

WORLD 4 / CHAPTER 3

FUNDAMENTAL AND TECHNICAL ANALYSIS

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The methods for forecasting exchange rates can be separated into three groups, each of which is based on an individual approach.

- Fundamental analysis
- Technical analysis
- Innovative approaches

Fundamental analysis

The analysis of economic indicators that determine supply and demand on FX-markets, is called fundamental analysis. Knowledge concerning indicators and their interdependencies ought to reveal the future development of exchange rates or interest rates. Models of fundamental analysis can be divided in two groups:

- Mono – causal Models: Purchasing Power Parity Theory; Interest Rate Parity Theory
- Integrated Models: Traditional Models
Keynesian Model, Monetary Approach
Asset Market Approach

Technical Analysis

Technical Analysis rests solely on the observation and analysis of historical price movements. Future developments are derived from past price developments. The models of technical analysis can be divided in two groups:

- Chart Analysis: Line Charts, Bar Charts, Candle Charts, Point and Figure Charts, Elliot Wave Theory
- Numerical Models: Trend Chasing Systems such as Moving Averages , MACD.
Anticyclical Systems such as Momentum and RSI
Time Series Analysis

Innovative Approaches

Generally, innovative approaches are numerical models that are based on the experience from informatics and chaos theory as well as from behaviorism. According to these approaches, exchange rates move as dynamic, non-linear systems. Neuronal networks and forecasts based on fractals are already being used. Innovative approaches are classified as follows:

- artificial neuronal networks
- fractal geometry
- pattern recognition

FUNDAMENTAL AND TECHNICAL ANALYSIS

1. Fundamental Analysis

Fundamental analysis explains future movements on FX and interest rate markets with variations of the economies' macroeconomic indicators.

First, fundamental analysis predicts the changes in the indicators so that it can determine the respective exchange rate. For this, information is gathered from publicly available data. Due to the time lag between collection and incorporation of the data about fundamental variables there is no immediate influence on exchange rates. Information about fundamentals often becomes really significant when compared to older data.

A distinction between mono-causal (single-variable) and integrated (multi-variable) models is made.

1.1. Mono-causal Models

Purchasing Power Parity

The purchasing power parity theory states that the exchange rate between two countries is determined by the real purchasing power of the countries' currencies. If identical goods were traded on the world market at different prices, arbitrage processes in goods would cause the supply and demand of goods and consequently of currencies to change and thus the exchange rate to adjust. An arbitrage process is the cheap purchase of goods in a foreign country in order to sell them more expensively in the home country. The exchange rate assures that two currencies, adjusted by the exchange rate, buy the same amount of goods. If the price level in one country and therefore the purchasing power of the currency changes, an adjustment of the parities can be expected in the long run. For example, the currency of a country whose price level rises is devalued.



The economic process can be explained as follows: If prices rise more in the domestic market than abroad the current account balance becomes negative. The demand for foreign currency increases and the domestic currency devalues due to market pressure.

Interest Rate Parity Theory

The interest rate parity theory describes the relationship between the interest rate differential and the swap rate. The economic thought behind this is the fact that the same investment must earn the same profit in the domestic and foreign market. If this were not the case investors would opt for the higher yielding alternative.

If the investment in the foreign market earns a higher yield the investor will hedge his or her currency risk by concluding a forward deal. This way, the exchange rate for the currency exchange is fixed. If currency risk can be eliminated in this way, the interest rate differential must equal the swap rate of the currencies. On the other hand, swap rates are determined by the interest rate differential between the currencies concerned. Since arbitrage in financial markets works rather swiftly, the interest rate parity theory explains rather the short run relationship between interest rate differentials and exchange rates.

1.2. Integrated Models

In contrast to mono-causal models, integrated models explain exchange rate movements with the help of several factors, taken simultaneously into account. Integrated models distinguish between traditional and new models.

Traditional Models

The traditional models are

- the Keynesian model
- the Monetary approach and
- the Asset Market Approach

These models belong to either the group of flow models or of stock models. Flow models are based on changes of the indicators (e.g. income change, asset change), whereas stock models look at the absolute numbers of the indicators (e.g. level of the income or amount of assets).

Keynesian Model

The Keynesian model is a flow model and uses mainly factors of the real economy to determine the exchange rate. The exchange rate is a result of the supply and demand of currencies.

The supply and demand of currencies depends on the size and direction of the trade in goods and services (e.g. transfers of guest workers to their home country). Therefore the current account is the dominant factor for the development of exchange rates. When analyzing exchange rates, the capital account is neglected because all capital flows are a result of activities in the real economy.

Therefore, the exchange rate always equals the relative prices of domestic and foreign goods. An exchange rate movement is caused either by a change in the domestic or foreign interest rate level that determines international capital flows, or a change in real income that influences the demand for exports and imports.

Monetary Approach

The monetary approach for determining the exchange rate is a stock model. It puts particular emphasis on the stock of monetary assets.

All balance of payments transactions are the result of portfolio decisions (investing money in different kinds of equity) taken by domestic and foreign investors. If there is a disequilibrium in the money market, investors adjust their portfolios accordingly. If there is an excess demand in the money market, portfolios are restructured and the foreign exchange demand increases (foreign exchange balance surplus). On the other hand, excess supply in the money market brings about a foreign exchange balance deficit.

Asset Market Approach

The Asset Market approach helps to determine short term foreign exchange rate movements. It is a further development of the monetary approach and is based on stock adjustments. Four assumptions are made:

- complete substitution of domestic and foreign financial assets
- unlimited capital mobility
- immediate adjustments to relevant data changes in the money market
- delayed adjustments to new information in the goods markets

The last assumption allows to keep the public income and the real assets constant in the short run. Thus, capital flows depend exclusively on the portfolio decisions of investors. The result of the portfolio restructuring depends mainly on the profit expectations and the characteristics of the assets (e.g. term structure of the investment opportunities). If monetary policy changes, investors adjust their financial assets. This leads to a change in exchange rate.

New Models

New models develop the traditional models further by incorporating stock variables (asset structure) and flow variables (changes in the current account balance) as well as by including short-term, mid-term and long-term factors for determining exchange rates.

Exchange rate and interest rate movements are often a result of readjustments by investors. On one hand, the new models are designed to include short-term adjustments of financial markets to changing structures. On the other hand, changes in investor expectations are also taken into account.

It is common for banks to produce fundamental analyses for different countries. For this, companies rely on various resources. For example,

- news agencies (e.g. Reuters or Telerate)
- centers for statistics
- central banks
- publicly available information (e.g. newspapers).

2. Technical analysis

Contrary to fundamental analysis, forecasting models of technical analysis are based on the observation and registration of past exchange rates in order to arrive at conclusions about future exchange rate developments from past movements. By tracking the exchange rate, trends and trend turning points should be recognized.

Technical analyses are often self-fulfilling-prophecies. This is true if many market participants interpret the signals the same way and therefore react also in the same way, e.g. sell a currency. Although this criticism is justified, the broad range of technical forecasting models assures that not all people act at the same time in the same way because each model can give a slightly different signal. Furthermore, the users of technical models influence their analyses with individual opinions so that even with the same model two people can draw different conclusions. Finally, trading decisions in the currency markets do not depend solely on the result of one forecast.

The methods of technical analysis are widely used and can be assigned to one of the following two categories:

- Chart Analysis
- Numerical Models.

2.1. Chart Analysis

Chart analysis shows the movement of exchange rates graphically in order to forecast future trends from previous exchange rate developments.

The following charts are in general use

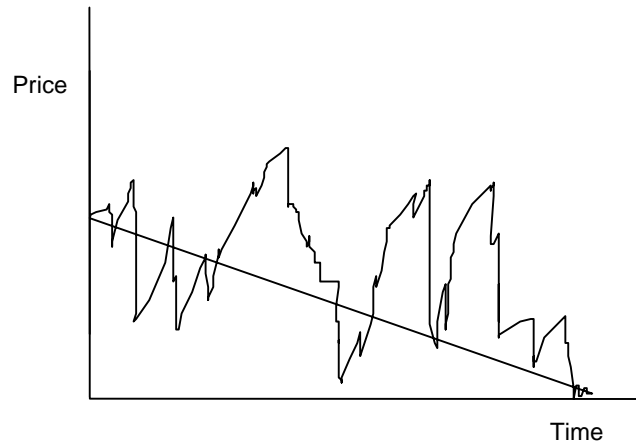
- Line Charts and Bar Charts
- Candle Charts
- Point and Figure Charts
- Elliott Wave Theory

The methods listed above help to determine, in advance, the right time for buying or selling a currency. Their forecasts are based solely on historical exchange rates – paying no attention to any other information. Additionally, we will discuss the Candle Chart which is popular in Japan.

Line Chart

The exchange rates for each time period are plotted in a diagram and the points are joined. Prices on the y-axis, time on the x-axis.

The line chart chooses for example the closing price of consecutive time periods, but can also work with daily, official fixings.

Example**Line chart***Graph 1: Line chart*

The relatively easy handling of line charts is a great advantage. Line charts do not show price movements within a time period. This can be a problem because important information for exchange rate analysis can be lost. This problem was remedied with the development of bar charts that represent a more sophisticated form of line chart.

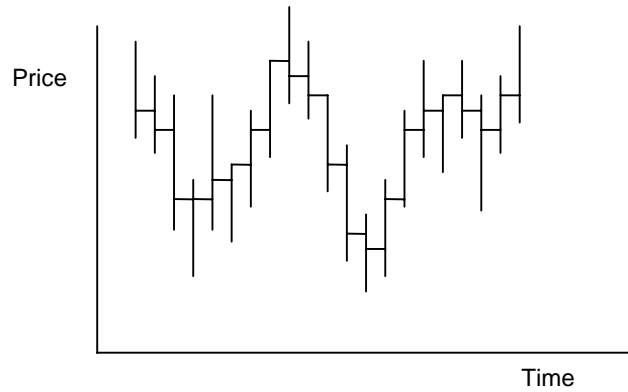
Bar Charts

The highs and lows of a foreign currency are plotted in a diagram and the points are joined with vertical lines (bars). A small horizontal tick to the left denotes the opening level while a small horizontal tick to the right represents the closing price of each interval.

Bar charts are often depicted on a daily basis, though professional traders often use shorter intervals.

Example

Bar chart



Graph 2: Bar chart

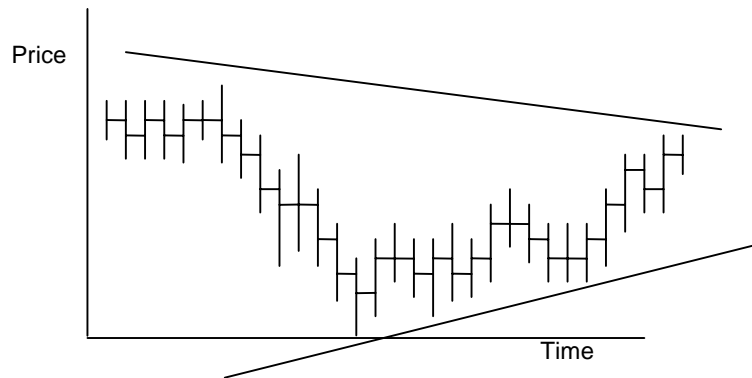
The analyst forecasts the future development of exchange rates from the graph. Therefore the determination of

- trends and trend channels
- resistance and support levels and
- chart patterns

is required.

Trendlines and Trend Channels

Methods to determine a trend assume that trends tend to continue until something seriously happens to change the trend. By drawing lines that touch the peaks and troughs of the chart, trends can be made visible. This requires that the lines are tangent to all bars.

Example**Trendlines**

Graph 3: Trendlines

Despite daily movements the development of foreign exchange rates can, in the long run, be interpreted as a system of overlapping trends of different lengths. According to the length of the trend one distinguishes three types of trends

- Primary trends
- Secondary trends
- Tertiary trends.

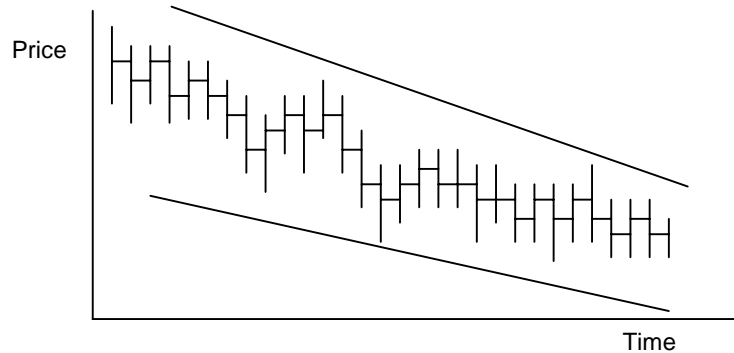
If a spotted trend continues, all future exchange rates are above or under the trendline. If the chart intersects the trendline, the trend either reverses or is interrupted for a short time(consolidation phase). The chart analyst then has to judge the current market situation. He tries to identify certain chart patterns or employ other techniques to interpret the chart.

In Point and Figure Charts trendlines can be drawn as fix 45° trendlines from every point in the chart. These draw a clear line between supply and demand and follow clear construction rules. Fix 45° trendlines can not be used in time-related charts because a change in the scale, particularly on the time axis, would considerably distort the information received from trendlines.

If two parallel trendlines can be depicted in a chart and each of them is a tangent to either the peaks or the troughs, the formation is called a trend channel.

Example

Trend channel



Graph 4: Trend channel

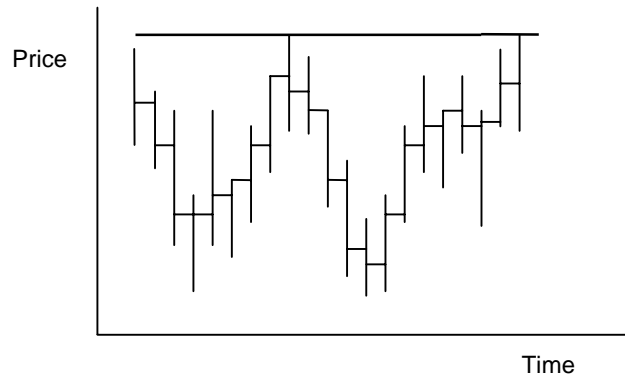
Resistance and Support Levels

Support and resistance levels are levels that a foreign exchange rate can not break through despite various movements in this direction. While in case of a support level the exchange rate remains above the level for a considerable time, the resistance level stops the upward trend of a currency.

If the exchange rate moves for a longer time within a trend channel the upper limit can be taken as the resistance level and the lower limit as the support level.

Resistance and support levels are widely used and are highly acclaimed references in the market because

- they deliver valuable information concerning the highs and lows of an exchange rate and
- because after a break-through a resistance level can become a support level and vice versa.

Example**Resistance level**

Graph 5: Resistance level

Chart Patterns

A chart pattern is a typical, repeating price pattern that can be shown in a chart. A developing chart pattern heralds a certain development of the exchange rate, though the interpretation demands a lot of experience from the analyst. A major distinction is made between

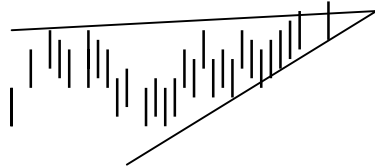
- trend sustaining patterns and
- trend reversal patterns.

Trend sustaining patterns confirm the continuation of the given trend. Trend sustaining patterns include triangles. Triangles are formed by two converging trendlines.

Example

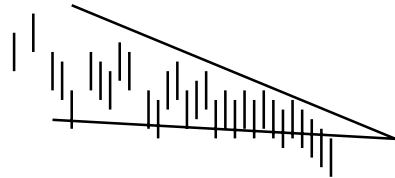
Triangles

Rising Triangle



Graph 6: Rising Triangle

Falling Triangle



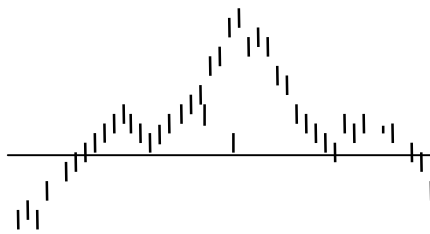
Graph 7: Falling Triangle

If one of the trendlines is a resistance or a support line (level) this indicates that the prices may break through the current level.

If an analyst spots a typical trend reversal pattern in his chart he expects a turn in the current trend. Major trend reversal patterns are shown in the illustrations below.

Example

Trend reversal patterns



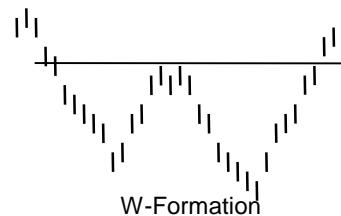
Top and Shoulder - Formation

Graph 8: Top and Shoulder - Formation



M-Formation

Graph 9: M-Formation



W-Formation

Graph 10: W-Formation

The best-known trend reversal pattern is the top and shoulder formation which is similar to a top and two shoulders. It indicates a downward trend. It is formed by three upward movements and two downward movements. By joining the base points of the formation (i.e. the shoulders) the neckline is formed. If the chart penetrates the neckline this is a signal to sell.

Besides top and shoulder formations there exist also Bottom Head and Shoulder formations, that are simply the reverse image of a top and shoulder. Consequently, it generates a buy signal as soon as the neckline is crossed.

Point and Figure Chart

Changes of the exchange rate are symbolized by crosses and circles. A cross (x) denotes a rise in the exchange rate, a circle (o) a fall in the exchange rate. Point and Figure Charts eliminate time and show instead price against price reversals. The price is plotted on the y-axis, price reversals on the x-axis.

New crosses or circles are plotted into the chart only if the change has reached a previously defined size ("boxsize", e.g. 10 pips). That way, negligible price changes are not considered. Identical symbols are depicted in columns. If the exchange rate changes by a multiple of the "boxsize", a new column with according symbols is started. Therefore the x- and o-columns change. The further to the right a column is situated, the more current are the price quotes.

Example

Point and Figure Chart

GBP/ USD quotes

1.5930	X		
1.5920	X		
1.5910	X		
1.5900	X	O	
1.5890		O	X
1.5880		O	
1.5870		O	
1.5860		O	

Indications regarding the development of the exchange rate are derived from the patterns of the consecutive columns. For a simple buy or sell signal the analyst looks first at the current column. If a cross-column exceeds the previous cross-column by at least one cross it is a signal to buy (foreign exchange rate increase). If a circle-column goes below the previous circle-column, it is a signal to sell.

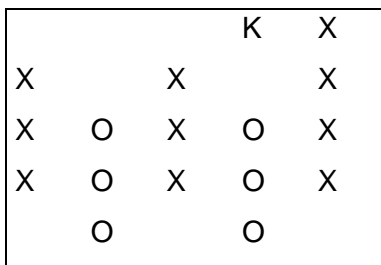
Like bar charts, Point and Figure Charts use trendlines, resistance and support levels.

In addition to simple buying and selling signals, triple tops and triple bottoms are major chart patterns. A triple top consists of three upward trends (three cross-columns) and two downward trends (circle-columns), whereas a triple bottom consists of three downward trends (three circle-columns) and two upward trends (two cross-columns). In each formation the columns alternate. At the triple top the last upward trend exceeds the levels of the two previous upward trends. This indicates a bull market and therefore the currency should be bought. At the triple bottom the last downward trend breaks through the levels of the previous downward trends. This indicates a bear market and the currency is to be sold.

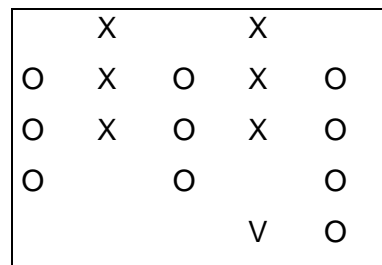
An additional bull signal in a triple top formation occurs, if the bottom of the first circle-column is lower than that of the second. Similarly, an additional bear signal occurs if in a triple bottom formation the first cross-column exceeds the second cross-column. Compare this situation to triangles (chapter 5.2.1.2.3.) with resistance or support lines as trendlines.

Example

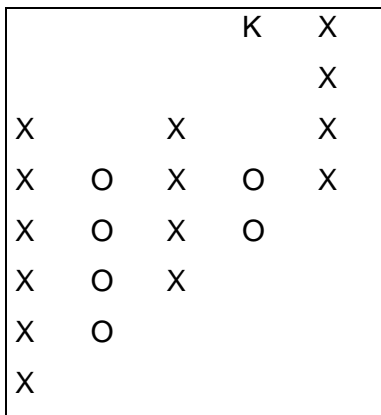
Triple Top Formation and Triple Bottom Formation



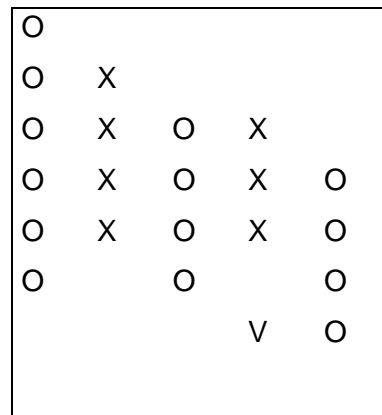
Triple Top



Triple Bottom



Triple Top with Bull signal



Triple Bottom with Bear signal

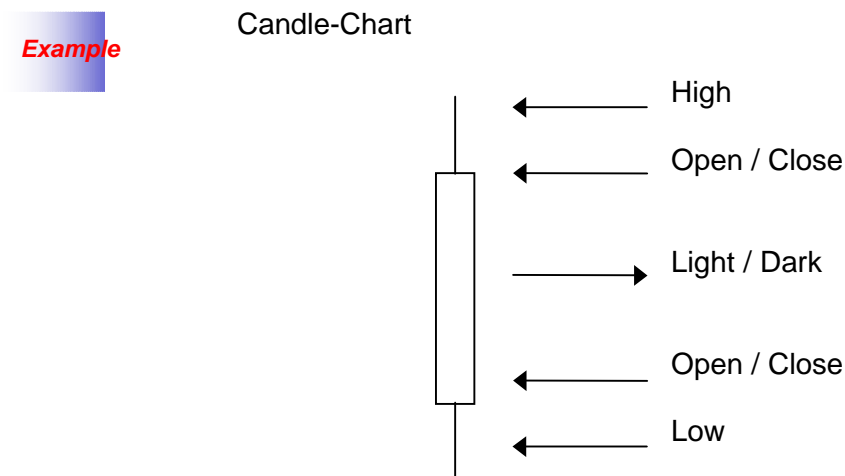
Point and Figure Charts differ from all other charts by using a strict scheme. This particularly helps in an unambiguous definition and recognition of chart patterns. This way, the drawing of arbitrary charts can be eliminated.

Moreover, they enable one to evaluate trading strategies based on Point and Figure Charts by simulating other strategies in the chart with historic data.

Candle-Charts

The price change between opening and closing price is depicted by a broad bar. The color of the bar shows if the price closed lower (black, dark) or higher (white, light).

The shape of a candle is created by a small and thin vertical line that is drawn above or below the bar. It shows if the currency movements were within or outside a stated bandwidth.



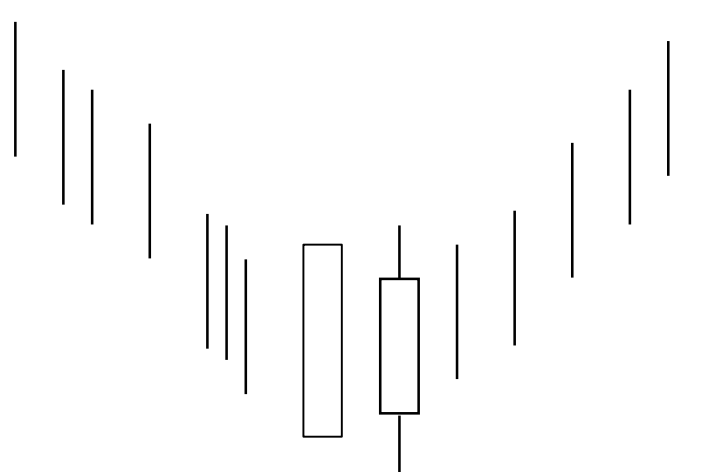
Generally, Candle-Charts do not deliver more information than bar charts (the candle is determined by horizontal ticks that denote opening and closing price of the bar chart). The main difference is the display of the price movements within the interval. The colored candle makes it easy to spot the direction of price movements.

All analyses applicable to the bar chart can also be used in the Candle-Chart. The colored visualization enables the analyst to see additional chart patterns.

Often the sequence of colors and the characteristic shape of the candle lead to specific Candle-Chart formations. If, for example, candles are based on daily data, the color shows if the previous day was bullish (light candle) or bearish (dark candle).



Engulfing Formation (bullish)

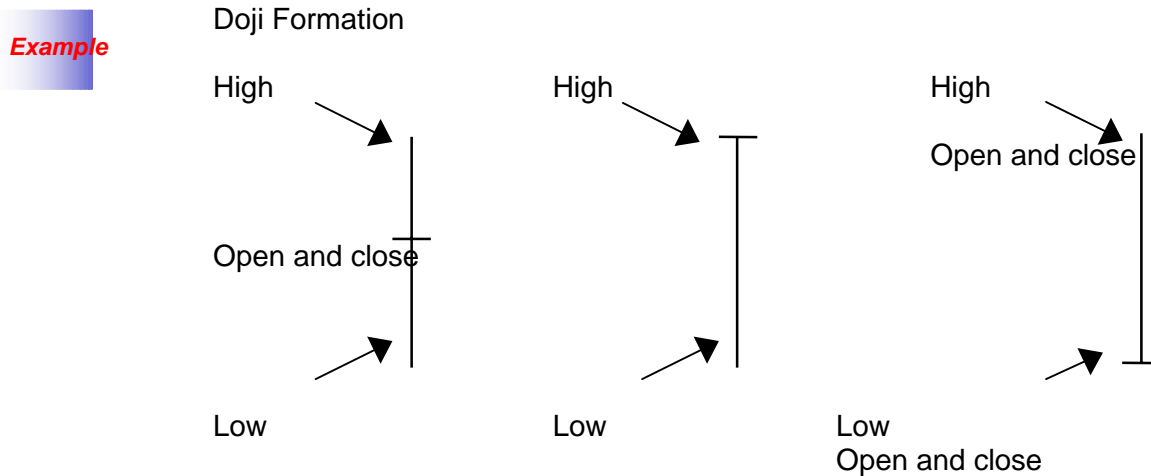


Graph 11: Engulfing Formation (bullish)

If there is already a downward trend in the market and a black candle (usually rather small) is followed by white candle that wraps the black one (i.e. new close > old open; new open < old close) one speaks of a bullish engulfing formation. It indicates the reversal from a current downward trend to an upward trend.

The reverse chart pattern in a market with a current upward trend is called a bearish engulfing formation (i.e. a white candle is followed by a black candle that wraps the white one). It indicates the reversal from a current upward trend to a downward trend.

A special situation occurs in the Candle Chart if bullish and bearish tendencies balance out and the opening price equals the closing price. The result is a candle that consists of a horizontal line only. This formation is called **Doji**.



Graph 12: Doji Formation

If there has been an upward trend before the Doji this is an indication of a ceasing of the trend (i.e. the bulls declined relatively to the bears).

Similarly, a consolidation phase can be expected if a Doji formation can be seen during a downward trend.

Elliott Wave Theory

The Elliott Wave Theory assumes that exchange rates move in waves. These movements take place regularly and can be used for forecasting exchange rates. These assumptions are based on the natural behavior of the market participants.

According to Elliott, prices move in eight waves, of which five are impulse waves and three are corrective waves. Impulse waves are usually denoted with numbers and corrective waves with letters. The following table contains the directions of impulse waves and corrective waves in a bull market (rising exchange rates) and a bear market (falling exchange rates).

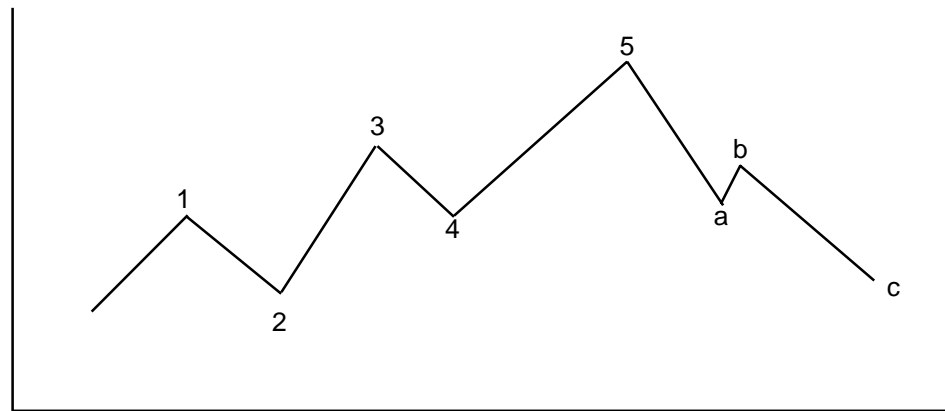
Direction of impulse waves and corrective waves

	<i>Bull cycle</i>	<i>Bear cycle</i>
Impulse waves	First, third and fifth wave move up. Second and fourth down.	First, third and fifth wave move down. Second and fourth up.
Corrective waves	Waves a and c move down, wave b move up.	Waves a and c move up, wave b move down.

Table 1: impulse waves and corrective waves

The wave pattern that is shown in the illustration below for a bull cycle looks similar for bull and bear cycle. The difference is the direction of the impulse waves and corrective waves. The upward movements (downward movements) of the impulse waves and corrective waves in the bull cycle correspond to the downward movements (upward movements) in the bear cycle.

Wave pattern for a bull cycle



Graph 13: Wave pattern for a bull cycle

This basic pattern can be found in each wave movement and repeats constantly. Many small movements can be summed up as a big movement. Elliott defined nine categories of cycles:

1. Great super cycle
2. Super cycle
3. Cycle
4. Primary wave
5. Intermediary wave
6. Mini wave
7. Minute wave
8. Minuette wave
9. Subminuette wave

The analyst must recognize from a bar or line chart the current state of the currency market in order to make a well-founded exchange rate forecast.

The so-called **Fibonacci numbers** play an important role in the Elliott Wave Theory. Fibonacci numbers are a mathematical sequence that follows the natural law of the golden ratio. It means that if one term is divided by its successor the ratio tends towards 0.618. The

Fibonacci Sequence is 1,1,2,3,5,8,13,21,34,55, 89, 144,.....It is generated by the following formula:

$$Z(n) = Z(n-1) + Z(n-2) \text{ for } n > 2$$

$$Z(1) = Z(2) = 1$$

$$Z(n) = n\text{-th Fibonacci-number}$$

A second peculiarity of the Fibonacci Sequence is that alternate terms are related by a ratio of 2.618 and its inverse 0.382. For $Z(1)$ and $Z(3)$ the ratio is 0.5. These three numbers (0.382, 0.618, 0.5) are used by technical analysis as Retracement levels. Retracement levels help to determine the intensity of the corrective wave in relation to the last impulse wave. A retracement level of 0.382 means that the correction was 38.2 % of the last upward trend.

2.2. Numerical Models

Till now we did not distinguish between forecasting, interpretation and the actual trading strategy. But numerical models demand more accuracy. First, we discuss methods (trend chasing systems and anticyclical systems) that aim to pursue a particular trading strategy. In this case, a particular price behavior is assumed. Only in the section on time series analysis will we be dealing with forecasting.

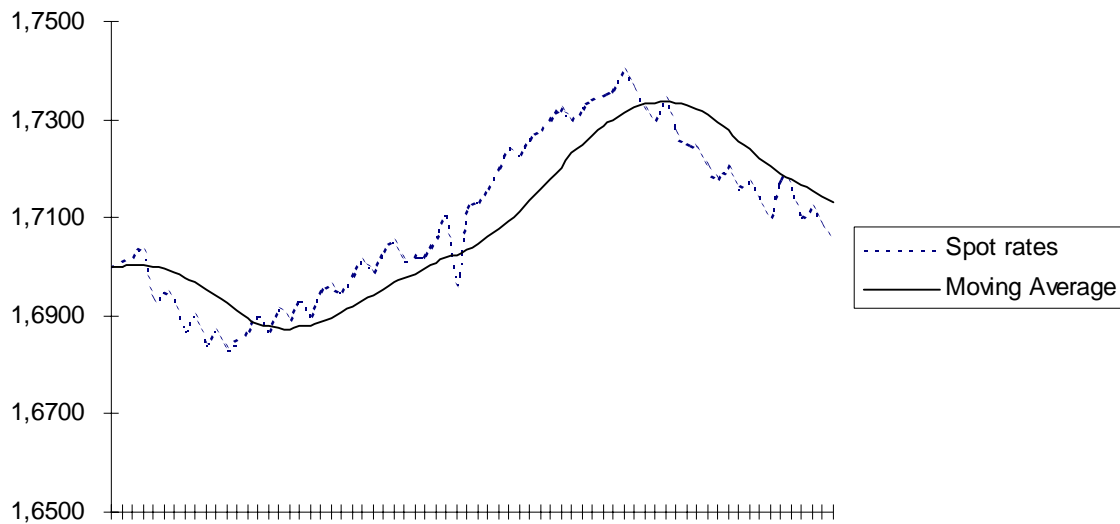
The great advantage of numerical models is the necessity to systemize and to formalize. These requirements force you to describe the presumed and factual relations on financial markets in detail and to understand your own trading strategies.

If you have found a mathematical formula it is easier to check the ideas and strategies by applying them to past situations. Furthermore, simulations can be carried out and strategies can be optimized.

Trend chasing systems

In chart analysis, we showed how trends in price movements are depicted (trendlines, trend channels). Trend phases play an important role because everybody wants to buy at a low (start of an upward trend, end of a downward trend) and sell at a high (end of an upward trend, start of a downward trend).

Typical mathematical trend chasing systems are Moving Averages. Moving Averages are rather simple instruments that serve as the basis for more sophisticated methods. If you plot in a line chart on the price axis averages of the previous days instead of the daily quotes you get a new line, that resembles the original chart but is a little smoother and has a time lag. The longer the average (i.e. the more data is used) the smoother the line and the bigger is the time lag.

Example**Moving Average***Graph 14: Moving Average*

The length of the average is appropriate if the price curve moves in an upward trend above the average and in a downward trend below the average.

If the price crosses the moving average line from above, an upward trend has finished and a downward trend has begun. The reverse case is a signal for a starting bull market.

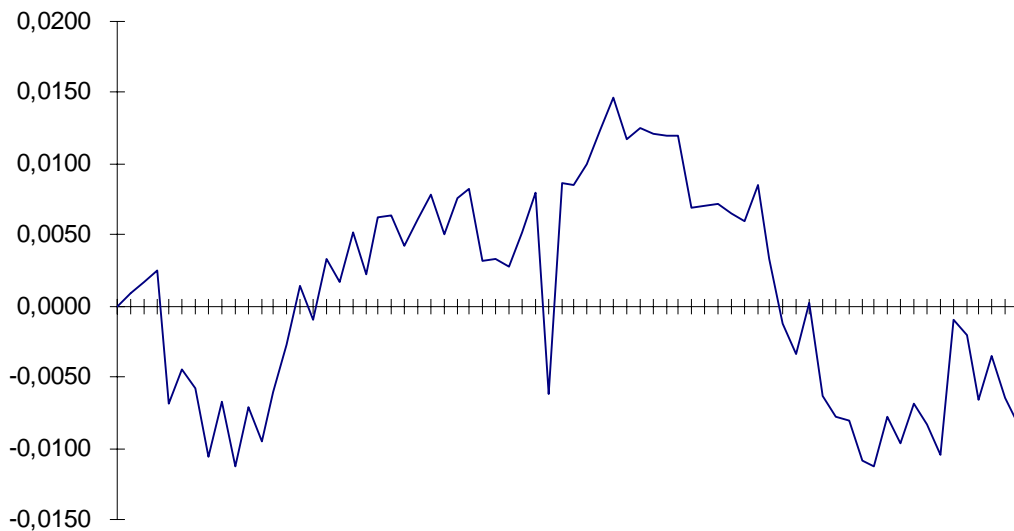
If trends shorten and the highs and lows change frequently, the time lag of moving averages can easily lead to a delayed signal. This is particularly true in sideways moving markets.

Then, it can happen that trading strategies are executed if a new trend is already established. In an extreme case the investor buys always dearly and sells always cheaply.

To remedy this disadvantage, the concept of moving averages is adapted. Instead of looking at the position of price and moving average, one refers to the difference between price and moving average.

 Example

Oscillator

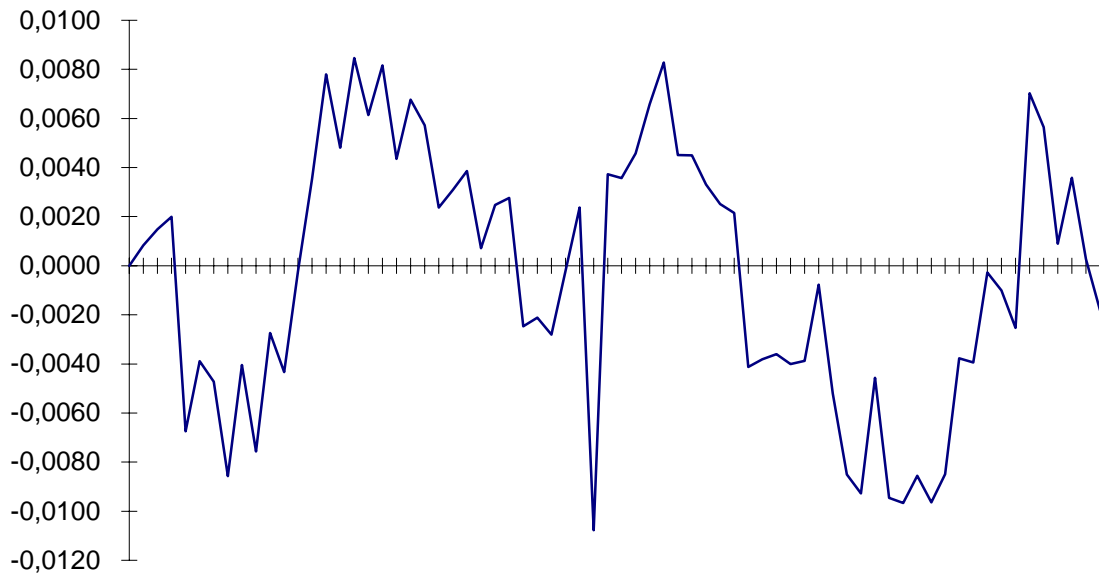
*Graph 15: Oscillator*

The line generated by the difference between price and moving average fluctuates around the x-axis. This picture is called a simple oscillator.

Oscillators are indicators that do not react on price data but to the changes of price data. Oscillators can have positive or negative terms. A positive difference indicates an upward trend, a negative difference a downward trend. The crossing of the x-axis denotes the trend reversal. A trading strategy based on this kind of oscillator resembles the corresponding trading strategy based on moving averages. Therefore, the time lag problem persists, i.e. trend reversals are shown too late. With the introduction of moving averages the significance of oscillators can be improved. This way a smoothed line follows the original curve. Now the crucial crossing is that of the moving average and not that of the x-axis.

Example

MACD (Moving Average Convergence Divergences)



Graph 16: MACD (= Moving Average Convergence Divergences)

The basic idea behind MACD is that the oscillator rather cuts its own average than the x-axis.

Besides the variations based on moving averages, many other systems can be developed and are used in practice.

Among others, oscillators are employed in combination with anticyclical systems such as momentum and RSI of Welles Wilder.

Anticyclical Systems

Contrary to trend chasing systems, anticyclical systems refer to exchange rate changes rather than absolute exchange rates. Major anticyclical systems are

- Momentum
- Relative Strength Indicator (RSI)

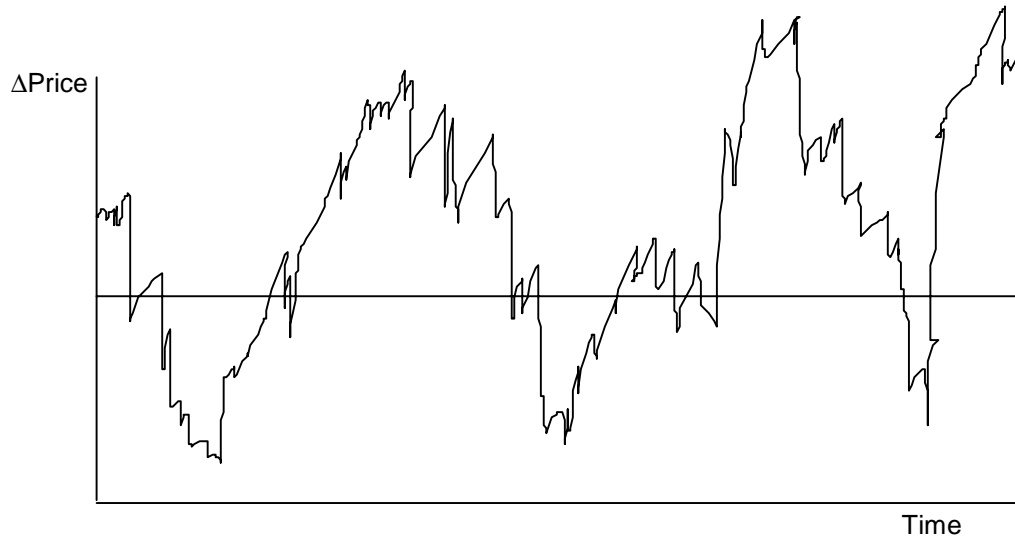
Momentum

The term momentum denotes the absolute change between two exchange rate quotes within a fixed time interval (e.g. price movements over the last 10 days).

The momentum is plotted in a chart where time is on the x-axis and price changes are on the y-axis. Linking the momentum points generates the momentum curve. If the individual opinion of the future price movements corresponds to the interpretation from the momentum, the momentum becomes a trend chasing system. To receive an anticyclical system you have to look at the slope of the momentum.

Interpretations of the momentum

<i>Momentum</i>	<i>Interpretation</i>
> 0	Exchange rate rose
= 0	Exchange rate did not change
< 0	Exchange rate fell

Example**Momentum curve***Graph 17: Momentum curve*

Momentum curves indicate trend reversals very early. If the momentum is positive (negative), the momentum curve falls (rises) even before the top (bottom) has been reached. The momentum should not be used as single trend indicator because it is prone to send wrong trading signals. Used in conjunction with other forecasting methods (e.g. moving averages) the momentum can be very useful as leading indicator.

Relative-Strength-Indicator of Welles Wilder

The Relative-Strength-Indicator is derived from an exchange rate comparison. Contrary to the momentum, the RSI compares many different exchange rate quotes. Moreover, the RSI lies always between 0 and 1.

The RSI is a ratio calculated by dividing the average price increases by the average price decreases of the same period. It is crucial to keep the time period between the compared prices constant (e.g. one day, one hour).

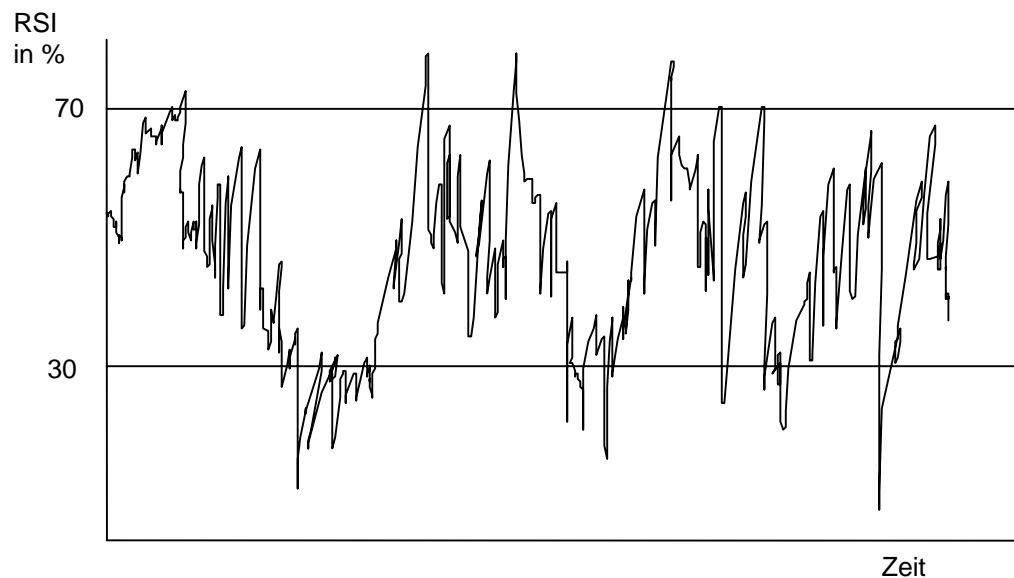
Interpretation of RSI-values:

<i>RSI</i>	<i>Interpretation</i>
< 0.5	The average profit (profit per subperiod) of the term was lower than the average loss.
= 0.5	The average profit (profit per subperiod) of the term equaled the average loss.
> 0.5	The average profit (profit per subperiod) of the term was higher than the average loss.

The RSI-values are plotted periodically into the RSI-Chart and the points are joined. The RSI is often quoted in per cent. Therefore, it takes on values between 0 % and 100 %.

Example

RSI-curve



Graph 18: RSI-curve

RSI-values between 0.3 and 0.7 do not indicate a trend reversal whereas results

- lower than 0.3 or
- higher than 0.7

indicate consolidation and herald a trend reversal.

If the RSI is higher than 0.7 the currency market is said to be "overbought". If the RSI is lower than 0.3 the market is said to be "oversold".

Time-series analysis

Time-series analysis is a broad field in mathematics and statistics. A time-series can simply be described as being the sequence of values pertaining to certain dates. A statistician then defines a stochastic process. A series of daily exchange rates is for him an outcome of the stochastic process.

The statistician aims to develop a mathematical model that can describe the stochastic process. If the description is also valid for the future one can also forecast the realizations. A time-series analyst divides a time-series in three components:

- I. trend
- II. cycle
- III. chance

His analyses focus on the exact identification and analysis of these components.

Since the results of the scientific work has not yet received much attention in the daily business we do not want to dwell further into this topic.

Innovative Approaches

The latest developments in technical analysis (since about 1990) are characterized by the use of innovative methods to analyze time-series. They often differ from statistical methods though they are not less complex. Their origin lies in science, particularly informatics and behaviorism.

Neuronal Networks

With the help of neuronal networks neuro-biologists tried to simulate their models of human learning, thinking and forgetting using computers. Neuronal networks learn, generalize, can be trained and even learn by heart. These attributes serve rather to emphasize the image of neuronal networks than to describe their real characteristics. Neuronal networks neither think nor are they intelligent. (They are rather a research area in artificial intelligence)

Neuronal networks are employed by several banks to forecast exchange rates (Commerzbank, Landesbank Hessen-Thüringen, WestLB). They are fed with historic price data and change their inner structure according to the deviation of the forecast from the actual price. Thus a model describing the relationship between historic and future prices is created. A continuation of these relations makes forecasts possible.

To classify neuronal networks as a method of technical analysis is not exactly correct. If neuronal networks forecast prices, they use time-series from other markets (e.g. stock market, interest market,...) in addition to the historic price data. This way, neuronal networks can be seen as a hybrid of fundamental and technical analysis, accordingly they are also labeled "synergetic analysis".

Fractal Geometry

The basic idea behind fractal geometry is that structures that appear in general (e.g. chart patterns in a monthly chart) also appear in detail (e.g. in a daily chart). If the relations between these structures (general and detailed) can be mathematically expressed additional information concerning these structures can be received.

The average change of a time-series is a good example. This is certainly bigger if the time series is based on monthly data and not on daily data. The relationship between the average changes can be described by the relationship between the corresponding periods (month and day). This description discloses further information about the changes in the time-series.

The forecasting system of the Swiss company Olsen & Associates, Zurich, pays attention to this kind of ideas. In combination with other considerations the time-axis is transformed. Various numerical methods are applied to analyze the resulting price series (with non-linear time-axis) and to get forecasts and trading signals. To use the result also in the real-time (linear!) context, a re-transformation of the time-axis is necessary.

The forecasting systems of Olsen & Associates are employed by several banks.

Pattern Recognition

Statistics and applied informatics are the origins of pattern recognition methods. Like the classic chart analysis it also tries to recognize patterns and formations in the price movements. Chart analysis defines formations (triangles, top-shoulder-formations) and their meaning in order to compare the current chart pattern with defined patterns. Pattern recognition looks first at the current situation and compares the observations with similar events in the past. These systems learn from historic situations for the future. The employment of pattern recognition in foreign exchange trading seems to be almost non-existent.

Summary of fundamental analysis

<i>Method</i>	<i>Model</i>	<i>Principle</i>
Mono-causal models		Explanation of exchange rate movements by one variable
	Purchasing Power Theory	Exchange rates are determined by the real purchasing power
	Interest Rate Parity Theory	The exchange rate is the result of the relationship between interest rate differential and the swap rates
Integrated Models		Explanation of exchange rate movements by various variables
Traditional models	Keynesian model	Exchange rates are determined by supply and demand
	Monetary approach	Exchange rates are the results of portfolio decisions taken by investors.
	Asset-Market-Approach	Further development of the monetary approach. Based on portfolio individual adjustments
New Models		Try to combine stock variables and flow variables in one model

Summary technical analysis

<i>Method</i>	<i>Model</i>	<i>Principle</i>
Chart analysis	Line chart	Individual prices are joined by a line
	Bar chart	Highs and lows of an interval are joined by a vertical line; opening and closing prices are denoted by horizontal ticks
	Candle-Chart	Price differences between opening and closing prices are marked by differently colored candle-bars
	Point-&-Figure-Chart	Crosses and circles are plotted in the chart as soon as prices changed by a pre-defined amount
	Elliott-Wave-Theory	Hypothesis that exchange-rate movements follow a regularly repeating wave pattern.
Numerical Models	Trend chasing systems	Identification and chasing of exchange rate trends.
	Anticyclical systems	Systemizing of different price movements and patterns; recourse on price changes, not on absolute data
	Time-series analysis	Statistically founded theories to examine time-series; time-series are divided into trends, cycles and chance.

Overview of innovative forecasting methods

<i>Method</i>	<i>Example</i>	<i>Principle</i>
Innovative forecasting methods		Complex mathematical approaches to model non-linear dynamic relationships
	Neuronal Networks	"Learn" from the past experience, in order to react correctly in the current situation
	Fractal Geometry	Attempt to describe the inner structure of price developments, to get additional information about the distribution of price changes
	Pattern Recognition	Comparison of the current pattern with similar patterns from historical simulations, in order to model the future price