Summa Management LLC

Alternative Graphical Specifications for Analysis of Securities Price Movements

Objectives

- Drive implementation to align with customer (= Kal, Joe, Ron) requirements
- Develop and evaluate custom trading algorithm for each security
- Identify and include necessary and sufficient data for effective trading algorithm
- Consolidate info (fundamental, technical, other analysis for this security?) in one place
- Compare with indices, etc.
- Visualize trends
- Implementable with current technology
- Practical amount of effort to implement and use
- Adequate performance (throughput – securities/hour)
- Reasonable cost (data sources, tools)
- Easily distributed (to Kal, Joe, Ron)
- Determine what to show in tabular form versus graphical form
- Graphs and data shown will vary for different types of securities
- Initially only for stocks and Exchange Traded Funds (ETF's)
    - ETF's include stock indices, bond funds, forex, commodities, etc.
- Produce hard copy and electronically viewable output
- Fit hard copy on a reasonable number and size of sheets

Scalability

- Adaptable to cover short to long time frames
- Narrow to wide price variability (good graph resolution with varying dynamic range)
- Able to automate to process a list of securities automatically
- Able to divide tasks among multiple setups to increase throughput

Extensibility

- Ease of adding new data elements (such as more "causes")
- Ease of adding additional technical indicators
- Ease of performing comparisons between securities or indices
- Reconfigurable for additional classes of securities

Verification

- Data cleansing (discussed below in more detail)
- Independent cross-checking of formulas and computations
- Compare output to that from on-line graphing programs

Miscellaneous

Integration with trading system

- Not required

Integrate human analysis

- Pencil/pen markups on paper graphs
  - Classification into regions
  - Quantifying trends
  - Identifying correlations
  - Identifying graph patterns
  - Producing trading signals
  - Notes
- Transcribe to electronic files
  - To distribute for review
  - To archive
  - Possibly to quantify (slope, length, etc. for lines)
- Alternately capture notes and markings electronically from the start

Back-testing

- Curve interpretation has to be done without seeing (and being biased by) the "future"
  - Hide the graph beyond some date and analyze up to that date, then progress
- Input trading algorithm from user and compute & graph returns versus time
  - Weighting factors for each cause
  - Enable and disable causes per classifications (such as in a trading range, trending, economic cycle, etc.)

Data Alignment

- Different exchanges around the world operate on different calendars with different holidays, and occasionally a security will have its own "trading holiday". Thus trading days often don't align between securities and other data sources (date of N^{th} trading day of the year of security #1 ≠ date of N^{th} trading day of the year of security #2).
- Thus data sources need to be date aligned before they are compared, and gaps where there is data in one source but none in the other need to be dealt with. Ways to deal with this are:
  - Linearly interpolate missing datapoints
  - Replicate prior datapoint to fill in a missing datapoint
  - Remove corresponding datapoint from second dataset when there is a gap in first dataset

Data Cleansing

- Simple algorithms should be used to flag data that is suspect. An examples is:
  - Isolated datapoint that is significantly larger or smaller than adjacent datapoints (note that a step function can be caused by a split or dividend, and thus would not be from erroneous data – see below)
- If data is indeed found to be corrupted, the following can be done:
  - A different data source (provider) can be utilized
  - The data can be patched up manually by finding the correct data from another source or understanding the cause of the error (such as a shifted decimal place)
  - The damaged data can be removed and replaced by adjacent data or a void (either algorithmically or manually)

Splits and Dividends

- Data services such as Yahoo! Finance report both a closing price and an "adjusted closing price", which accounts for splits and dividends (with dividends being reinvested in the security). Swing trading likely holds securities for shorter than the interval needed to qualify to receive dividends, so dividends should be excluded from the "adjusted price" that is used to compute trading system returns.
- For computing trading returns, a price adjusted for splits needs to be used, as the multiplied number of shares is cancelled by the divided price-per share. Since some buyer & seller behavior is predicated on the absolute price, it is also useful to graph the unadjusted (for both splits and dividends) price.

Methodology

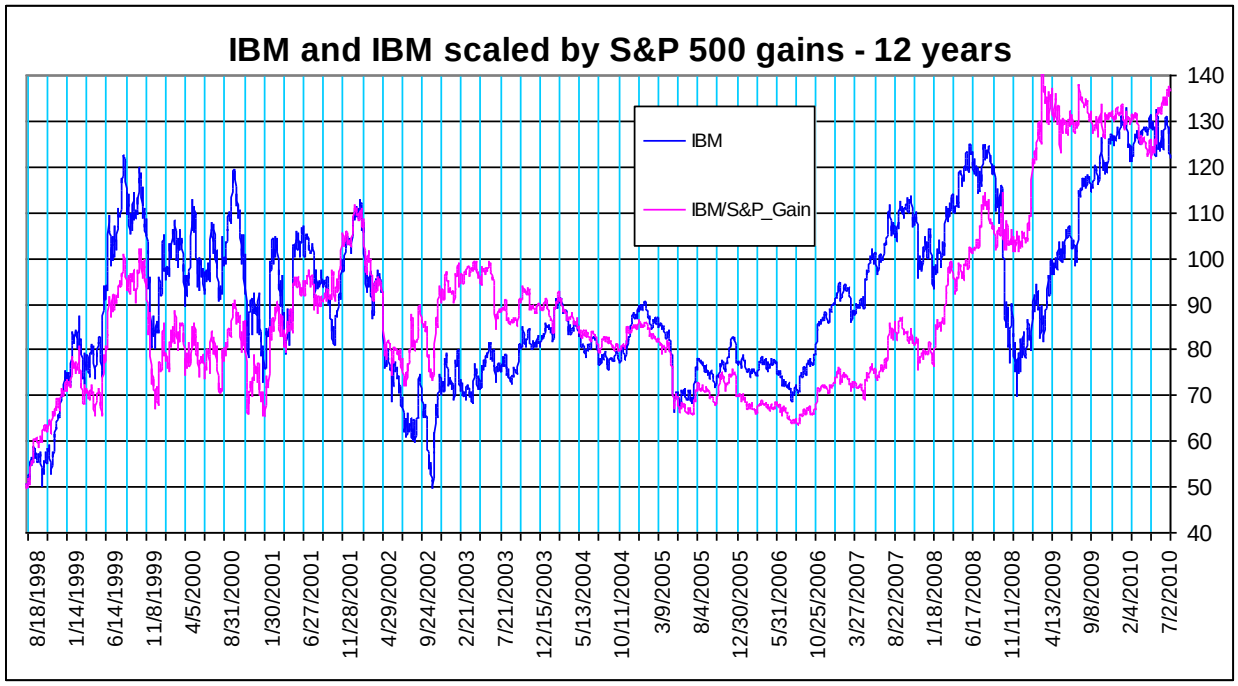
- Mock-up first for usability feedback
  - With Excel
- Automate graph generation for analysis phase
  - Explore state-of-the-art in commercial software packages for traders
  - Evaluate capabilities of service providers (brokerage houses, etc.)
  - Excel + Visual Basic for Applications (VBA) may suffice
  - MATLAB is better suited than Excel for processing large datasets, when 3D visualization is dictated, and when processing algorithms become complex or sophisticated
  - User groups and 3rd party vendors accumulate code (available for free or a small fee) that may accelerate development in Excel or MATLAB
    - Technical indicators
    - Forecasting
    - Statistical analysis

Maintainability

- Documented adequately for the original developer (Ron) to maintain

What to graph (for stocks)

Prices – scaling	Pros	Cons	Recommendation
Actual prices (no scaling)	Incorporates buyer psychology – more cautious with expensive stocks, more risk-taking with cheap stocks	Artificially shows decrease (split) or increase (reverse split) in value for all time after the event (see the graphs that follow)	Chart this
Split-adjusted prices	Conveys true picture of how stock did over time		Chart this too
Split + dividend adjusted prices	Commercial technical analysis and graphing tools seem to use this	Likely holding stocks too short of a time to qualify for the dividend, so it is inaccurate to include it	
Normalized to an index or other security	Shows relative performance	Adds noise of the index to the noise of the stock	


IBM and IBM scaled by S&P 500 gains - 12 years
IBM
IBM/S&P_Gain
140
130
120
110
100
90
80
70
60
50
40
8/18/1998
1/14/1999
6/14/1999
11/8/1999
4/5/2000
8/31/2000
1/30/2001
6/27/2001
11/28/2001
4/29/2002
9/24/2002
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8/4/2005
12/30/2005
5/31/2006
10/25/2006
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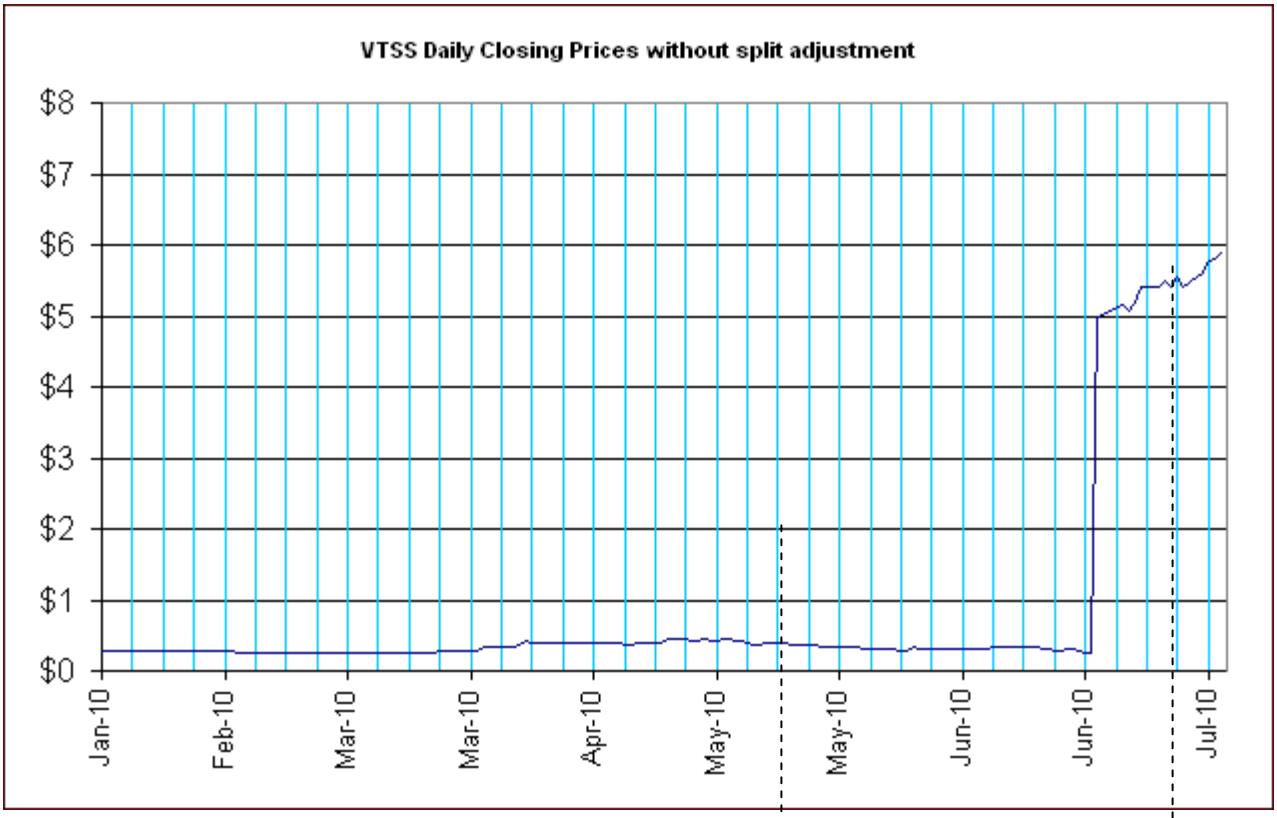
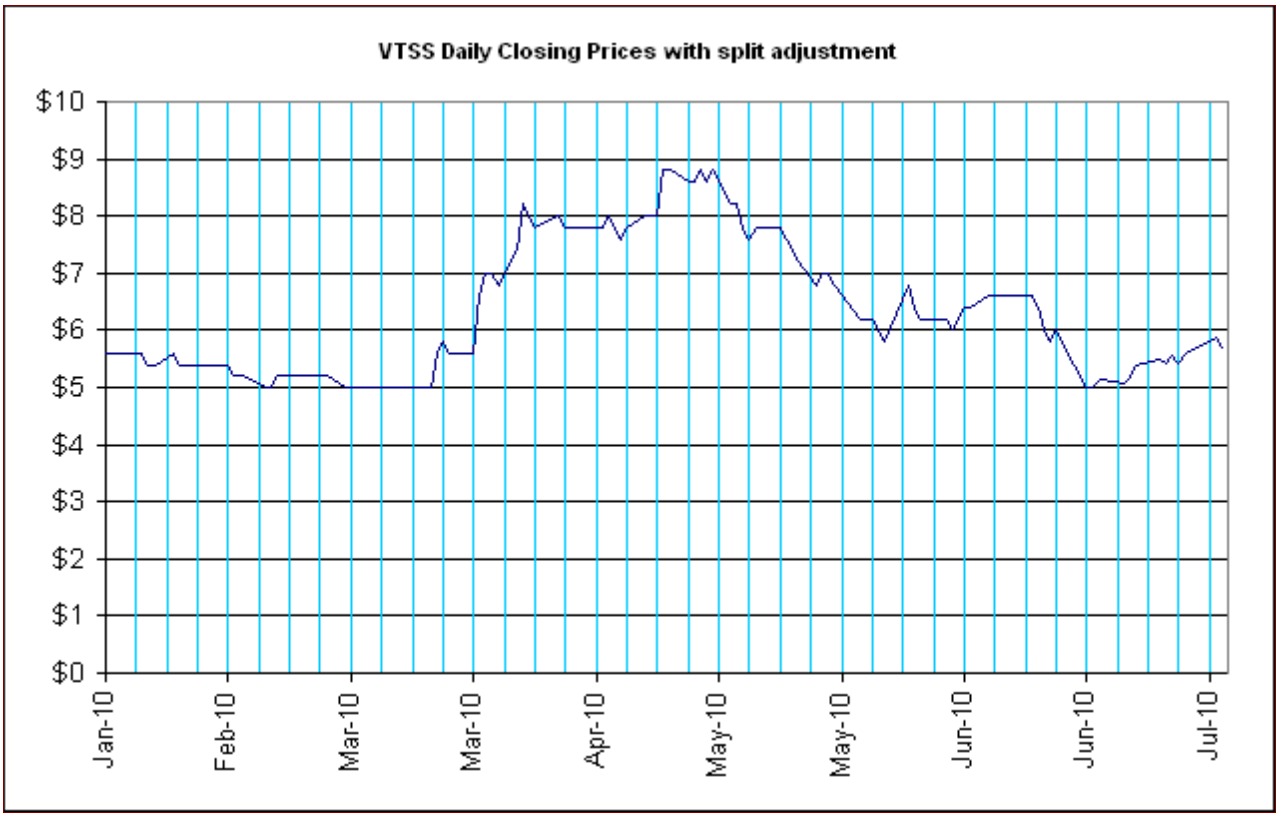
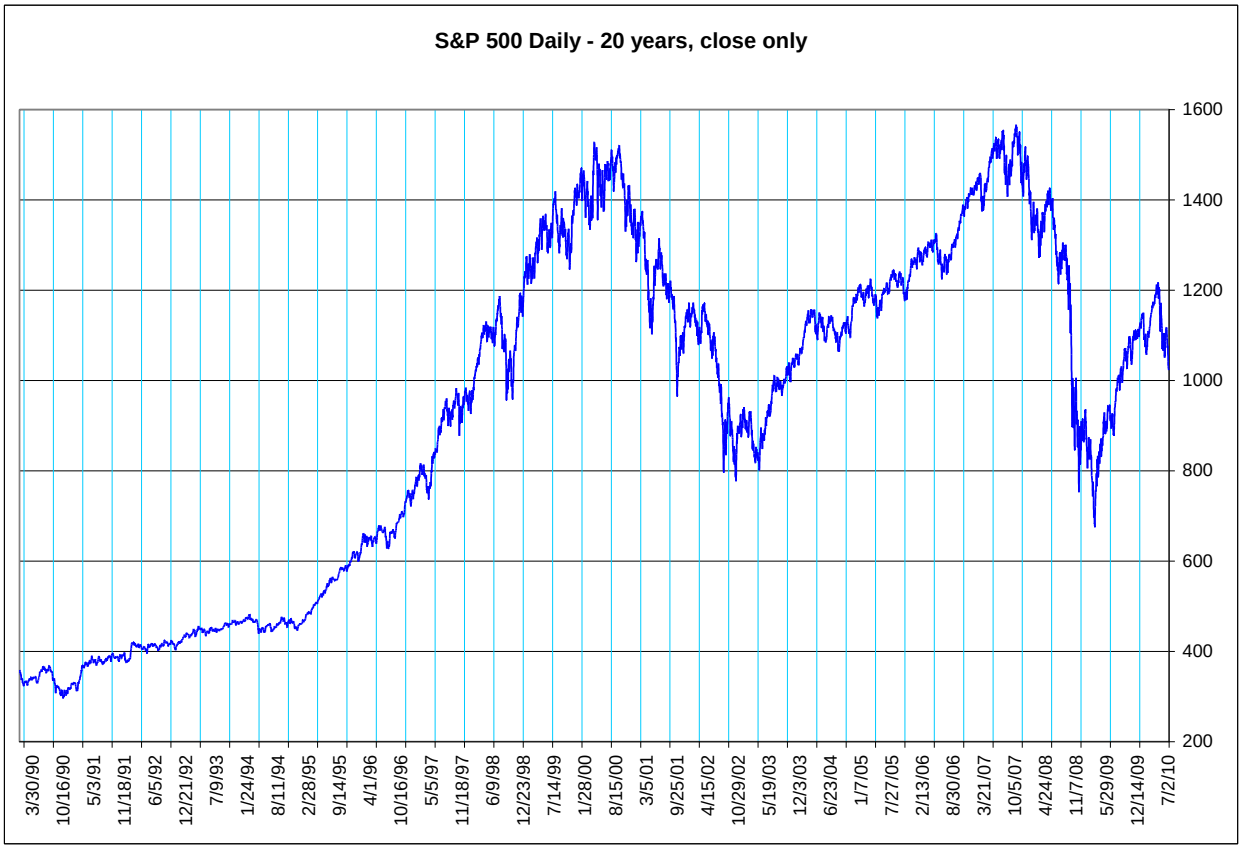
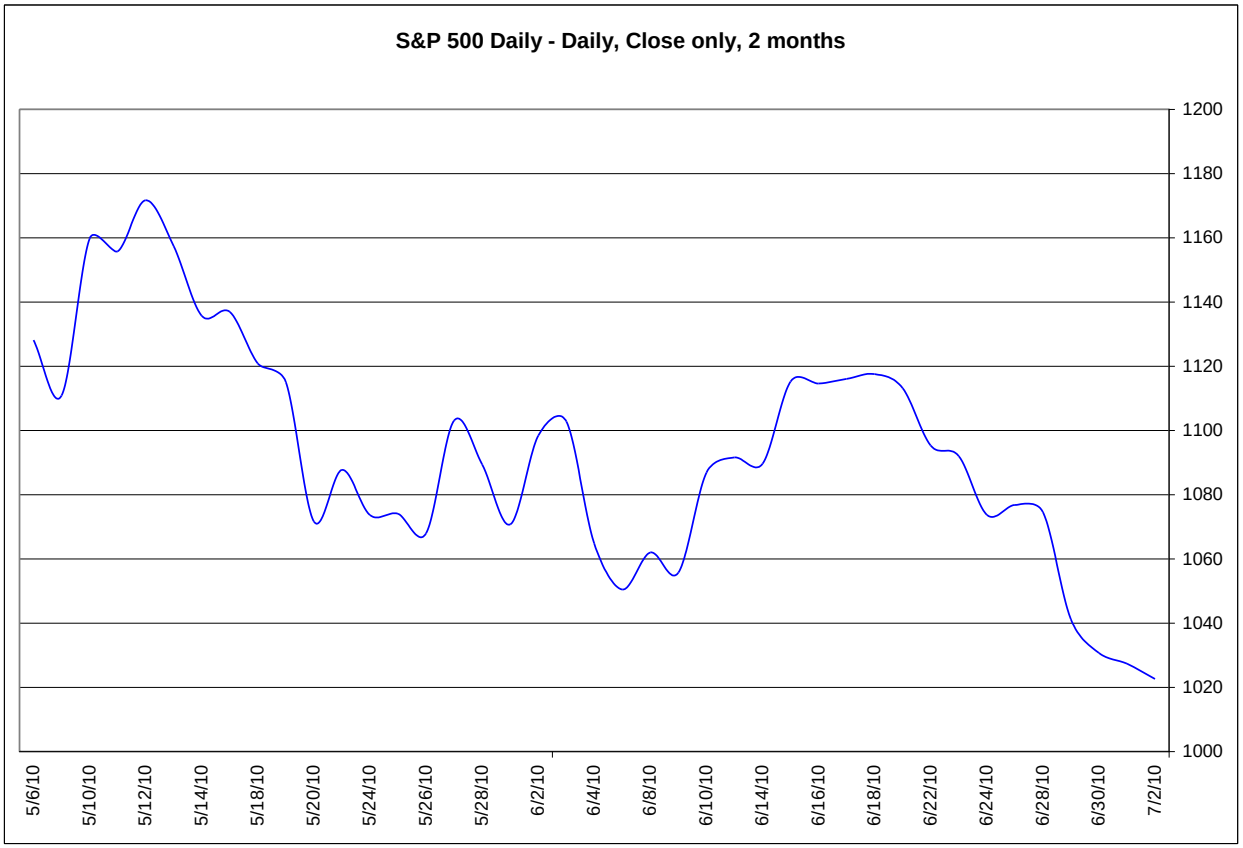
4/13/2009
9/8/2009
2/4/2010
7/2/2010

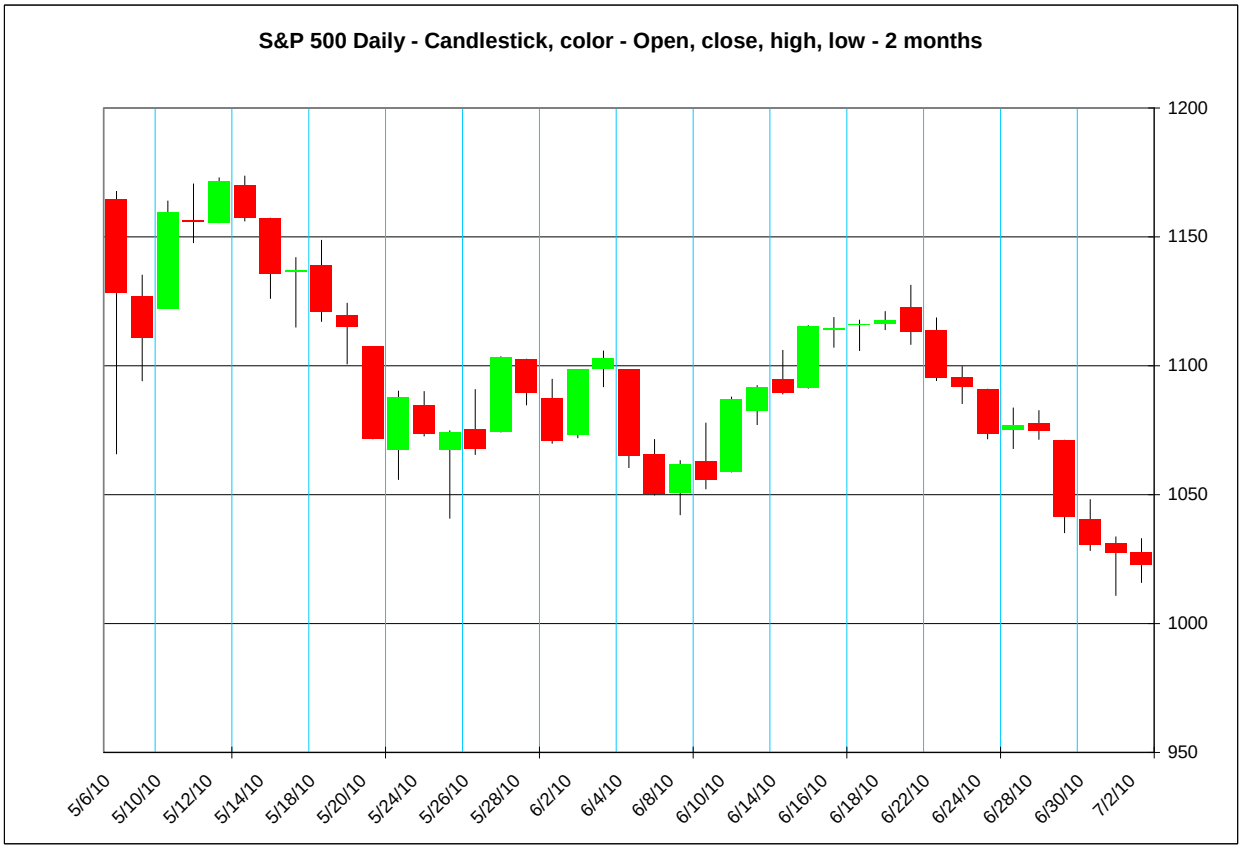

VTSS Daily Closing Prices without split adjustment
$8
$7
$6
$5
$4
$3
$2
$1
$0
Jan-10
Feb-10
Mar-10
Mar-10
Apr-10
May-10
May-10
Jun-10
Jun-10
Jul-10



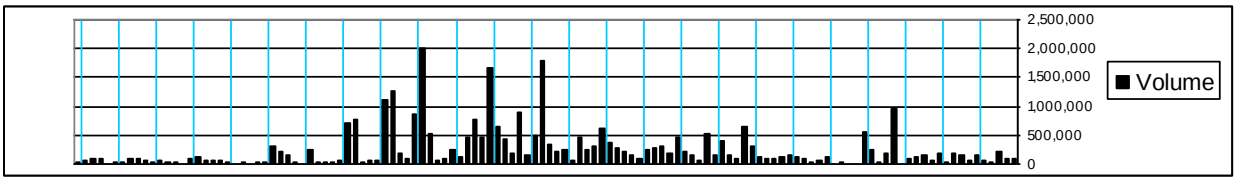
Prices – open, close, high, low	Pros	Cons	Recommendation
Close only	Simple, less cluttered view	Hides gapping and intra-daily volatility; Can't do candlestick chart patterns (Dummies p. 80-85)	Chart this for long timeframes (high datapoint density)
All 4	Supports recognizing all types of chart price patterns	Cluttered	Chart this for short timeframes (low datapoint density)



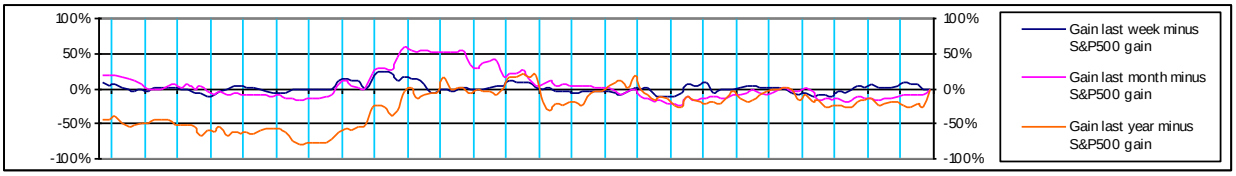




Volume	Pros	Cons	Recommendation
Absolute	Shows degree of liquidity and strength of price		Chart this in the standard way (bars, starting from 0)
Split-adjusted		No need to adjust the volume if the price is split-adjusted	

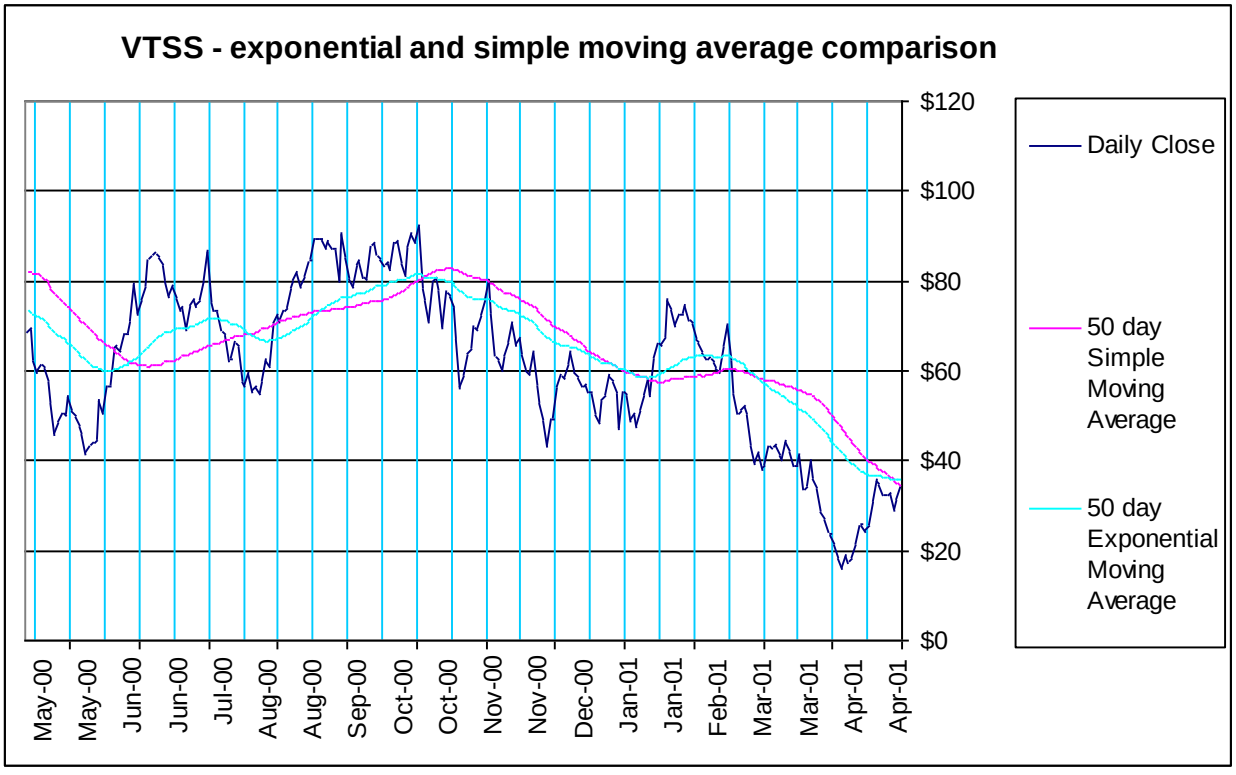


Return – interval	Pros	Cons	Recommendation
Over a fixed time (previous week, month, year)	Running account of stock's growth in several timeframes	Doesn't show return from selling short	Chart this
From start of graph to date	For buy-and-hold strategy	Covers a variable amount of time	

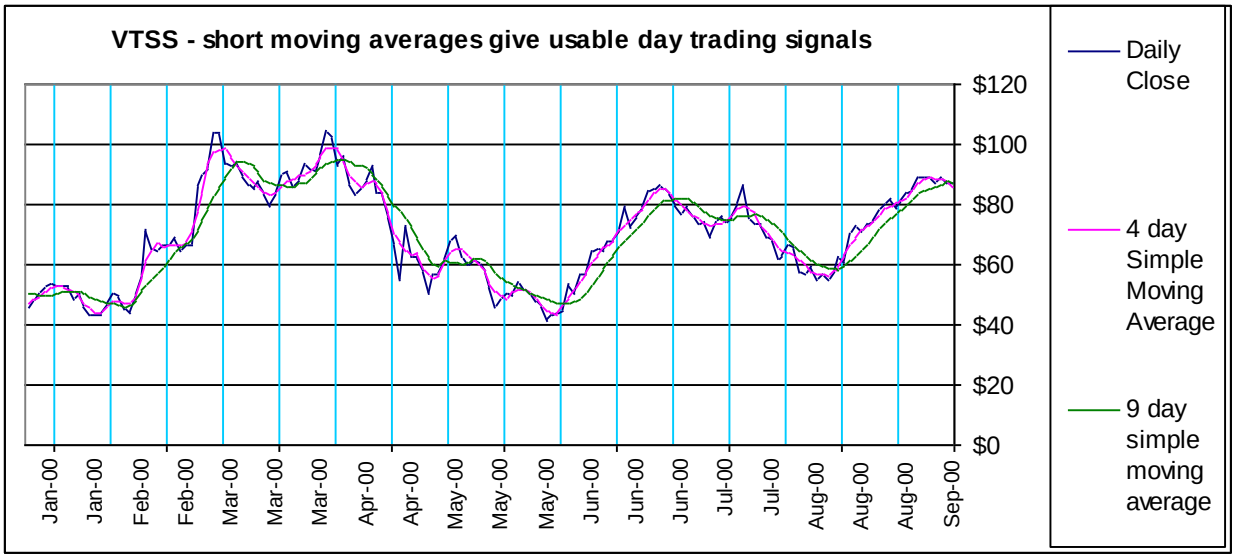


Return – annualization	Pros	Cons	Recommendation
None – just % gain over the time period	Keeps numbers from getting outrageous; Multiply gains from successive segments to get gain over entire interval	Have to mentally factor in the time the gain accrued over to see if this is a good return or not	Chart this
Non-compounded annualization (gain / year-fraction)	Approximate comparison between other investment instruments	Very volatile when extrapolating from short time frames	
Compounded (1 + gain) ^ (1 / year-fraction) - 1	Easy comparison between other investment instruments	Extremely volatile when extrapolating from short time frames	

Moving Averages – Type	Pros	Cons	Recommendation
Simple	Whipsaws less frequently	Slower to react since past data weighted evenly; Most commonly type used to follow stocks	Show this with stock prices
Exponential	Faster to react since recent data weighted more heavily; Used within many technical indicators (MACD, RSI, DMI)	Whipsaws more frequently	
Custom weighting	Can be a compromise between the two	Non-standard	

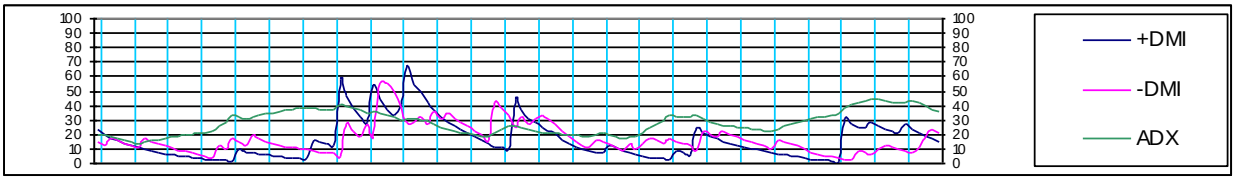


Moving Averages – Duration	Pros	Cons	Recommendation
Small number of periods	Reacts quickly	Whipsaws	Use less than 18 days (i.e. 4 & 9) for swing trading (Dummies p. 104)
Large number of periods	Filters out noise	Reacts slowly; Signals too infrequently for swing trading (Dummies p. 104)	Use 50 and 200 days for monthly+ trades

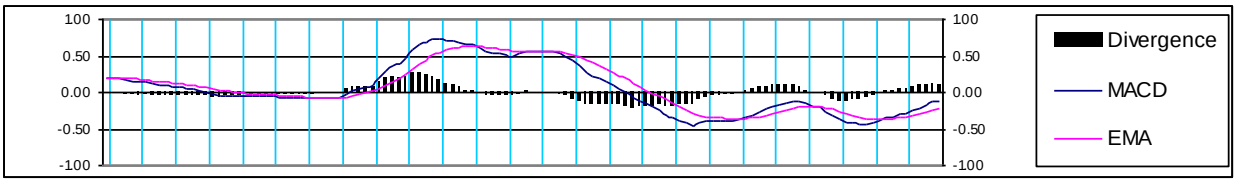


Technical Indicators – Trending	Pros	Cons	Recommendation
Directional Moving Index (DMI / ADX)	Recommended by Dummies book	Not valid when in a trading range	Chart this
Moving Average Convergence / Divergence (MACD)	Recommended by Dummies book	Not valid when in a trading range	Chart this
Others?		Most other trending indicators give similar data as the above	

Directional Moving Index
Trending Indicator
Interval: DMI:14 days, ADX:25 days
Signal: +DMI crossover with -DMI
ADX below 20 = not trending

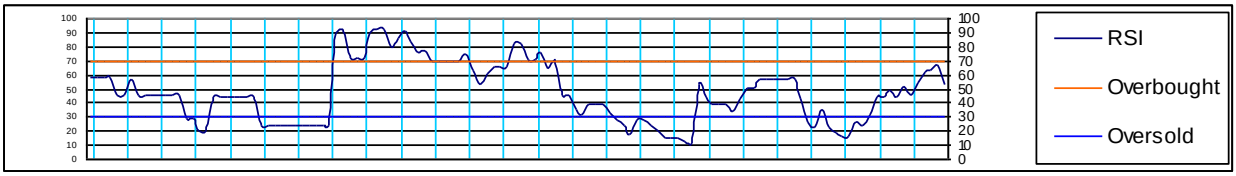


Moving Average Convergence Divergence (MACD)
Trending Indicator
Parameters: MACD - 12 & 26 days; Divergence - 9 days
Rising histogram = buyers increasing in strength, falling = sellers increasing
Signals: divergence, MACD-EMA crossover, MACD crosses 0

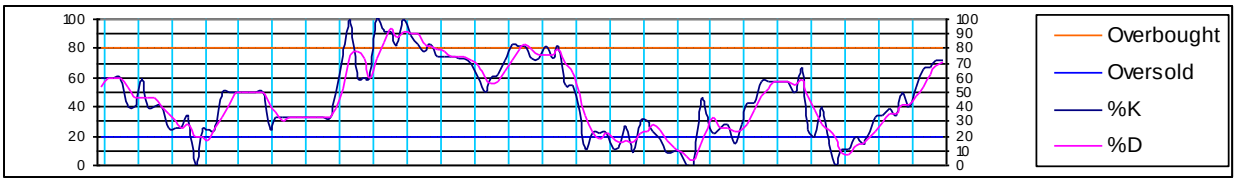


Technical Indicators – Non-trending	Pros	Cons	Recommendation
Relative Strength Index (RSI)	Recommended by Dummies book	Not valid when trending	Chart this
Stochastics (%K, %D)	Recommended by Dummies book	Not valid when trending	Chart this
Others?		Most other non-trending indicators give similar data as the above	

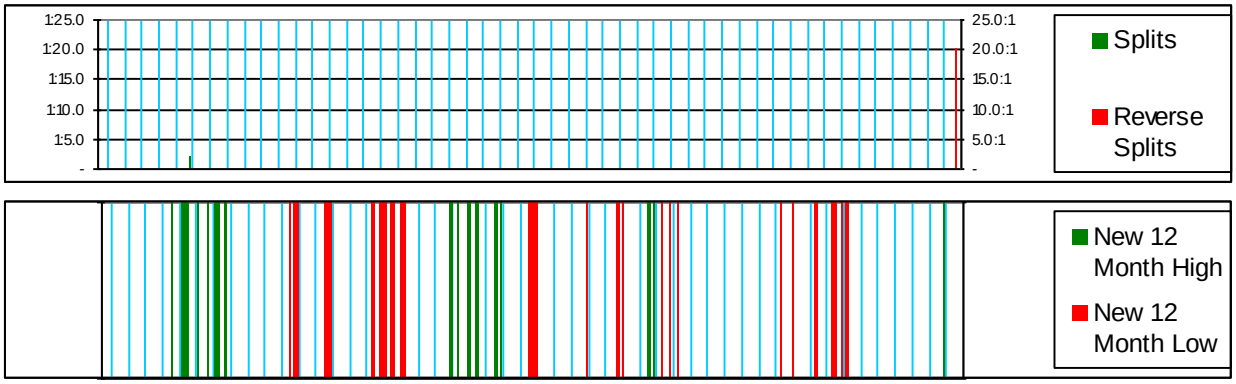
Relative Strength Index (RSI)
Non-trending Indicator
Parameters: 14 & 14 days
Lagging trend strength (magnitude; not direction)
Below 20 = weak, above 50 = extremely strong



Stochastics
Non-trending Indicator
Parameters: 14 & 3 days
Momentum indicator. Act on crossover with extreme pullback, after peak or trough in %D



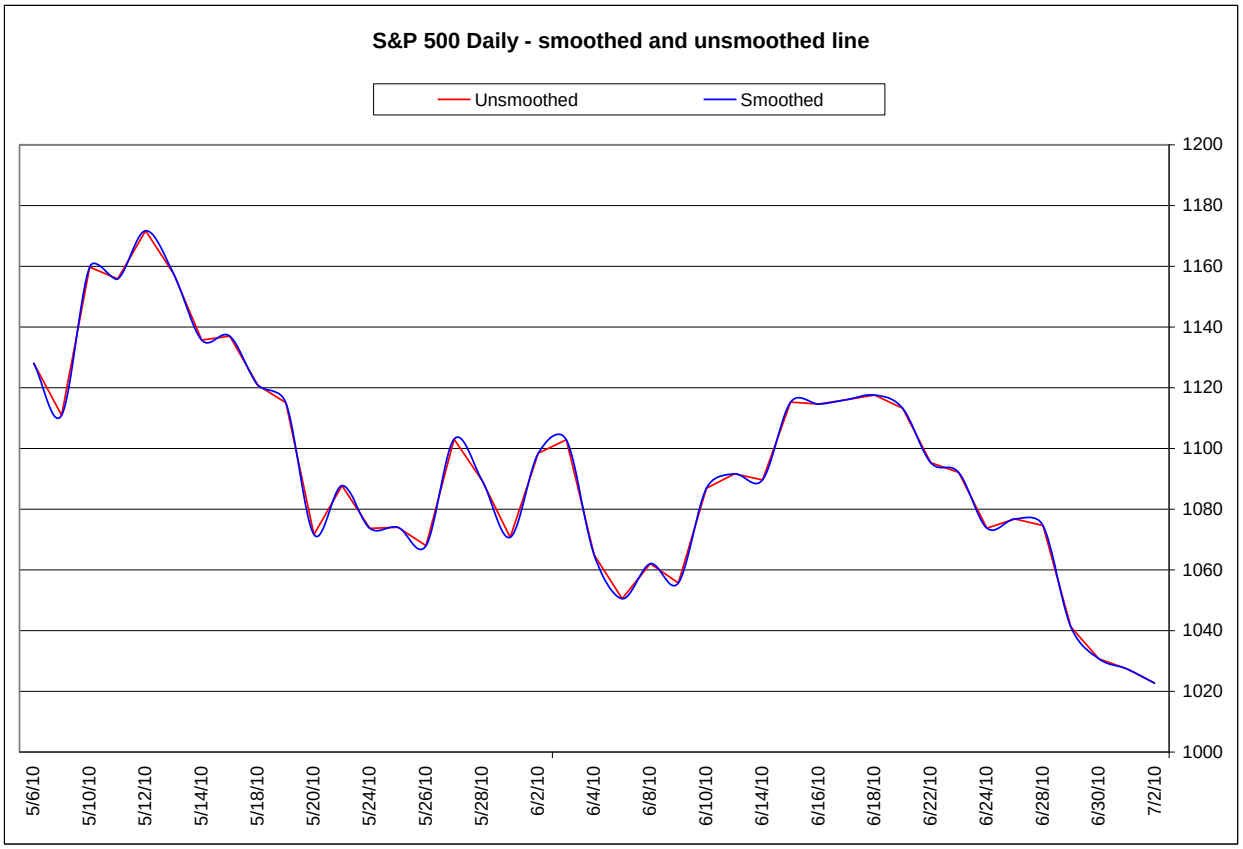
Events – list	Pros	Cons	Recommendation
Splits & reverse splits			Chart this
Close to an earnings report			
Setting new record high or low			Chart this
Others?			

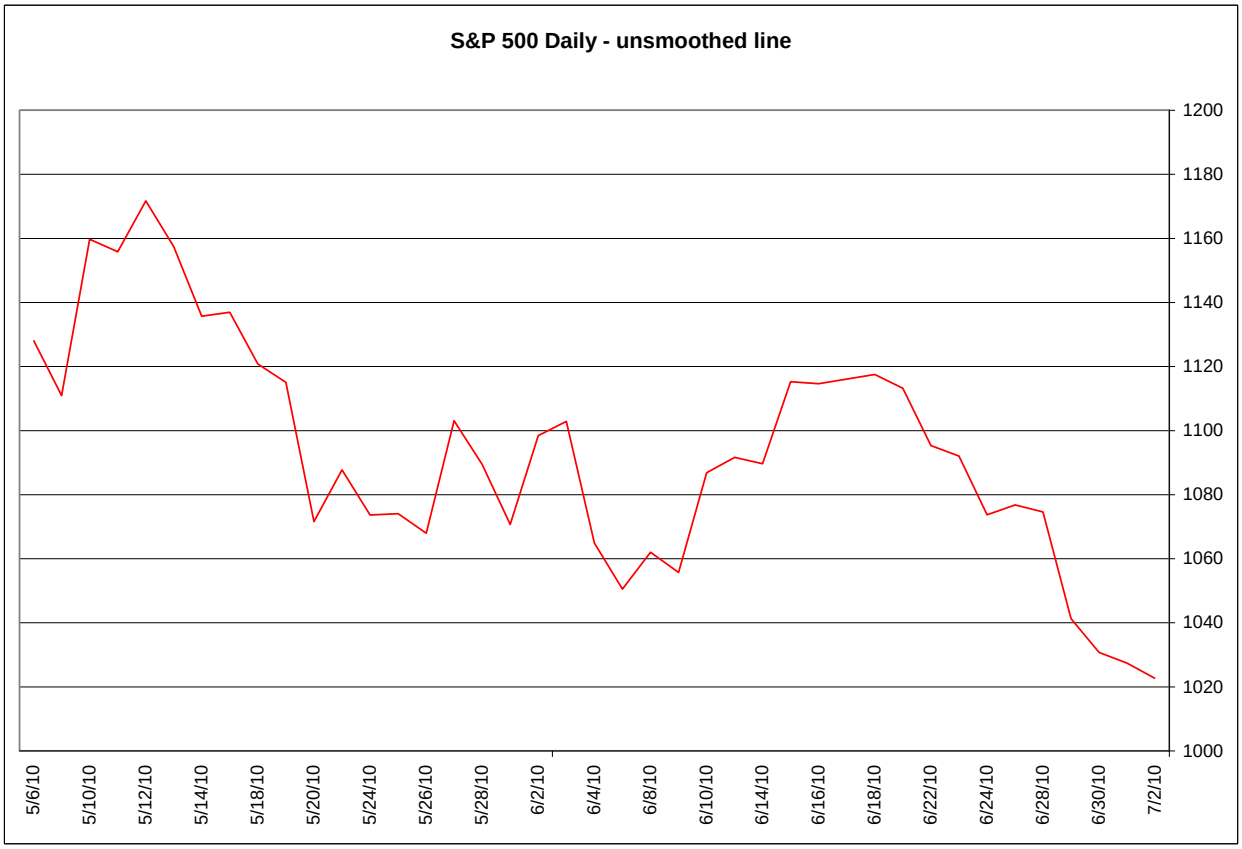


Other "causes" – list	Pros	Cons	Recommendation
News			
Interest rates			
Consumer confidence			
Unemployment rate			
Others?			

How to graph

Chart Lines – smoothing	Pros	Cons	Recommendation
Straight lines connect data points	Charting does no extrapolation	Choppy looking graphs	
Smoothed line fits data points	Natural looking graphs	Smoothed line can go below and above actual data points	Use this





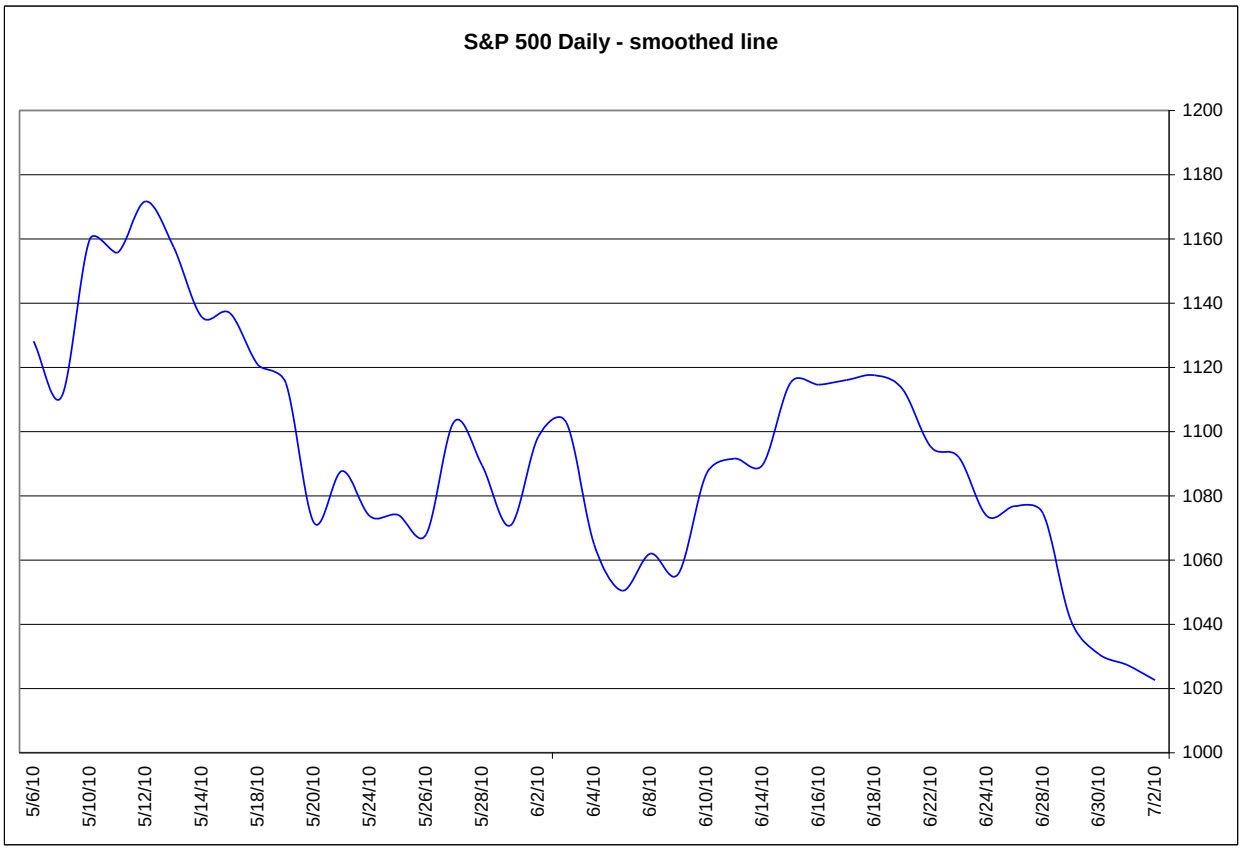
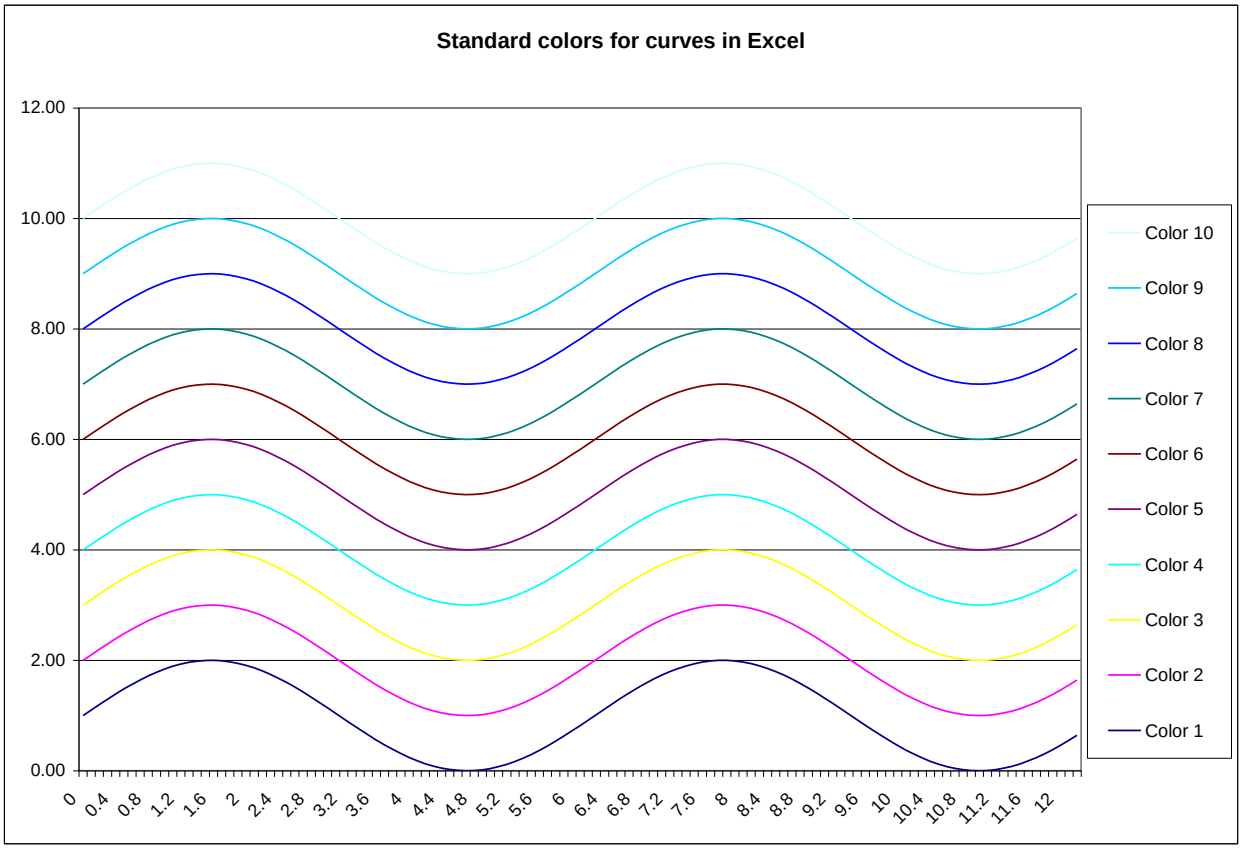
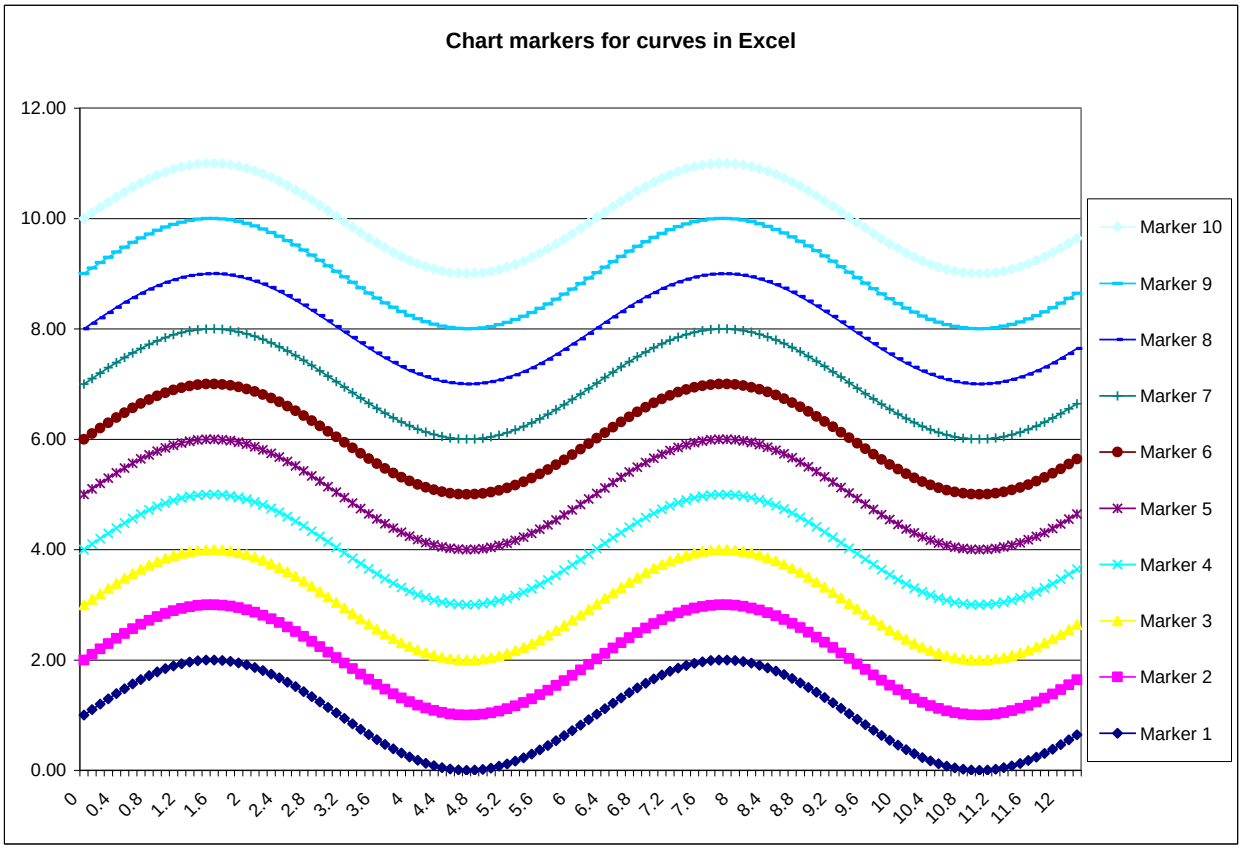


Chart Lines – differentiation	Pros	Cons	Recommendation
Color	Simple method that doesn't clutter the graph; Colors can convey meaning too (green = good, red = bad)	Hard to see if they don't contrast with the background; Max easy to differentiate – maybe 5 or so; If color-blind user, then trouble	Select to contrast with one another and the background
Markers (circle, square, triangle, etc.) at each datapoint	Wide set of combinations available to differentiate a large number of lines	Clutters up a graph; Less intuitive than color; Excel wants to place a marker on each datapoint (see graph below)	None
Line style (solid, dotted, dashed, etc.)	Best for straight lines	Can be confusing on volatile graphs	Solid
Line weight (thin, thick, etc.)	Simple	Only a few variations practical; Not as strong of a differentiator as the others	Regular





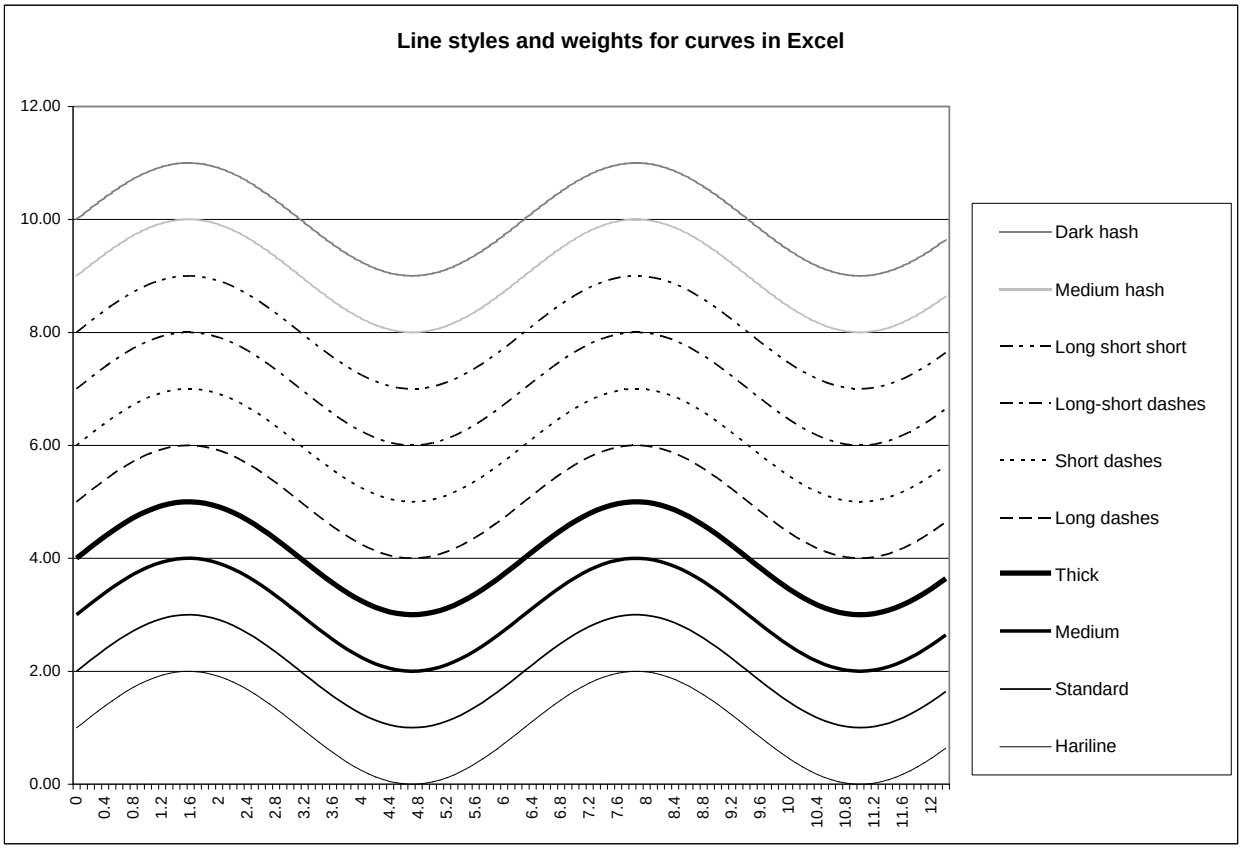
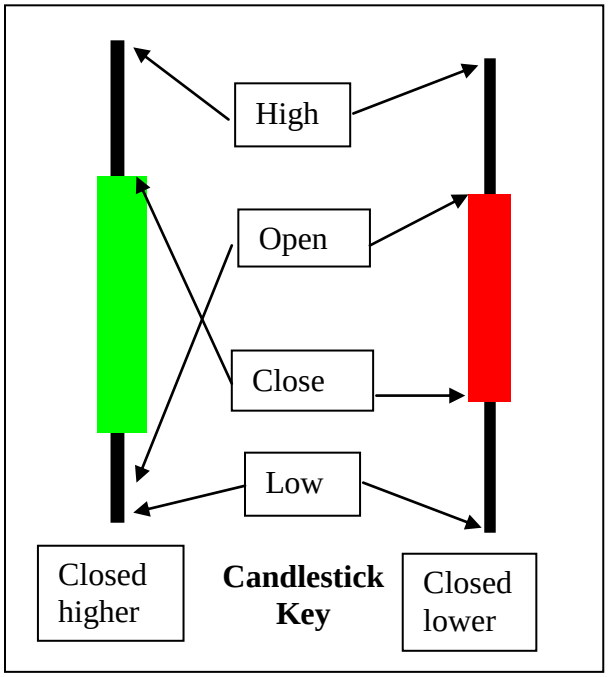


Chart – background and fonts	Pros	Cons	Recommendation
Gray, colored, or white background	White consumes less ink; Pens/pencils/markers will show best on this	Light colors for graphs don't show up	White
Sans serif fonts	Simple and crisp		Arial
Scale with graph size	Aesthetic – looks in proportion	Auto-scaling causes graph area to change as font size changes, aggravating alignment between graphs	Minimum of 4 point

Chart – printed size	Pros	Cons	Recommendation
Large area	Bigger charts can show more data and more detail	Too tall or too wide and handling becomes difficult; It become hard to see the big picture if it is stretched out too much	2’ by 10’ max

Chart – keys	Pros	Cons	Recommendation
Identifier for each trace	Makes it clear what is what	Reduces graph area	Needed if more than one item graphed
Coding of complex data (such as candlestick)	Clarifies how to interpret	Reduces graph area	Only need until familiar with the code



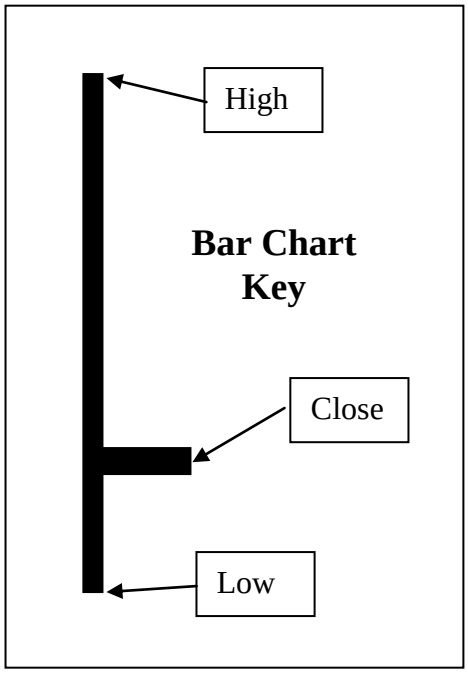
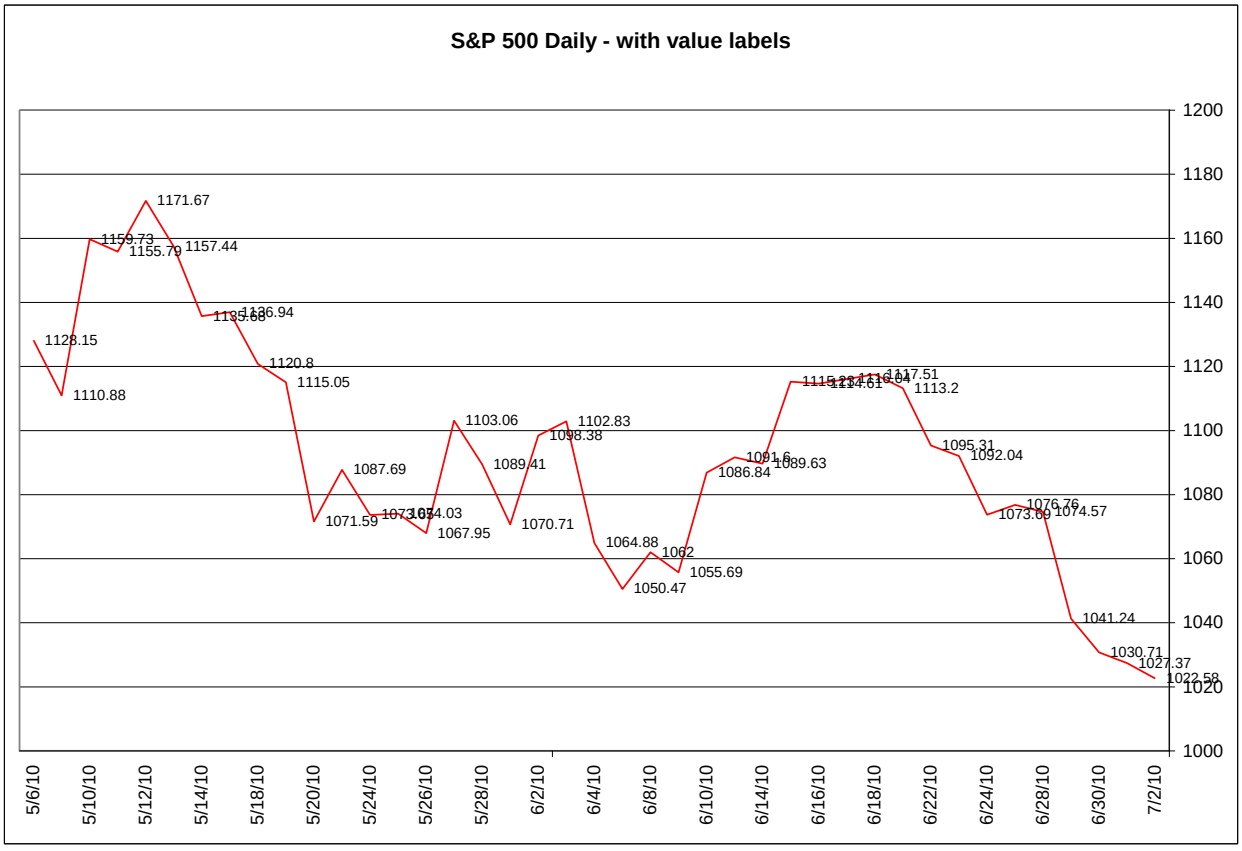
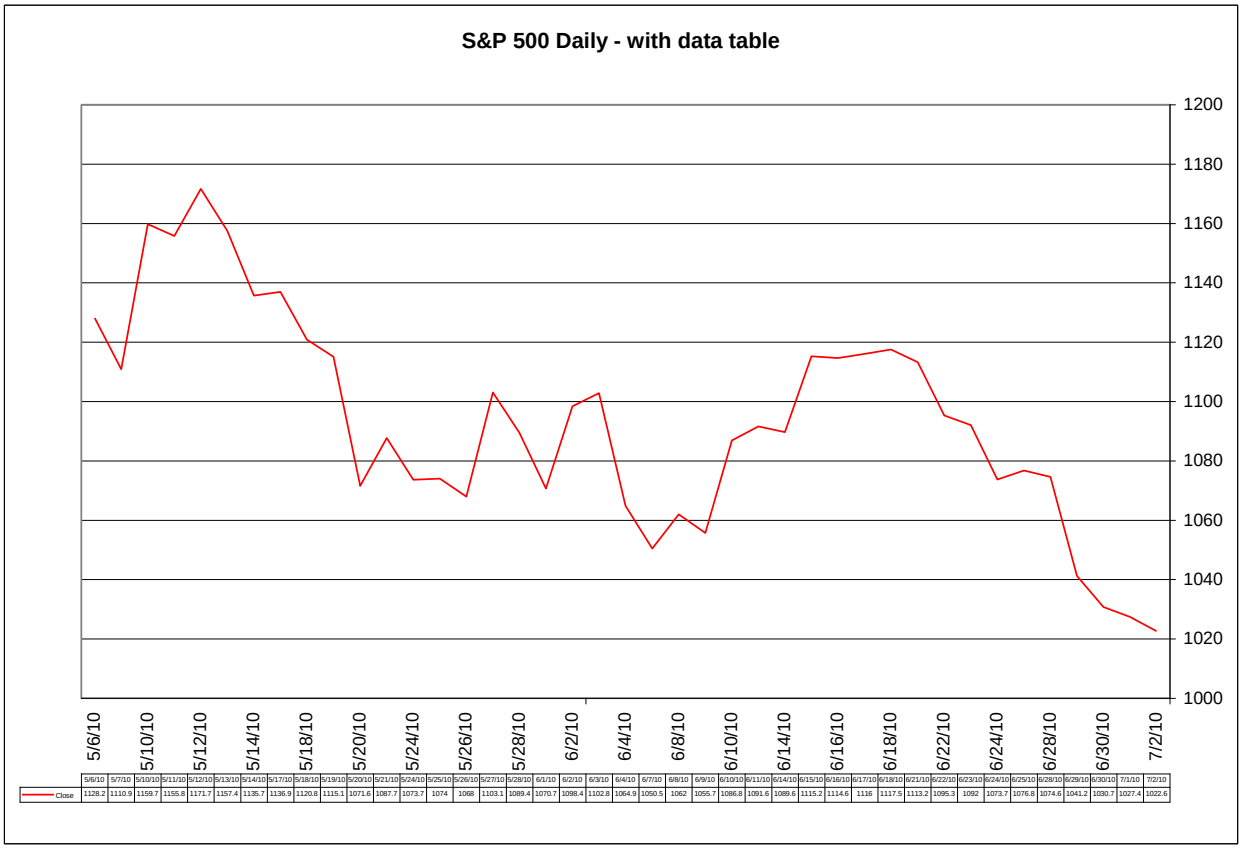


Chart – value labels and data tables	Pros	Cons	Recommendation
Annotation of value at each datapoint	Don't have to visually interpolate datapoint	Unacceptable clutter except on very sparse graphs	
Table of values as part of the graph	Don't have to visually interpolate datapoint	Unacceptable clutter except on very sparse graphs	
Table-Graph	Can show computed values in tabular form at pre-defined events of interest	Must decide what event triggers to use, and what relationships to quantify on the graph, a-priori	



Interactive systems (i.e. working at a terminal or on a computer within the graphing program) often allow real-time readout of the value of a curve at the cursor position. Some allow placement of multiple cursors and support live computation of deltas, etc. between the cursors.



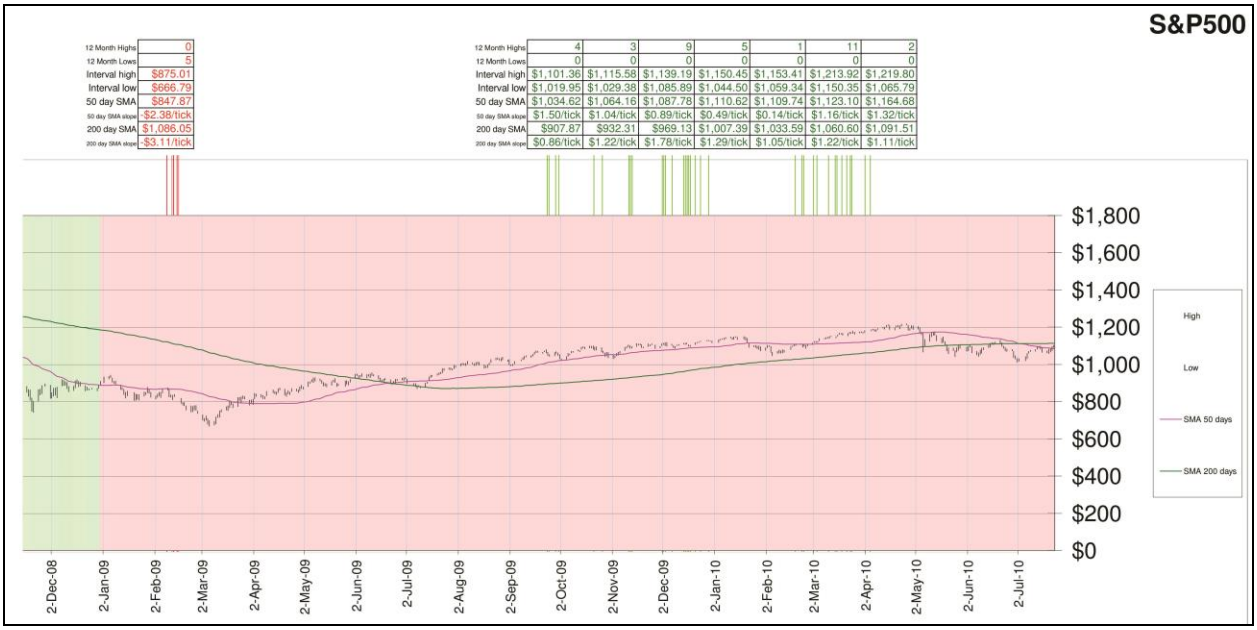
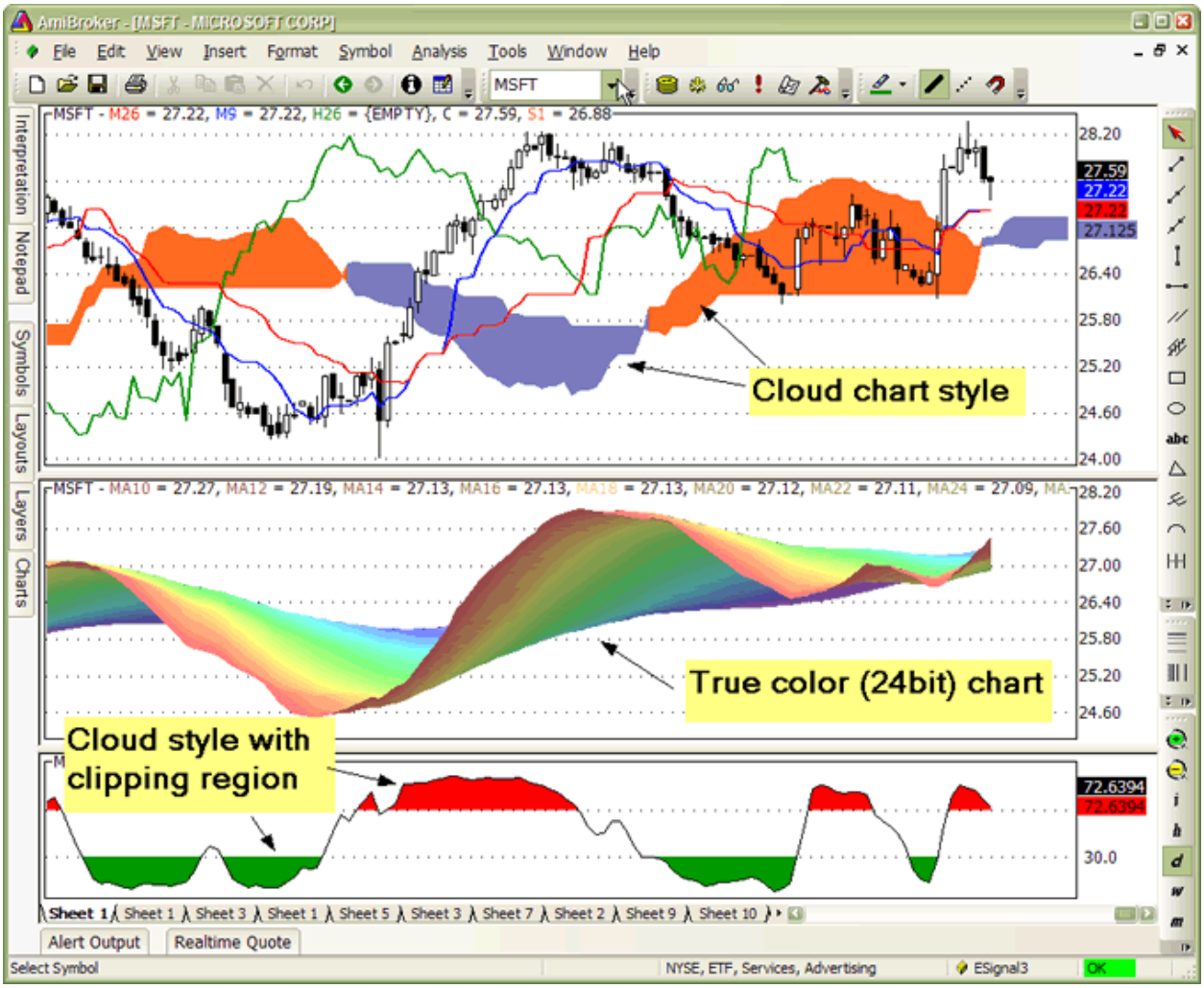


Table-Graph with daily high-low stock graph, 50 and 200 day simple moving averages, 12 month record highs and lows (vertical red and green lines), and economic cycle (background color).

Price Chart – types	Pros	Cons	Recommendation
Line (example from www.multicharts.com below)	Just shows one variable per line	Hides gapping and intra-day volatility; can't do candlestick chart patterns (Dummies p. 80-85)	Use this for long time frames (numerous datapoint graphs)
Bar	Can show open, close, high, low	More difficult to read than candlestick	
Candlestick	Supports recognizing all types of chart price patterns	Too cluttered if data points are closely spaced	Use this for graphs with ≤ 10 points/inch
Volume-High-Low-Close	Precludes need for separate volume chart	2nd Y scale used by volume, so not available to be used as a second stock price scale (in Excel)	
Cloud (example from http://www.amibroker.com/ below)			
Cloud with clipping (example from http://www.amibroker.com/ below)			
Trucolor (example from http://www.amibroker.com/ below)			
3 Line Break (example from www.multicharts.com below)			
Dots (example from www.multicharts.com below)			
Histogram (example from www.multicharts.com below)			

Price Chart – types	Pros	Cons	Recommendation
Kagi (example from www.multicharts.com below)			
Point and Figure (example from www.multicharts.com below)			
Renko (example from www.multicharts.com below)			
Symbol (example from www.multicharts.com below)			



Line on Close

This chart type connects the closing price for each bar with a line.

Candlesticks

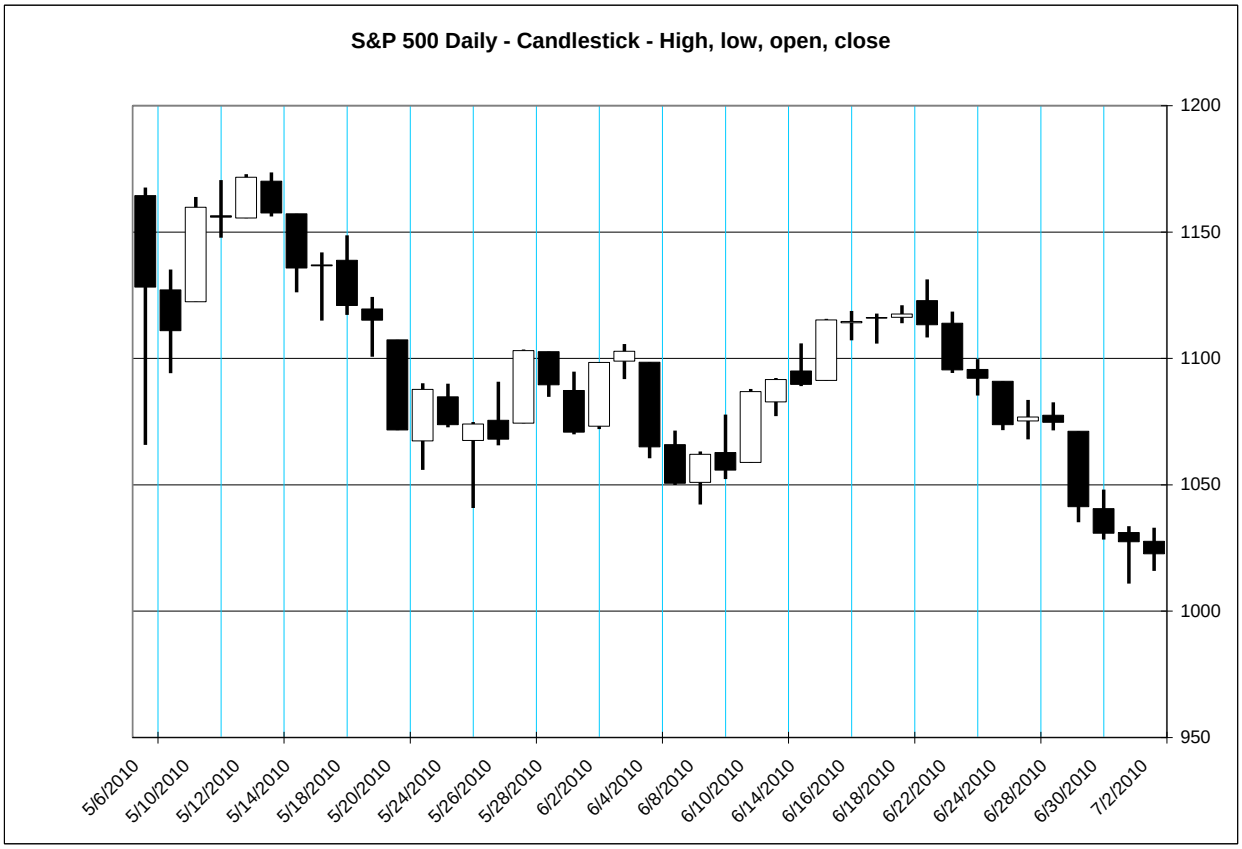
This chart type uses the same price data as regular bar charts, with each candlestick representing the open, high, low, and close. The thick part, called the real body, represents the range between opening and closing prices. Long thin lines, shadows and wicks/tails, represent the range of price movement for the bar.

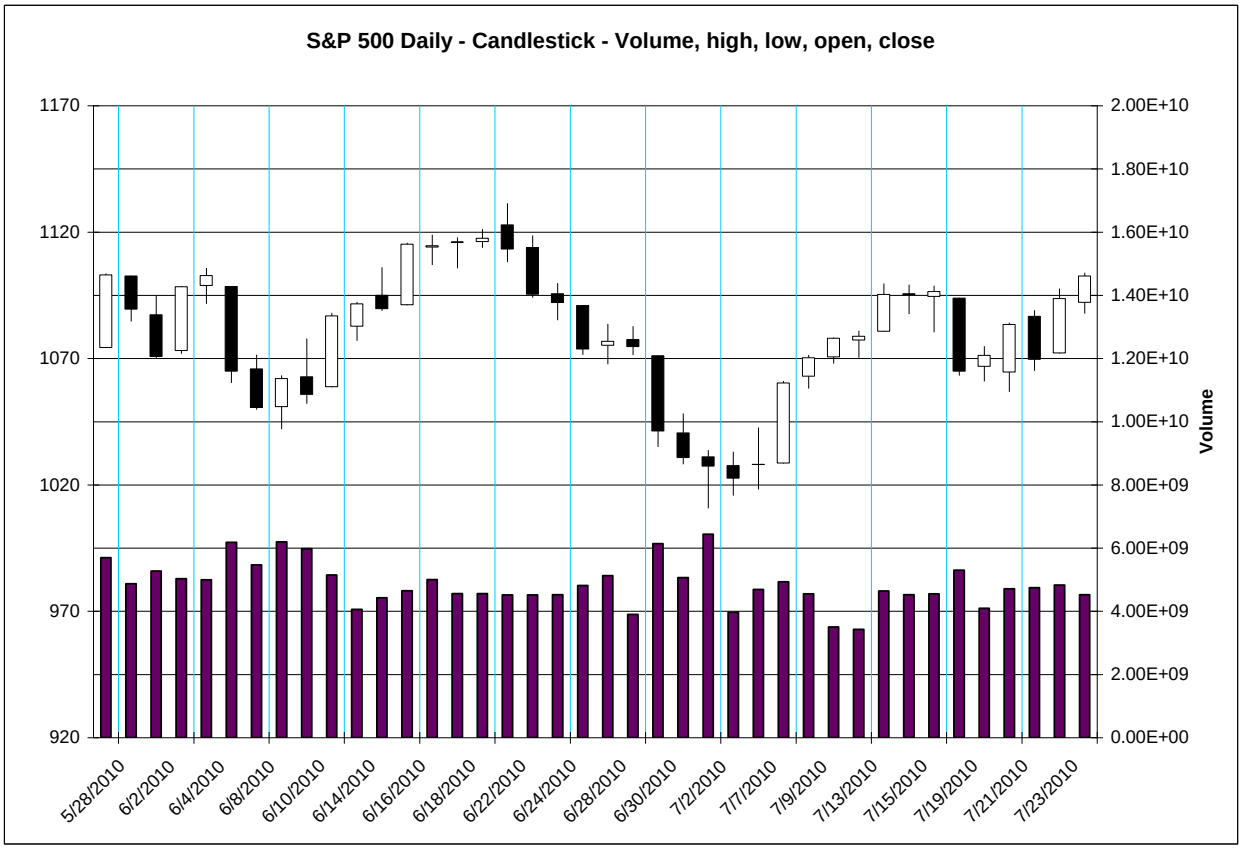
Candlesticks with border

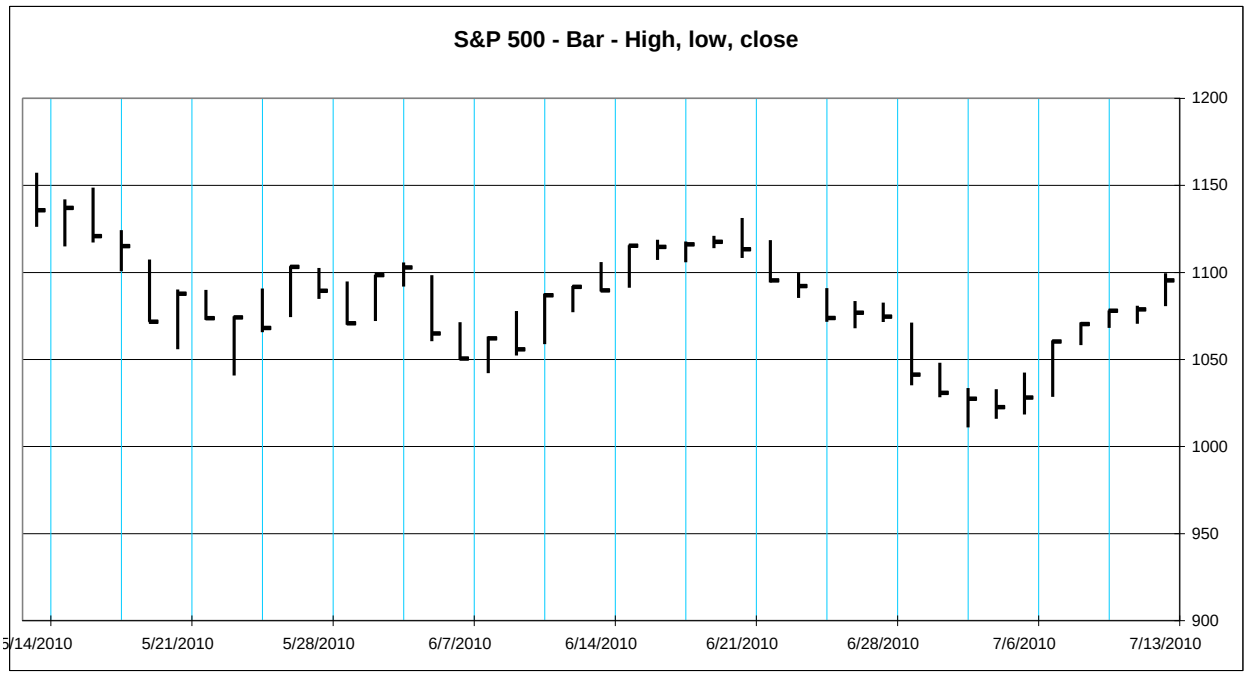
The only difference from a regular candlesticks chart is the borders around the body of the candle.

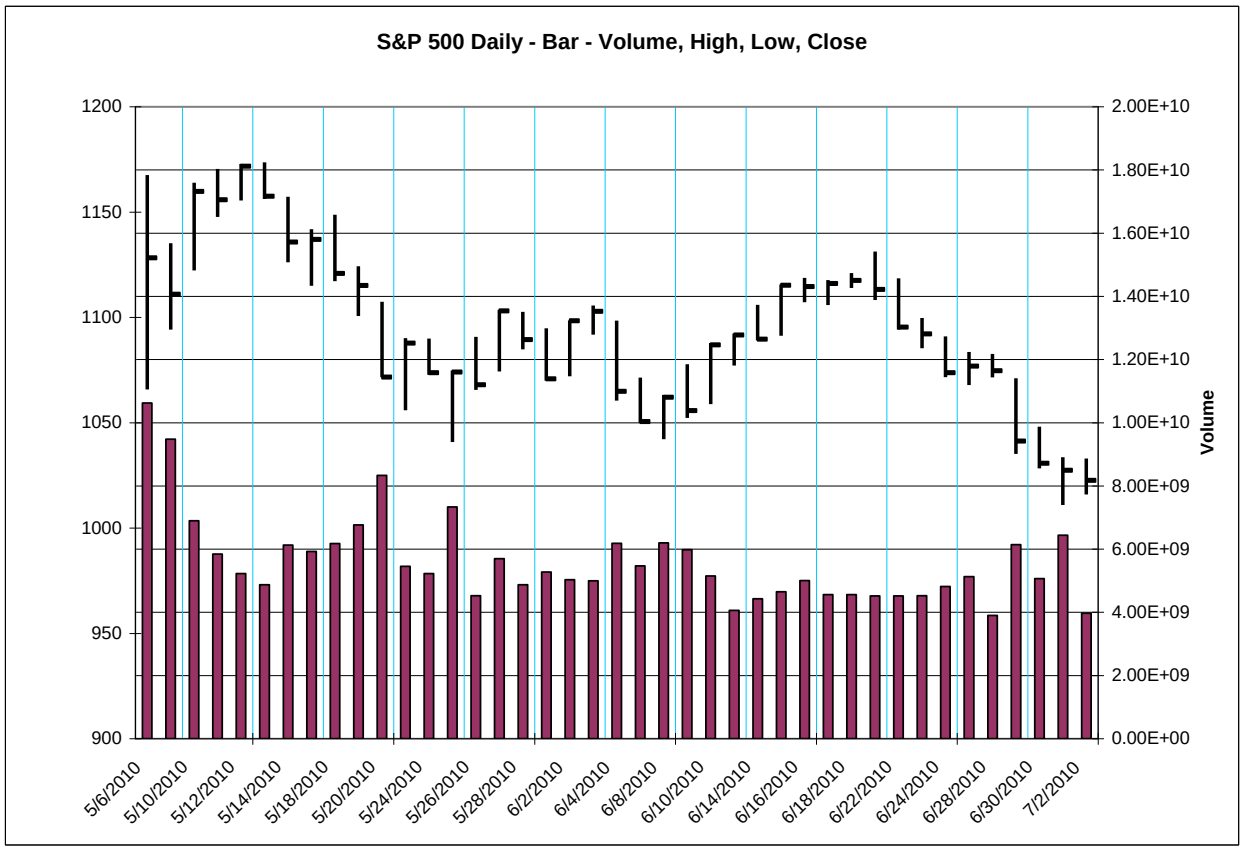
Hollow Candlesticks

Hollow candlesticks appear when the closing price is greater than the open, and filled candlesticks appear when the closing price is less than the open. This is the only difference from a regular candlestick chart.







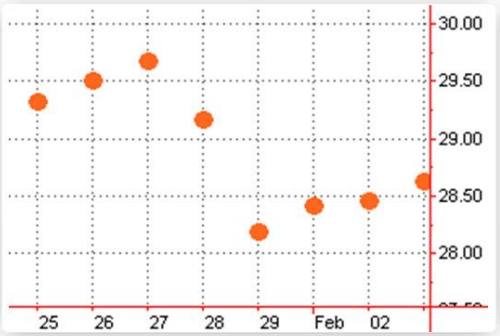


OHLC

This chart type is the most common way to display data for analysis. Open, high, low, and close prices are shown for the time increment represented by the bar. Bar charts can be time-based, tick-based, or volume-based.

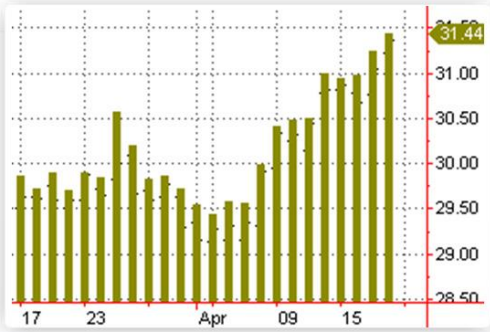
3 Line break

This chart type only plots price movements, without taking time or volume into consideration. This chart type displays a series of vertical boxes that are based on price changes.



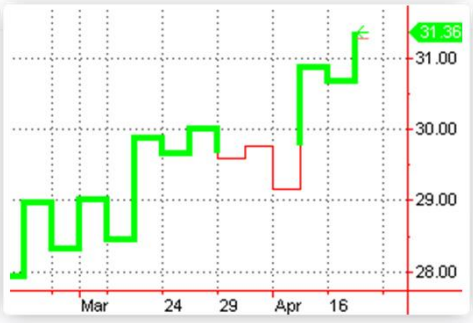
Dots

This chart type plots a single dot at the closing price of each bar.



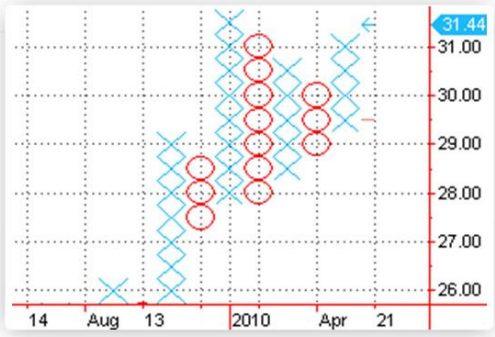
Histogram chart

This chart type plots vertical lines, which can be based on volume, price, and other factors.



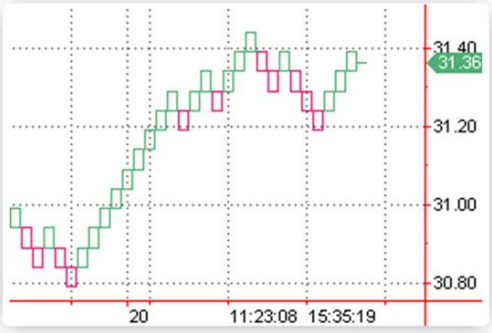
Kagi

This chart type looks like a continuous line that changes directions and switches from thin to bold. The direction changes when the price changes beyond a predefined amount, and the line switches between thin and bold if the last change bypassed the last horizontal line.



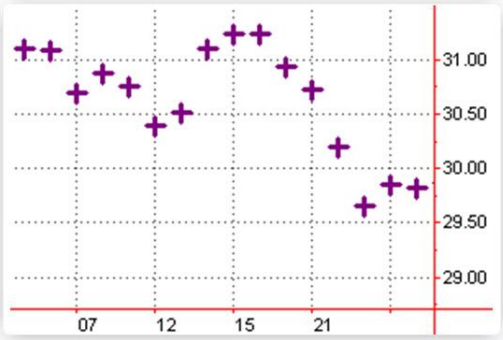
Point and Figure

This chart type only plots price movements, without taking time into consideration. A column of X's is plotted as the price rises—and O's as the price drops.



Renko

This chart type only plots price movements, without taking time or volume into consideration. It is constructed from ticks and looks like bricks stacked in adjacent columns. A new brick is drawn after the price passes the top or bottom of previously predefined amount.



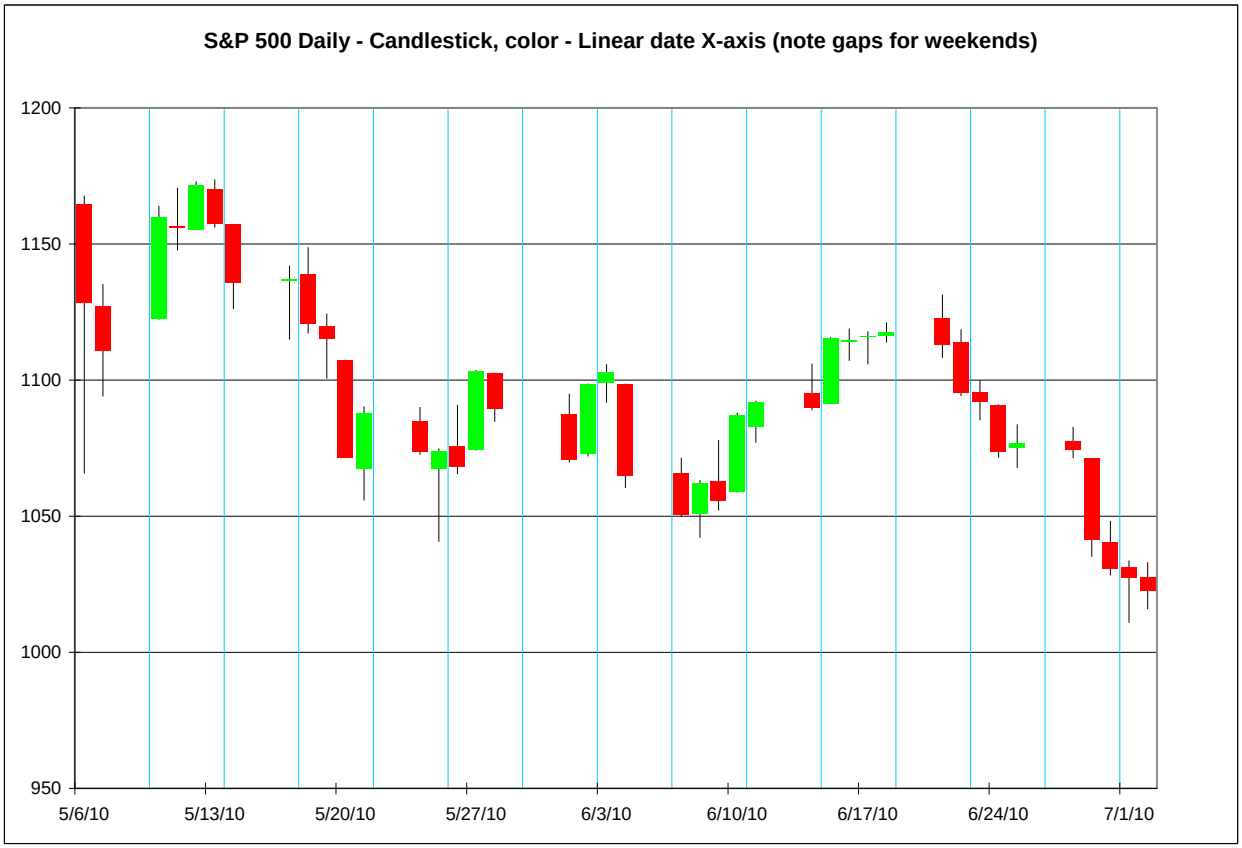
Symbol Chart

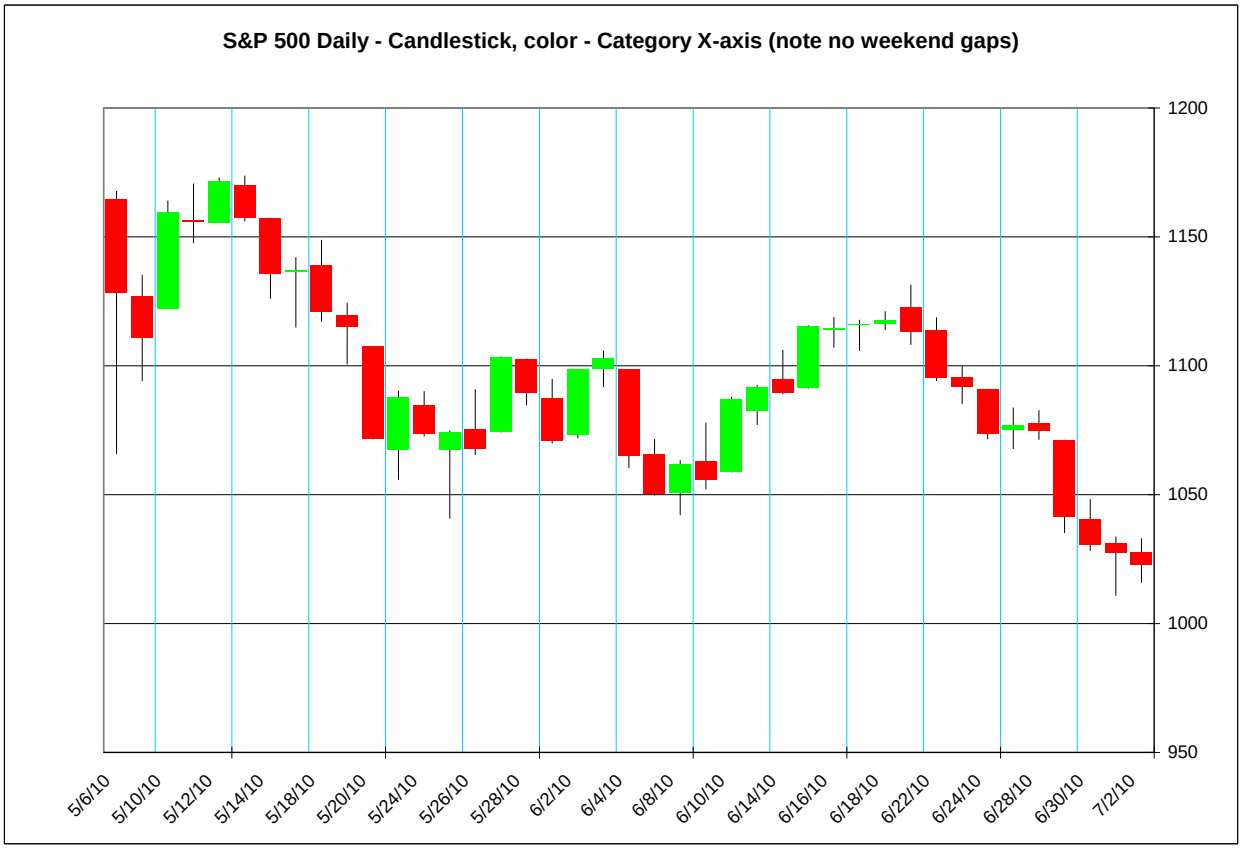
This chart type plots crosses at specified price values (indicators only).

Chart types – for other variables	Pros	Cons	Recommendation
Line	Good for moving averages and technical indicators		
Area	Often used to show cumulative data		
Stacked area	Often used to show the components comprising a cumulative data		
Scatter	Useful when there can be multiple values (in Y) for each point (in X)		
Column	Good for events	An individual column signaling an event must be wide enough to be noticed	
Stacked column	Shows relative contribution of several variables to an end quantity, at each point in time		
Pie	Useful to show proportional contributions	Not useful to show data versus time	
Surface	Useful when data is in 3-dimensions		
Polar	Useful when data is polar in nature or cyclic		

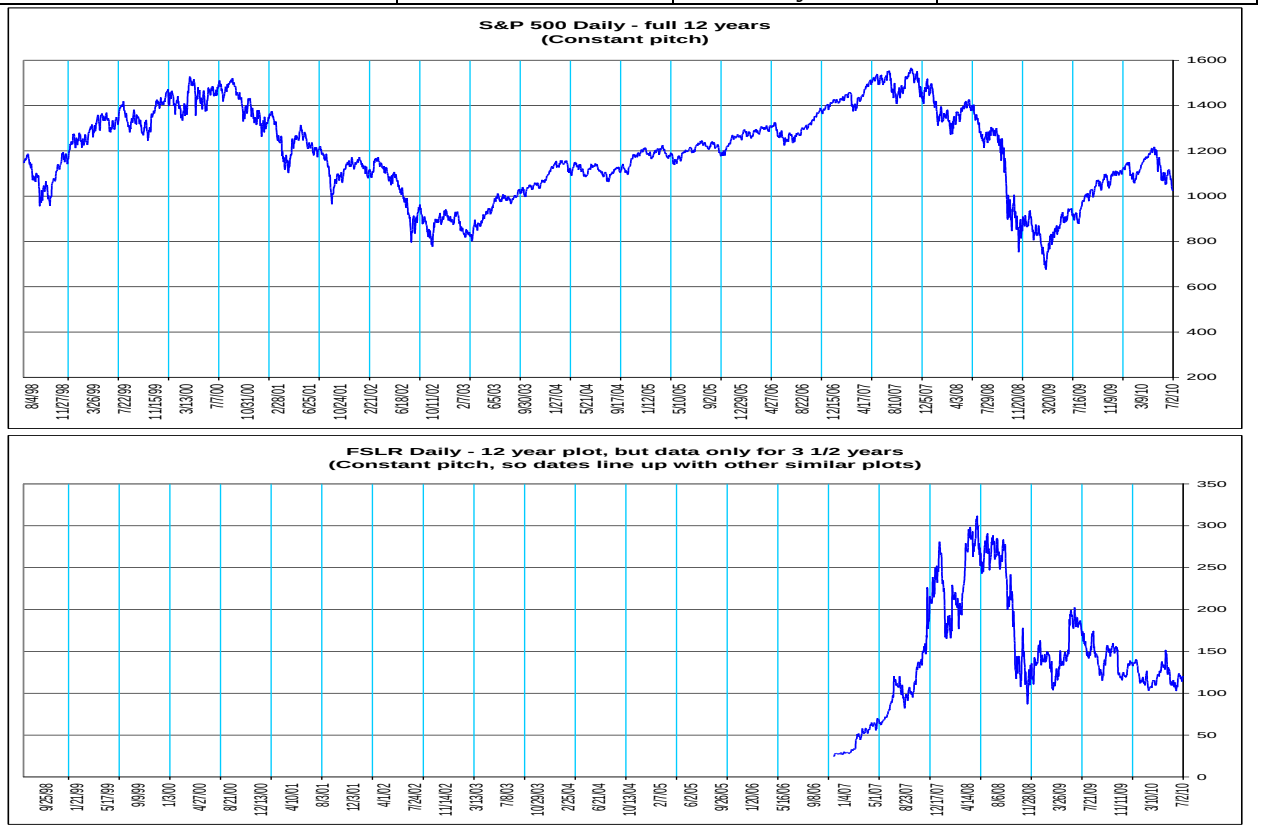
X-Axis

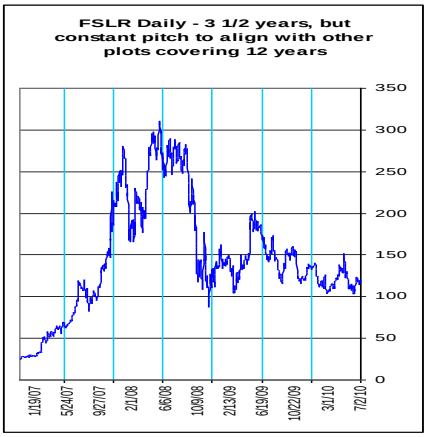
Axis – type	Pros	Cons	Recommendation
Category	Graphs are uniform in X, without gaps for weekends and holidays		Use this
Date	Can place gridlines at month boundaries, even though these vary per the number of days / month	Graphs have gaps for weekends and holidays	
Value		Graphs have gaps for weekends and holidays	



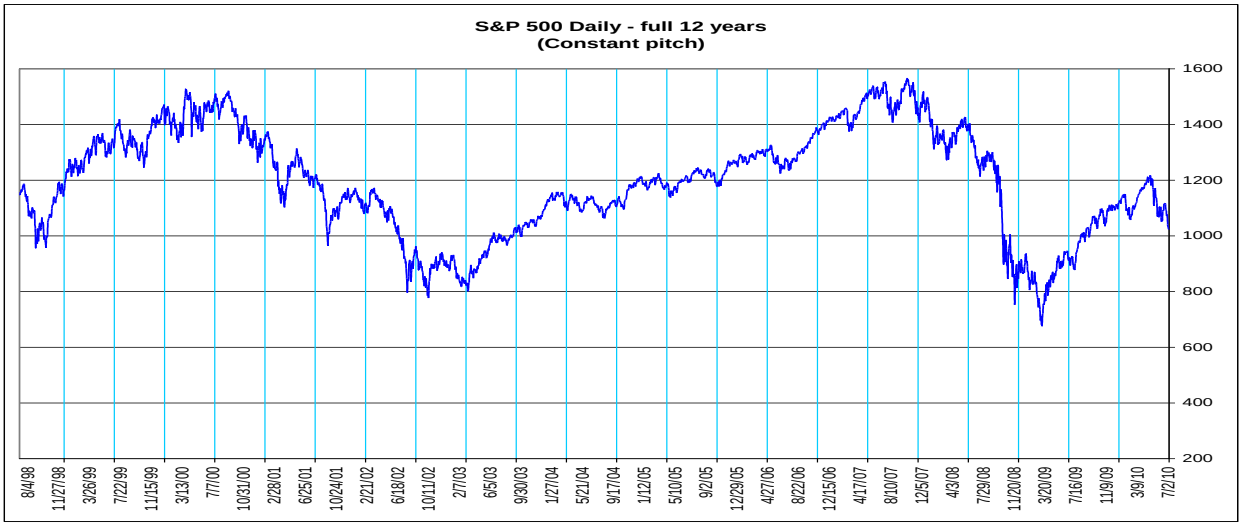


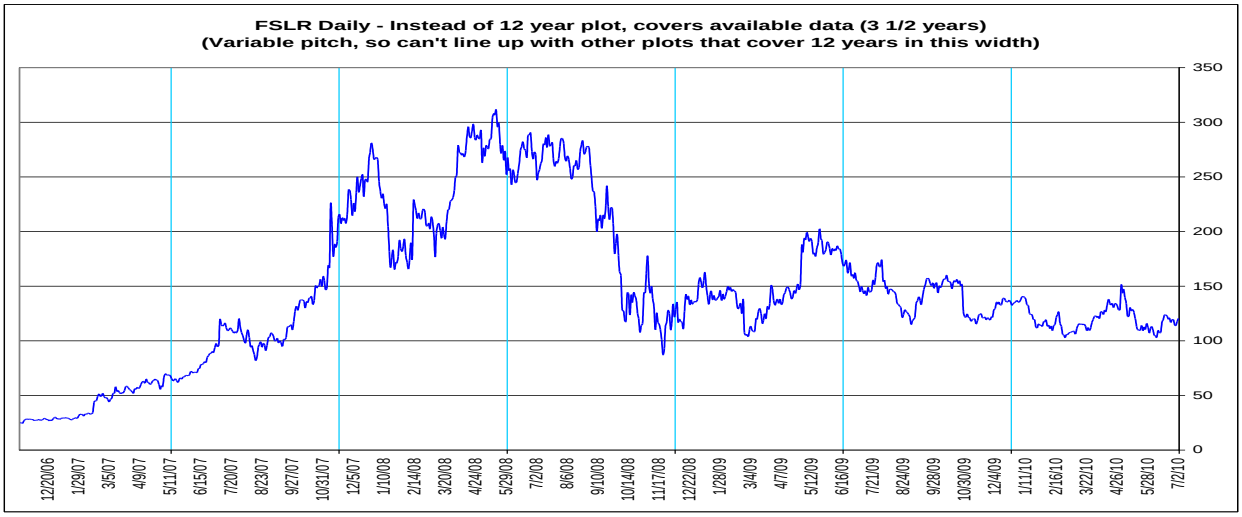
Graph width – missing data	Pros	Cons	Recommendation
Shorten if data is missing	Saves paper	Harder to align to compare across different graphs	
Uniform length, with blank graph where there is no data	Easier to compare multiple charts	Makes larger graphs than needed; Awkward to handle when not necessary to be so	Use this



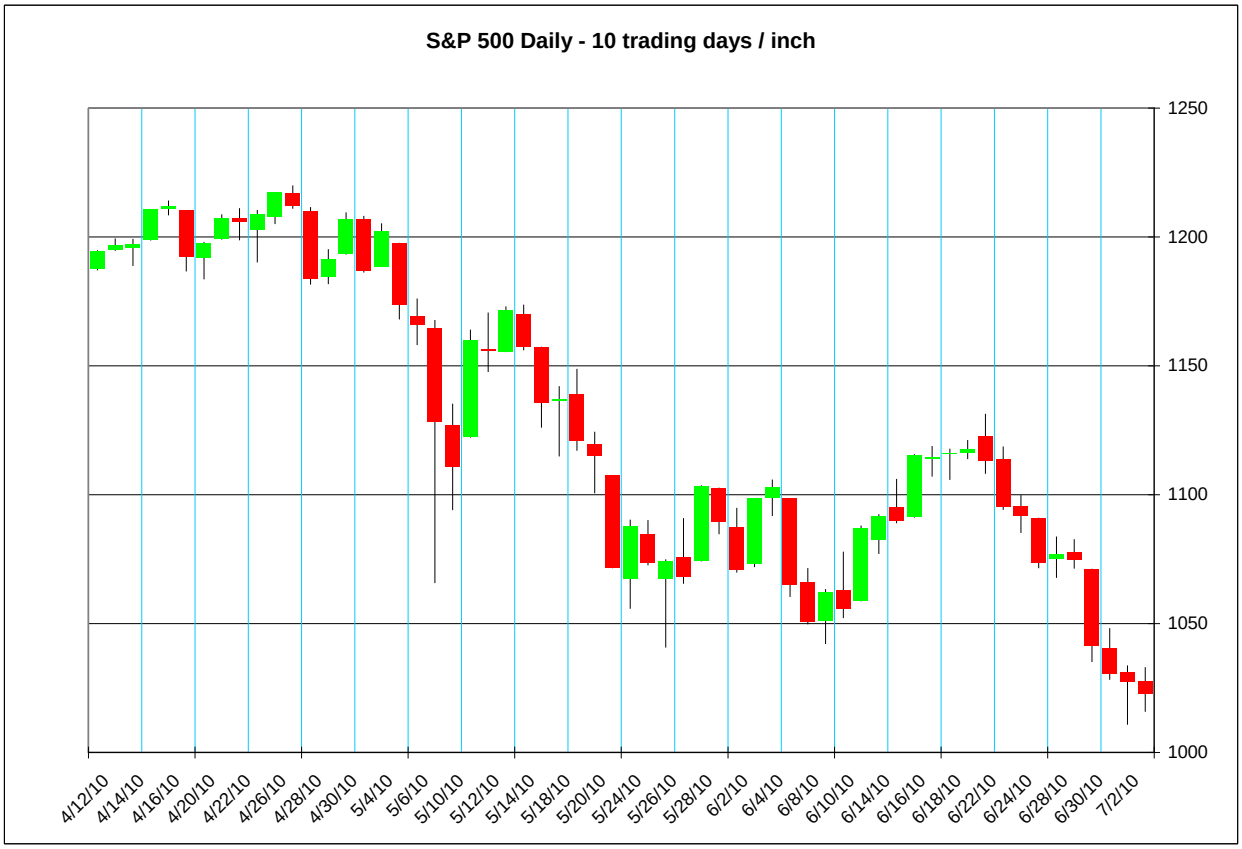


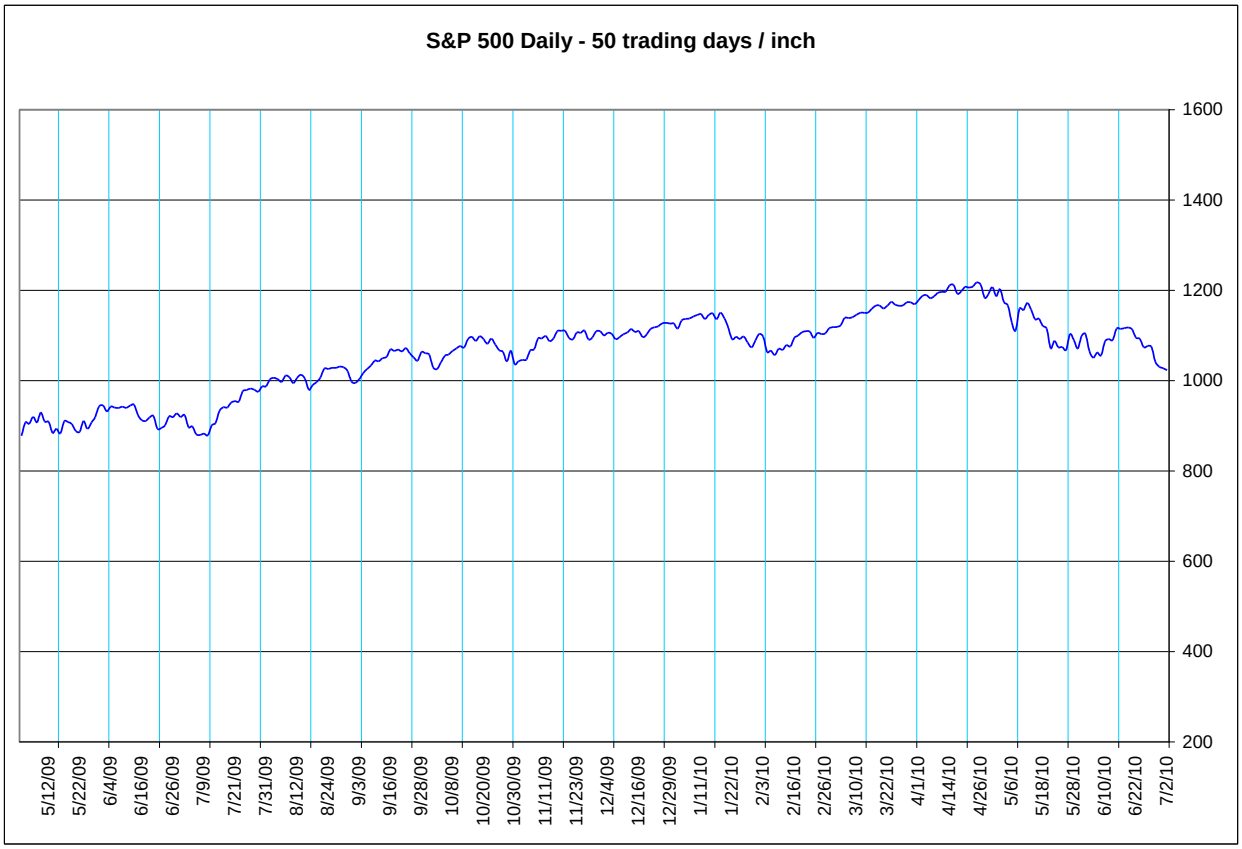
Graph – scale stability	Pros	Cons	Recommendation
Constant pitch (trading days/inch)	Eases comparison between charts covering different durations	Long timeframes make for long charts; Charts aren't of a standardized size so may be harder to display	Use this
Variable pitch (chart width constant for varying durations graphed)	Keeps long duration graphs to a manageable size	Different time scales makes comparison across graphs difficult	

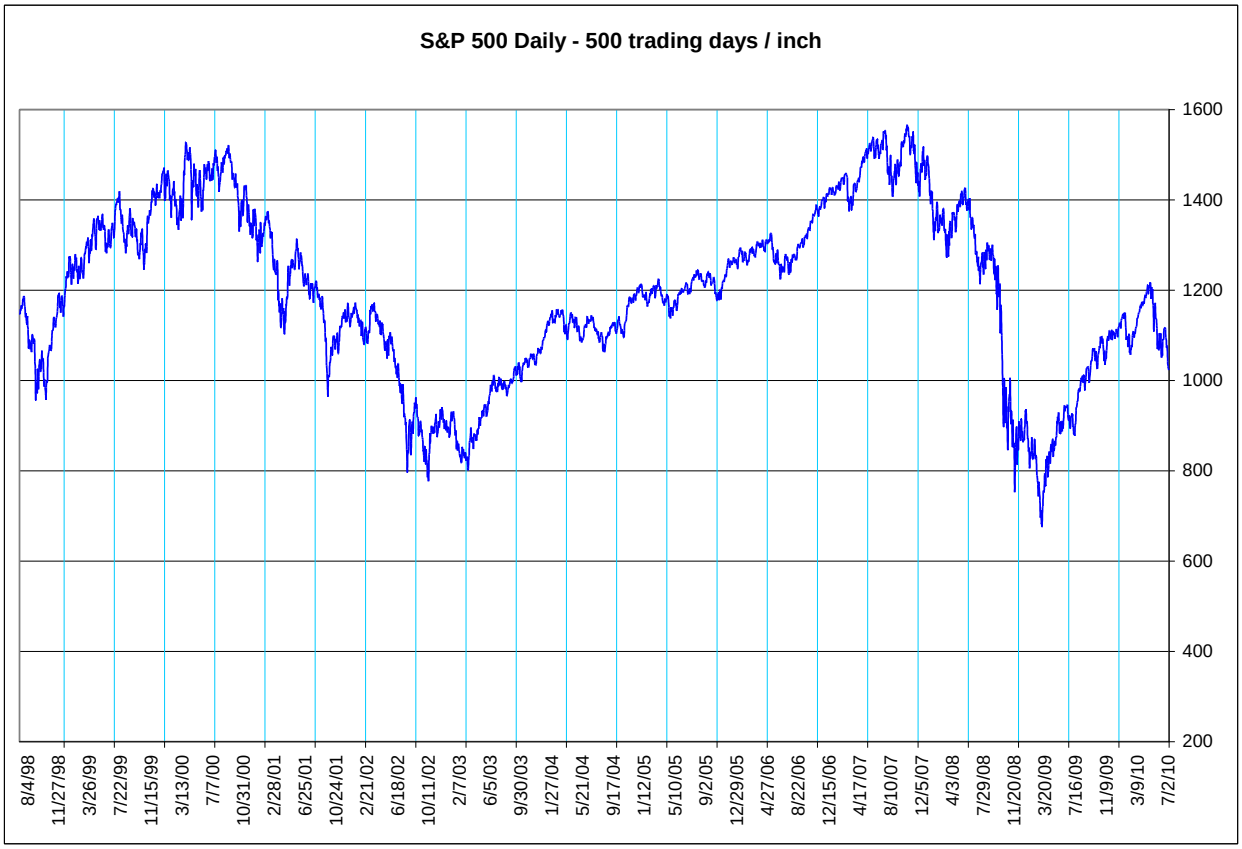


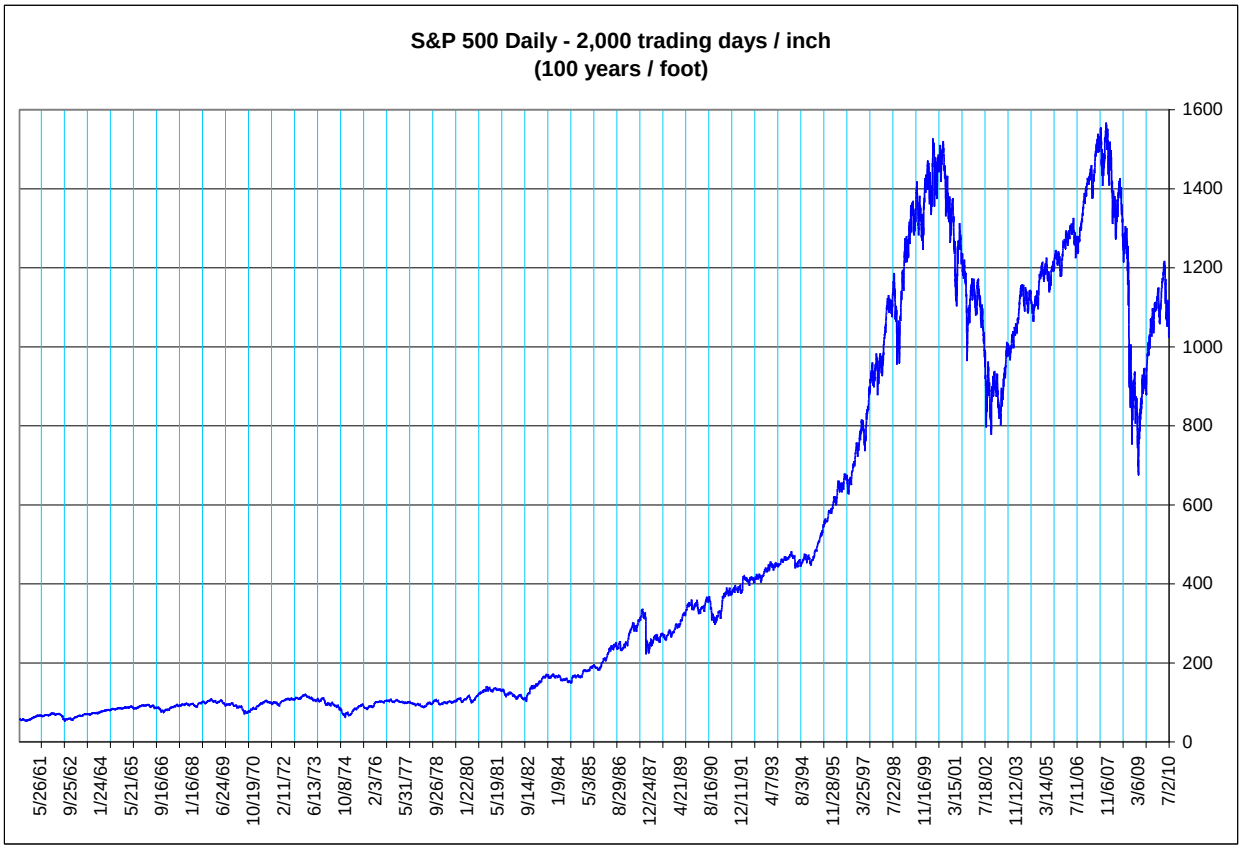


Graph – multiple ranges	Pros	Cons	Recommendation
10 trading days (2 weeks) /inch	Can distinctly show open, close, high, low	Can't see the forest for the trees	Good for analyzing current trade possibilities
50 trading days (2 months) /inch	As compact as practical if showing open, close, high, low	Too dense to look at specific day's values easily	Good for seeing cycles
500 trading days (20 months) /inch	Good for showing long-term trends	Lose daily and weekly detail	Good for seeing cycles
25,000 trading days (100 years) /foot	Good for showing really long-term cycles	Lose monthly detail	
Other base pitch than 10			
Other pitch steps than 5,10,50			







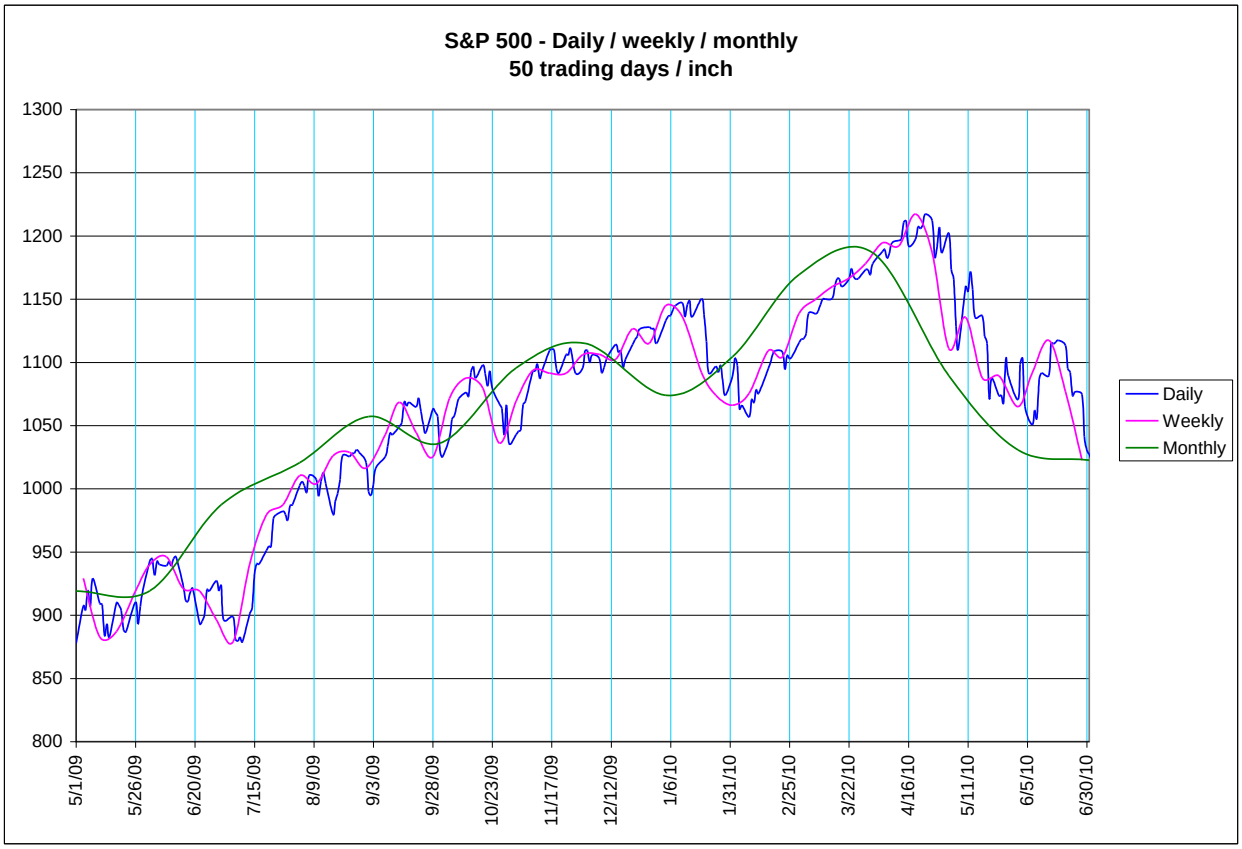


Graph – x pitch type	Pros	Cons	Recommendation
Linear	Intuitive	Graphs can get big	Stay linear
Logarithmic	Compresses the far past while still showing detail in the recent past	Difficult to align multiple graphs if over different periods	
Other (custom)	Can stretch regions of interest to show more detail and compress areas of little interest, while still showing a long interval	Varying timescales are hard to digest	

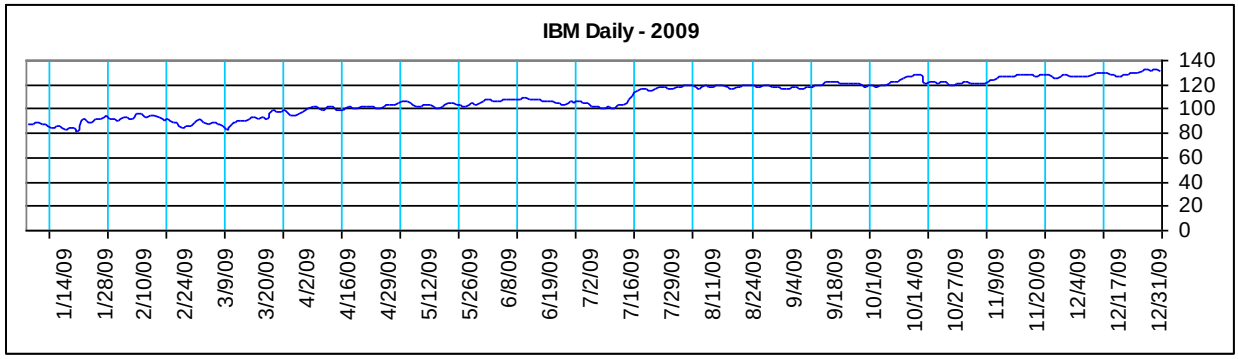
Graph – period	Pros	Cons	Recommendation
Fixed start, variable stop; such as 1/1/1998 to present	Always includes a given set of economic cycles	Duration gets longer for later graphs than earlier ones	1998 to present
Sliding start and stop dates, such as always the last 12 years or the last 6 months	Graphs remain same length even when done at later dates	May pass over the interesting parts of an historic economic cycle	

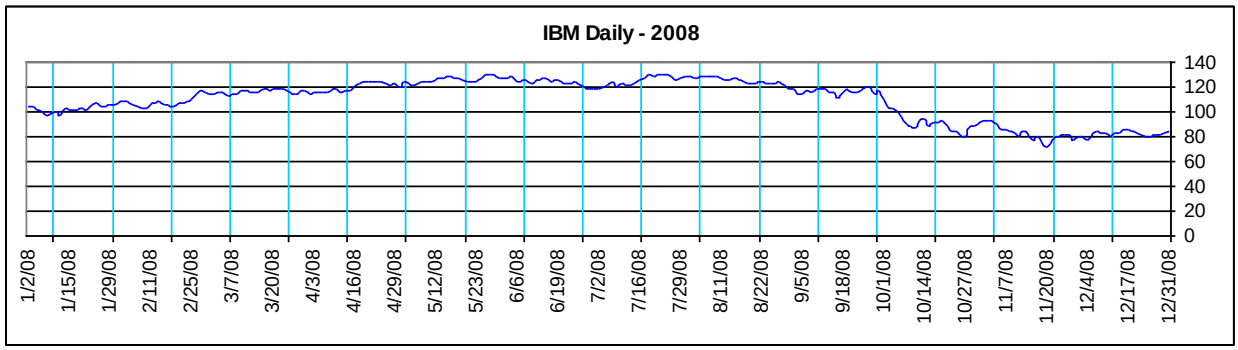
Timescale – duration	Pros	Cons	Recommendation
Maximum – day one of the stock to the present	Missing nothing	Ancient history may not be relevant to the company today	
Big picture	Shows multiple economic cycles	Can be unwieldy	2 economic cycles (12 years)
Recent detail	Shorter time, so more practical to show greater detail		6 months
Combination	Best of both worlds		3 graphs: 12 years compressed, 12 years wide, 6 months normal

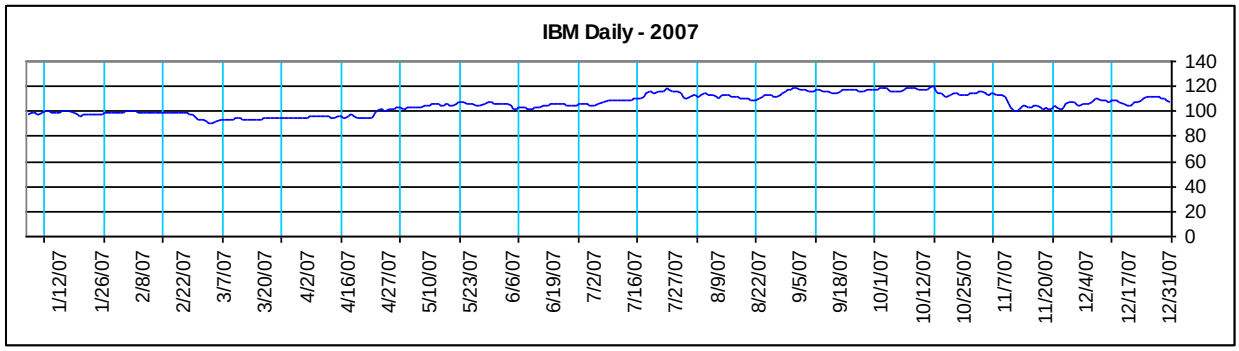
Timescale – resolution	Pros	Cons	Recommendation
Hourly		Unnecessarily short for swing trading	
Daily			Just right for swing trading
Weekly		Too granular for swing trading	
Monthly		Too granular for swing trading	



Multiple graphs – vertically stacked	Pros	Cons	Recommendation
1 year each (1/1 to 12/31)	Shows annually cyclic businesses in relation to same time in previous years	Although the business may be annually cyclic, the stock may not be	
1 economic cycle per graph (scale changes to keep width constant)	Eases comparison at same point in economic cycles	Time scales can be different from graph to graph	



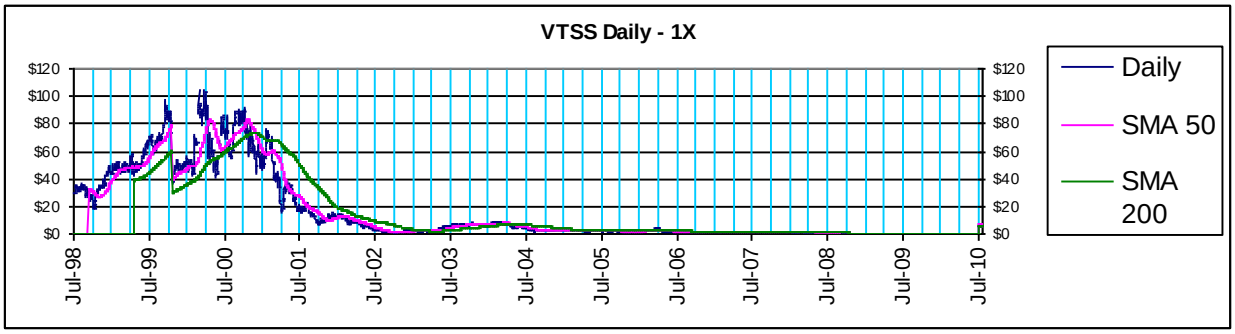


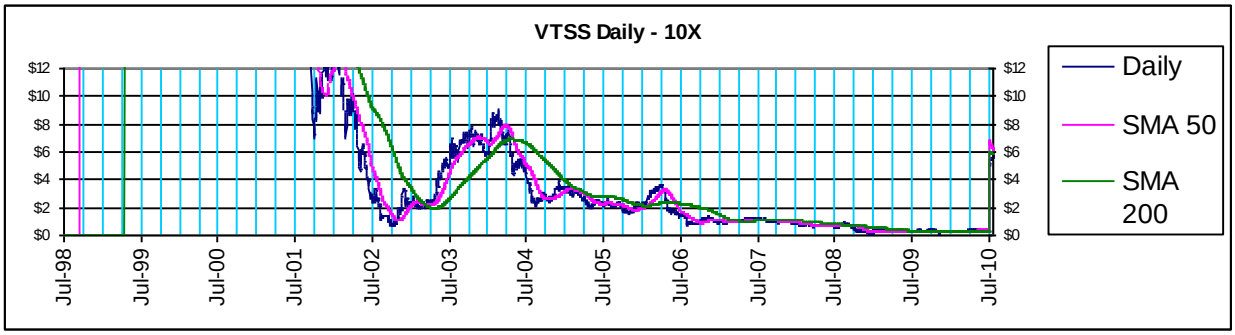


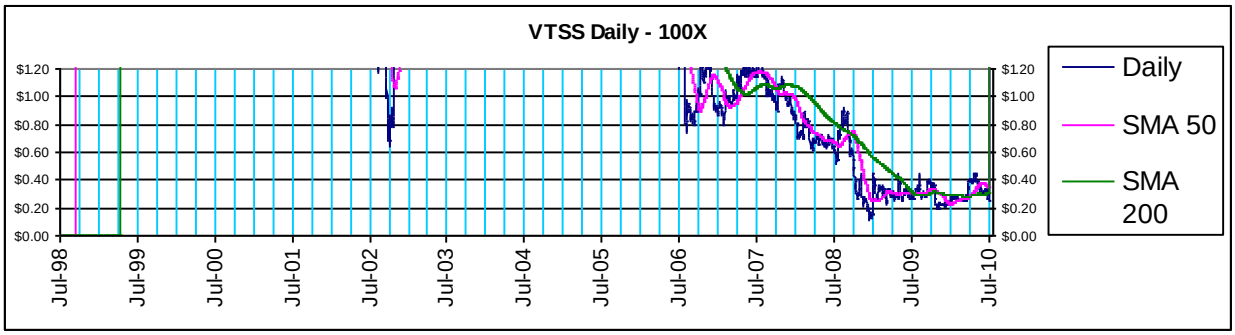
Y-Axis

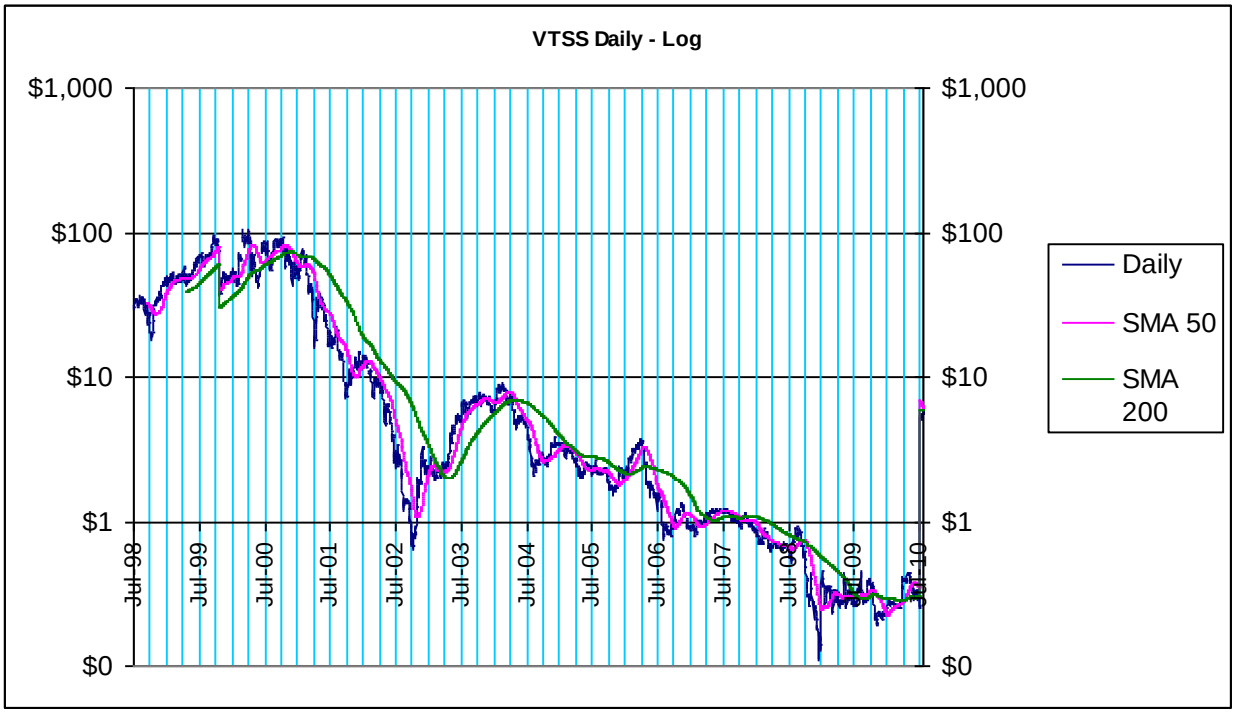
Scale – price	Pros	Cons	Recommendation
0 to security max price (so max varies from security to security)	Normalizes price between different securities; Full use of graph height to show price history; Starting from '0' keeps price fluctuations from being amplified in the graph	Scale varies between securities; Percentage change looks different when security is high versus when low; Harder to see variations compared to restricted range Y axis values	Use this
Security min to security max	Scale adjusted to the upper and lower limits of the data, so most detail shown in a given graph size	Scale varies between securities; Securities with small price oscillations look the same as securities with large price oscillations: Same percentage change looks different when security is high versus when low	Use where looking at fine detail
To fixed max (say 1000)	Uniform comparison between securities	May clip higher values and not show sufficient detail; Percentage change looks different when security is high versus when low	

High dynamic range – stacked & log	Pros	Cons	Recommendation
Additional graph if needed, as scale of the 1st / 10	Expands to show detail lost in normal graph	Additional graph takes up space	Use when value varies over a large range
Additional graph if needed, as scale of the 1st / 100	Expands further to show detail lost in normal graph	Additional graph takes up space	Use when value varies over a range too large to cover in 2 graphs
Logarithmic scale	Can show detail over very wide range; Percentage changes show consistently independent of the price	Distorts (compresses highs, expands lows)	





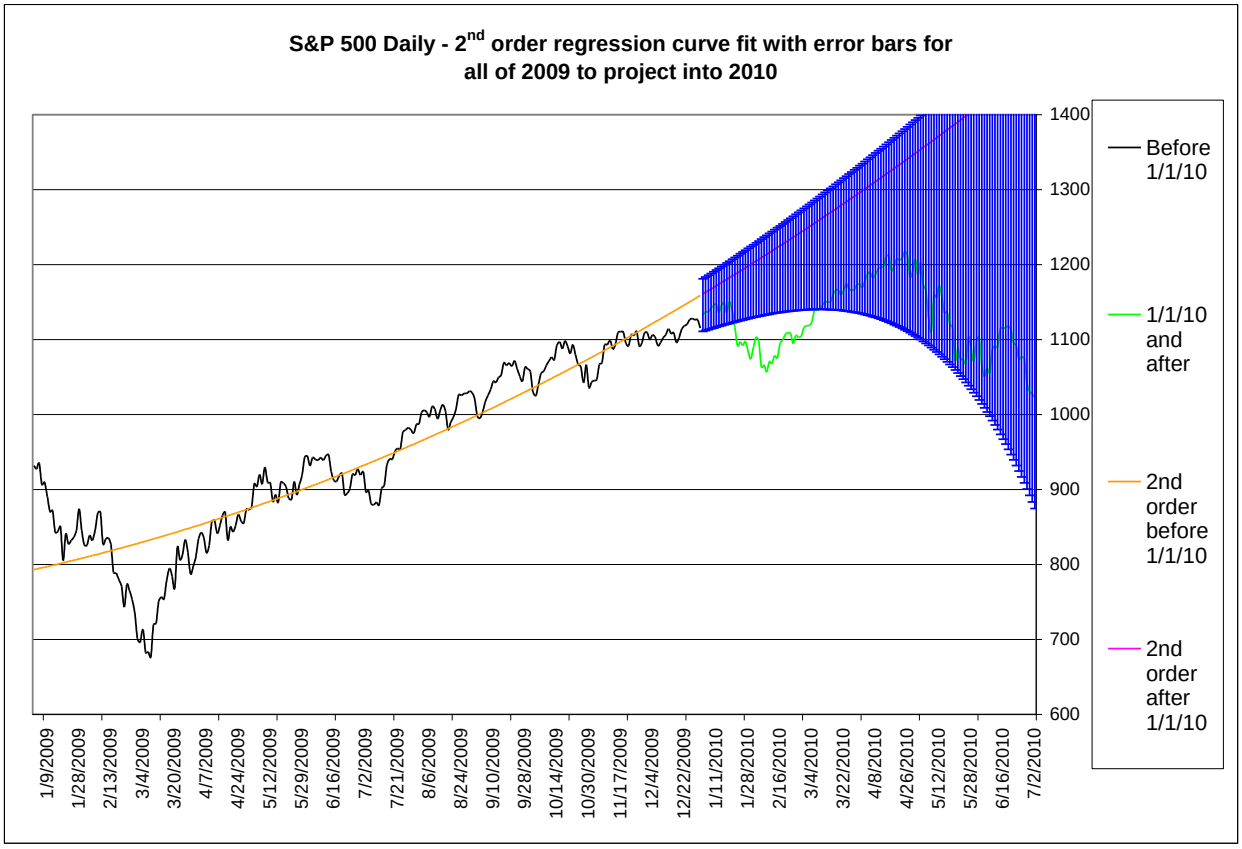


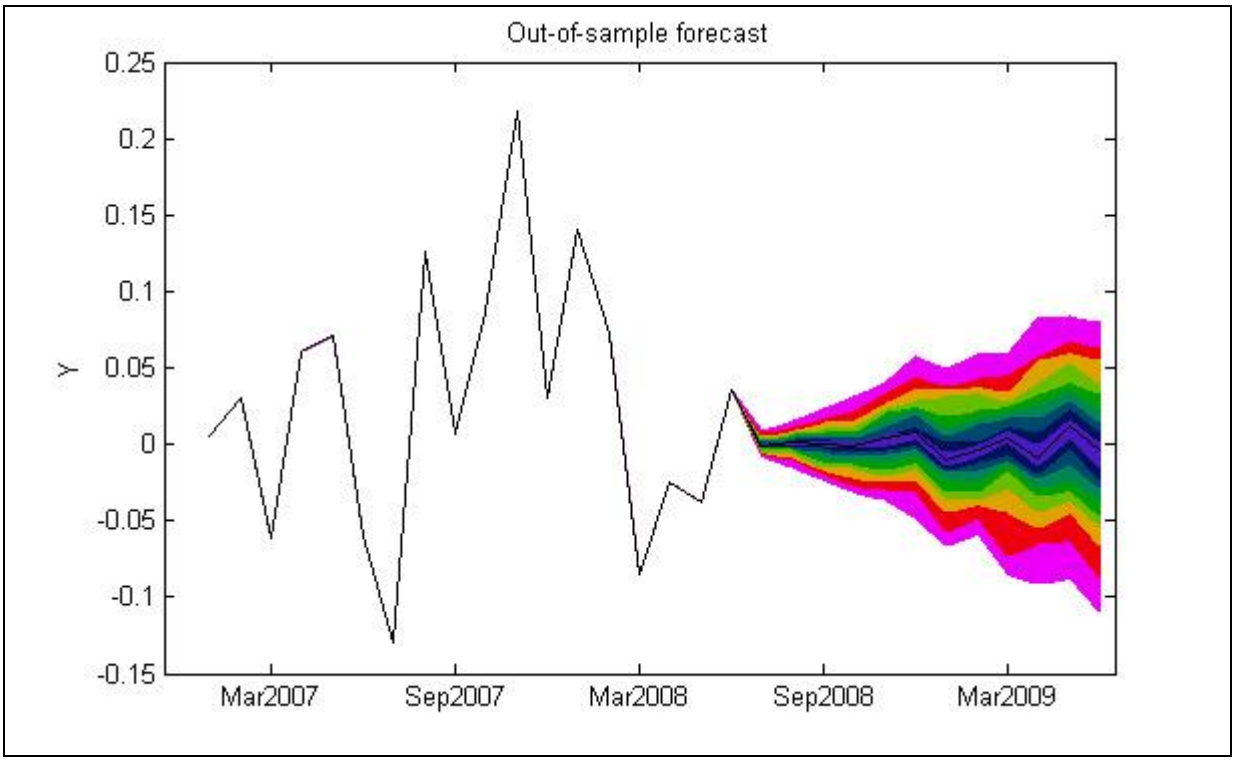


Axis – labels	Pros	Cons	Recommendation
Left or right side only	Good for small charts; Allows for the second axis to be a different scale for an overlaid graph	More difficult to correlate the scale with the data when chart gets wide	Do when charts are shorter than 1' wide
Both left and right side	Easy to find the scale on a moderately wide chart	Need to take care to keep the axis scales in sync – can't rely on automated scaling	Do when chart is between 1' and 2' wide
Periodically across chart	Facilitates finding the scale on a wide chart (>2')	Adds clutter	Nice to have, but many charting tools (such as Excel) don't support this

Axis – gridlines	Pros	Cons	Recommendation
Spacing should be consistent across all charts that are stacked vertically	Easy to correlate events between charts	May take manual tweaking to achieve	
Color	A light color drops out and clutters less		Sky blue (Windows color)

Error Bars and Bands	Pros	Cons	Recommendation
Error bars	Often used to show how accurate projections are expected to be		
Error bands (example from Matlab)	Shows continuous range of estimate accuracies around the nominal estimate		





Error bands, color coded to show the likelihood that future values are within a projected range.

Overlays

Overlays can be drawn manually on printouts or specialized software packages can create computer-generated overlays under commands from a user via a graphical user interface. Computer-generated overlays have the following advantages over manually drawn ones:

- They are easy to store (electronically) / archive and retrieve, and share remotely
- Once the software package is mastered, it is quicker to draw via computer
- The parameters of the overlays can be numerically linked to / derived from the graphed data
- Easier to erase / reposition

Conversely they have the following disadvantages:

- If one wants a different type of overlay that is not supported by the software package, it is generally difficult to add this new functionality

Overlay Types	Pros	Cons	Recommendation
Andrews' Pitchfork			
Arc			
Ellipse			
Extended line			
Extended Parallel Lines			
Fibonacci Retracement			
Fibonacci Speed/Resistance Arc			
Fibonacci Speed/Resistance Fan			
Fibonacci Trend-Based Time Lines			
Fibonacci Time Zones			
Gann Fan			
Gann Square			
Horizontal Line			
Horizontal Parallel Lines			
Parallel Line			
Ray Line			
Ray Parallel Lines			
Regression Channel – Raff Regression			
Regression Channel – Raff Regression			
Regression Channel – Segment High-Low			
Regression Channel – Standard Deviation			
Regression Channel – Standard Deviation – Standard Error			
Rectangle			
Text			
Trend Line			
Triangle			
Cycles			
Fibonacci Extension			
Time Extension			

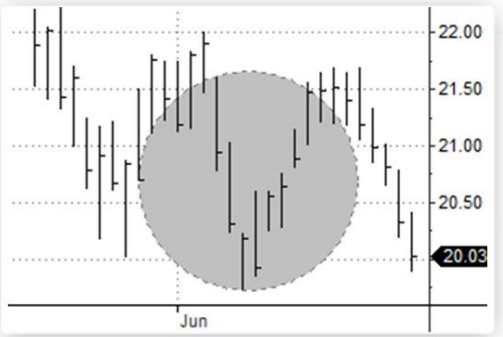
Examples from http://www.multicharts.com/trading-drawing-tools/ :

Andrews' Pitchfork

This drawing tool helps predict the support and resistance areas in a trending market. It consists of three parallel lines—usually drawn from three consecutive major peaks or troughs.

Arc

This is a non-analytical drawing tool that looks like an arched line, and it's used for highlighting necessary chart segments. Arcs can be drawn at any angle.



Ellipse

This is a non-analytical drawing tool for highlighting the necessary parts of a chart.

Extended Line

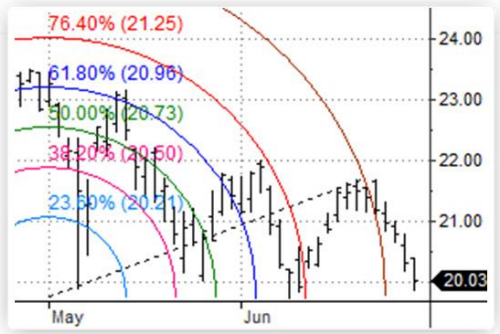
This analytical drawing tool indicates past and future directions of price movement. This is a trend line that extends left and right on the chart.

Extended Parallel Lines

This analytical drawing tool draws parallel trend lines that are extended to the left and right on the chart. They outline the equidistant channel in which the market trades. The upper horizontal line is the resistance line. The lower horizontal line is the support line. If either of these lines is penetrated, a price breakout may occur.

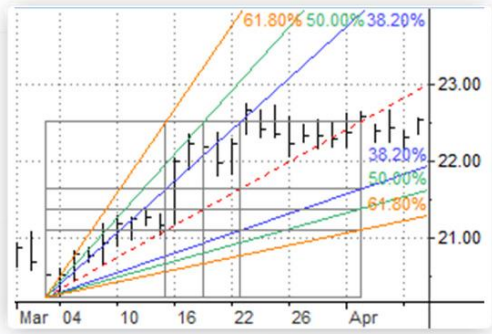
Fibonacci Retracement

This analytical drawing tool examines support and resistance levels, as well as price breakouts. It is represented by a series of horizontal lines that intersect the trend line (drawn between two extreme points) at the Fibonacci levels or selected distance percentages.



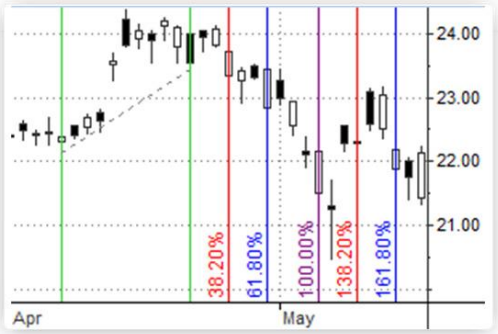
Fibonacci Speed/Resistance Arc

This analytical drawing tool determines the direction and speed of trend reversal, and it indicates support and resistance levels. You can draw up to 11 arcs based on any selected distance percentages as well as Fibonacci percentages.



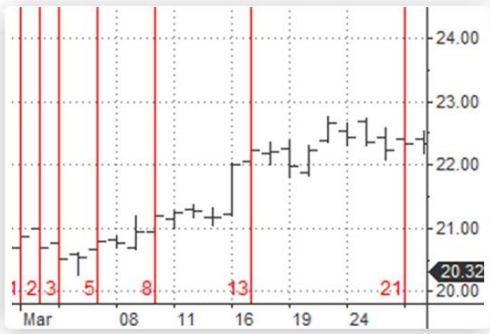
Fibonacci Speed/Resistance Fan

This analytical drawing tool indicates support and resistance levels of an existing trend and the price level at which possible changes in the trend may occur. You can draw up to 11 lines based on any selected distance percentages as well as Fibonacci percentages.



Fibonacci Trend-Based Time Lines

This analytical drawing tool predicts future price corrections and examines support and resistance levels, as well as price breakouts. It is represented by a series of vertical lines at date and time levels, which show probable price corrections in the existing trend.



Fibonacci Time Zones

This analytical drawing tool is represented by a series of vertical lines, and it indicates significant price movements near them. These vertical lines are spaced according to the Fibonacci number sequence (0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, …).

Gann Fan

This analytical drawing indicates time and price movements from important highs and lows, and it identifies price breakouts. Angled lines fan out from the selected point. They indicate a time-to-price relationship that may be relatively fast or relatively slow, depending on the size of the Gann angle.

Gann Square

The Gann Square is created by drawing a Gann Fan from each corner of a square.

Horizontal Line

This analytical drawing tool indicates a particular price level. You can draw more than one in order to mark support and resistance levels.

Horizontal Parallel Lines

This is a pair of horizontal parallel lines that outline the equidistant channel in which the market trades.

Parallel Lines

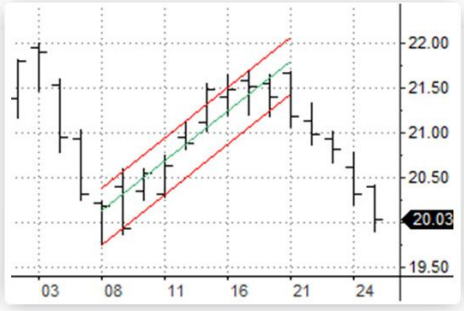
This is a pair of parallel lines that outline the equidistant channel in which the market trades.

Ray Line

This analytical drawing tool indicates possible future direction of price movement. This is a trend line that can only be extended to the right.

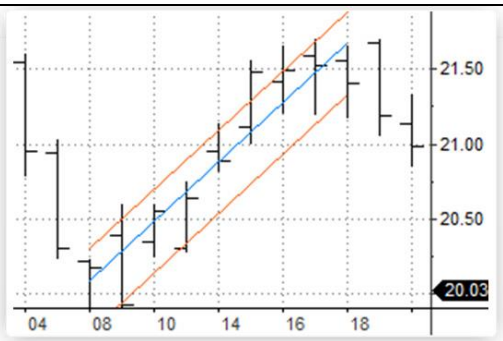
Ray Parallel Lines

This analytical drawing tool draws parallel trend lines that are extended to the right only. They outline the equidistant channel in which the market trades.



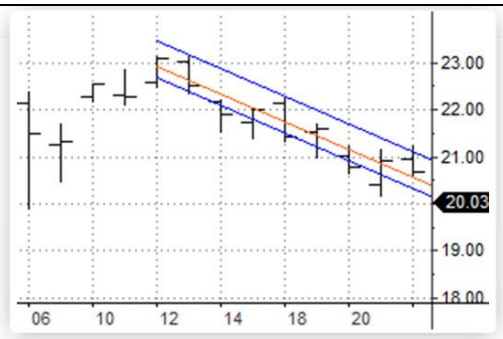
Regression Channel - Raff Regression

Gilbert Raff developed this analytical drawing tool, and it precisely defines a price trend and its support and resistance levels. It is represented by two parallel equidistant lines drawn above and below the linear regression line, and it is based on the maximum upward and downward oscillation.



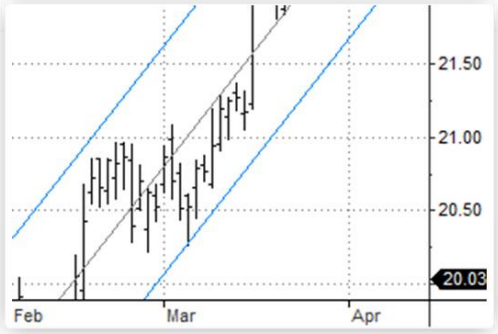
Regression Channel - Segment High-Low

This is a channel based on a regression line, which is calculated from open, high, low, and close values. The upper line is based on the highest value for the period and the lower line on the lowest value. The outer bounds outline the equidistant channel in which the market trades.



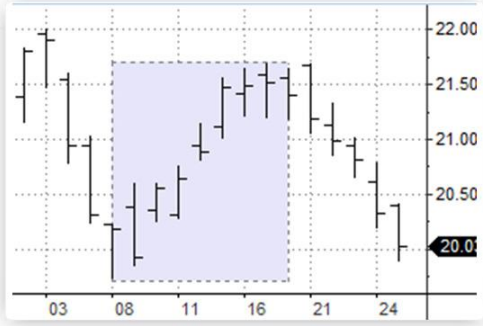
Regression Channel - Standard Deviation

This analytical drawing tool shows two parallel equidistant lines based on a specified number of standard deviations and is drawn above and below the regression line.



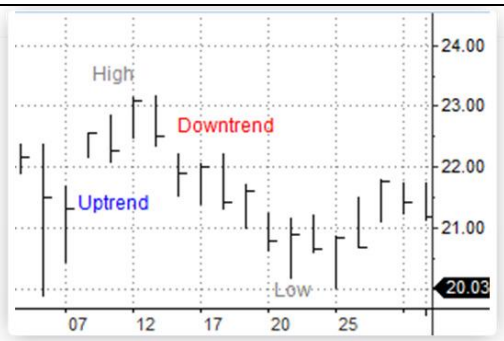
Regression Channel - Standard Error

This analytical drawing tool shows two parallel equidistant lines based on a specified number of standard errors and drawn above and below the regression line.



Rectangle

This is a non-analytical drawing tool for highlighting the necessary parts of a chart.



Text

Text is a non-analytical drawing tool used to display user comments, and other text, directly on the chart.

Trend line

This analytical drawing tool indicates the direction of price movement.

Drawing tools from AMI Broker software package:

Curve Fitting & Algorithmic Predictions

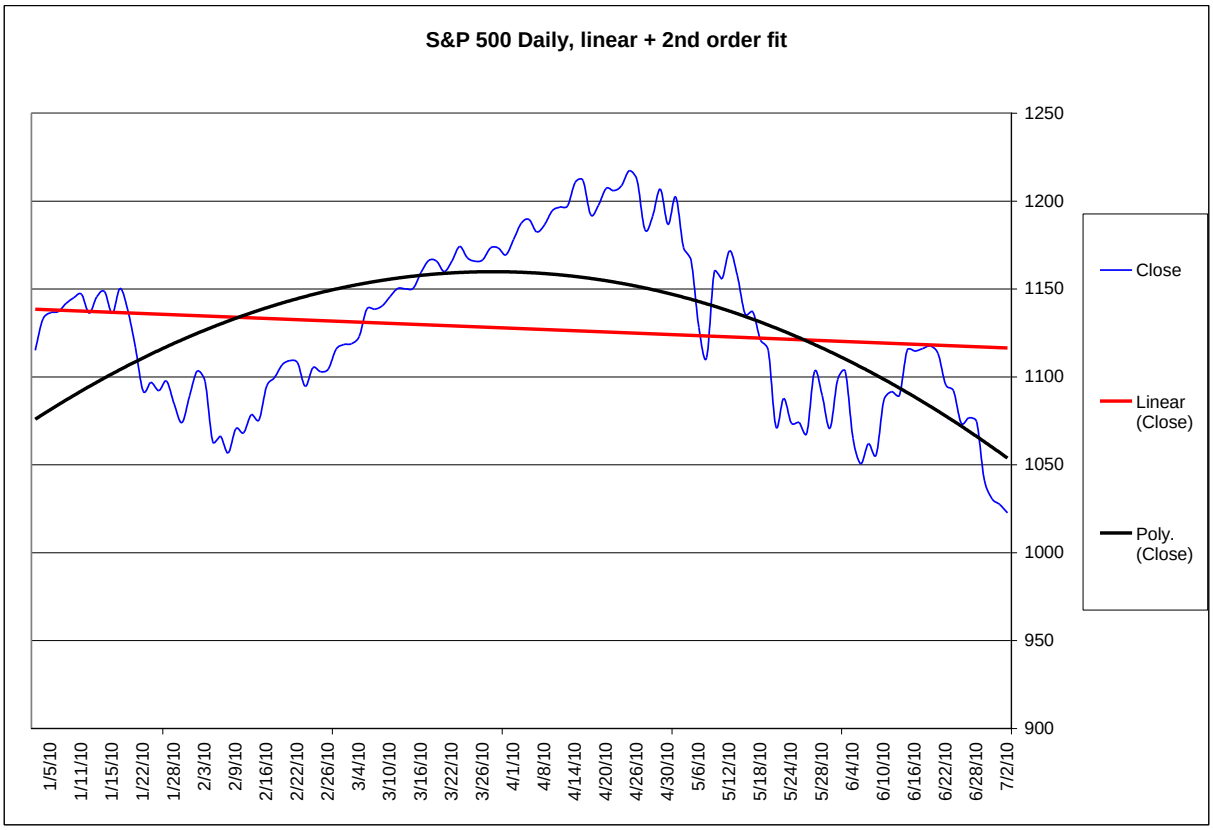
Curve fitting can be used to characterize and quantify a segment of a price history. It can also be used to predict future trends and prices.

Predicted future prices can be extrapolated from a set of historical prices by using one of a number of curve fitting methods on historical data stretching back a selected amount of time from the date of the prediction. Extension of the fitted curve into the future produces the prediction.

First and second order polynomial least squares fit

A linear or straight-line fit is defined by its Y-intercept and slope. It can be used to characterize trends.

Second order fitting is useful where the curve approximates a parabola. Since a 2nd order curve continues toward either + or – infinity as one gets away from the peak (or valley, if upside down), it is likely that the curve will soon diverge from the stock graph, since stocks don't behave this way in the long term.



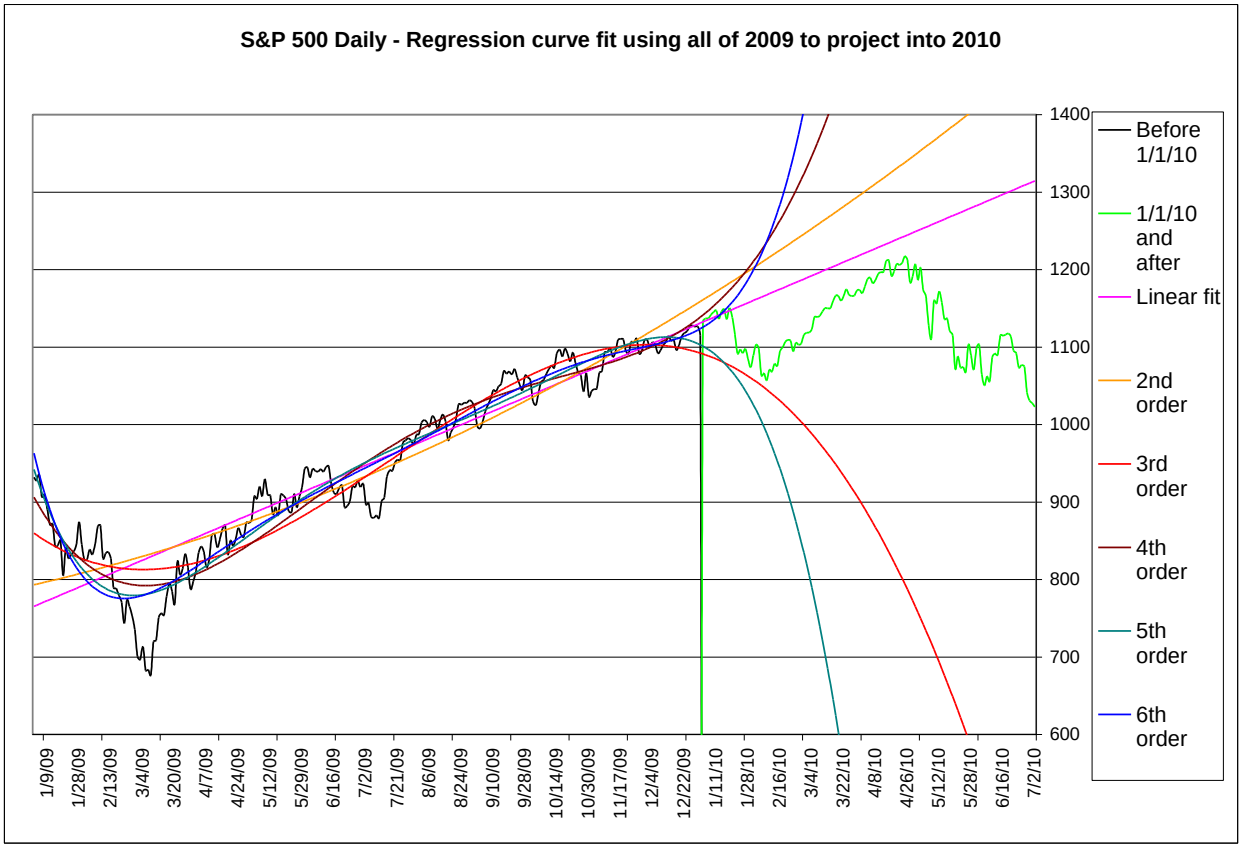
High order polynomial fits

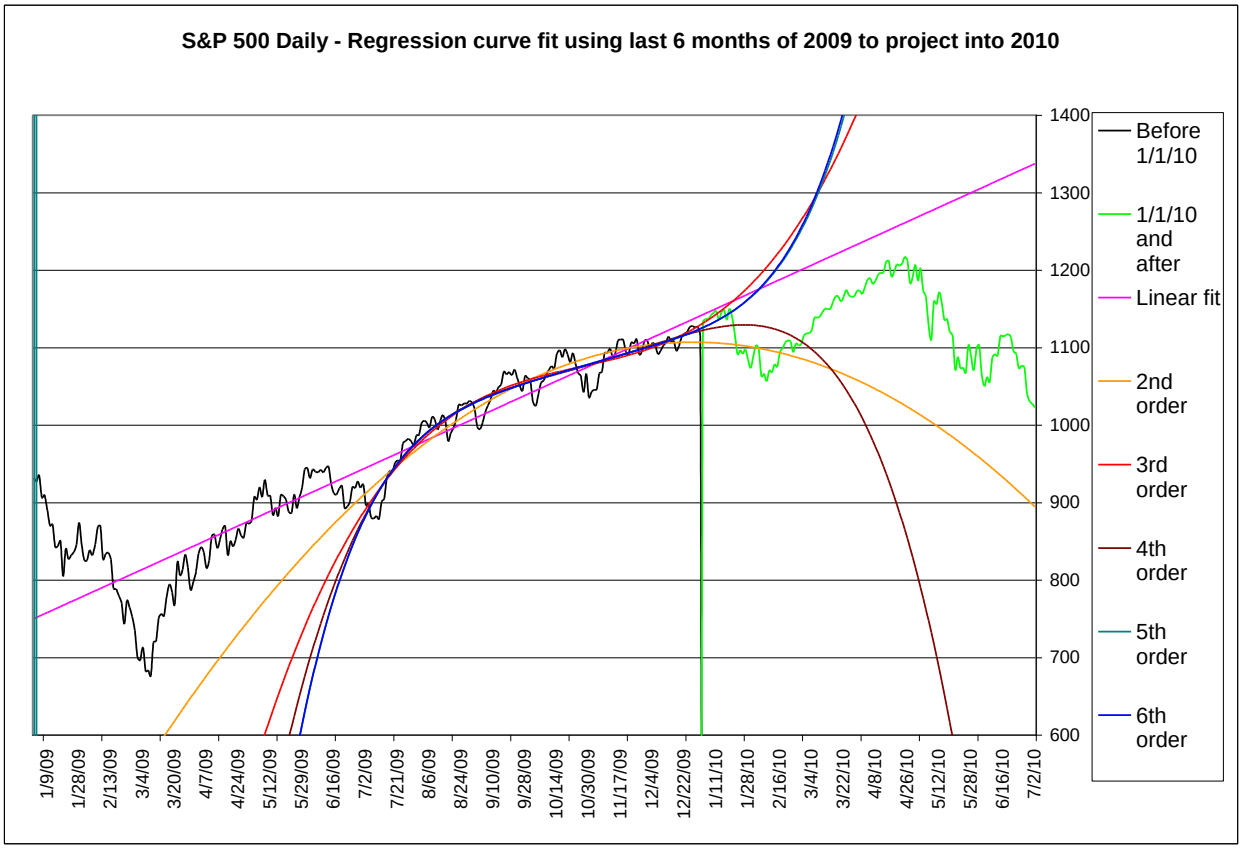
The following graphs illustrate attempts to forecast future stock prices based on a polynomial fit of historical prices. The first set of 5 graphs assume that is now January 1, 2010 and one is trying to project the S&P 500 from that point forward. Since it is late July 2010 as of this writing, we know what the S&P 500 actually did between 1/1/2010 and July 2010, so we can judge how well the various projections matched what really occurred. Each chart shows first through 6th order polynomial least-squares-fits and subsequent projections. The graphs vary in how much history was used to do the curve fitting, as follows:

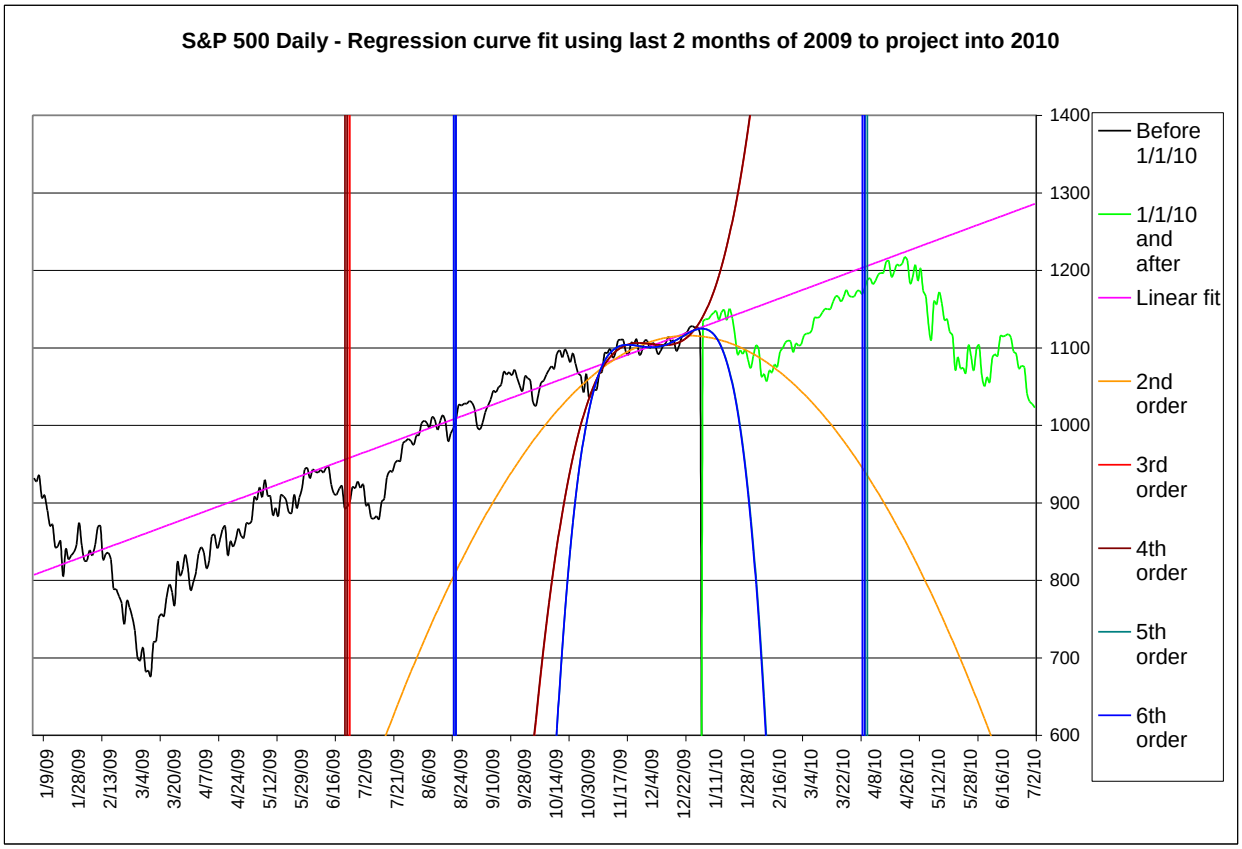
- The first one uses the full year of 2009
- The second one uses the last 6 months of 2009
- The third one uses the last 2 months of 2009
- The fourth one uses the last month of 2009
- The fifth one uses the last 2 weeks of 2009

The 6th chart evaluates projecting from a different point in time – March 1, 2010 – by fitting curves to the data from the full month of February, 2010.

The last chart does the same during the midst of the bull market in the spring of 2009, trying to project through the rest of 2009, by extrapolating from 2 months of data. At least in these examples, there is no consistent winner using polynomial curve fittings.




S&P 500 Daily - Regression curve fit using last 6 months of 2009 to project into 2010
1400
1300
1200
1100
1000
900
800
700
600
1/9/09
1/28/09
2/13/09
3/4/09
3/20/09
4/7/09
4/24/09
5/12/09
5/29/09
6/16/09
7/2/09
7/21/09
8/6/09
8/24/09
9/10/09
9/28/09
10/14/09
10/30/09
11/17/09
12/4/09
12/22/09
1/11/10
1/28/10
2/16/10
3/4/10
3/22/10
4/8/10
4/26/10
5/12/10
5/28/10
6/16/10
7/2/10
Before 1/1/10
1/1/10 and after
Linear fit
2nd order
3rd order
4th order
5th order
6th order


S&P 500 Daily - Regression curve fit using last 2 months of 2009 to project into 2010
1400
1300
1200
1100
1000
900
800
700
600
1/9/09
1/28/09
2/13/09
3/4/09
3/20/09
4/7/09
4/24/09
5/12/09
5/29/09
6/16/09
7/2/09
7/21/09
8/6/09
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9/28/09
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10/30/09
11/17/09
12/4/09
12/22/09
1/11/10
1/28/10
2/16/10
3/4/10
3/22/10
4/8/10
4/26/10
5/12/10
5/28/10
6/16/10
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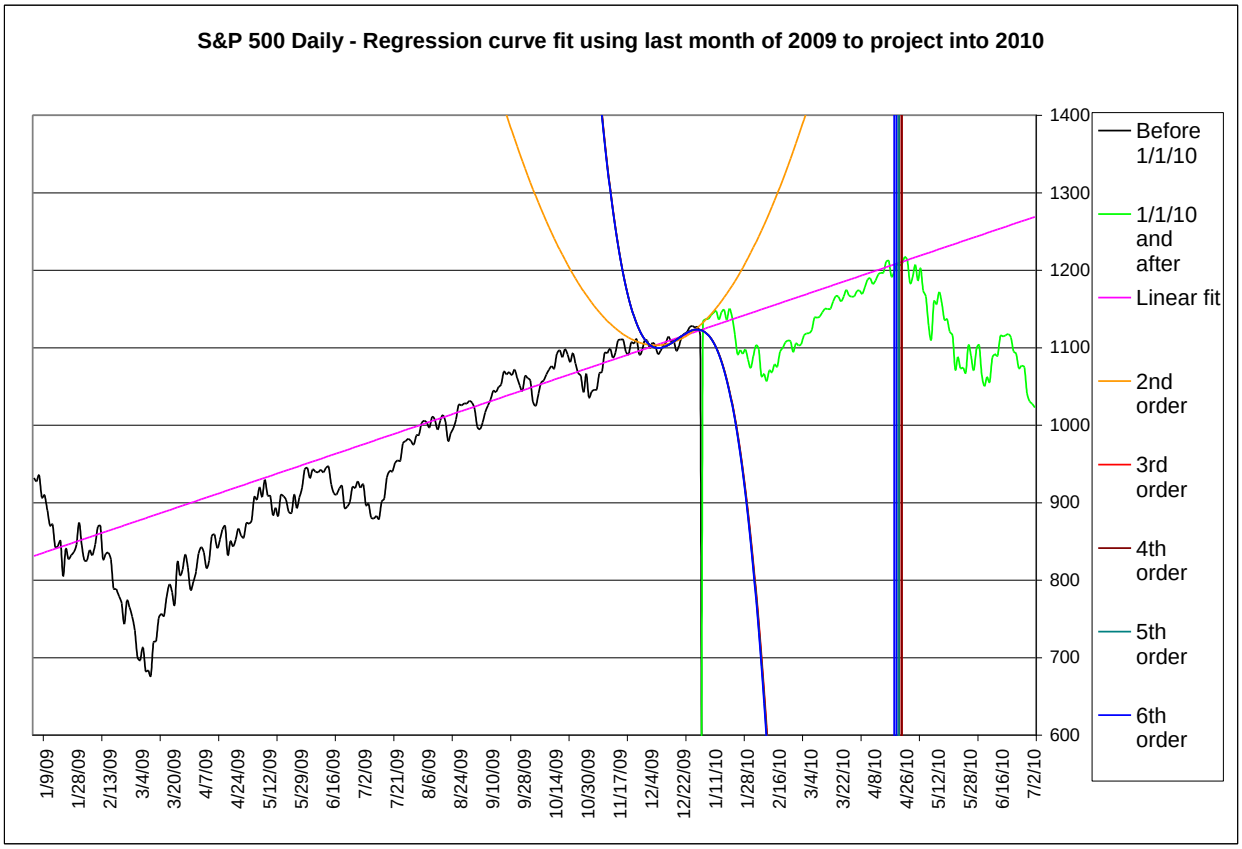
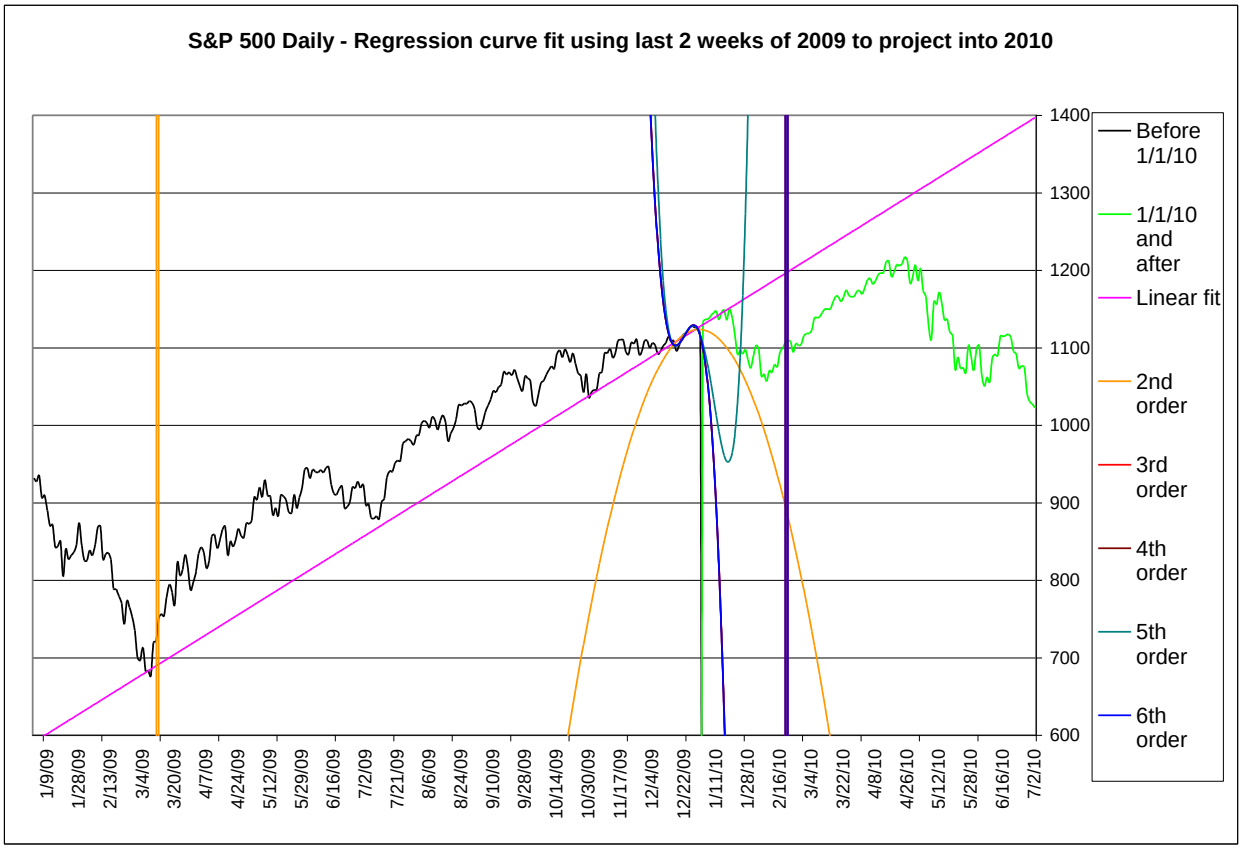
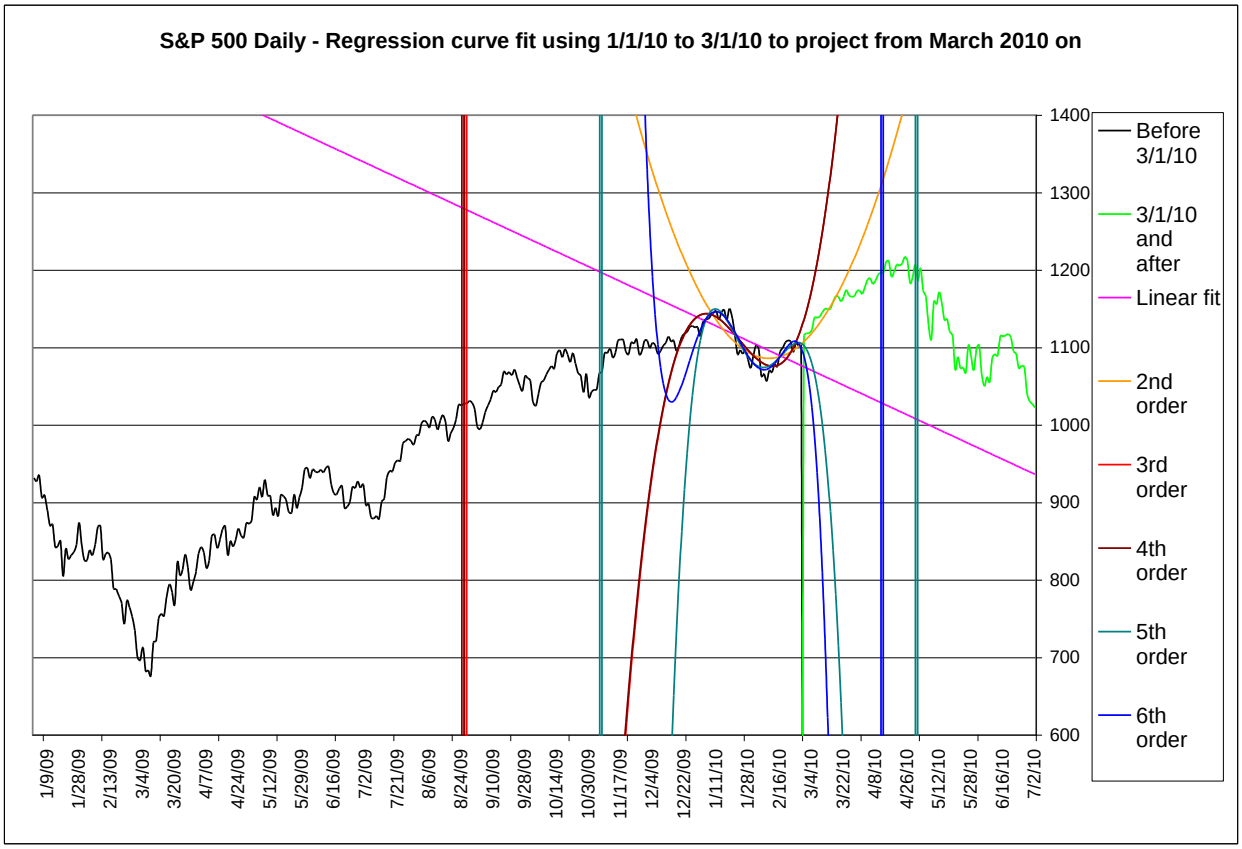
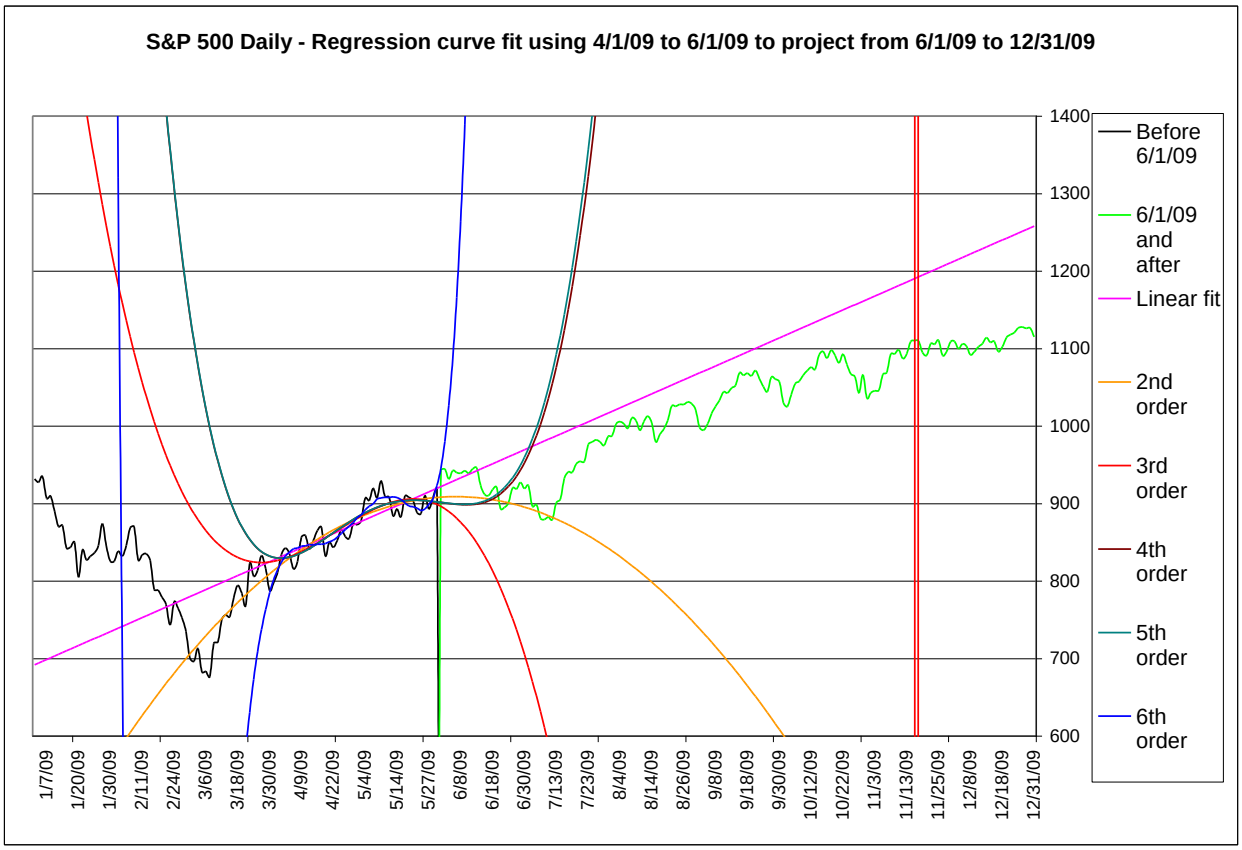
Before 1/1/10
1/1/10 and after
Linear fit
2nd order
3rd order
4th order
5th order
6th order





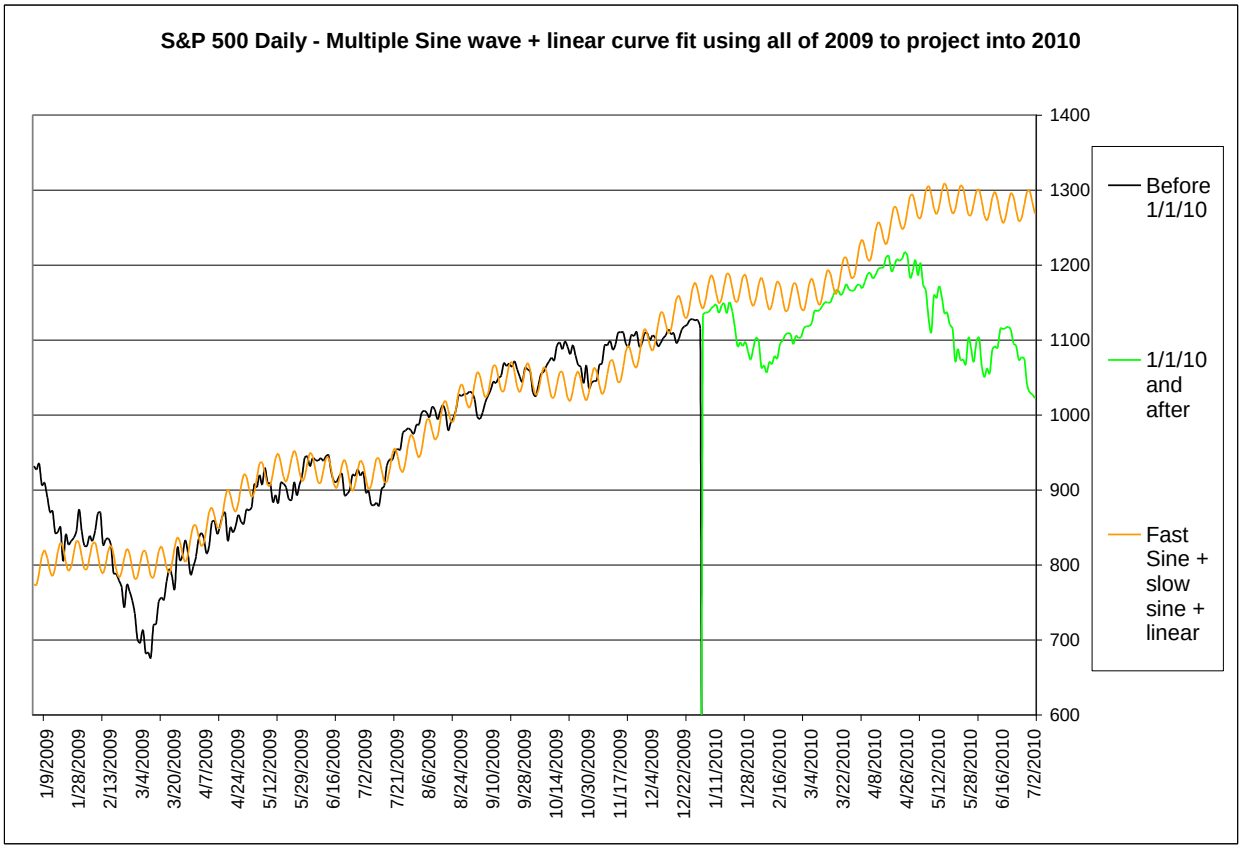




Fits using other functions

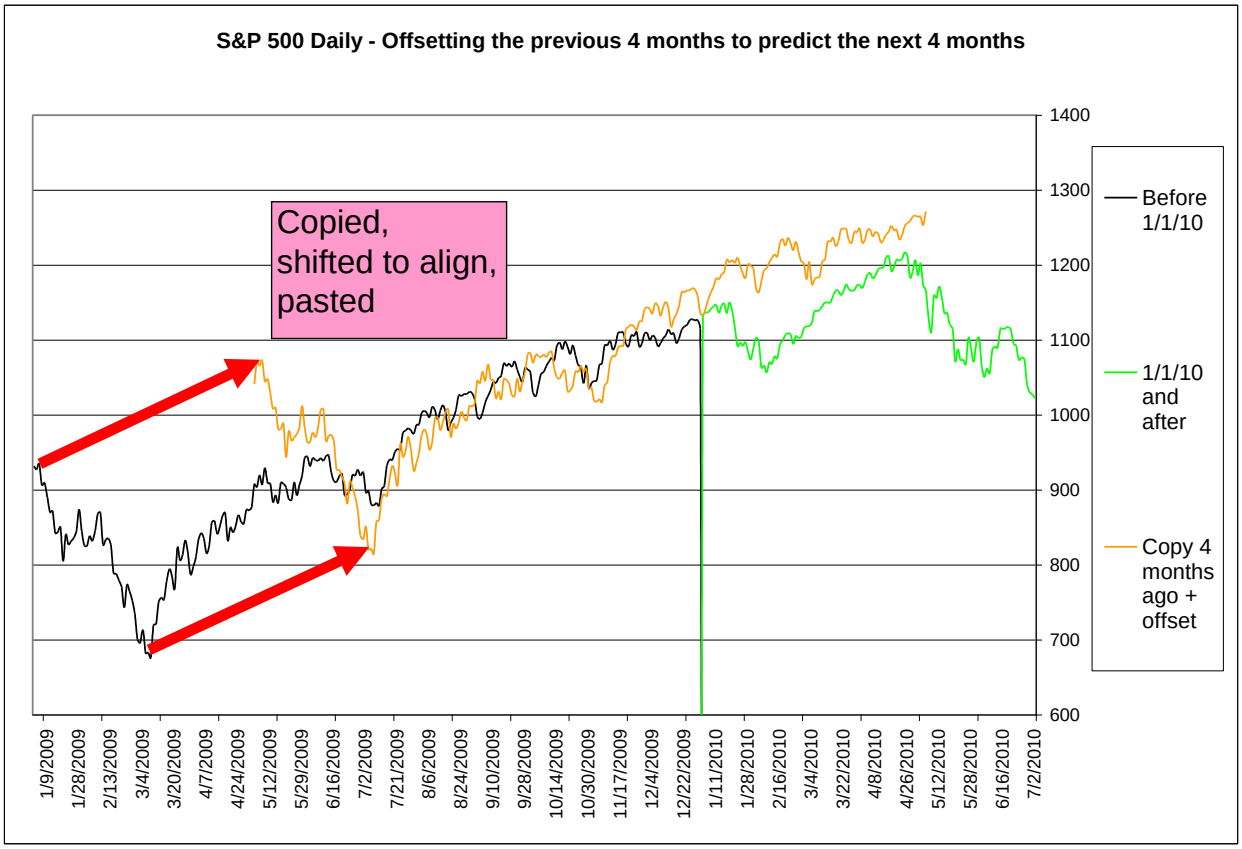
Sine wave

It is not surprising that polynomials do not fit stock price curves well, since these curves inherently do not resemble polynomial functions. It would seem that a closer fit could be made with a combination of slowly and rapidly oscillating sine waves, imposed on a ramp. The next figure shows such an estimation waveform that has been manually tuned.



The curve itself

A yet further extrapolation method is to use the stock curve itself, instead of a mathematical approximation, to estimate its future shape. This works if patterns continue to repeat themselves. Here it looked like the same pattern (a quick dip followed by a climb) was occurring a 3rd time, but it turns out that it didn't.



Miscellaneous Predictive Functions

A number of other functions can be used to generate curves whose formulas are optimized to match historical data and then extended past the historical data to predict future datapoints. Here are some examples, from http://www.ipredict.it/ForecastingMethods.aspx :

Classical Algorithms
1. Simple Moving Average
2. Geometric Moving Average
3. Triangular Moving Average
4. Parabolic Moving Average
5. Double Moving Average
6. Exponential Moving Average
7. Double Exponential Moving Average
8. Holt's Double Exponential

9. Triple Exponential Moving Average
10. Holt's Triple Exponential
11. Adaptive Response Rate Exponential Smoothing
12. Holt Winter's Additive
13. Holt Winter's Multiplicative
14. Holt Winter's Modified Multiple Seasonalities
15. Additive Decomposition
16. Multiplicative Decomposition
17. Sparse Series Croston's Exponential
18. Linear Trend / Regression

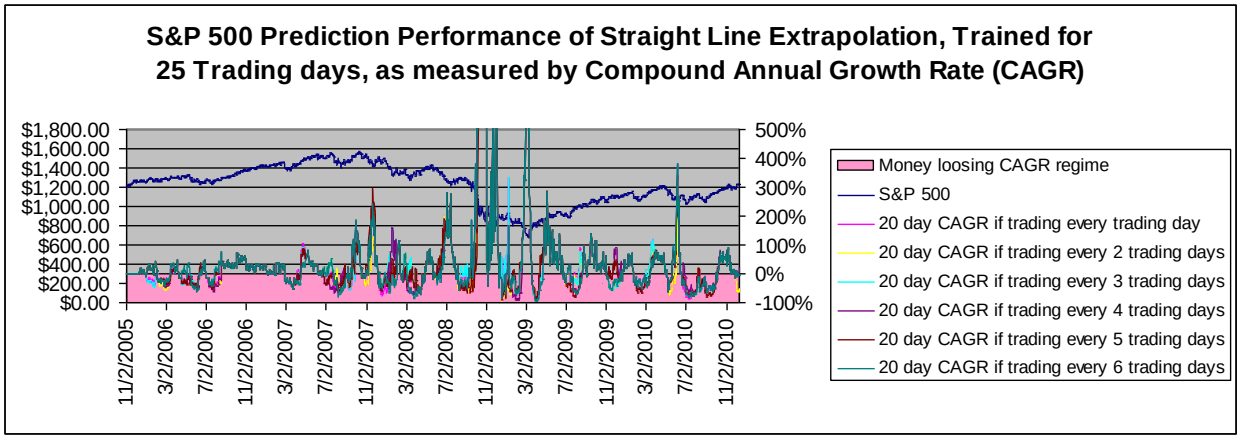
Curve and Bayesian Model Fitting
19. Linear Trend and Additive Seasonality
20. Linear Trend and Multiplicative Seasonality
21. Linear Trend and Multiple Seasonalities
22. Polynomial
23. Logarithmic
24. Exponential

Wavelet Smoothing and Forecasting
25. Frequency Identification
26. Haar De-noising
27. Daubechies Linear De-noising

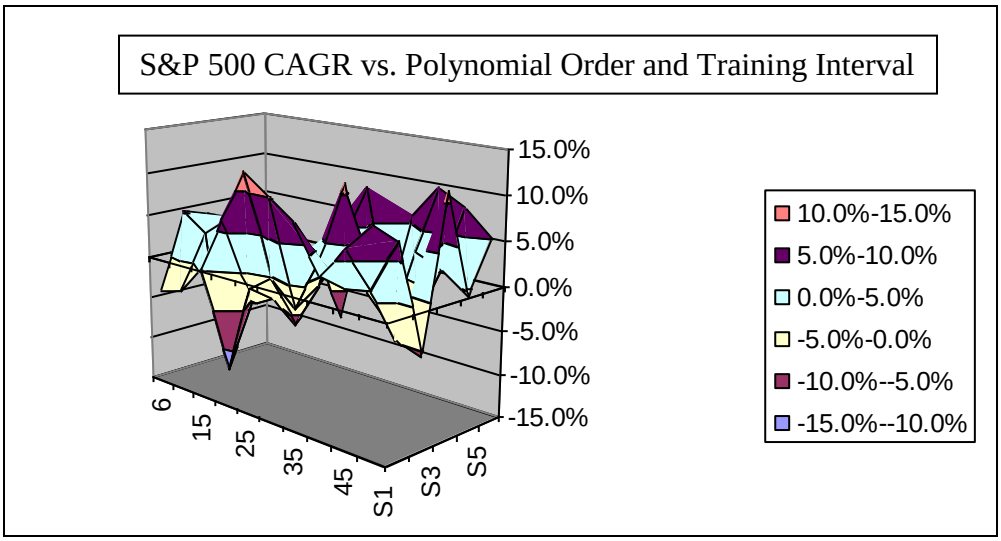
The method shown above for polynomials, sine waves, and the curve itself, where actual historical data is graphed up to the prediction date, overlaid by the fitted curve which then extends into the future beyond the prediction date, accompanied by actual data beyond the prediction date (assuming the prediction date is in the past so actual data exists) shows graphically how well the fitted curve tracks the historical data and predicts the "future" data.

Prediction Performance over Time

If the validity of a predictive algorithm is to be tested over time, then it is useful to derive a figure-of-merit for each prediction, and then this figure-of-merit can be graphed over time, showing the performance of the predictions over time.



If back-testing is performed on multiple variants of a predictive algorithm, then a graph of the figure-of-merit as a function of the configuration parameters should be made, as shown here:



Cross-Correlations

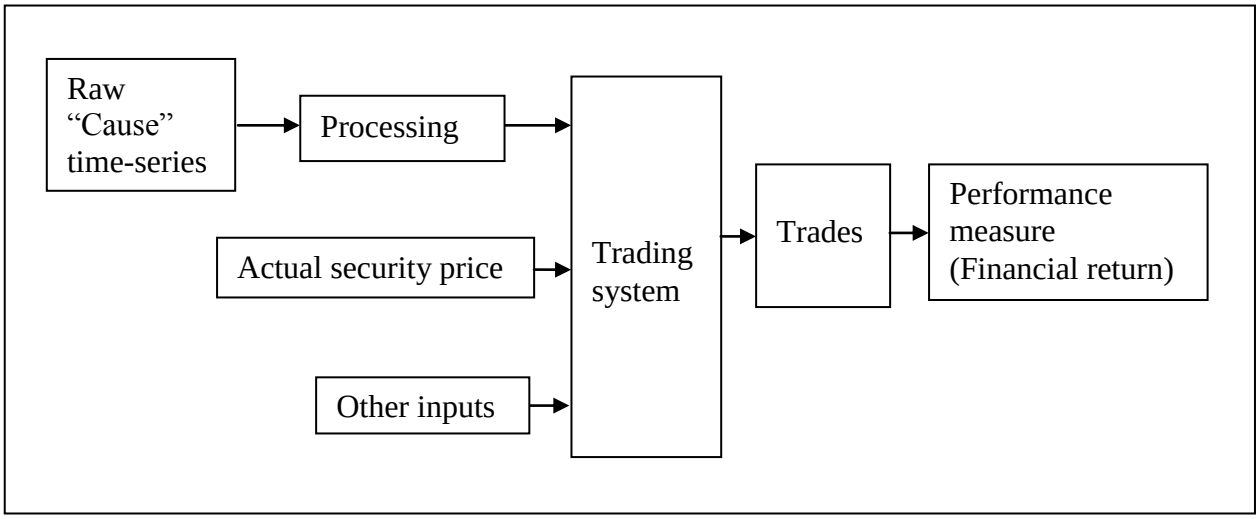
Mathematically speaking, correlations quantify how well the ratio of a pair of time-series conforms to being a straight line – thus increasing or decreasing in synchrony, after removing any bias (offset) or scaling (multiplier) from each series. Cross-correlations step one time-series past another, and at each step compute the correlation of the two. Peaks in the cross-correlation correspond to where the two waveforms (datasets versus time) best track each other in their undulations. The displacement of a peak from the X-axis corresponds to the time shift (steps) between the time-series where the peak correlation occurred. This displacement is the amount that one series is a leading or a lagging indicator of the other (depending on whether the peak is to the left or the right of the X-axis).

What to correlate

Correlating a security's price to that of a potential "cause", such as interest rates, housing starts, etc. may not yield meaningful results. What is pertinent is how the cause data will be processed to produce a trading decision for the security. Examples of such processing are:

- Cause rises at least X% for each of N successive intervals
- Cause slope, measured over N intervals, is over X
- Cause drops by X% then rises by at least Y% within N intervals
- Cause breaks the record high of the last N trading intervals
- Cause #1 rising when Cause #2 falling

However, the mathematical correlation of such processed data to the security price again may not be salient. The bottom line is the financial return rate that can be produced using the given cause, processed as desired, driving a trading system. Refer to the block diagram below. The trading system adds a non-linear effect (for instance, crossing a threshold drives the system to trade or not), and also, for instance, could introduce new factors that would gate when the system pays attention to the processed cause to drive trades. For example, the trading system may ignore this processed cause between Thanksgiving and New Years, as it has been found to be unreliable at the end of the year. These added factors invalidate correlation data that is derived from a subset of the system, such as the cause or processed cause to the security price. For conclusions about the usefulness of a cause to be meaningful, the model to evaluate performance must encompass all significant portions of the proposed actual trading model.

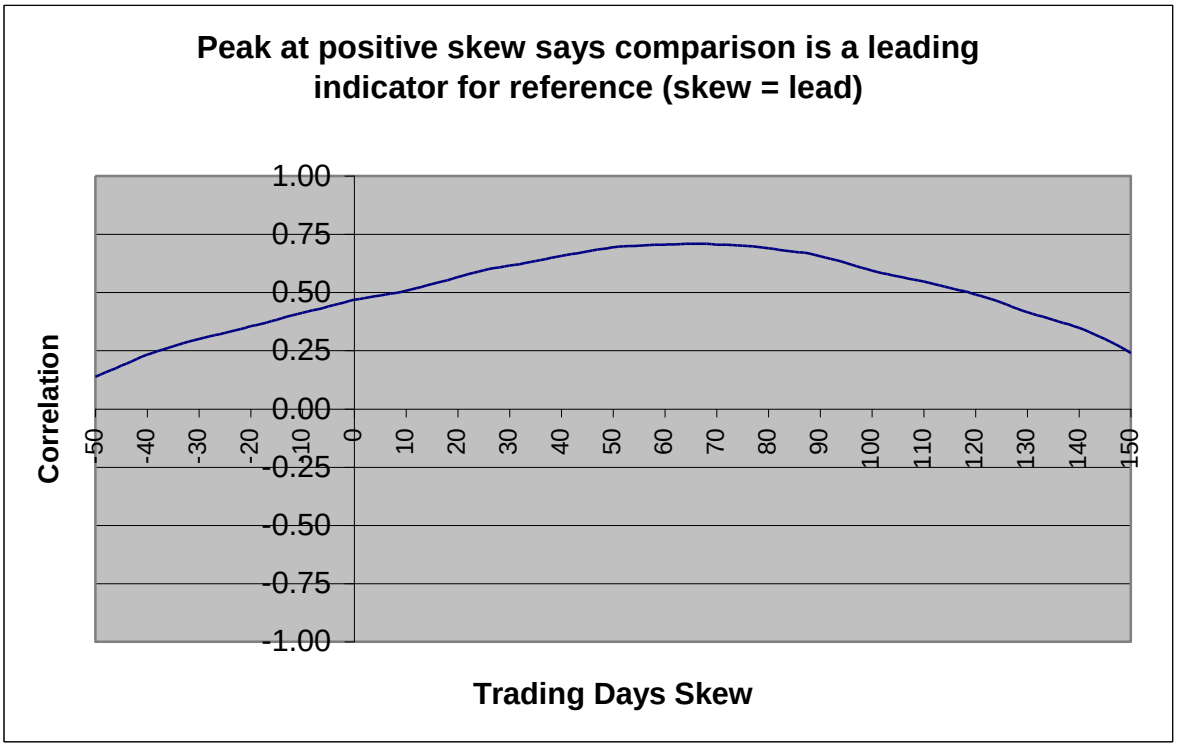


Graphing cross-correlations

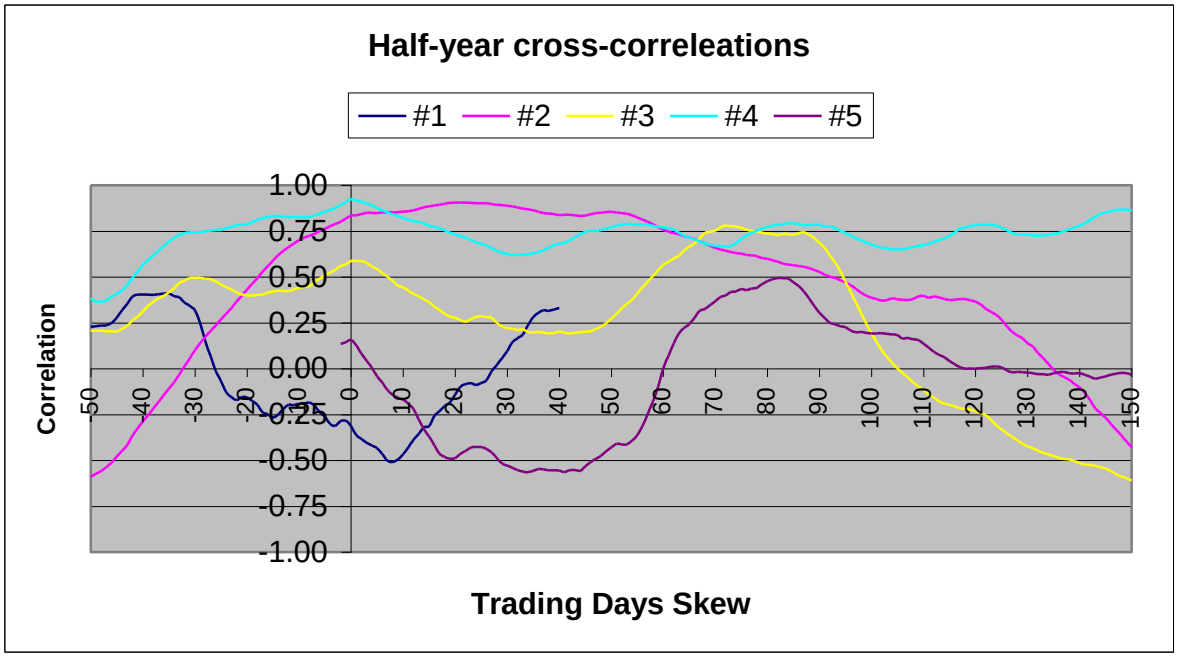
Cross-correlations can be performed over a single long interval, as shown below. This curve shows good correlation (0.65) between precious metals prices and the S&P 500, with changes in the metals prices preceding movements in the S&P 500 by 65 trading days, over this 2 year 8 month interval.

For the 2.67 year period from 11/01/07 to 07/02/10

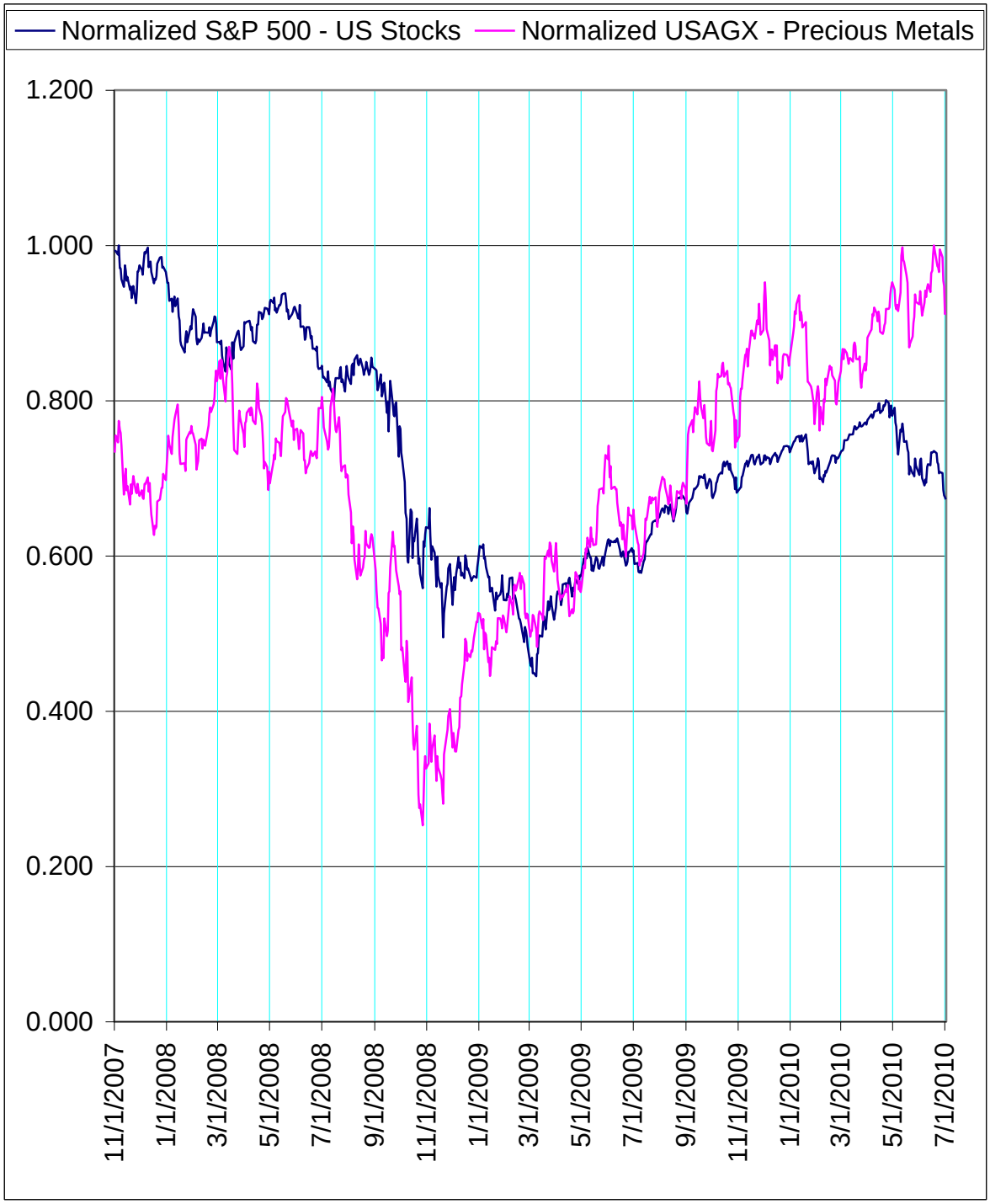
USAGX - Precious Metals as an indicator for **S&P 500 - US Stocks**



However this may mask correlations that change or are cyclic with time. So it is also informative to divide a long time interval up into contiguous segments, and to compute and graph the various segments on an overlapped time scale, as shown below. This shows that the degree of correlation dropped in the last 6-month period relative to the previous 3, so the effectiveness of this as a leading indicator may be declining.



Graphing the two datasets on the same axis, with the prices normalized, shows the correlation visually, as below.



Recommendations

These recommendations apply to printed, but not necessarily on-screen, graphs.

Stock Price History	Conditions	Recommendation
What to graph	When interested in buyer/seller psychology	Actual prices
	All other times	Split-adjusted prices
	When assessing the strength of trends	Price(s) + volume
	All other times	Price(s) (volume is optional)
	Graphs of more than 10 trading periods per inch and less-dense graphs not being analyzed for chart patterns	Closing prices only
	All other times	Open, High, Low, Close
Period graphed	To see long-term trends	Cover at least 1 full economic cycle
	To see short-term trends	Cover 10 to 100 X the proposed trading time frame
Graph dimensions	To study long time frames or stacked comparisons between a security and causes/indices	No more than 24” tall by 10’ long
	All other times	To fit on an 8.5” x 11” sheet
Type	Graphs of more than 10 trading periods per inch and less-dense graphs not being analyzed for chart patterns	Line
	All other times	Candlestick graph
X-axis	Always	Time progresses left to right, even spacing between trading intervals
	Across a series of graphs that will be compared	Consistent graph pitch (trading intervals/inch), consistent start & end dates
	Short-term analysis	10 trading days/inch
	Medium-term analysis	50 trading days/inch
	Long-term analysis	500 trading days/inch
	High-frequency trading	Sub-daily prices
	All other times	Daily prices

Stock Price History	Conditions	Recommendation
Y-axis	When analyzing fine-grained price behavior and security minimum price is > 20% of security maximum price	Bottom of graph (minimum Y value) is just below minimal value graphed
	When not analyzing fine-grained price behavior	Bottom of graph is $0
	All other times	Split into multiple vertically stacked graphs with Y axis maximum scaled 10X between successive graphs until minimum value is over 20% ; bottom of each graph is $0
	Charts less than 1’ wide	Show Y axis scale on left side
	All other times	Show Y axis scale on both sides

Styles	Conditions	Recommendation
Smoothing	Line charts	Use line smoothing
Color		Select to contrast with other lines and the background when printed
Markers		None
Line style		Solid
Line weight		Regular
Background	When showing underlying economic cycle, etc.	Color shaded with key
	All other times	White
Vertical gridlines		Light blue (sky blue in Excel)
Horizontal gridlines		Light blue (sky blue in Excel)
Annotations and data tables		None

Technical Indicators	Conditions	Recommendation
Trending indicators	When studying trends	Short simple moving average overlay on price, pick interval to optimize trading return
	When studying trends	Long simple moving average overlay on price, pick interval to optimize trading return
	As desired	Stacked graph of DMI/ADX
	As desired	Stacked graph of MACD
	As desired	Others
Non-trending indicators	As desired	Stacked graph of RSI
	As desired	Stacked graph of Stochastics
	As desired	Others

Events	Conditions	Recommendation
Splits and reverse splits	As desired	Stacked graph of Splits
Record highs and lows	As desired	Stacked graph of new record highs/lows
"Causes"	As desired	Stacked graph of individual "causes"

Time-Series Predictions	Conditions	Recommendation
	Single date in the past forward	Combination graph of security price history before the prediction, price history after the prediction, and the prediction curve (both before and after the prediction date)
	Back-testing for a series of dates	Combination graph of security price history with trading system performance (CAGR) over the previous month
	Parameterized back testing of a series of dates	Combination graph of security price history with trading system performance (CAGR) over the previous month for the optimal parameter set; graph of CAGR versus parameters

Cross-correlations	Conditions	Recommendation
		Graph the correlation versus skew over the entire interval analyzed; also subdivide the interval and make a subsequent graph with an overlay for each subdivision. A third graph of the two time series that were compared (versus time), after normalizing each, is also recommended.