Scaling Properties and Trading Strategies of the Moving Average Difference

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A valuable technical indicator for currency trading strategies is the difference between a fast moving average and slow moving average of closing price. This report describes how the average of the fast minus slow, simple moving average (<SMADiff>) depends on the slow moving average period and market volatility. The relationships between <SMADiff> and slow moving average period and market volatility are compared to predictions of scaling laws. Based on these results, trading models are proposed and evaluated.

To start, we look at the absolute value of the difference between the closing price (fast moving average period of 1) and a slow, simple moving average (SMADiff). This difference is defined by equation 1 for a window size of N=500 bars. <SMADiff> has units of pips. Figure 1 shows an example of the SMA Difference. We will analyze the EURUSD one hour currency data over the period of 2004-2020.

$$< SMADiff >= \frac{1}{N}\sum_{i=1}^{N}(Close_i - SMA(Slow\ Period)_i) \qquad \text{Eq 1}$$

FIGURE 1: SMA Fast – SMA Slow Moving Average

A Strawman Trading Strategy Based on <SMADIff>

A strawman trading strategy is specified to measure the benefits of using dynamic parameters that characterize the pattern, such as the slow moving average.

Consider a strategy that executes a buy trade when the SMADiffLow< SMADiff < SMADiffHigh and a sell trade when –SMADiffLow> SMADiff > -SMADiffHigh. The free parameters in this strategy are the SMA Slow Period and the values of SMADiffLow and SMADiffHigh. Fixed values, for these three parameters, gives a poor trading performance, when using the parameter Optimizer in the Metatrader 4 Tester. We will show that the trading performance can be vastly improved by using a dynamic model for the slow moving average period based on volatility and other pattern characteristics.

A Look at SMADiff Behavior

Figure 2 shows the monthly average value of the SMADiff versus month, for a slow period selection of 75 one hour bars.

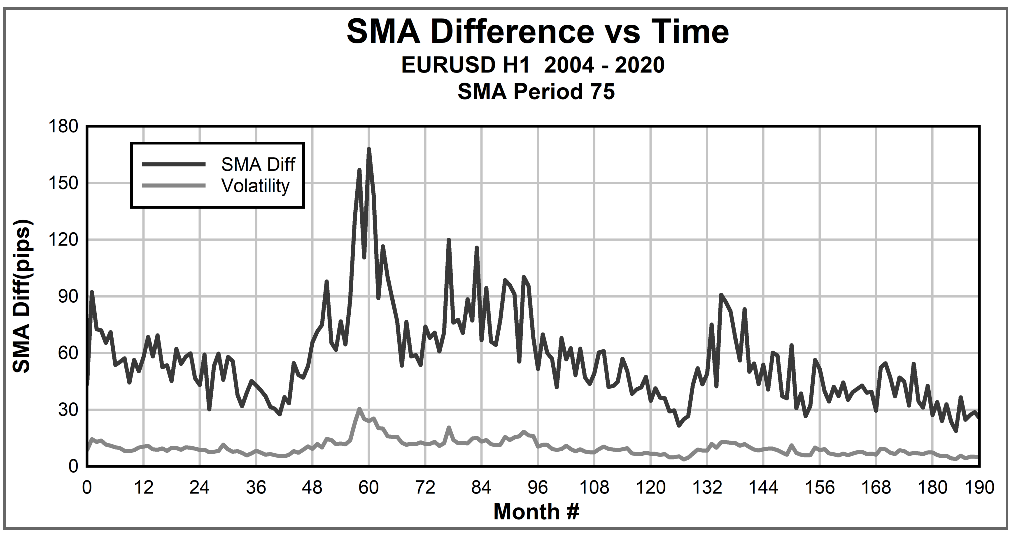

Figure 2: SMA Difference and Volatility versus Month

Interestingly, the behavior of the Average SMADiff over time is very similar to the behavior of volatility over time. In fact, a wide range of volatility indicators exhibit this behavior. These indicators include the Average True Range, Bollinger Band spread, the Standard Deviation and various representations of volatility. This is covered in the report “Volatility Indicators and Their Long Term Behavior”. Here, Volatility is specified as the average value of the absolute bar change in pips.

Figure 3 shows the raw SMADiff data, for a specific volatility and slow period selection.

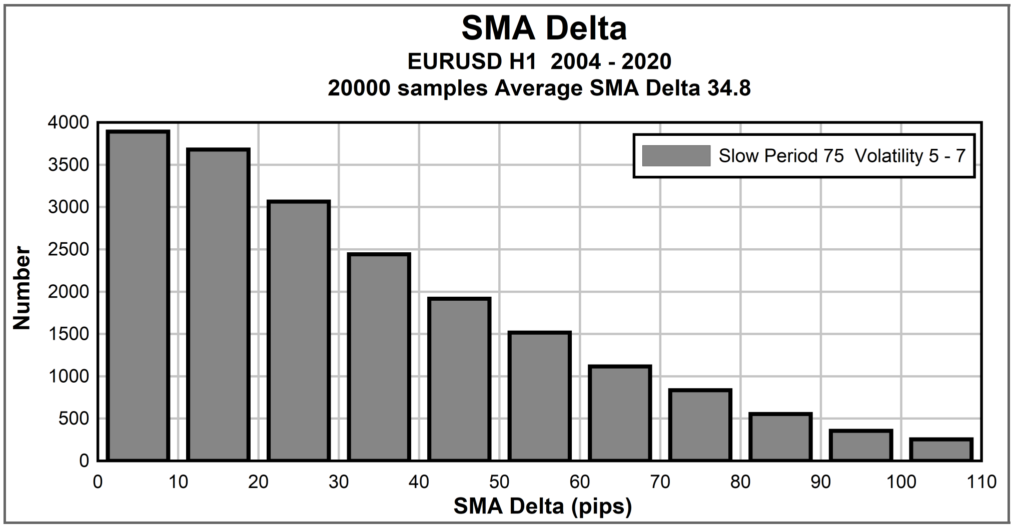

Figure 3: SMA Diff data for specific volatility region and slow period

The average value of the SMADiff is 34.8. The data is not Gaussian and smoothly falls off from the first bin. The data in the first bin will contribute to price whipsaw effects that weaken the performance of trading strategies using slow moving averages.

The Dependence of SMADiff on Volatility and Slow Period

In the next figures, will look at the average value of the SMADIff more closely to see what dependence Average SMADiff has on volatility and slow period selection.

Figure 4 shows the Average SMADiff versus slow period for selections of volatility regions on a log-log plot, while Figure 5 shows the Average SMADIff versus volatility for selections of the slow period on a log-log plot. In both plots, the <SMADiff> behaves linearly on a log-log plot.

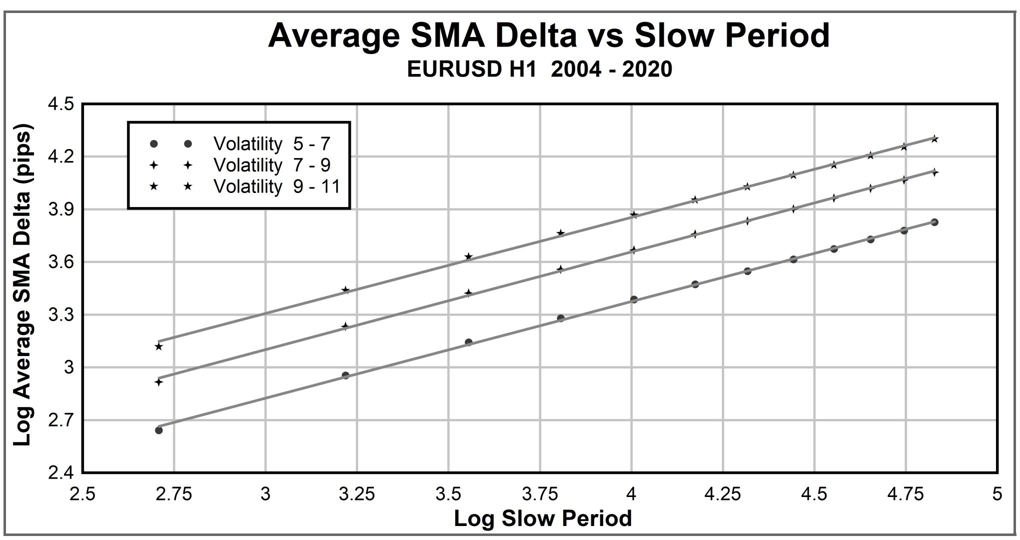

Figure 4: Average SMADiff versus Slow Period and fitted lines from equation 2.

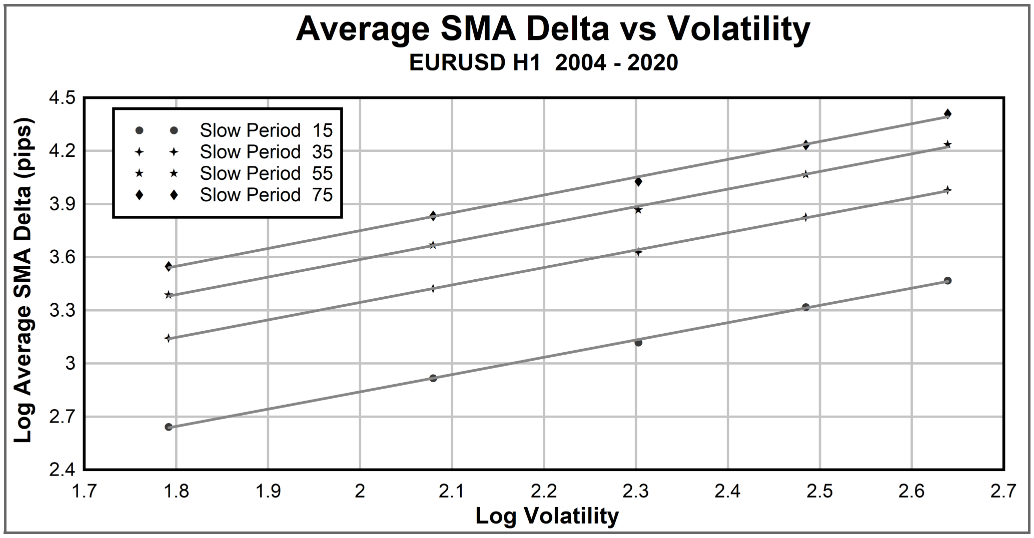

Figure 5: Average SMADiff versus Volatility and fitted lines from equation 3.

Role of Scaling Laws

In previous articles in *Technical Analysis of Stocks and Commodities* (February 2020, July 2020, October 2020), the role of scaling laws was discussed. These laws arise when a characteristic of a pattern has an independence of scale. A common example is a coastline zigzag pattern viewed from various altitudes. The average zigzag segment length is a scaling pattern characteristic and the altitude represents the measurement scale. A general, one dimensional, scaling law has the form:

$$< Y(X) > = \left(\frac{X}{C}\right)^M$$

for pattern characteristic Y, input parameter X, slope constant M and constant C. X represents measurement scale. This equation can be rewritten as

log(<Y(X)>) = M log(X) + D

where D is a constant.

It was shown in previous articles describing the zigzag pattern and moving average crossover pattern, two key pattern characteristics scaled with two pattern input parameters. For the zigzag pattern, these input parameters were the Directional Change Threshold of the zigzag segment and Volatility while pattern characteristics were the Average Segment Price Change and the Average Segment Length.

In this case, the <SMADiff> is the pattern characteristic and the input parameters are Volatility and SMA Slow Period. The proposed scaling laws for the average SMA difference (<SMADIff>) are:

$$< SMADiff(P) = \left(\frac{P}{E}\right)^{D}$$

for SMA Slow Period (P) , slope constant D and constant E.

$$< SMADIff = \left(\frac{V}{B}\right)^{A}$$

for Volatility (V) , slope constant A and constant B.

These two equations can be rewritten in the log-log form as:

log(<SMADiff>) = D log(P) +F Eq. 2

for slope constant D and intercept constant F.

log(<SMADiff)> = A log(V) +G Eq. 3

for slope constant A and intercept constant G

Figures 4 and 5 show that the Average SMADiff scales very precisely with volatility and slow moving average period, described by equations 2 and 3.

Because the slopes on the two figures are all parallel, the Average SMADiff will also satisfy a two dimensional scaling law. Two dimensional scaling laws were introduced in the July, 2020 issue of *Technical Analysis of Stocks and Commodities*. The two-dimensional law for <SMADiff> is:

$$< SMADiff(V,P) > = \left(\frac{V}{B}\right)^{A} \left(\frac{P}{E}\right)^{D}$$

This equation can be rewritten in the log-log form as:

log(<SMADiff>) = A log(V) + D log(P) + H Eq. 4

for slope constants A and D and intercept constant H.

Figures 6 and 7 shows the excellent fit of the SMADiff data with the two dimensional scaling law in equation 4.

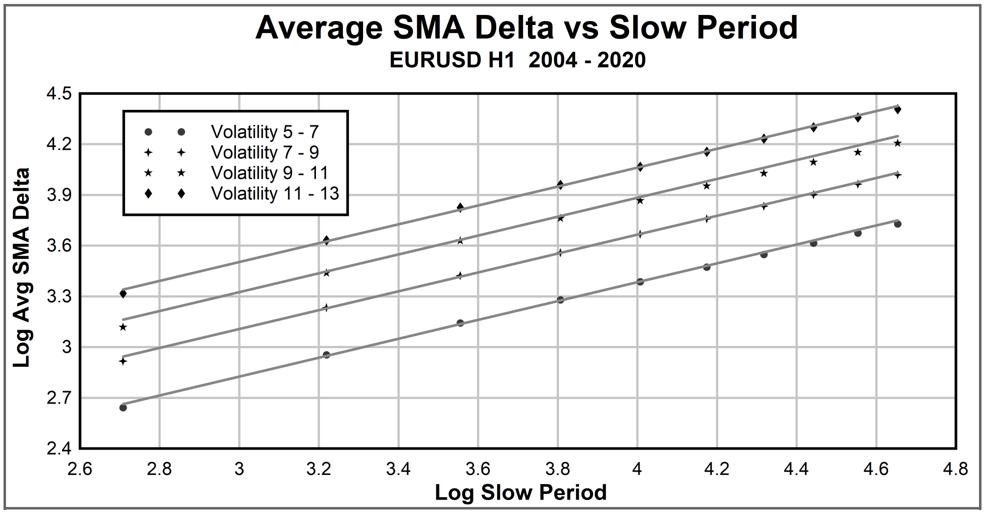

Figure 6: Average SMA Difference versus Slow Period with fitted lines from equation 4

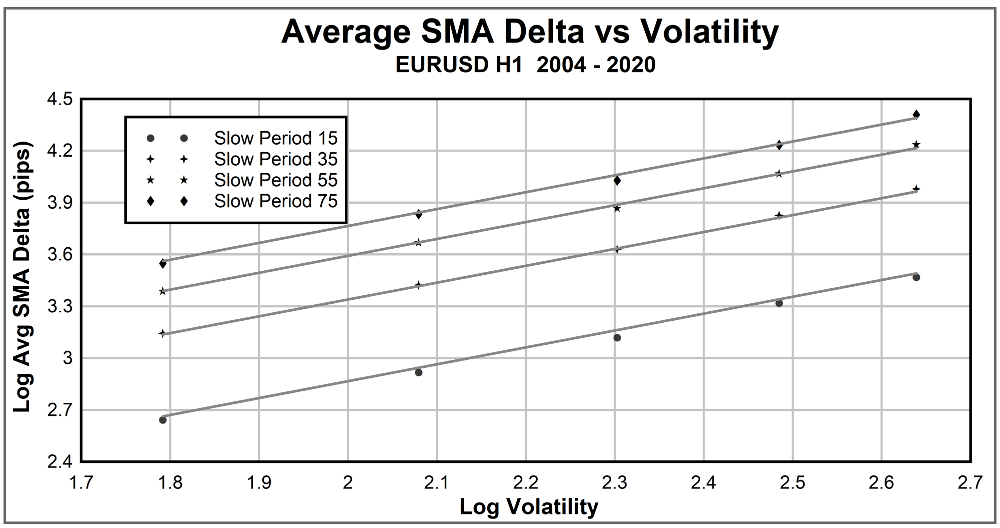

Figure 7: Average SMA Difference versus Volatility with fitted lines from equation 4

From equation 4, we now can precisely predict the Average SMADiff given a slow period selection and a measured volatility. How is this useful in developing a trading strategy?

Given a average SMADiff, equation 4 gives a predicted slow period based on volatility and desired Average SMADiff. The optimal Average SMADiff should not be fixed in time but also dynamic. From Figure 2, we see that the Average SMADiff follows the behavior of volatility. We can model the Average SMADiff as being linear with volatility for slow periods. This modifies equation 4 as follows:

Slow Period = exp((R*V- H – A log(V))/D) Eq. 5

for Slow Period slope D, Volatility slope A, intercepts constant H and constant R.

Trading Model Test Results

A trading strategy was devised, for comparison purposes only, to execute a trade when the SMADiff falls into a narrow, optimal range. For the Auto mode strategy, the slow period was determined from equation 5. For the Fixed mode strategy, an optimal fixed slow period was selected using the Metatrader4 Optimizer. Figure 8 shows the comparison of the Auto and Fixed modes from back testing with the Metatrader4 Tester from 2010-2020.

Strategy	# trades	Profit (1Lot)	Profit Factor	Avg Profit
Fixed Slow Period	452	27,430	1.39	60.7
Dynamic Slow Period	404	38,682	1.64	95.7

Figure 8: Test Performance Slow Period Models. The Dynamic model outperforms the Fixed model.

Conclusions

Figure 8 shows that a dynamic slow period based on the scaling properties of the Average SMA Difference provides better performance than a fixed slow period selected to give the best fixed slow period performance.