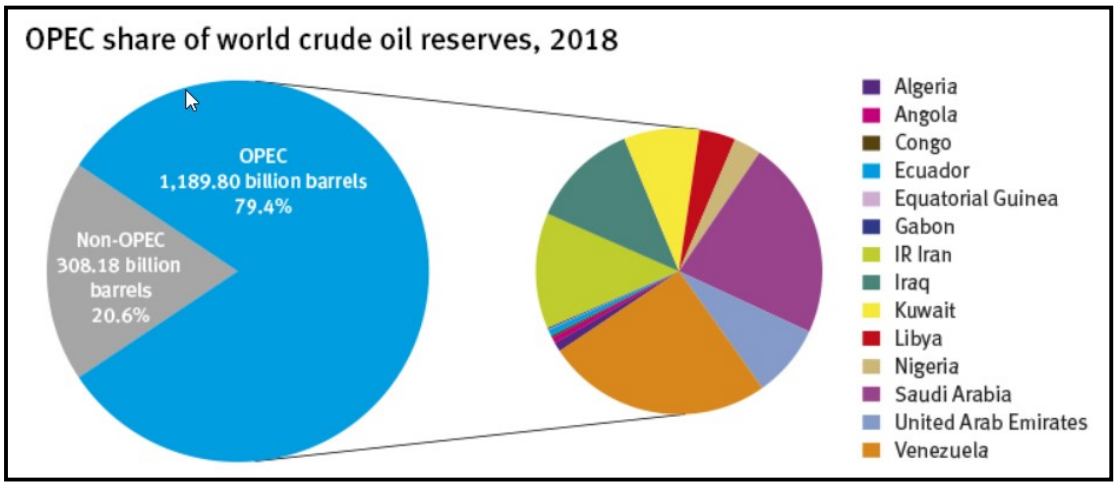
Source: westshorepipeline.com, 2021

3.2.3 Major Players

Organization of Petrol Exporting Countries (OPEC) is an intergovernmental organization of 13 oil-exporting countries. It controls about 79.4 percent of the total proven oil reserves of the world (OPEC: OPEC Share of World Crude Oil Reserves, 2021). The established benchmarks for crude oil worldwide are WTI, Brent, and Dubai.

United states of America, Russia, Canada, and China are other big oil producing nations that are not a part of OPEC. Figure 5 represents the share of oil reserves among OPEN and Non OPEC countries.

Figure 5. OPEC Share of World Crude Oil Reserves, 2018



Source: OPEC, 2021

3.2.4 Crude oil prices

The market of crude oil is huge as it is the prime source of world energy needs and extremely volatile too. This makes it one of the most complex markets by nature. It is rather difficult to predict its economy by the knowledge of simple supply and demand law, which is generally applicable for most of the other markets. Beyond the supply and demand rule, it also has to take into account that oil is a depleting, non-renewable source of energy and is restricted only to a few geographical locations.

In addition, there is an added cost of extraction and storage associated with it, which again depends on:

a. Present rate of oil production; and
b. Amount of cumulative oil production.

Other factors like the outcome of OPEC meetings and the decisions of other oil-producing nations like Russia, natural disasters (like due to COVID-19 lockdown, crude oil prices plummeting below zero during April 2020), climate conditions, political unrest, and production and storage costs (Hung, 2021). The influence of all these factors on crude oil brings a lot of uncertainty and volatility in its price. Analyzing the uncertainty that is not always apparent and is influenced by so many factors is not easy to quantify and makes it difficult to study its impact on the crude oil market.

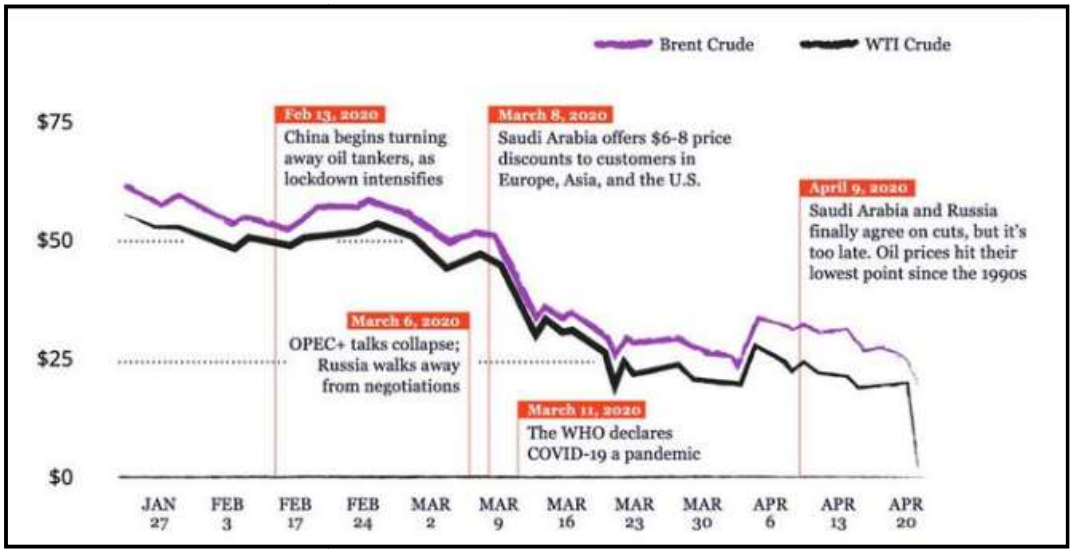
The two main approaches to quantify and analyze uncertainty are:

a. Rely on volatility index by CBOE for risk assessment; and
b. Keeping track of daily news about the economic and political scenarios.

The change in investors‘ perception of uncertainty pushed the prices of oil upwards or downwards resulting in price volatility, which happened during the current pandemic also. In his study, Czudaj states that since the past few years, the crude oil market is not merely driven by fundamentals only but has shifted more towards a financialized market (Czudaj,2019).

The figure 6 below gives an example of how the prices of crude oil (Brent and WTI) reacted to various factors (political, economic, social) from February to April 2020.

Figure 6. Fluctuation in the Price of Crude oil- Brent and WTI



Source: www.forbes.com, 2021

3.2.5 Types of Crude Oil

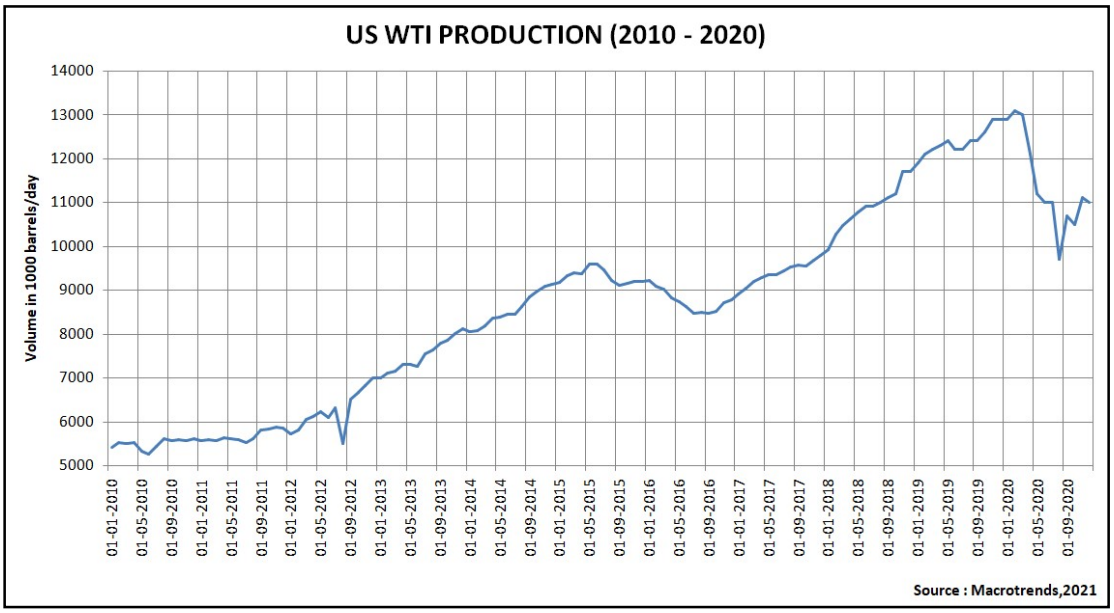
A. WTI

WTI (West Texas Intermediate) is a U.S. blend of sweet light crude oil, with low density and lower sulphur content (light sweet grade oils trade at a premium over sour and heavy oils). Its delivery point is in Cushing, Oklahoma with 90mn barrels of the storage facility. U.S. crude oil market has seen a significant increase as U.S. oil production went up sharply in late 2016, which is evident from the graph below, and at the same time, the ban on the export of US crude oil was also lifted. The Infrastructural transformation of the U.S. Gulf Coast had taken place making it a network terminal with massive storage capacity.

With the increase in the supply of WTI, WTI started dominating the crude oil market all over the world and global markets started adopting WTI pricing in their crude oil trading. The prices of crude oil in the commodity market of different countries derive their prices from the WTI pricing. Thus, the WTI market provided arbitrage opportunities to investors in the global marketplace.

WTI Crude Oil futures are physically delivered contracts with an underlying commodity-1,000 barrels of crude oil, priced in US dollar per barrel. These are the most traded crude oil futures, with more than 1 million future contracts traded per day (CME, 2020).

Figure 7. US WTI Production from 2010 to 2020



Source: Macrotrends, 2021

B. Brent

Brent is also light-sweet crude oil with a little higher sulfur content than WTI. About 66 percent of crude contracts worldwide use it for price referencing. It is mainly extracted from four oil fields in the North Sea namely Brent, Ekofisk, Forties, and Oseberg by ExxonMobile and Royal Dutch Shell. Since it is extracted from the sea, transportation to various locations is easier and cheaper (CME, 2021).

C. Dubai

As clear from the name, it is crude from Middle Eastern and the Persian Gulf. It is sour, heavier, and has higher sulfur content than Brent and WTI. It is also referenced as Fateh Crude. It is mainly delivered to Asian and Australian markets.

3.2.6 Trading in Crude Oil

One of the most interesting commodities in this regard is crude oil. It is not generally possible for an individual investor to invest in it on its own due to the large sum of capital needed also storing it is a big issue (Czudaj,2019).

To invest in crude oil there are mainly following 3 main options:

a. Purchasing the shares of a company associated with crude oil. The issue with this way is that instead of being affected by the prices of raw material (crude oil), stock prices will reflect the overall financial performance of the company. But on the other hand, the investment will have high liquidity, less volatility, and a guaranteed return on investment
b. Investment in the derivatives market
c. Purchase of ETFs or through commodity indices.

3.3 Financial Instruments

There are various instruments present to trade in the commodities market which are explained below:

3.3.1 Commodity Futures

Futures are instruments that obligate its buyer or seller to buy or sell a predetermined quantity of the underlying commodity at a fixed price on a date specified in the contract (which is generally after 30 days). The buyer or seller is obligated to act on its contract unless they offset it before the due date by equivalent spot price sell/purchase. Most of the futures contracts provide the option of cash settlement instead of delivery.

Example: Suppose an investor enters into a futures contract to buy 10,000 barrels of oil at a price of $80 per barrel in 30 days. Now, the investor is obliged to take delivery of the oil at the rate specified or he/she may take a reverse position in the spot market, in this case, sell 10,000 barrels of oil at the current rate, to offset the liability of the futures contract (Rodeck, 2021).

In the crude oil market, futures are the most common instrument for investors. These are used by investors for hedging as well as speculation. West Texas Intermediate (WTI) is the most popular oil future. It is traded on NYMEX platform (Now a part of the CME Group). The second is Brent oil futures, which are traded on ICE, London platform.

3.3.2 Commodity Options

Option derivative, like futures, is a contract to buy or sell the underlying asset at specified price on a specific date. But unlike futures, they give right to its buyer instead of obligation to exercise it. It means if the prices are favorable the investor has the option to let the contract expire instead of acting on it, and for this right, they pay a premium at the time of entering the contract. So, the loss does not exceed the amount of premium paid.

The options are of two types:

a. Call Option: It gives the investor the right to buy the underlying asset at the predetermined price within a certain time period (before the expiry of the contract)
b. Put Option: It gives the investor the right to sell the underlying asset at the predetermined price within a certain time period (before the expiry of the contract) (Overby,2021)

3.3.3 Swaps

These are kinds of derivatives in which two parties mutually agree to exchange the cash flow of the underlying commodity at a fixed price at a specific time in the future. These are generally used in the crude oil market to provide a hedge to investors against volatile price fluctuations.

Swaps are not available on exchanges. As they are mutually agreed between two parties these are traded over the counter and are mostly dealt with by financial service companies as no exchange regulates these instruments. The most generally used swaps include currency and interest rate swaps (Rodeck, 2021).

A swap generally consists of two components- a fixed leg and a floating leg. As the name suggests, the fixed leg component is fixed and already mentioned in the contract while the floating leg component adheres to market price of the underlying asset. One of the parties (mostly the consumer of a commodity) held floating-leg price and the other party (generally producer) will hold fixed-leg component. So, upon the settlement of the contract, the first party (consumer) gets a guaranteed fixed price, and the second party (producer) hedges its risk in case of negative price movements.

3.3.4 Commodity Indices

These instruments are an easy way to enter the commodity market without entering the market of futures and options. It provides a basket of commodities and investors take a position in these commodity indices. And the value of this instrument depends on the value of underlying commodities. So, the investor can invest in commodities without having the obligation to buy/sell physical commodities. This instrument is preferred by the investors as it provides an option to them to diversify their portfolios instead of investing in one particular commodity.

3.3.5 ETFs and ETNs

Commodity Exchange Traded Funds (ETF) and Exchange Traded Notes (ETN) are the entry doors for small investors in the commodity market as these funds collect and merge funds from various low scale investors and make a large portfolio that traces the price of a single underlying commodity or a basket of commodities. According to Max Chen from the ETF trends.com website, with ongoing development and expansion in infrastructure all over the world, it is the best time to invest in ETFs.

3.4 Types of trading

There are three main ideologies of trading- hedging, speculation, and arbitraging.

3.4.1 Hedging

It is used as a tool of risk management by investors and traders by taking a reverse position in the market. This helps to reduce the losses in case the market goes in the opposite direction than believed. But in case the trend does not reverse, there is a loss in profit too. The hedgers are generally risk-averse; they take advantage of future markets to protect their funds from the fluctuations of the market. Hedging does reduce the risk of the investor or trader, but it cuts down profit margin too as it involves its own cost. Hedging is generally carried out in the futures market to minimize the loss in case of any adverse movement of price origination from the underlying commodity's production, storage, transportation, or final sale. So, hedging focuses on reducing losses rather than on making money (Newbery, 2008). Example of profitability from Hedging: Airlines are one of the major buyers of crude oil as jet fuel is a critical expense in their balance sheet. Mostly, about 80% of the fuel cost is bear by the airlines. Southwest Airlines Company, an American airline, has saved millions of dollars by smartly using hedging. During high fluctuations in oil prices in 2008, the company has 70% of its fuel hedged and unlike its contemporaries suffering huge losses the Southwest Airlines Company instead reported cash savings of approximately USD1.3 billion in 2008 (Keeton, 2010).

3.4.2 Speculation

Speculators are in the market for the sole purpose of earning a profit. They purchase (or sell) the assets only to resale (re-buy) later instead of using them, with the objective to earn profit from the price differences. For speculation, the market should be liquid, which means that there is continuous demand and supply of the good and the market is not stagnant. It is suitable for two markets, commodities futures market and financial asset (share and bonds) market (Newbery, 2008).

To take advantage of buying and selling prices of an asset, speculators may use futures or options to speculate and take a position. In the futures market, the perspective of profit, as well as loss, is very high while in the options market, there is a set limit for gain and loss (Hull, 2015)

3.4.3 Arbitragers

Arbitraging was very popular in old times when modes of transfer of information were not that fast. Here, the arbitrager takes advantage of the difference in the price of the two markets generally due to exchange rate difference, by entering into transactions in multiple markets (two or more) at the same time to lock in risk-free profit. For example, if a stock is trading in a US market at $100 and in the UK market at £70 and the exchange rate at the time is $1.50 per pound. The arbitraging can be done by buying 100 stocks from the US market and simultaneously, selling them in the UK market to earn a profit of : 100[(70*1.5)-100] = $500 (minus transaction costs) without any risk. But such opportunities do not last long as the market tends to shift to equilibrium. Also, nowadays, with advancements in technology, arbitrage opportunities are very limited. (Hull,2015)

3.5 Exchange Markets

There has been a significant increase in commodity trading in the past few decades. The globalization of markets, awareness, and reach of technology even to the small investors has made it easier to understand and invest in commodities, which was initially assumed to be too risky. The investment in the commodity market is also done to take advantage of their negative correlation with the equity markets. The investment in the commodity market can be done through cash market or spot market, forward market, and futures market.

3.5.1 Spot market

Spot market or cash market, as the name suggests, works on a real-time basis at spot rates. The trade values or deliveries are settled immediately or at T+2. Spot prices are generally determined by the market through the general demand and supply rule. Financial instruments like equity, bonds, bills, foreign exchange, and commodities all trade in the spot markets.

The spot market is of two types:

a) Over-the-Counter Market: Here the buyer and seller meet and fix terms of trade mutually and there is no involvement of a third party or any regulatory body. The

contract is not standardized in terms of price, volume or other norms and terms are as per the agreement of both parties involved. There can be a risk of default also as there is no guarantor in between. But the high liquidity and real-time settlements make this market highly attractive for investors.

b) Organized Market Exchange: Here the buyer and seller meet in the organized trading platform in a physical or online format. These exchanges are regularized and have standardized procedures. Trading often takes place through the brokers- authorized by the exchange. The price of securities is decided by the rule of demand and supply in the market (Garner, 2013).

3.5.2 Forward Market

A forward contract is a private negotiation of a commodity price developed between a producer and seller so that the commodity is to be delivered at a specific date, price, and location in the future. For example, a farmer, who wants to sell an agricultural commodity such as wheat somewhere in November and wants a party to purchase in November. So, both parties make an agreement to deliver and collect the goods at a specific date, price, and location. This helps to lock the price for both parties and greatly reduces the risk of price fluctuation and increases the price stability.

Theoretically, this seems perfect if both parties keep their promises. For example, the same farmer found that he is getting more money in the open market, compared to what he had agreed in the contract, might choose to default on the forward contract. Thus, we can see these situations will lead to a lack of trust and motivation for both parties.

To resolve such issues, it requires an unrelated third party. This third party collects a good faith deposit from both parties. In case of failure to the contract, the suffered party receives this deposit in good faith to cover its financial loss.

3.5.3 Future Market

A futures contract is a forward contract that is standardized in terms of grade, size of a commodity, tick size, notional value, its future date, and location of delivery. It is better than forwards as it is traded on exchanges instead of being privately negotiated as in the case of forwards. This makes the counterparty risk negligible as the transactions are backed by exchange houses. Exchanges ensure that both “the seller” and “the buyer” must deposit an initial guaranteed amount called a margin. This margin is used for the settlement to the losing party in case of any default risk happens such as drought causing a reduction in grade or amount of any crop. Futures are more actively traded in the market in a regulated environment.

Participation is no longer limited to just buyer and seller. Now, unrelated third parties can also contribute to the markets and get profited from them.

3.6 Fundamental Analysis

Fundamental analysis means to predict the price of underlying assets through the basic rule of demand and supply (by the study of economic forces). In the case of equity fundamentals of the company are checked based on its financial statements, product demand, and company's goodwill to predict the movement of its shares. With the commodity market, the bid and demand of the futures are studied. Any phenomena internal or external which may affect a company's/ commodity's production, demand, and prices are tracked and recorded. For example, the Crude Oil prices plummeted during April 2020 with the start of lockdown worldwide due to the Covid-19 pandemic, anticipating low demand of oil due to the standstill of transportation. Fundamental analysis assists in determining the overpriced and underpriced commodities/securities and help to decide on when to buy, when to hold, and when to sell. As the basic factors of fundamental analysis keep on changing it is mainly used for forecasting long-term trades instead of short-term trades for which technical analysis is used. The trends influencing any changes in demand and supply of the commodity are looked for by fundamental analysts.

Fundamental analysis has two basic approaches:

a. Top-down Investing approach: It is a traditional approach that starts with broad macroeconomic analysis, followed by industry analysis, and finally narrows down to microeconomic analysis.

b. Bottom-up Investing Approach: It is an alternative approach that focuses on a specific company and from there moves on to the related industry. It believes that an individual company can perform well regardless of the industry's performance.

3.7 Technical analysis

Thomsett M.C. in his book named Technical Analysis of Energy Market says that technical analysis is more than the study of only price trends. It should also consider the size and momentum of the market. Based on charting and studying trends of these factors one can determine their entry and exit positions (Thomsett, p211).

Similarly, John J. Murphy in his book Technical Analysis of the Financial Markets, says that in order to study technical analysis it is very important to understand what it actually means and how it is different from fundamental analysis. He defines technical analysis as the study of the market behavior by the ways of graphs to forecast future prices. Market behavior mainly includes the study of price, volume, and open interest which will be discussed in later sections. (Murphy, p 38).

The philosophy of Technical analysis is mainly based on three assumptions:

a. Market behavior covers it all : It assumes that whatever that may affect the markets (political, environmental, fundamental factors) is already reflected in the price of the asset in the market. If demand is increased the price of the asset will also increase. The movement of price itself reflects the demand and supply of the market and so technical analysis, in itself covers the study of fundamental analysis too.

b. Price shifts in trend : It is a most fundamental belief of technical analysis because in case it is not true there is even no point in doing the analysis itself as technical analysis predicts trends using historical data. The main objective of the technical analysis is to plot the chart and look for the trends in the initial stages of their formation so that trading can be done in that direction for maximum profit generation. The trend continues in that direction until triggered by the signs of reversals.

c. History repeats itself : Market behavior and its technical analysis are mostly guided by the psychological behavior of market players. The various studies of chart trends for more than a century reveal the bullish and bearish trends of the market. It assumes that human psychology behaves more or less in the same way therefore what had happened in the past will repeat itself in the future.

3.7.1 Data required

For the purpose of technical analysis, we need data for price, volume, and open interest.

3.7.1.1 Price

Price indicates the value of the financial instrument in the current moment and keeps on changing every second and at a time in microseconds. At the end of each day the opening price, closing price, highest price, and lowest price of the day are displayed. And as per these prices' graphs are plotted that are used in technical analysis. A simple line graph is plotted to show price movement over a longer period of time. But for technical studies, more sophisticated charts like stair and candlestick charts are used (Murphy, 1999).

3.7.1.2 Volume

Volume indicates the total number of contracts traded during a day in the market. It is recorded using vertical bar graphs. The higher bar represents heavy volume and the lower bar represents the lighter volume of trade. Volume bars are used to determine the strength of the ongoing trend as the downward slope of the graph shows a weakening of volume and thereby reversal of trend may be anticipated (Thomsett, 2014).

3.7.1.3 Open Interest

Open indicates a total number of contracts outstanding in the market at the end of the day. In the futures market, it is the total number of outstanding futures contracts held by either longs or shorts but not the sum of both as for every long position equivalent shot position. So the total of either of the one side is considered (Thomsett, 2014). This data provides information about whether the money is entering or leaving the market and through that anticipate the trend of the market.

3.7.2 Type of Charts

Various types of charts are used for technical analysis so that all data of required duration is located in one place for comparison and forecasting. Graphs are used to demonstrate volume, time period, and mainly price movement. With the advancements in technology, it has become very convenient to plot various kinds of charts but the main ones that are most frequently used are line charts, bar charts, and candlestick charts (Schwager, 1999).

3.7.2.1 Line Chart

Line charts are simple and take into account the closing price of each day only. As many analysts consider closing prices as the most decisive price of the day. This type of chart is mostly used to record and track price activity for long periods of time. Like for studying historic data of past five years, line charts are most suitable.

Figure 8. Example of Line Chart

Source: www.dailyfx.com, 2021

3.7.2.2 Bar Chart

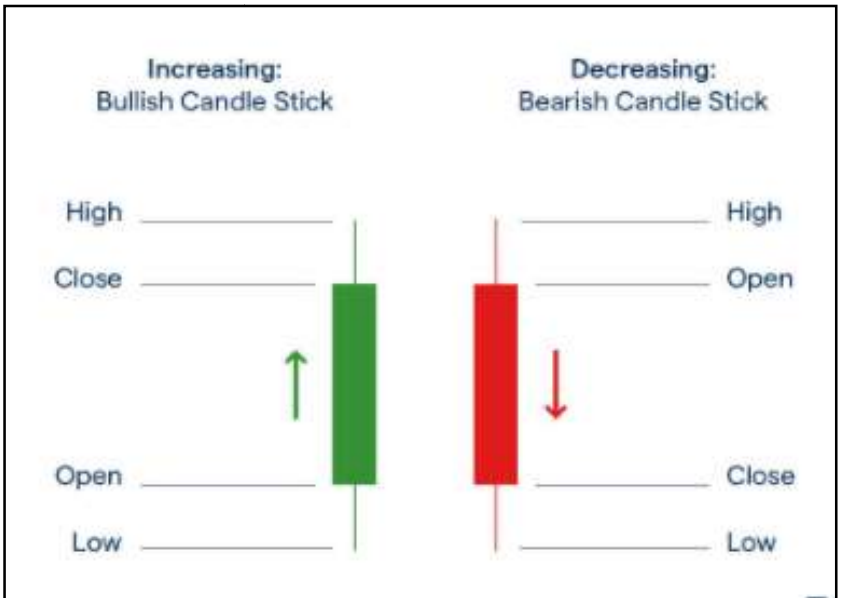
Bar charts are widely used by technical analysts. In a bar chart, the daily movement of price is represented through a vertical bar with a tick on the right side representing the

closing price and a tick towards the left representing the opening price. The upper and lower end of the bar represents the highest and lowest price of the time duration. The bars are shown in green color when the closing price is higher than the opening price and in red when the closing price is lower than the opening price.

3.7.2.3 Candlestick Chart

Candlestick charts were firstly used by the Japanese for their rice future markets. These were later adapted by western markets and became a very popular mode of charting. A candlestick bar is very similar to a bar chart as it also represents the opening, closing, highest, and lowest price levels of a time period. It has a candle-like body that represents the opening and closing prices and the difference between opening and closing prices is visible through the length of the candle. There is an upper spike or wick indicating the highest price and a lower spike indicating the lowest price of the time duration. The color-coding of candles is done according to the level of opening and closing prices. If the opening price is lower than the closing price candle will be white or green and if the opening price is higher than the closing price candle will be black(red). This concept of color coding was later adapted into bar charts too.Figure 9 shows the price reading for bullish and bearish candlesticks.

Figure 9. Candelstick Patterns



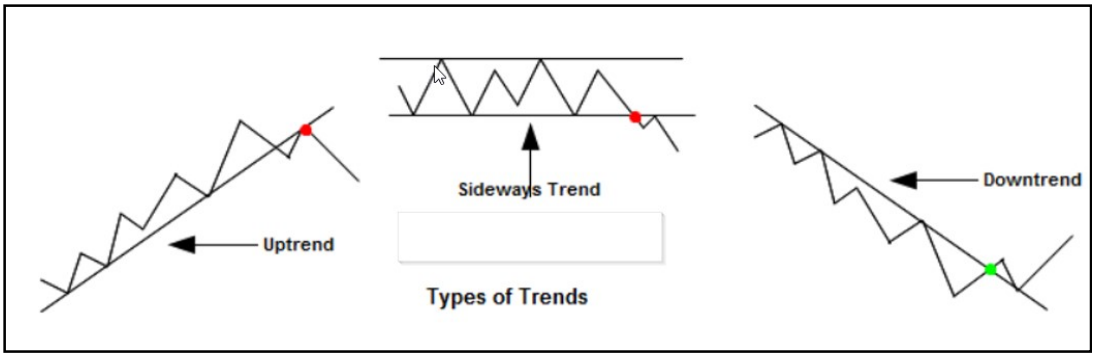
Source: www.tradersagency.com, 2022

3.7.3 Trends

One of the basic functions of technical analysis is to study the trends. The early a trend is identified the more it can be utilized to make profits. But what are these trends? In simple terms, it is the direction of the movement of the market. For example, when it is going up, it is an uptrend and when it is going down, it is a downtrend. But the prices of any asset in the market do not move in a straight line, they always keep fluctuating, and rates are changed almost per second. So, the movement of price gives a zigzag pattern instead of a straight line. The zigzag movements consist of high (peak) and low (trough) points. The direction of these high and low points gives the idea about the market trend. When the successive peaks and troughs are higher than the previous peaks and troughs, it's an uptrend, and when the successive peaks and troughs are lower than the previous peaks and troughs it is a downtrend. Also, when they are almost the same as previous ones it is called a sideways trend.

Though markets are believed to be either moving up or down, they, almost one-third of the time, remain in a state of equilibrium also (sideways trend) when supply and demand forces stay relatively balanced. This market is often referred to as a trendless market. This market is not ideal for using technical tools, as the technical tools are for studying the up and downs of the market. If applied in a static market, they will have very low accuracy that may result in loss-making for the investors (Murphy, 1999)

Figure 10. Tyes of Trends



Source: www.topstockresearch.com, 2021

3.7.4 Indicators

Indicators are mathematical formulas that are used to predict pattern-based signals on the basis of price, volume, and other data. By using these indicators on historical data future prices are predicted. The indicators used in this study are explained below.

3.7.4.1 Moving Average

It is one of the most basic, flexible, and commonly used indicators. As its name suggests it is an average value of a series. But here the series is not fixed but moving. For example, if we consider a 10-day moving average, the total of the last 10 entries from the reference time is taken and divided by 10, and like that the series is made. So, it evens out the fluctuations from the data and shows a trend. Moving average used for short term (25 days), medium-term (50 days), and long term (200 days). [These are commonly used values by analysts, one can plot moving average as per their requirement but using commonly used norms will give more accurate information.] It is quite understandable that a 200-day moving average is more even than a 20-day moving average as it captures more fluctuations from the recent entries. So the long-term moving average is good to depict trends for long-term investments but the shorter-term, recent fluctuations in the market are better captured by short-term moving average. Since it uses historical data, it is a lagging indicator. Generally, for calculation of moving average closing price is used. But some analysts prefer to use the mid-price of the day or average of high, low, and closing price, and price bands of an average of high and low prices are preferred by some to define volatility buffer (Rockefeller, 2011). In this study, closing prices are used for calculation purposes.

a. Simple Moving Average

It is one of the most basic, flexible, and commonly used indicators. As its name suggests it is an average value of a series. But here the series is not fixed but moving. For example, if we consider a 10-day moving average, the total of the last 10 entries from the reference time is taken and divided by 10, and like that the series is made. So, it evens out the fluctuations from the data and shows a trend. Moving average used for short term (25 days), medium-term (50 days), and long term (200 days). [These are

commonly used values by analysts, one can plot moving average as per their requirement but using commonly used norms will give more accurate information.] It is quite understandable that a 200-day moving average is more even than a 20-day moving average as it captures more fluctuations from the recent entries. So the long-term moving average is good to depict trends for long-term investments but for the shorter term, recent fluctuations in the market are better captured by the short-term moving average. Since it uses historical data, it is a lagging indicator. Generally, for calculation of moving average closing price is used. But some analysts prefer to use the mid-price of the day or average of high, low, and closing price, and price bands of an average of high and low prices are preferred by some to define volatility buffer (Rockefeller, 2011). In this study, closing prices are used for calculation purposes.

b. Weighted Moving Average

This takes care of the problem of giving more emphasis on recent price values. It is calculated by multiplying, for example, 20th-day value with 20, 19th day with 19, and so on till 1st day by 1 and dividing its total sum with the sum of the multipliers (20+19+…..+2+1). So, more weighting is given to the recent entries in comparison to older entries. But this average also fails to address the first issue of limited price data taken into consideration.

Figure 11 shows the plotting of simple and weighted moving averages.

Figure 11. Graph showing SMA and WMA

Source: www.tradersagency.com, 2021

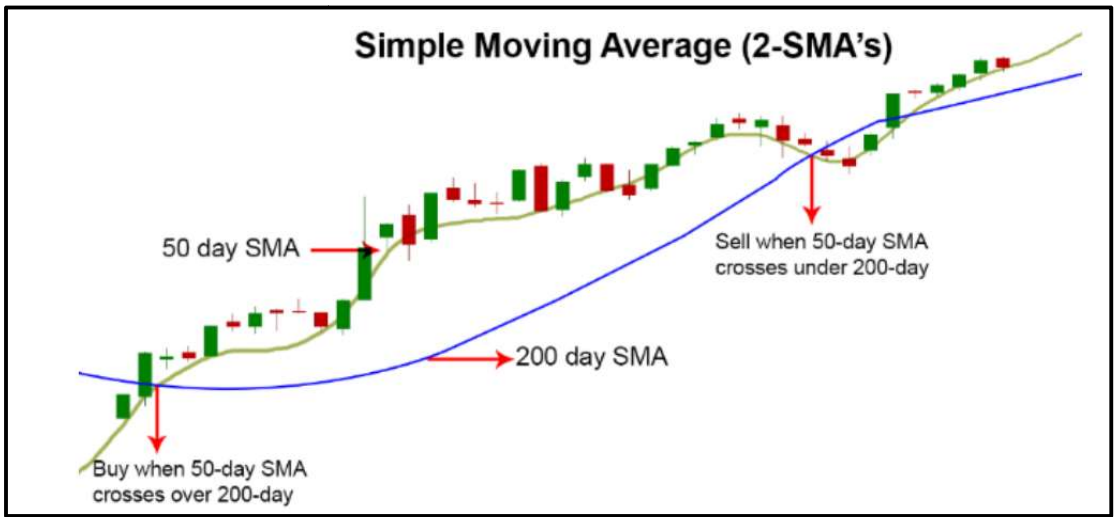
c. Exponential Moving Average

It resolves both the issues of the simple moving average. It uses a weighted average giving more weight to the recent prices. Also, it considers all the previous data of the life of the instrument. It is done by adding some percentage of the last day's value to a percentage of the previous day's value, making both equal to 100%. The calculation of the exponential moving average is quite complex but can be easily calculated with the help of a computer (Rockefeller,2011).

3.7.4.2 Use of two moving Averages

Two moving averages are simultaneously used to generate more reliable signals. It is referred to as the double crossover method. Here two terms are chosen, the most common combinations are 5 and 10 and 10- and 50-days averages. When the shorter-term average crosses the longer-term from below it denotes a 'buy' signal and when it crossed the longer-term average from above it denotes a 'sell' signal. It is very effective to predict signals of trend reversals (Murphy, 1999).

Figure 12. Moving Average Corssover Graph



Source: www.tradersagency.com, 2021

3.7.5 Moving Averages Convergence Divergence (MACD)

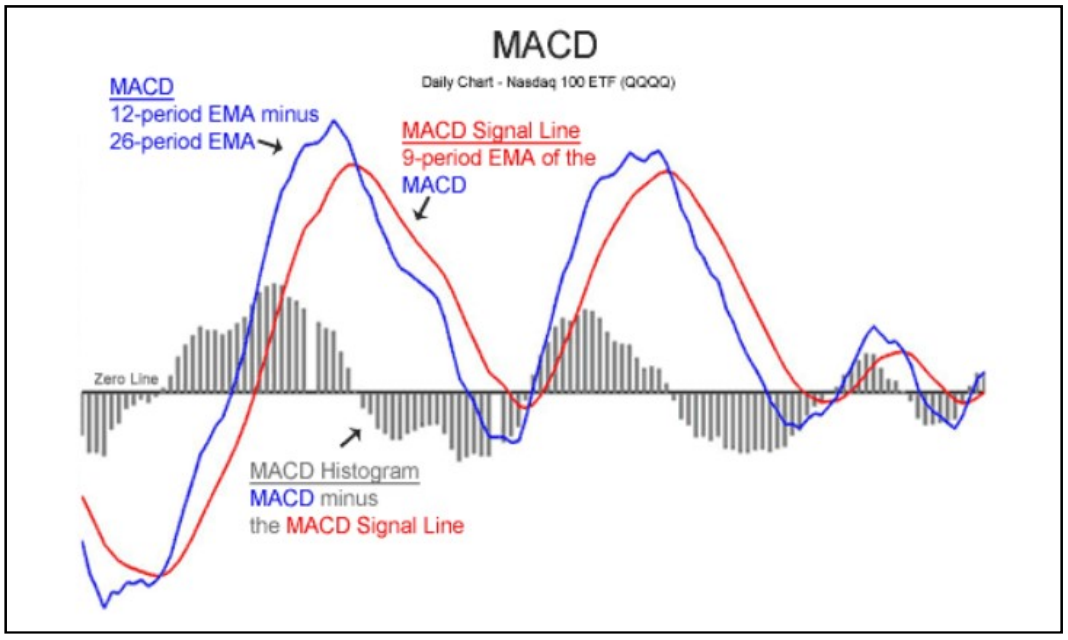
It is a complex indicator as it combines multiple moving averages for tracing momentum from crossovers, convergence, and divergence. It provides great predictions. It reads the price and momentum pace. Two durations of exponential moving average are taken (generally of 26 and 12 days/session) and the difference between the longer moving average and the shorter moving average is called a moving indicator. It trends over or under the baseline. The signals are generated by moving averages convergence, divergence, and crossing over of centerline (Thomsett, 2014).

MACD has 3 components

- MACD Line: 12 days EMA - 26 day EMA
- Signal Line: 9 days EMA of the MACD line
- MACD Histogram: MACD line-signal line

All the components are explained graphically in figure 13.

Figure 13. Graph Explaining MACD components



Source: www.medium.datadriveninvestor.com, 2022

3.7.6 Relative Strength Index (RSI)

It is a momentum oscillator as it measures the velocity as well as strength or weakness of the signal. It was first introduced by J. Welles Wilder in his book in 1978. The trends often get flattened or move sharply in the reverse direction. RSI is used to anticipate such reversals on the basis of slowing down or pacing up of momentum (Thomsett, 2014).

It assigns an index value from 0 to 100. The derivative is considered as 'overbought' as the index crosses 70 and 'oversold' as the index touches down the 30. When overbought the price of the derivative is supposed to reverse downwards and vice versa in case of oversold. An RSI graph is shown in figure 14 below.

Figure 14. Graph Showing RSI movement

Source: www.tradingview.com, 2021

4 Practical Part

In the practical part, three combinations of indicators are used to study the profitability in crude oil futures. The combinations are

a. Moving average crossover with MACD
b. Moving average crossover with RSI
c. MACD with RSI

For the purpose of this study, 10 and 20 days simple moving averages are considered.

4.1 Contact Specifications

There are several approaches to formulate the strategies while trading. Technical analysis is a vast field in itself and there are several indicators that are used by technical analysts to find out buying and selling signals. Some indicators work well with one commodity and some with others according to their volume, volatility, market size, and other factors. The most popularly used technical indicators include moving averages, RSI, Bollinger bands, MACD, stochastic indicator (not in that particular order) among many others.

For the practical part of this thesis, the selected technical indicators are moving average, relative strength indicator (RSI), and moving average convergence divergence (MACD). These indicators are used on the historical data of WTI crude oil (CME). The buy and sell positions are created using the signals generated by applying the above-mentioned indicators and the profitability is calculated for each indicator and their combination.

Following are the specifications of the WTI crude oil future contract traded on CME

Table 1. Crude Oil contract Specifications

Contract size	1000 barrels
Contract currency	USD
Price quotation	US dollars and cents per barrel
Tick size (min. price fluctuation)	0.01/barrel
Tick value	USD 10 (1000*.01)

Source: cmegroup.com, 2021

4.2 Trading System Parameters

4.2.1 Capital

To start with trading, firstly capital is required to buy and sell the financial derivatives in the market. For this thesis, a capital account of USD 50,000.00 is set to invest in the crude oil futures. This amount is decided as high margins are required to trade in the crude oil market. Also, the margin for risks and extra reserves are taken into consideration so that trading is not interrupted due to the inadequate amount in the account.

4.2.2 Risk Management

Risk management entails restricting the investments so that, in an event of a huge market move or a wave of consecutive losses, the overall loss is manageable and bearable. It also aims to make sure that the investor is left with the adequate trading amount to restore his/her losses through further profitable trading within a reasonable time. The margin of risk identified appropriate for the investor is used to decide the stop-loss limit. It is a price at which the trading system will trigger and close the open positions and limit the loss of the investor. (Lei and Li, 2012)

Similarly, the strategy to protect gains is called take-profit. Its main advantage involves the execution of orders without further guessing or greed and making targeted profits. It protects the investor from any sudden and unfavorable price fluctuations.

The risk percentage for the trading system used here is 5%. So, the risk for each trade is limited to USD 2500 (50000*5%). In case the prices fluctuate in an unfavorable direction, a stop-loss order is triggered limiting the loss to USD 2500 per trade.

4.2.3 Margins

In the exchange market, the exchange houses act as the agent between buyers and sellers and run the risk of default on their part. It also needs money for its smooth working and maintenance. For this purpose, it requires margin from the traders. Margin is required to be deposited to open future contracts. Margin requirements can also change according to the market conditions. Higher margins may be required to hedge higher risks in the volatile market.

There are two types of margins charged by exchange houses:

a. Initial Margin: It is a margin required to be deposited for initiating a futures position. It is the safety deposit in case of insolvency of the trader. The amount depends on the exchange house and the broker.

b. Maintenance Margin: It is the minimum margin that must be maintained in the account at any given point in time. This can fluctuate depending on the market conditions and position of the account.

In case the amount in the account falls below the level of maintenance margin the account holder will receive a call from its broker to immediately deposit money up to the initial margin amount. Instead, the position exposure can be reduced to bring the account to the level by the margin available in the account. In case none of the above steps are taken, the position of the account can automatically be liquidated to eliminate the risk of the clearing house (CMEgroup.com, 2021).

For this study, the initial margin of USD 3310 and maintenance margin of USD 3100 are taken as per the requirements of the trading tool used. So, the total margin required to trade-in future oil contracts is USD 6410. Now, if the account falls to USD 2900, the exchange house will call to ask to bring the account up to the initial margin level i.e., USD 3310.

4.2.4 Trading system

The trading system defines a set of rules based on which the future trades are carried out. These rules are based on either fundamental or technical analysis depending on the trader. It clarifies the steps on when to trade and how to trade acting as a rulebook of trading. The rules set out or the strategy formulated is first validated by back-testing (application of the formulated strategy on the historical data) and then through paper trading (by simulating in a live market without involving real money).

Traders can formulate their own rules for trading based on their own technical and/or financial evaluation and risk-taking aptitude. First of all, the input signal is defined to determine the entry position. It can be different depending on the long or short position. Once the input signal is received, the trader enters the market taking either a long or short position as per the market condition. The open long or short position is exited on receipt of an output signal. The output signal can be either based on the rule for exit in the system or due to the triggering of the stop-loss signal. The proper trading system hedges the trader from unprecedented losses due to volatile price movements in the market (Garner, 2013).

4.2.5 Continuous Future Contracts

A continuous future contract is not an actual future contract. It is rather a group of future contracts that are spliced together to create a smooth long-term price chart. It is required especially in the case of backtesting as the futures contracts have a limited and predetermined life span. The expiry of one contract and listing of another creates a gap in its price in between two months. For example, suppose an oil future is expiring on the 27th of April, now the new contract of May listed will have 1 month of premium added to it so will be priced higher and there will be a difference in price of the two contracts at the same time. So, to create a continuous price chart to apply the trading system on long-term historical data, the futures contracts are spliced up to correct the gaps and time differences to generate a continuous long-term price chart. This price chart generated is artificial but serves the purpose. The continuous contracts are created based on volume, open interest, or frequency of trade.

4.2.6 Position Trading

Maintaining the trading position for the long term (up to a few days, months, or even years) is called a position trading strategy as the trader keeps hold of his long or short position for a certain amount of time. Here the focus is on long terms gains instead of taking advantage of short-term fluctuations. The position traders are trend followers, and they rely on and formulate trading systems based on technical and fundamental analysis. This system of trading involves proper formulation of entry and exit points and clear marking of stop loss in the system (Lawler, 2021).

4.2.7 Formulation of Trading System

a. The entry position is to decide on the basis of the first signal received and thereafter the positions are created on the receipt of subsequent signals – from MA crossover or MACD or RSI.
b. The position is held until the next signal is received to exit the position (long or short based on open position)
c. As soon as the position is liquidated, the new position is created immediately.
d. In case, the position is liquidated due to trigger of stop-loss, the new position is entered on the receipt of the next signal.
e. The last position is exited at the end of the observed period whether a signal is received or not.
f. The stop loss is pegged at 5% of the account value i.e USD 2500. On the other hand, take profit is marked at USD 5000. Keeping the ratio of loss to profit at 1:2. If it does not fall below USD 5000, the next take-profit is marked at USD7500 and USD 9500.

4.3 Application of the Trading Strategy to Real Data

For the application of the strategy, Track n Trade software version EOD futures 5.0 is used which allows simulating trade on historical data. In this part, the signals are generated on the data of the year 2016 by using moving average crossover, RSI, and MACD indicators. At the outset of the first signal, the position is entered, either long or short depending on the signal. For example, if the signal is for selling, a short position is entered and maintained till the signal for buy is received. Once the buy signal is received, the open position is exited, and a new long position is created immediately. Here, only one position is kept open at a time to maintain the account balance and avoid confusion. If the position is exited automatically due to the trigger of stop-loss, the next signal is awaited to enter a new trade. At the end of the period under observation, the open position is closed even without the onset of any signal.

Three combinations of indicators are used to study the proposed trading system

a. Moving average crossover with MACD
b. Moving average crossover with RSI
c. MACD with RSI

The methodology used for all three combinations was to open the position on the very first signal of the accessed period. If the signal is to sell, a short position is opened till the appearance of the next buy signal. As the buy signal is received, the open short position is closed and immediately a long position is opened at the same price. This process is repeated till the end of the accessed period and the position was closed on the last day observed period even if no signals were received. The process broke on the trigger of stop loss and take profit orders. In such cases, the position was closed on the trigger and a new position is opened on the receipt of the next signal and the above process was repeated.

The analysis is performed on the entire period under review (2016-2020) with all the three combinations of indicators as mentioned above. A total of 206 signals was received during the entire period from all three indicators.

4.3.1 Strategy 1- Moving Average Crossover and MACD

The first position was opened on 7th January 2018 at a price of USD 52.31/barrel when the MACD line provided a signal by crossing over the signal line from above indicating a sell signal. So, a short position is opened. The position was held till the next signal is received to take an opposite position i.e., a long position. Signal to buy was received on 26 January 2018 at USD 48.74/barrel giving a profit of USD 3570 in the first trade due to a drop in price by USD3.57 per barrel. Immediately, a long position is booked on at USD 48.74 price and held till the occurrence of the next sell signal. The process was repeated till 26 November 2018 as the profit crossed the take-profit level of USD 5000 and when beyond USD7500 and even USD 9500. When it started retreating the profit was booked at USD 9500. The next trade was opened on the receipt of the Buy signal from MACD again on 4 December 2018 and this trade was also stopped due to the trigger of stop loss level this time. Trade was exited with a loss booking of USD 2500 and further loss was prevented due to the hedging technique used. One more stop-loss signal was observed on 1 August 2019 when prices went down by USD 2.73 in a single day, MACD sell signal was received just after MACD buy signal on 31 July 2019 generating a loss of 2500 due to the trigger of stop-loss levels. At the start of the pandemic in 2020, the crude oil prices heavy fluctuation was seen crude oil prices and the short position opened on 26 February 2020 was closed with booking a profit of USD 8310 on 9 March 2020. And the very next long position was closed at a stop loss level of USD 2500 on 22 April 2020. The whole calculations till the end of the observed period are given in Appendix Table 3.

Figure 15. WTI price and MACD-MA indicator graph, 2022

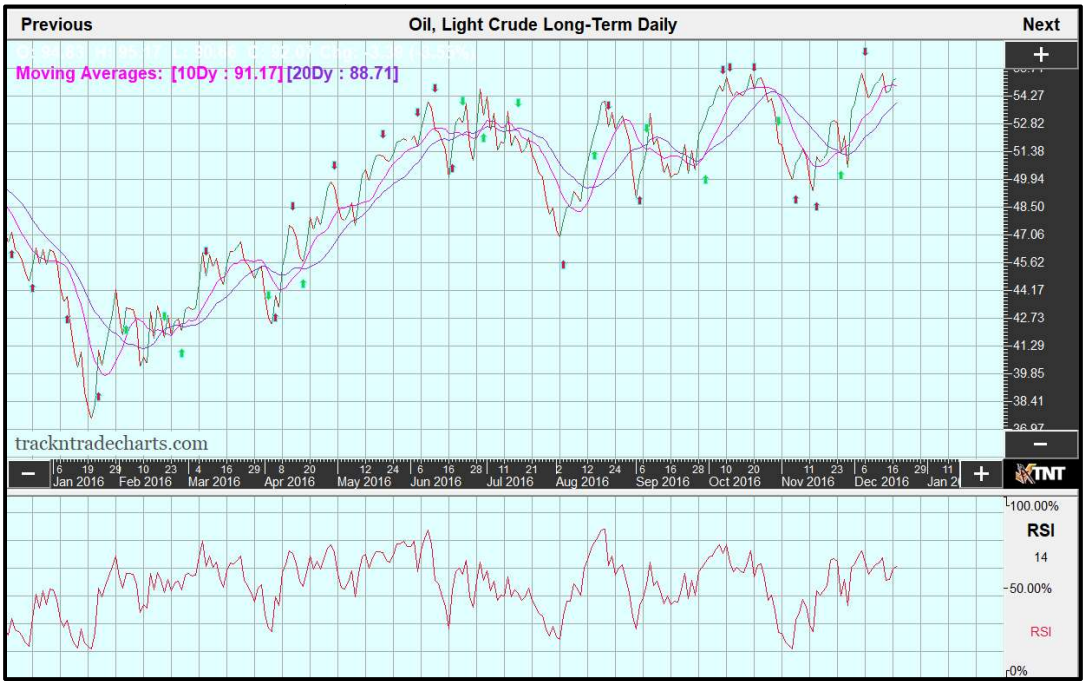
Source: Own processing in Track n Trade software, 2022

Figure 15 shows the signals generated in the year 2016 by plotting MACD and crossover of 2 moving averages (10 and 20 days) on the daily price chart of WTI futures. The blue arrows show the signals generated by MACD and green ones by moving average crossovers. The 10-day moving average is represented by the pink line graph and 20 days moving average by the purple line graph.

4.3.2 Strategy 2- Moving Average Crossover and RSI

For the second strategy, moving average crossover and RSI signals are used to trade in the WTI market in the observed period. The first signal was generated on 8 January 2016 by RSI indicator for a long position at USD 52.23. This position was liquidated due to the trigger of stop-loss signal on 13 January 2016 incurring a loss of USD 2500 in the very first trade. The second signal received was again for the long position by RSI indicator on 22 January 2016 at USD47.68. No signal was received for about a month and the position was kept open till the sell signal was received by moving average crossover signal on 19 February 2016 resulting in a profit of USD 680. Subsequently, a short position was opened based on this signal which was closed in a week on 26 February 2016 again by MA crossover signal. All the signals and calculations for this strategy are tabulated in Appendix Table 4.

Figure 16. WTI price and RSI-MA indicator graph, 2022



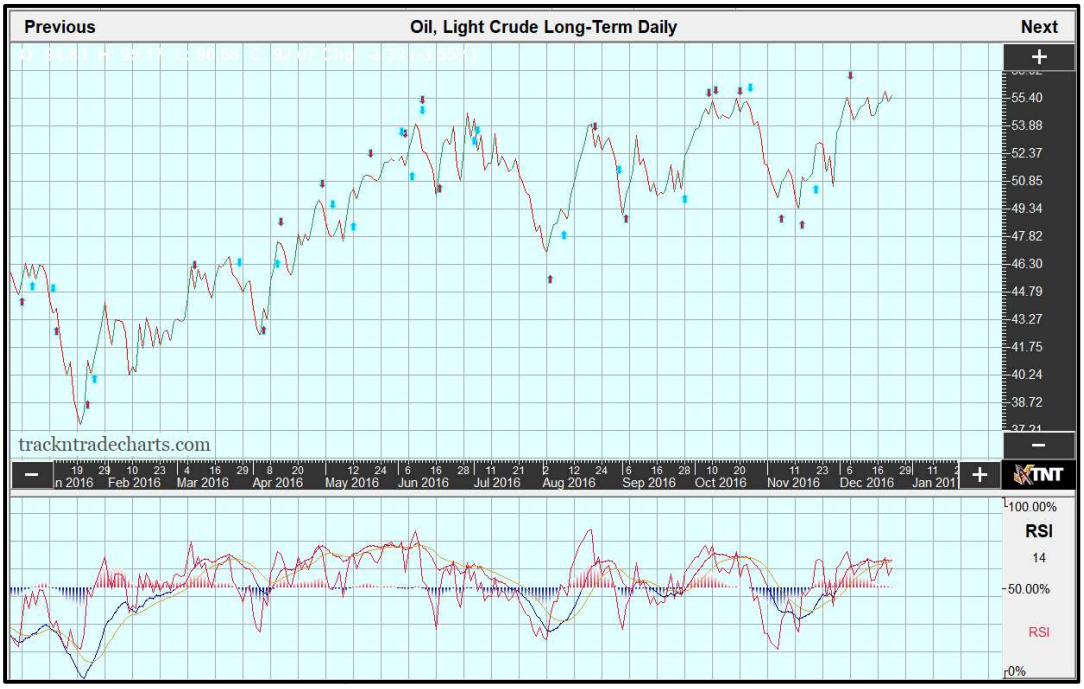
Source: Own processing in Track n Trade software, 2022

Here in figure 16 RSI graph is plotted below the price chart and RSI signals are indicated by the red arrows. Green arrows are for moving average crossover signals as already explained in strategy 1 above.

4.3.3 Strategy 3- MACD and RSI

The third strategy is a combination of RSI and MACD signals. The first trade was opened on 7 January 2016 by taking a short position on MACD signal but was exited on the next day with RSI signaling an oversold market. Trades were continued as per set procedure and a total of 90 positions were opened during the entire period of 5 years. All the signals and calculations for this strategy are tabulated in Appendix Table 5.

Figure 17. WTI price and RSI-MACD indicator graph, 2022



Source: Own processing in Track n Trade software, 2022

Here in figure 17 RSI graph is plotted below the price chart with MACD histogram .The RSI signals are shown by red arrows and MACD signals by blue arrows.

5 Results and Discussion

5.1 Evaluation of the strategies

The following table compares the implemented strategies on various parameters.

Table 2. Comparison of implemented Strategies

	MA crossover-MACD	MA crossover-RSI	MACD-RSI
Total number of trades	99	70	90
Gross profit	73060	77900	78180
Gross Loss	-62400	-33310	-51580
Profitable trade	38	41	47
Loss trades	61	27	43
Average profit per trade	737.98	1145.59	868.67
Average loss per trade	630.30	489.85	573.11
Net Profit	10660	44590	26600
Profit factor	1.17	2.34	1.52
Percentage of Signals Received from MA crossover	13.13	41.18	-
Percentage of Signals Received from MACD	85.86	-	46.67
Percentage of Signals Received from RSI	-	61.76	48.89

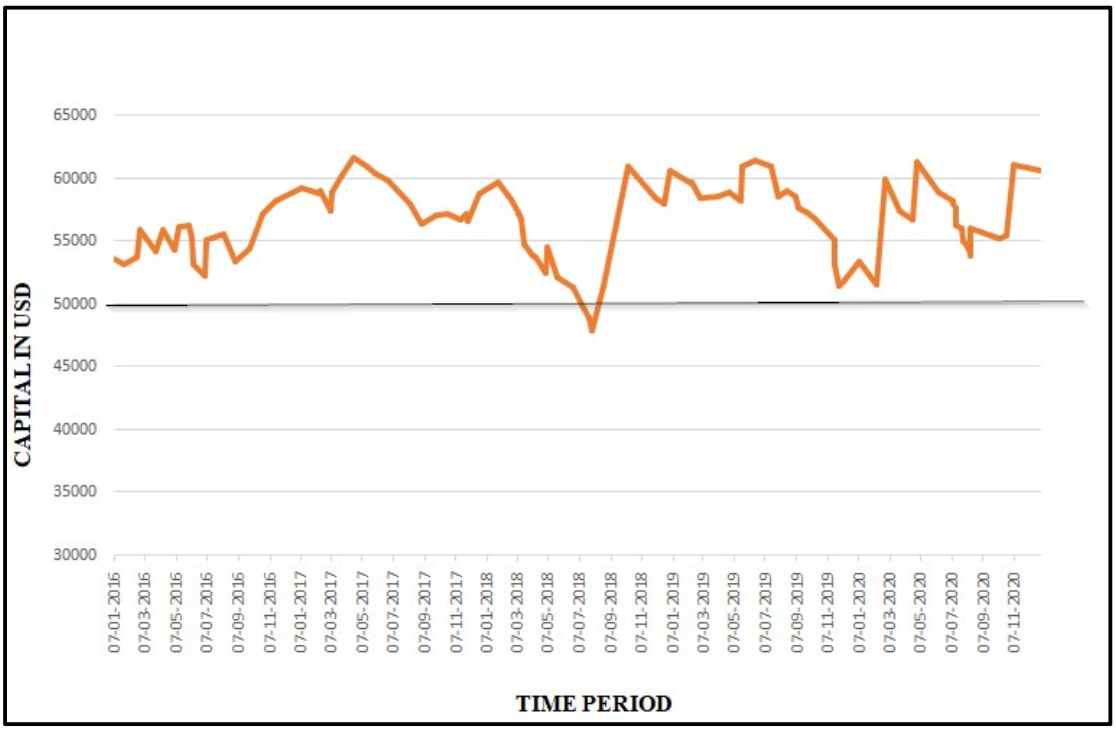
Source: Own processing, 2022

5.2 Strategy 1- Moving Average Crossover and MACD

In this strategy, about 86% of total trades are generated from the signals received from the MACD indicator and moving crossover signals lagged the MACD signals. MACD generated quite frequent signals due to which the trades were not held for longer time durations. Only 38.8% of the total trades were profitable and 61.6% of them resulted in a loss. During the entire period, the stop loss level was triggered 4 times and take-profit for 3 times. These 3 take-profit trades generated a sum of USD 23440. The highest loss of USD 9100 was recorded in the year 2019. Net profit of USD10660 was generated at the end of the assessment period giving a profit factor of 1.17 which is satisfactory.

The figure 18 shows the equity curve for this strategy. It can be seen that capital went down the initial levels only for a short duration in year 2018.

Figure 18. Equity curve for trading strategy MA crossover-MACD



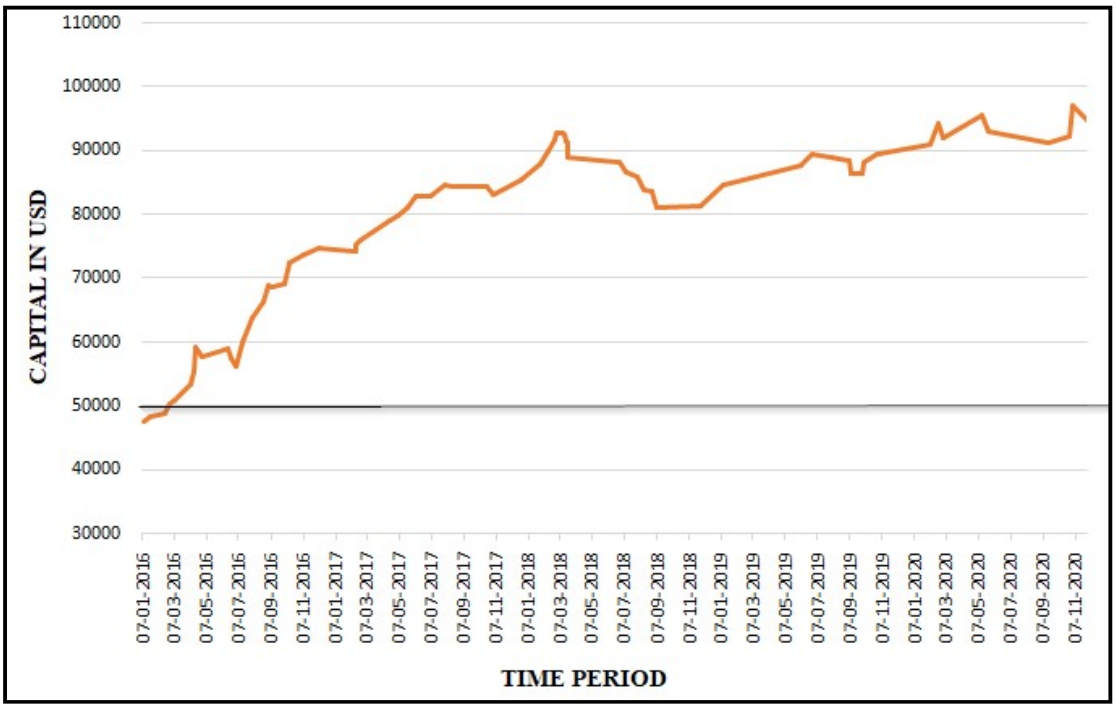
Source: Own processing, 2022

5.3 Strategy 2- Moving Average Crossover and RSI

Here the signals generated by MA crossover and RSI indicator were in the ratio of 2:3. More than half of the trades (59%) generated profit during the observed period. The total loss generated from all 27 loss-making trades during the entire period of 5 years was USD 33310. Stop-loss was triggered only on one occasion on 5 September 2018 and profits did not cross take-profit levels during the entire period under assessment. A net profit of USD 44590 was generated at the end of the assessment period giving a profit factor of 2.34 which is quite good. MA crossover and RSI signals generated maximum profits in comparison to the other two strategies.

It can be seen from equity curve in figure 19 that only capital kept growing and was always above opening level for the whole period after a negative start in 2016.

Figure 19. Equity curve for trading strategy MA crossover-RSI

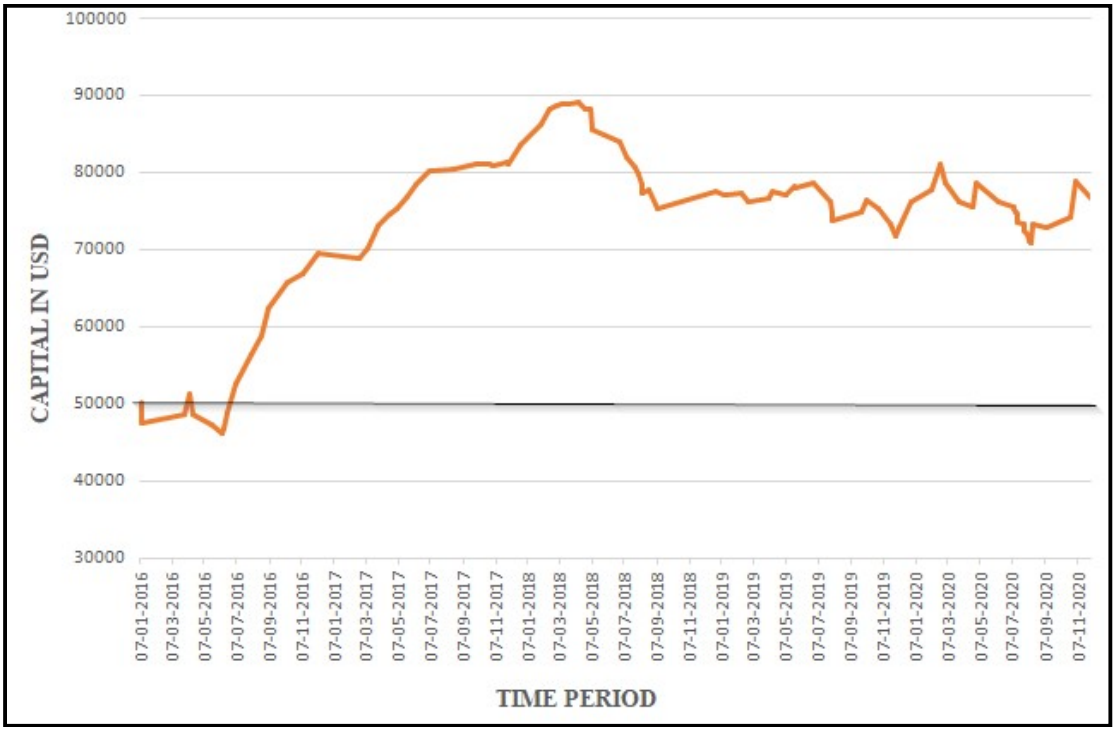


Source: Own processing, 2022

5.4 Strategy 3- MACD and RSI

The signals generated by both the indicators were almost equal. 52.2% of the total trades were profitable. The years 2016 and 2017 generated a profit of USD 32120 while the rest of the years were loss-making. Stop-loss level was triggered 8 times during the assessed period while take-profit was never triggered. A net profit of USD 26600 was generated at the end of the assessment period giving a profit factor of 1.52 which was better than MA crossover and MACD but worse than MA crossover and RSI. This turned out to be the second-best strategy of all three. Figure 20 shows the equity curve for this strategy. Decline of capital can be seen after year 2018.

Figure 20. Equity curve for trading strategy MACD-RSI



Source: Own processing, 2022

6 Conclusion

The objective of this work was to understand commodity trading, crude oil market, financial derivatives, technical analysis, and its tools, and how to use them to design a profitable trading system. The first part of the literature review section discussed the nature of commodities, their classification, factors affecting the prices of commodities in addition to demand and supply forces, the history and evolution of the commodity market, and common platforms where commodities are traded. It further discusses crude oil, its extraction, and transportation which is quite unique and adds further to the cost of the oil. The OPEC countries and their decisions and policies have a huge impact on the oil market as they control about 79.4% of the total known oil reserves of the world. Other big players like Russia and USA also influence the crude oil prices. According to its location and composition, crude oil is classified into different types, namely West Texas Intermediary (WTI), Brent and Dubai.

The second part reviews the financial derivatives mainly futures, swaps, and options, and their use in trading markets for speculation, hedging, or arbitraging purpose. In this study, the closing prices of WTI futures contracts are used for speculative trading. The chapter gives a brief outlook of fundamental analysis and concentrates more on technical analysis as it is the chosen method for predicting the oil prices in this paper. The technical analysis part discusses its basic assumptions, trends formation, type of charts, and indicators. The combinations of three indicators are used in this study to formulate strategies for trading in the market under study. The chosen indicators were Moving averages, MACD, and RSI.

In the practical part, a trading system was developed to invest in WTI futures, which are traded in the CME market. A 5-year data series of WTI daily closing price was taken from2016 to 2020 to simulate the back trading. The crude oil commodity is chosen as it is highly volatile and one of the most important commodities for the economic development of the countries. High fluctuations have been observed in the crude prices in the recent past due to the onset of the current COVID pandemic. Future derivative is preferred over other as it issimple in valuation and more liquid than other derivatives.

Contract specifications are taken in lieu with WTI futures contract details on CME market where size of one contract equals to 1000 barrels of oil. All the prices are quoted in USD.

The value of a single contract is very high and prices of crude oils may fluctuate even up to 5 USD in a day (during the period under observation maximum fluctuation of USD 5.41was seen in a day on 9 March 2020) so the margin requirements in the market are also rather high. To cope up with the high margins a trading account with initial capital of USD 50,000 was setup so that there is sufficient margin available to trade in highly volatile oil market and trades are not suspended due to insufficient amount in the account. To avoid unexpected and huge losses, stop loss is marked at 5% of the initial capital. So, level of USD 2500 (5% of 50,000) was set as stop loss level. Similarly, it is important to book profits in a high volatile market at the correct time and not to second gess and keep greed takeover the decision-making process. So, the first take profit level was set at two times the stop loss level i.e., at USD 5000. If the profit keeps on going forward, the next level was set at USD 7500 and last at USD 9500.

Next, trading rules are defined to enter and exit the market. The long position was entered when buy signals are received and the short position was entered when sell signals are received. The three combinations of indicators- MA crossover with MACD, MA crossover with RSI, and MACD with RSI were used to simulate trades from the entire period under study. The signals for entry were received from crossing over of the two moving averages (10 and 20 days) when the MACD line crosses the signal line and fluctuation of RSI above 70 or below 30. The signals are recorded by using the Track'n Trade platform in version 5.0 End of Day Futures. When a signal was received, a long or short position was opened (depending on the type of signal) and the position was held till the next signal is received to liquidate the current open position. Once it is received, the position is closed and immediately a new position was opened based on it. Only one trade was kept open at a time for avoiding high exposure and capital needs. When the level of stop-loss was hit, the position was closed instantaneously booking a loss of USD 2500. This helped to minimize the losses and hedged the funds. Similarly, when the take-profit level was hit, the market was observed and if the profit falls below the set price, the position was closed booking profit at the set level. In both cases, the next trade was entered on the onset of the next signal by the taken indicators. The process was repeated for all three combinations for the entire period of the data series. The details and calculations can be referredto in the tables provided in the annexure.

For the MA crossover and MACD combination strategy a total of 99 trades were carried out during the entire 5-year period. Out of which, only 38 trades resulted in profit. The MACD signal dominated over the MA crossover signal and generated 85.86% of signals alone. The 13 out of 99 trades generated by MA crossover signals resulted inan overall loss of USD 2890. This means all the profits were generated by the MACD signals only. One signal generated by both the indicators resulted in a profit of USD 2090. The overall profit at the end of the observed period was USD 10660.

The most profitable combination proved to be the MA crossover and RSI one. A total of 70 trades were carried out during the observed period out of which 41 resulted in profit. Though the ratio of trades from MA and RSI was 2:3 theratio of profit generated was 1:6. 29 trades out of 41 generated through RSI resulted in profit while only 12 of 28 trades from MA crossover turned out to be profitable. Two trades end up giving no profit no loss. Trades were exited at stop-loss levels 5 times during the period. The profits raise rapidly during the first two and half years. The overall profit at the end of the observed period was USD 44590.
The third and last combination was of MACD and RSI indicators which generated a total of 90 trades in 5 years under review. Both indicators opened almost equal trade positions (MACD 42 and RSI 44). But maximum profit was generated by the trades initiated by the RSI signal which is 74% of the net profit even though4 out of 6 stop loss trades during the period were from RSI. Only a profit of USD1400 by generated by MACD initiated trades during the assessed period. Five positions were opened based on signals from both the indicators which resulted in a profit of USD 5430. The overall profit at the end of the observed period was USD 26600.

The comparison of all three strategies showed that the RSI and MA crossover was most successful and even though take profit levels were never reached in the entire period and there were 5 stop loss transactions, the highest profits were accumulated using this combination of the indicators. The profit factor came out to be 2.34 for this strategy. Also, the combination of MA crossover with MACD did not work well as MACD supersede the MA crossover signals and only 13 signals were generated by the MA crossover signal, 9 of which resulted in a loss.

Even with RSI, MA crossover though generated 28 signals, 15 of them resulted in loss-making trade. MACD indicator though was not very profitable overall, was able to signal all three take-profit signals when with MA crossover and generated a profit of USD 23440 by 3 trades only.

The crude oil market is highly volatile and capital intensive. A single contact (1000 barrels) may expose the investor to a risk thousand times the price of a barrel of crude. So, may not be suitable for small traders in the market. This study could help the readers to select suitable indicators for trading in the WTI futures market.

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8 List of figures, Tables and Abbreviations

8.1 List of Figures

8.2 List of Tables

8.3 List of Abbreviations

CBOT - Chicago Board of Trade
CME - Chicago Mercantile Exchange
EMA - Exponential Moving Average
ETF - Exchange Traded Funds
ETN - Exchange Traded Notes
ICE - Intercontinental Exchange
MA - Moving Average
MACD - Moving Average Convergence Divergence
NYMEX - The New York Mercantile Exchange
OPEC - Organization of Petrol Exporting Countries
RSI - Relative Strength Indicator
SMA – Simple Moving Average
WMA – Weighted Moving Average
WTI - West Texas Intermediate

9 Appendix

Table 3. Working Chart - MA crossover with MACD

SN	Position	Entry Date	Entry Price	Indicator	Exit Date	Exit Price	Profit/Loss
1	Sell	07-01-2016	52.31	MACD	26-01-2016	48.74	3570
2	Buy	26-01-2016	48.74	MACD	19-02-2016	48.36	-380
3	Sell	19-02-2016	48.36	MA	26-02-2016	47.86	500
4	Buy	26-02-2016	47.86	MA	28-03-2016	50.1	2240
5	Sell	28-03-2016	50.1	MACD	12-04-2016	51.85	-1750
6	Buy	12-04-2016	51.85	MACD	04-05-2016	53.61	1760
7	Sell	04-05-2016	53.61	MACD	12-05-2016	55.23	-1620
8	Buy	12-05-2016	55.23	MACD	02-06-2016	57.11	1880
9	Sell	02-06-2016	57.11	MACD	07-06-2016	57.03	80
10	Buy	07-06-2016	57.03	MACD	10-06-2016	55.97	-1060
11	Sell	10-06-2016	55.97	MACD	01-07-2016	57.99	-2020
12	Buy	01-07-2016	57.99	MA	05-07-2016	56.99	-1000
13	Sell	05-07-2016	56.99	MACD	09-08-2016	54.13	2860
14	Buy	09-08-2016	54.13	MACD	31-08-2016	54.68	550
15	Sell	31-08-2016	54.68	MACD	28-09-2016	56.86	-2180
16	Buy	28-09-2016	56.86	MACD	25-10-2016	57.91	1050
17	Sell	25-10-2016	57.91	MACD	18-11-2016	55.23	2680
18	Buy	18-11-2016	55.23	MACD	09-01-2017	56.25	1020
19	Sell	09-01-2017	56.25	MACD	14-02-2017	55.19	1060
20	Buy	14-02-2017	55.19	MA	15-02-2017	54.69	-500
21	Sell	15-02-2017	54.69	MA	06-03-2017	54.43	260
22	Buy	06-03-2017	54.43	MACD	08-03-2017	52.85	-1580
23	Sell	08-03-2017	52.85	MACD	28-03-2017	51.4	1450
24	Buy	28-03-2017	51.4	MACD	21-04-2017	52.85	1450
25	Sell	21-04-2017	52.85	MACD	15-05-2017	51.45	1400
26	Buy	15-05-2017	51.45	MACD	01-06-2017	50.66	-790
27	Sell	01-06-2017	50.66	MACD	28-06-2017	51.17	-510
28	Buy	28-06-2017	51.17	MACD	10-08-2017	50.55	-620
29	Sell	10-08-2017	50.55	MACD	31-08-2017	52.36	-1810
30	Buy	31-08-2017	52.36	MACD	29-09-2017	50.73	-1630
31	Sell	29-09-2017	50.73	MACD	20-10-2017	49.99	740
32	Buy	20-10-2017	49.99	MA	16-11-2017	50.02	30
33	Sell	16-11-2017	50.02	MACD	27-11-2017	50.37	-350
34	Buy	27-11-2017	50.37	MACD	29-11-2017	50.76	390
35	Sell	29-11-2017	50.76	MACD	22-12-2017	51.28	-520
36	Buy	22-12-2017	51.28	MA/MACD	29-01-2018	53.37	2090
37	Sell	29-01-2018	53.37	MACD	23-02-2018	52.42	950
38	Buy	23-02-2018	52.42	MACD	08-03-2018	51.06	-1360
39	Sell	08-03-2018	51.06	MACD	09-03-2018	52.05	-990
40	Buy	09-03-2018	52.05	MACD	13-03-2018	51.86	-190
41	Sell	13-03-2018	51.86	MA	16-03-2018	51.94	-80
42	Buy	16-03-2018	51.94	MA	19-03-2018	51.54	-400
43	Sell	19-03-2018	51.54	MA	21-03-2018	52.44	-900
44	Buy	21-03-2018	52.44	MA	06-04-2018	51.5	-940
45	Sell	06-04-2018	51.5	MACD	11-04-2018	52.44	-940
46	Buy	11-04-2018	52.44	MACD	01-05-2018	52.25	-190
47	Sell	01-05-2018	52.25	MACD	04-05-2018	53.5	-1250
48	Buy	04-05-2018	53.5	MACD	25-05-2018	55.6	2100
49	Sell	25-05-2018	55.6	MACD	26-06-2018	58.06	-2460
50	Buy	26-06-2018	58.06	MACD	12-07-2018	57.25	-810
51	Sell	12-07-2018	57.25	MACD	25-07-2018	58.53	-1280
52	Buy	25-07-2018	58.53	MACD	02-08-2018	57.4	-1130
53	Sell	02-08-2018	57.4	MACD	22-08-2018	58.35	-950
54	Buy	22-08-2018	58.35	MACD	11-10-2018	61.89	3540
55	Sell	11-10-2018	61.89	MACD	26-11-2018	52.39	9500
56	Buy	04-12-2018	54.22	MACD	20-12-2018	50.4	-2500
57	Sell	20-12-2018	50.4	MACD	31-12-2018	50.89	-490
58	Buy	31-12-2018	50.89	MACD	11-02-2019	53.52	2630
59	Sell	11-02-2019	53.52	MACD	13-02-2019	54.51	-990
60	Buy	13-02-2019	54.51	MACD	01-03-2019	54.57	60
61	Sell	01-03-2019	54.57	MACD	05-04-2019	55.8	-1230
62	Buy	05-04-2019	55.8	MACD	26-04-2019	55.96	160
63	Sell	26-04-2019	55.96	MACD	20-05-2019	55.62	340
64	Buy	20-05-2019	55.62	MACD	22-05-2019	54.92	-700
65	Sell	22-05-2019	54.92	MACD	18-06-2019	52.23	2690
66	Buy	18-06-2019	52.23	MACD	17-07-2019	52.71	480
67	Sell	17-07-2019	52.71	MACD	31-07-2019	53.11	-400
68	Buy	31-07-2019	53.11	MACD	01-08-2019	50.38	-2500
69	Buy	19-08-2019	51	MACD	05-09-2019	51.52	520
70	Sell	05-09-2019	51.52	MA	09-09-2019	52.01	-490
71	Buy	09-09-2019	52.01	MA	26-09-2019	51.1	-910
72	Sell	26-09-2019	51.1	MACD	11-10-2019	51.41	-310
73	Buy	11-10-2019	51.41	MACD	19-11-2019	50.96	-450
74	Sell	19-11-2019	50.96	MACD	21-11-2019	52.68	-1720
75	Buy	21-11-2019	52.68	MACD	29-11-2019	50.67	-2010
76	Sell	29-11-2019	50.67	MACD	06-12-2019	52.36	-1690
77	Buy	06-12-2019	52.36	MACD	08-01-2020	52.64	280
78	Sell	08-01-2020	52.64	MACD	10-02-2020	50.92	1720
79	Buy	10-02-2020	50.92	MACD	26-02-2020	49.06	-1860
80	Sell	26-02-2020	49.06	MACD	09-03-2020	40.75	8310
81	Buy	27-03-2020	37.5	MACD	22-04-2020	34.25	-2500
82	Sell	22-04-2020	34.25	MA	30-04-2020	34.95	-700
83	Buy	30-04-2020	34.95	MACD	12-06-2020	39.62	4670
84	Sell	12-06-2020	39.62	MACD	08-07-2020	42.75	-2500
85	Sell	09-07-2020	42.17	MACD	10-07-2020	42.8	-630
86	Buy	10-07-2020	42.8	MACD	14-07-2020	42.59	-210
87	Sell	14-07-2020	42.59	MACD	15-07-2020	43	-410
88	Buy	15-07-2020	43	MACD	16-07-2020	42.77	-230
89	Sell	16-07-2020	42.77	MACD	27-07-2020	43.89	-1120
90	Buy	27-07-2020	43.89	MACD	28-07-2020	43.65	-240
91	Sell	28-07-2020	43.65	MACD	04-08-2020	44.65	-1000
92	Buy	04-08-2020	44.65	MACD	11-08-2020	44.45	-200
93	Sell	11-08-2020	44.45	MACD	12-08-2020	45.21	-760
94	Buy	12-08-2020	45.21	MACD	13-08-2020	44.98	-230
95	Sell	13-08-2020	44.98	MACD	07-10-2020	42.77	2210
96	Buy	07-10-2020	42.77	MACD	23-10-2020	41.95	-820
97	Sell	23-10-2020	41.95	MACD	05-11-2020	41.74	210
98	Buy	05-11-2020	41.74	MACD	21-12-2020	47.37	5630
99	Sell	28-12-2020	47.27	MACD	31-12-2020	47.68	-410

Table 4. Working Chart - MA crossover with RSI

SN	Position	Entry Date	Entry Price	Indicator	Exit Date	Exit Price	Profit/Loss
1	Buy	42377	52.23	RSI	42382	48.8	-2500
2	Buy	42391	47.68	RSI	42419	48.36	680
3	Sell	42419	48.36	MA	42426	47.86	500
4	Buy	42426	47.86	MA	42437	49.48	1620
5	Sell	42437	49.48	RSI	42467	49.06	420
6	Buy	42467	49.06	RSI	42473	51.67	2610
7	Sell	42473	51.67	RSI	42478	49.67	2000
8	Buy	42478	49.67	MA	42488	53.62	3950
9	Sell	42488	53.62	RSI	42538	55.18	-1560
10	Buy	42538	55.18	RSI	42544	56.41	1230
11	Sell	42544	56.41	MA	42552	57.99	-1580
12	Buy	42552	57.99	MA	42565	56.83	-1160
13	Sell	42565	56.83	MA	42585	53.23	3600
14	Buy	42585	53.23	RSI	42604	57.15	3920
15	Sell	42604	57.15	RSI	42615	54.71	2440
16	Buy	42615	54.71	RSI	42621	57.41	2700
17	Sell	42621	57.41	MA	42646	57.7	-290
18	Buy	42646	57.7	MA	42653	58.16	460
19	Sell	42653	58.16	RSI	42681	54.85	3310
20	Buy	42681	54.85	RSI	42710	56.17	1320
21	Sell	42710	56.17	RSI	42780	55.19	980
22	Buy	42780	55.19	MA	42781	54.69	-500
23	Sell	42781	54.69	MA	42789	53.61	1080
24	Buy	42789	53.61	RSI	42843	54.34	730
25	Sell	42843	54.34	RSI	42860	51.33	3010
26	Buy	42860	51.33	RSI	42879	52	670
27	Sell	42879	52	RSI	42894	50.53	1470
28	Buy	42894	50.53	RSI	42921	52.09	1560
29	Sell	42921	52.09	RSI	42922	52.09	0
30	Buy	42922	52.09	MA	42948	52.22	130
31	Sell	42948	52.22	RSI	42964	50.36	1860
32	Buy	42964	50.36	RSI	43017	49.98	-380
33	Sell	43017	49.98	MA	43028	49.99	-10
34	Buy	43028	49.99	MA	43039	50.06	70
35	Sell	43039	50.06	RSI	43091	51.28	-1220
36	Buy	43091	51.28	MA	43129	53.37	2090
37	Sell	43129	53.37	RSI	43145	50.67	2700
38	Buy	43145	50.67	RSI	43158	52.66	1990
39	Sell	43158	52.66	RSI	43160	50.81	1850
40	Buy	43160	50.81	MA	43172	51.86	1050
41	Sell	43172	51.86	MA	43175	51.94	-80
42	Buy	43175	51.94	MA	43178	51.54	-400
43	Sell	43178	51.54	MA	43180	52.44	-900
44	Buy	43180	52.44	MA	43181	52.3	-140
45	Sell	43181	52.3	RSI	43269	56.35	-2500
46	Buy	43280	57.15	MA	43292	56.42	-730
47	Sell	43292	56.42	RSI	43312	57.84	-1420
48	Buy	43312	57.84	RSI	43325	56.97	-870
49	Sell	43325	56.97	MA	43340	59.02	-2050
50	Buy	43340	59.02	MA	43348	58.82	-200
51	Sell	43348	58.82	MA	43411	62.01	-2500
52	Buy	43433	53.57	RSI	43476	53.92	350
53	Sell	43476	53.92	RSI	43622	50.76	3160
54	Buy	43622	50.76	RSI	43644	53.82	3060
55	Sell	43644	53.82	RSI	43679	51.98	1840
56	Buy	43679	51.98	RSI	43713	51.52	-460
57	Sell	43713	51.52	MA	43717	52.01	-490
58	Buy	43717	52.01	MA	43738	49.97	-2040
59	Sell	43738	49.97	MA	43742	49.97	0
60	Buy	43742	49.97	RSI	43766	51.58	1610
61	Sell	43766	51.58	RSI	43866	50.21	1370
62	Buy	43866	50.21	RSI	43882	51.65	1440
63	Sell	43882	51.65	RSI	43892	48.19	3460
64	Buy	43892	48.19	RSI	43943	34.25	-2500
65	Buy	43964	34.43	MA	43978	38.14	3710
66	Sell	43978	38.14	RSI	44083	42.49	-2500
67	Buy	44090	43.71	RSI	44131	41.74	-1970
68	Sell	44131	41.74	MA	44137	40.58	1160
69	Buy	44137	40.58	RSI	44165	45.32	4740
70	Sell	44165	45.32	RSI	44196	47.68	-2360

Table 5. Working Chart - MACD crossover with RSI

SN	Position	Entry Date	Entry Price	Indicator	Exit Date	Exit Price	Profit/Loss
1	Sell	07-01-2016	52.31	MACD	08-01-2016	52.23	80
2	Buy	08-01-2016	52.23	RSI	08-03-2016	49.48	-2500
3	Sell	28-03-2016	50.1	MACD	07-04-2016	49.06	1040
4	Buy	07-04-2016	49.06	RSI	13-04-2016	51.67	2610
5	Sell	13-04-2016	51.67	RSI	12-05-2016	55.23	-2500
6	Sell	20-05-2016	55.52	RSI	07-06-2016	57.03	-1510
7	Buy	07-06-2016	57.03	MACD	10-06-2016	55.97	-1060
8	Sell	10-06-2016	55.97	RSI/MACD	17-06-2016	55.18	790
9	Buy	17-06-2016	55.18	RSI	05-07-2016	56.99	1810
10	Sell	05-07-2016	56.99	MACD	03-08-2016	53.23	3760
11	Buy	03-08-2016	53.23	RSI	22-08-2016	57.15	3920
12	Sell	22-08-2016	57.15	RSI	02-09-2016	54.71	2440
13	Buy	02-09-2016	54.71	RSI	10-10-2016	58.16	3450
14	Sell	10-10-2016	58.16	RSI	07-11-2016	54.85	3310
15	Buy	07-11-2016	54.85	RSI	06-12-2016	56.17	1320
16	Sell	06-12-2016	56.17	RSI	23-02-2017	53.61	2560
17	Buy	23-02-2017	53.61	RSI	08-03-2017	52.85	-760
18	Sell	08-03-2017	52.85	MACD	28-03-2017	51.4	1450
19	Buy	28-03-2017	51.4	RSI/MACD	18-04-2017	54.34	2940
20	Sell	21-04-2017	52.85	MACD	05-05-2017	51.33	1520
21	Buy	05-05-2017	51.33	RSI	24-05-2017	52	670
22	Sell	24-05-2017	52	RSI	08-06-2017	50.53	1470
23	Buy	08-06-2017	50.53	RSI	05-07-2017	52.09	1560
24	Sell	05-07-2017	52.09	RSI	17-08-2017	50.36	1730
25	Buy	17-08-2017	50.36	RSI	29-09-2017	50.73	370
26	Sell	29-09-2017	50.73	MACD	26-10-2017	50.04	690
27	Buy	26-10-2017	50.04	MACD	31-10-2017	50.06	20
28	Sell	31-10-2017	50.06	RSI	27-11-2017	50.37	-310
29	Buy	27-11-2017	50.37	MACD	29-11-2017	50.76	390
30	Sell	29-11-2017	50.76	MACD	21-12-2017	50.98	-220
31	Buy	21-12-2017	50.98	MACD	29-01-2018	53.37	2390
32	Sell	29-01-2018	53.37	RSI/MACD	14-02-2018	50.67	2700
33	Buy	14-02-2018	50.67	RSI	27-02-2018	52.66	1990
34	Sell	27-02-2018	52.66	RSI	09-03-2018	52.05	610
35	Buy	09-03-2018	52.05	MACD	22-03-2018	52.3	250
36	Sell	22-03-2018	52.3	RSI	11-04-2018	52.44	-140
37	Buy	11-04-2018	52.44	MACD	24-04-2018	52.61	170
38	Sell	24-04-2018	52.61	RSI	04-05-2018	53.5	-890
39	Buy	04-05-2018	53.5	MACD	08-05-2018	53.51	10
40	Sell	08-05-2018	53.51	RSI	18-06-2018	56.35	-2500
41	Buy	26-06-2018	58.06	MACD	11-07-2018	56.42	-1640
42	Sell	11-07-2018	56.42	RSI	25-07-2018	58.53	-2110
43	Buy	25-07-2018	58.53	MACD	02-08-2018	57.4	-1130
44	Sell	02-08-2018	57.4	MACD	07-08-2018	58.46	-1060
45	Buy	07-08-2018	58.46	MACD	08-08-2018	57.18	-1280
46	Sell	08-08-2018	57.18	MACD	22-08-2018	58.35	-1170
47	Buy	22-08-2018	58.35	MACD	05-09-2018	58.82	470
48	Sell	05-09-2018	58.82	RSI	07-11-2018	62.01	-2500
49	Buy	26-12-2018	51.51	RSI	11-01-2019	53.92	2410
50	Sell	11-01-2019	53.92	RSI	13-02-2019	54.51	-590
51	Buy	13-02-2019	54.51	MACD	25-02-2019	54.79	280
52	Sell	25-02-2019	54.79	RSI	05-04-2019	55.8	-1010
53	Buy	05-04-2019	55.8	MACD	11-04-2019	56.22	420
54	Sell	11-04-2019	56.22	RSI	06-05-2019	55.38	840
55	Buy	06-05-2019	55.38	RSI	22-05-2019	54.92	-460
56	Sell	22-05-2019	54.92	MACD	24-05-2019	53.93	990
57	Buy	24-05-2019	53.93	RSI	28-06-2019	53.82	-110
58	Sell	28-06-2019	53.82	RSI	31-07-2019	53.11	710
59	Buy	31-07-2019	53.11	MACD	01-08-2019	50.38	-2500
60	Sell	01-08-2019	50.38	MACD	02-08-2019	51.98	-1600
61	Buy	02-08-2019	51.98	RSI	26-09-2019	51.1	-880
62	Sell	26-09-2019	51.1	MACD	04-10-2019	49.97	1130
63	Buy	04-10-2019	49.97	RSI	28-10-2019	51.58	1610
64	Sell	28-10-2019	51.58	RSI	21-11-2019	52.68	-1100
65	Buy	21-11-2019	52.68	MACD	29-11-2019	50.67	-2010
66	Sell	29-11-2019	50.67	MACD	06-12-2019	52.36	-1690
67	Buy	06-12-2019	52.36	MACD	30-12-2019	53.59	1230
68	Sell	30-12-2019	53.59	RSI	05-02-2020	50.21	3380
69	Buy	05-02-2020	50.21	RSI	21-02-2020	51.65	1440
70	Sell	21-02-2020	51.65	RSI	02-03-2020	48.19	3460
71	Buy	02-03-2020	48.19	RSI	10-03-2020	42.63	-2500
72	Buy	27-03-2020	37.5	MACD	22-04-2020	34.25	-2500
73	Sell	22-04-2020	34.25	MACD	30-04-2020	34.95	-700
74	Buy	30-04-2020	34.95	MACD	27-05-2020	38.14	3190
75	Sell	11-06-2020	39.63	RSI	08-07-2020	42.75	-2500
76	Sell	09-07-2020	42.17	MACD	10-07-2020	42.8	-630
77	Buy	10-07-2020	42.8	MACD	14-07-2020	42.59	-210
78	Sell	14-07-2020	42.59	MACD	15-07-2020	43	-410
79	Buy	15-07-2020	43	MACD	16-07-2020	42.77	-230
80	Sell	16-07-2020	42.77	MACD	27-07-2020	43.89	-1120
81	Buy	27-07-2020	43.89	MACD	28-07-2020	43.65	-240
82	Sell	28-07-2020	43.65	RSI/MACD	04-08-2020	44.65	-1000
83	Buy	04-08-2020	44.65	MACD	07-08-2020	44.34	-310
84	Sell	07-08-2020	44.34	RSI	12-08-2020	45.21	-870
85	Buy	12-08-2020	45.21	MACD	13-08-2020	44.98	-230
86	Sell	13-08-2020	44.98	MACD	09-09-2020	42.49	2490
87	Buy	09-09-2020	42.49	RSI	23-10-2020	41.95	-540
88	Sell	23-10-2020	41.95	MACD	02-11-2020	40.58	1370
89	Buy	02-11-2020	40.58	RSI	30-11-2020	45.32	4740
90	Sell	30-11-2020	45.32	RSI	31-12-2020	47.68	-2360