How MACDs Really Work

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Introduction

One of the problems with moving averages is that when they cross over each other, the trend is well on the way and in many cases, the trend has virtually finished, and is about to retract. This is where most traders come unstuck, and most Investors just don't get it.

Traders can easily move into a trade only to find that the positive trade immediately moves into decline, and in a day they are losing money, so on pulling out they are down at least a few percent on that trade. This is not a problem if the failure rate is about 1 in 5 but when it gets lower, to about 1 in 3 then trades tend to break even overall, and below this it is all negative territory.

These are troubled waters, as trading is basically a probability (numbers) game, and using moving averages tilts the table towards positive trending stocks as the way to go, and the momentum (or rate of change) usually kicks in at the crossing up of the two moving averages, so getting in late is often too late if the time constants of the moving averages in question are too slow/big, and EOD data is being used.

In other words if you don't watch the waves coming in before they get to you and start paddling to catch the wave of choice, then you can get dumped by a poor choice of wave, have excellent waves drift straight past you, or catch a wave that peters out – and then get dumped by the following waves!

One of the 'tricks of the trade' is to watch for early signals, and the Moving Average indicator does not do this that well but it is a good historical indicator – and that is usually too late! What is needed is a 'predictor' on a moving average – something that watches when the moving averages converge and diverge.

Moving Average Convergence Divergence (MACD)

This acronym "MACD" stands for **Moving Average Convergence / Divergence** and all it is, is the difference between two moving averages - but which two? As I am given to understand Gerald Appel[1] developed the MACD, and he apparently favoured EMA12 and EMA26 as the two moving averages.

Just to confuse matters that little bit more, a trailing moving average (a 9EMA) of this MACD is put on the same graph to 'trigger' a buy or sell with the crossover of the MACD. There is a lot more to this indicator than meets the eye, and apart from it being one of the major indicators in use today, I really believe that proportionately few people have actually understood exactly what the MACD and its trigger is and does.

In fact a EMA12 is equivalent to an IIR filter with k = 0.1538461 and a EMA26 is equivalent to k = 0.077074. I am guessing that it was actually based on k = 0.075 making and EMA25.6666 and k = 0.150 making a EMA12.3333. Mathematically that is much easier, and that is the basis of my supposition!

[1] http://www.signalert.com/MACD%20tutorial.pdf

Looking more closely at two moving averages with different time constants, as price changes move, the moving averages cross over, then move away, then close and cross on each other, but what is really going on! Going back to basics where we used Oliver Heaviside's[2] singularity functions[3] of unit step and unit ramp we got clear pictures of what really happens.

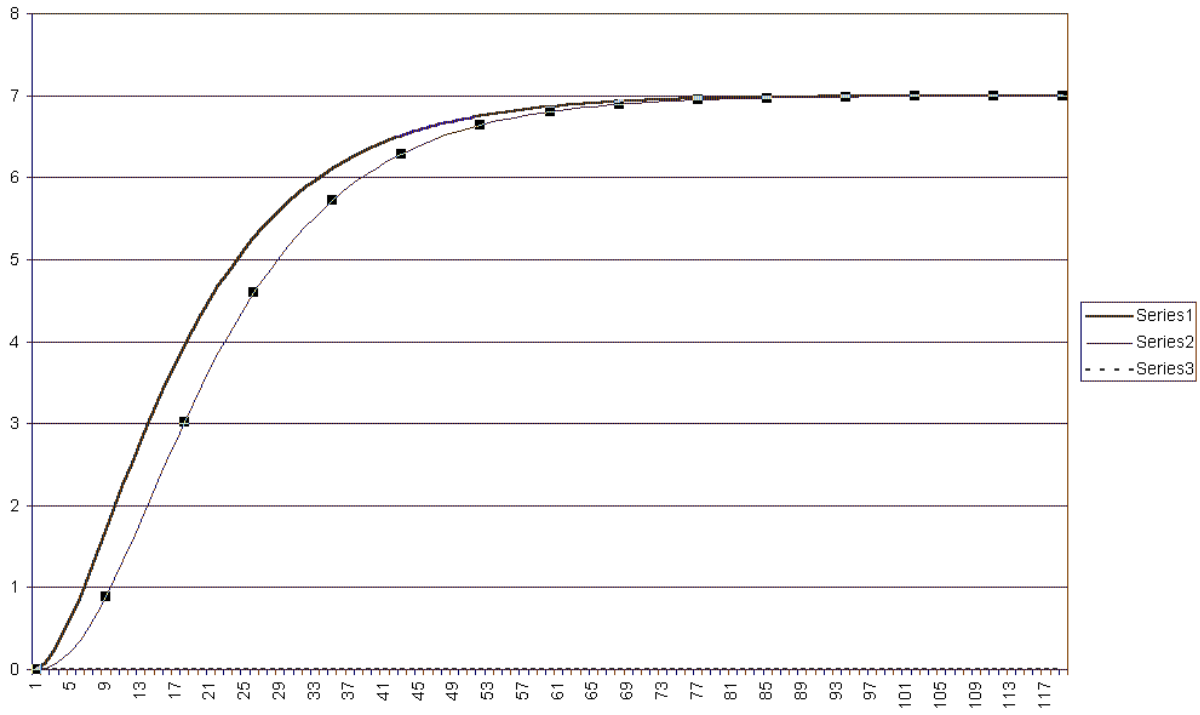
With a moving average applied to a step function the moving average follows towards the new value of the step with time (usually in an exponential manner) and eventually converges on that new value to within 1 % by five time constants.

With a ramp, the moving average tracks the ramp and after five time constants has a virtually constant error (to within 1 % anyway), and that is plenty good enough for this application in stock market prices!

Some Clinical Analysis

Now! By having two moving averages and taking the difference between these two moving average results we get some 'interesting' results, but a little intuition is required!

The answer (in the time domain) is the time dependent difference between the two time constants – or other coefficients for the IIR filters that each make 1st order response systems! Starting with a ramp function, the result is unsurprisingly a long-term constant as shown below:



This above graph is anything but exciting to the uninitiated! It shows the thick line (the MACD), which is the difference between the two exponential moving averages (EMA12 and EMA26 in this case) as they both respond to a ramp input.

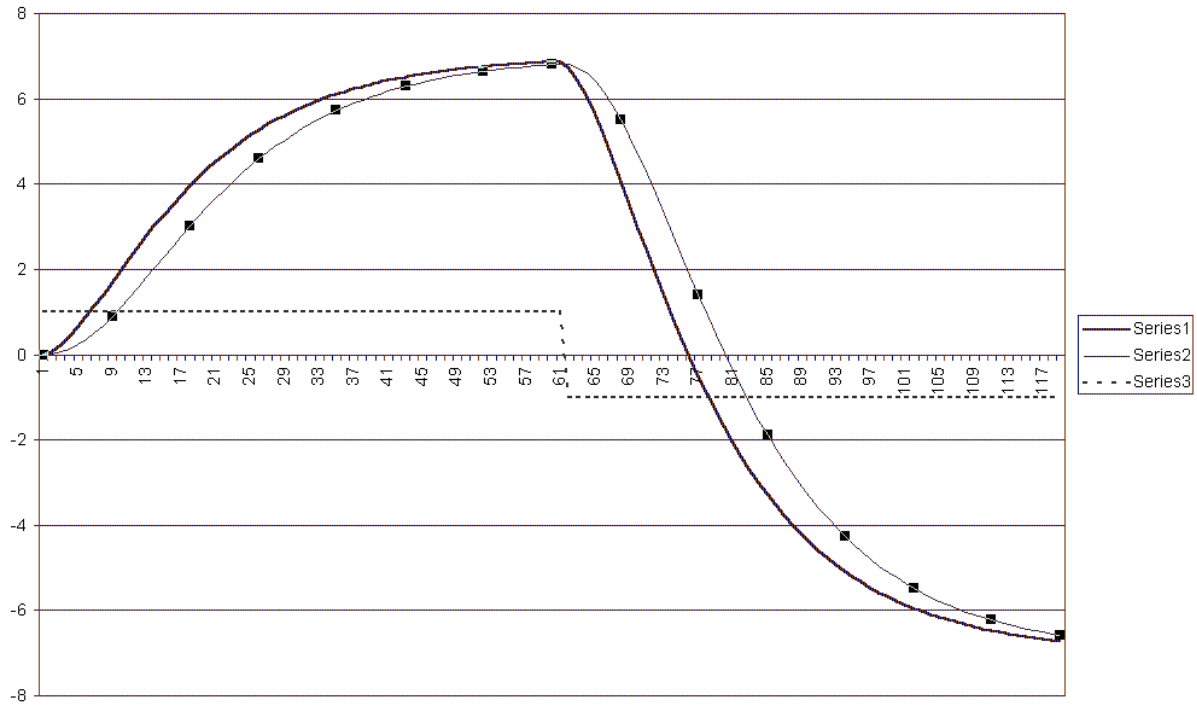
(Remember in an earlier chapter that a moving average is a 1st order system and it has a constant error to a ramp input – after infinity time! In getting there the larger

[2] http://www.moore.org.au/sata/05_ema/20031214%20The%20Genius%20of%20Oliver%20Heaviside.pdf
[3] http://www.engr.sjsu.edu/kghadiri/EE112/Lecture_Notes/Singularity%20function.pdf

time constant moving average takes longer to converge to constant error from the ramp.)

The difference in transients result rises above zero value (important) that converges on a constant value (also very important), which in this case only, is 7. This theoretical MACD line is screaming out "buy – and hold" and with good reason, as the price is a positive ramp.

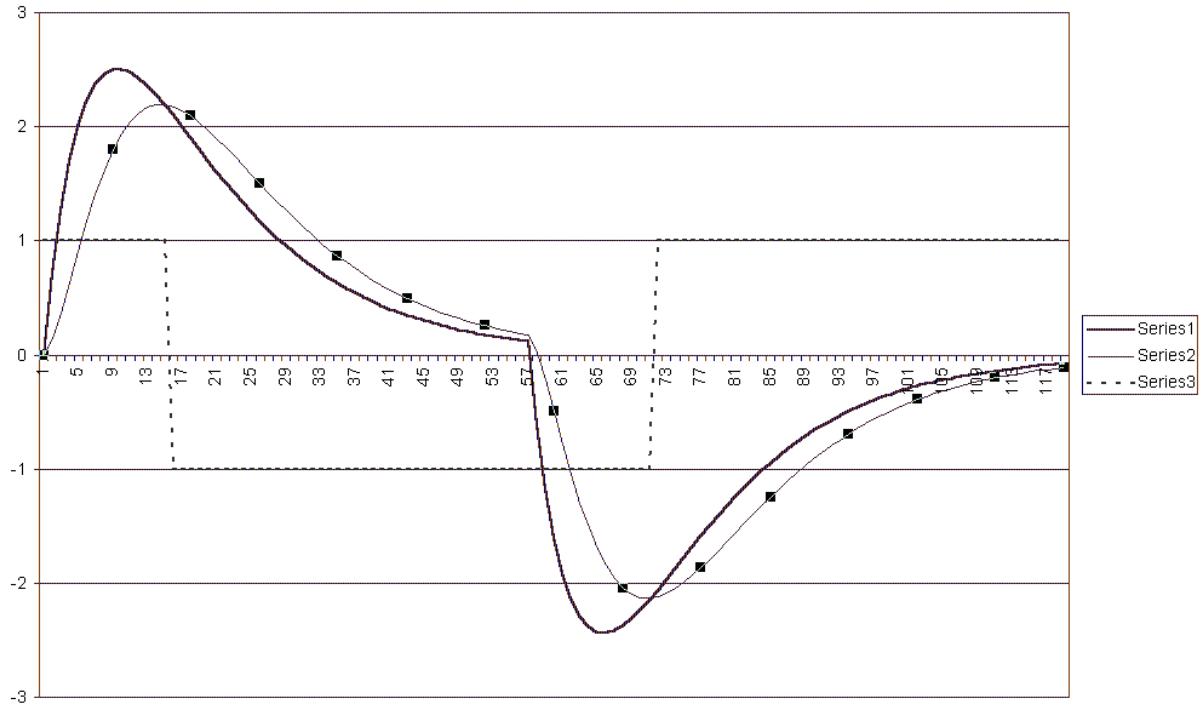
There is a second line on this left hand side graph (which is the EMA9 of the MACD) has marker dots on it and it is following the MACD, and in time converges on the MACD as the MACD had become a constant – and this is one achillis heel of the MACD. It is called the 'Trigger' and few people really understand what it does and why, but I will answer that later!



Now let's change the ramp so that it turns down, as shown in the graph above. The thick line almost immediately turns down and crossed under the trigger line, and the "Series 3" dotted line flips negative with the crossover, screaming out "sell – sell"! So the MACD works in this clinical case (for now)!

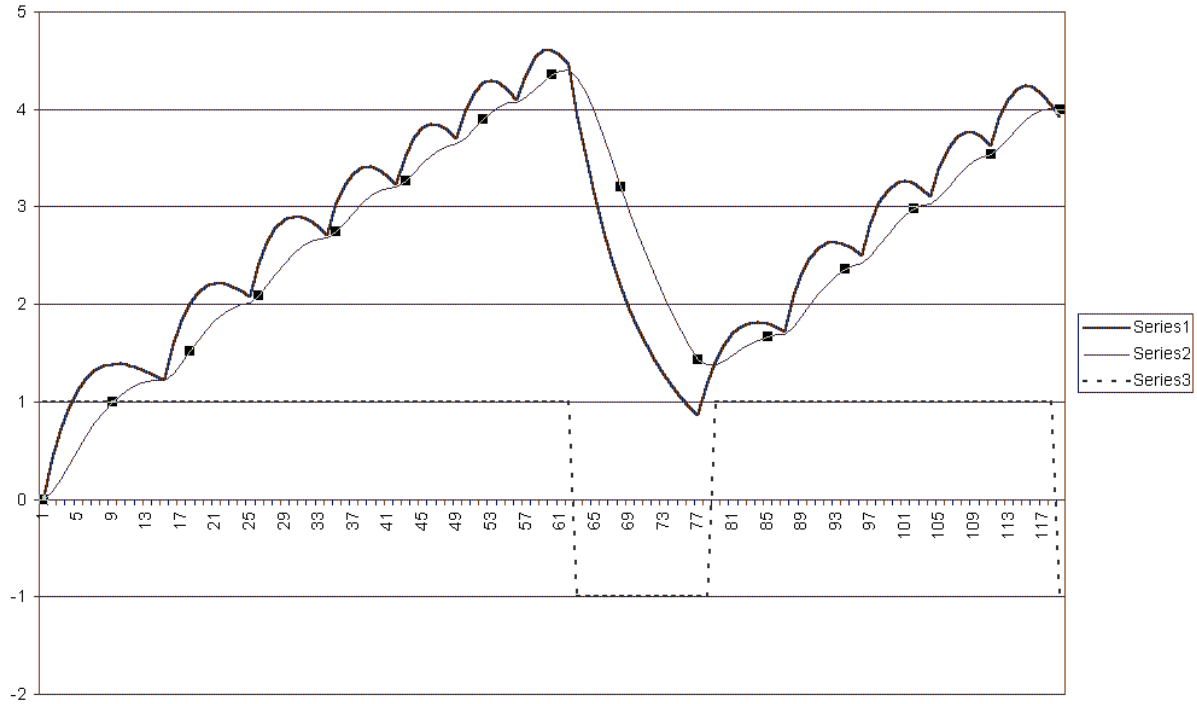
Now lets apply a Heaviside Step to an MACD as before and look what happens! This is shown in the left hand-hand side graph below.

In this case shown below, the price suddenly jumps and immediately settles on a constant value. The MACD rises and peaks, then starts to decay as it converges on zero – because the long term error from a 1st order system to a constant input is zero! The marked trigger line crosses up over the MACD saying "sell – sell"!



Well after the price has let the MACD and trigger converge towards zero, a negative price step is then applied to the input, and the reverse happens where the MACD peaks low and then converges back on zero – but the trigger line follows and after a time delay says “buy – and hold”. Now we are on thin ice!

It must be realised that the security prices are in-effect small discrete changes of constant values, and the longer the time constants are left to sit, the more sensitive these are to false trigger.



In the above graph the price is stepped up by units of 5 to keep the MACD from triggering a sale, then dropped by 5 when 35 was reached, then stepped up in steps

of 5 again! If this was taken a little further then not only would the very popular MACD be even more accentuated, but the price steps would also!

So now we know that the MACD can and will consistently false trigger on a time associated slowly rising stepped price, as the difference between the fast and slow EMAs (being the MACD), will result in an overshoot, that on correction will then intersect the trailing trigger line (EMA of the MACD). Here are some practical examples to demonstrate.

Comments and Corrections are welcome