Scaling Properties of the Moving Average Crossover Pattern

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Preliminaries

The moving average of price is a common indicator for trading strategies. One application of this indicator is the crossover of fast and slow moving averages to identify trade entry and exit opportunities. The Moving Average Crossover (MAC) pattern consists of cross up and cross down segments. A segment is the collection of the bars between fast and slow moving average crossover points. Figure 1 illustrates a MAC pattern segment with some associated descriptive parameters, which are described in the following paragraphs.

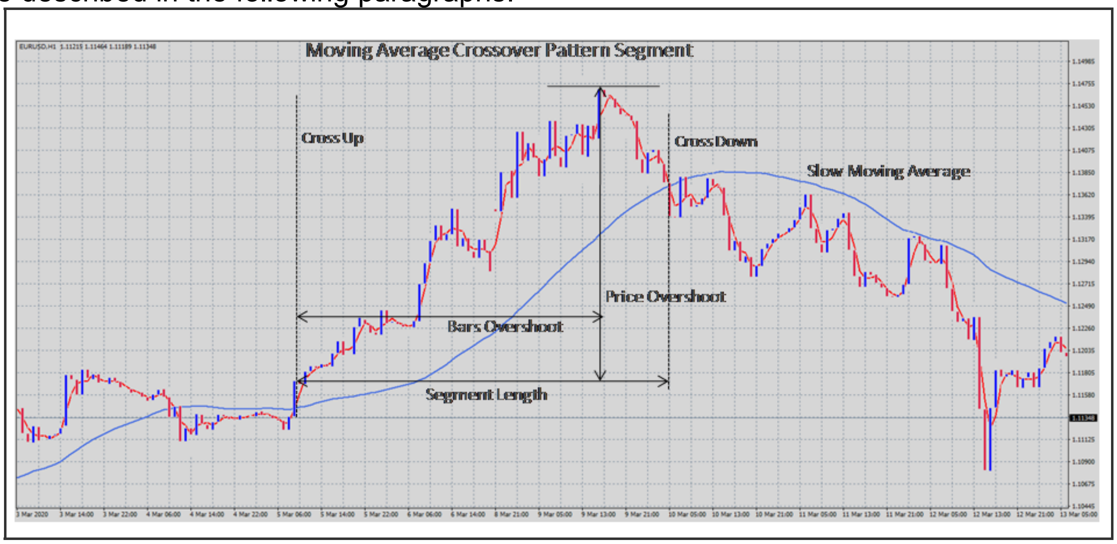

FIGURE 1: SEGMENT IN A MOVING AVERAGE CROSSOVER PATTERN. A segment is shown with descriptive parameters.

A segment, as shown in Figure 1, is defined to be all of the bars between up/down moving average crossovers.

The MAC pattern has several segment descriptive parameters.

Segment Descriptive Parameters include:

- Maximum (for up crossing) upward price change in a segment (Price Overshoot)
- Number of bars to maximum price overshoot in a segment (Bars Overshoot)
- Maximum (for up crossing) downward price change in a segment (Price Undershoot)
- Number of bars to maximum price undershoot in a segment (Bars Undershoot)
- Number of bars between crossovers in a segment (Segment Length)

- Price change for the complete segment (Segment Return)

The MAC pattern also has Segment Input parameters.

Segment Input Parameters include:

- Fast and slow moving average periods
- Moving average type (Simple, Exponential, Smoothed…)
- Market volatility (as measured by indicators such as ATR, Bar Volatility, Bollinger Band upper/lower spread)
- Market Trend conditions (as measured by indicators such as ADX, RSI, Stochastic Oscillator, Trend Correlation Factor, SMA Slope)

All analysis has been performed on one hour EURUSD currency data from 1/2004-8/2020.

Role of Scaling Laws

In previous articles in *Technical Analysis of Stocks and Commodities* (February 2020, July 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. In the case of the MAC pattern, the Average Segment Length scales with Volatility which represents the observation scale. A general, one dimensional, scaling law has the form:

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

for descriptive parameter 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, two key Segment Descriptive Parameters scaled with two Segment Input Parameters. These input parameters were the Directional Change Threshold of the zigzag segment and Volatility while descriptive parameters were the Average Segment Price Change and the Average Segment Length.

For the MAC pattern, three descriptive parameters: the Average Price Overshoot, Average Bars Overshoot and the Average Segment Length all scale with the Segment Input Parameters of Volatility and Slow Moving Average Period.

These three descriptive parameters also follow two dimensional scaling laws of the form:

$$< Y(X,Z) > \; = \left(\frac{X}{B}\right)^{A} \left(\frac{Z}{E}\right)^{D}$$

for input parameters X and Z and descriptive parameter Y.

Two dimensional scaling laws were described in the July 2020 issue of *Technical Analysis of Stocks and Commodities*.

The two dimensional scaling law can be rewritten in log-log form as

Log(<Y(V,P)> A Log(V) + D Log(P) + K Eq 1

for descriptive parameter Y, and input parameters Volatility (V) and Slow Period (P). A and D represent slope parameters and K is the intercept constant.

In the following sections, three descriptive parameters: Average Segment Length, Average Price Overshoot and Average Bars Overshoot will evaluated using equation 1.

Analyzing the Average Segment Length

The Average Segment Length is the average of number of bars in a crossover segment and is also the inverse of the number of pattern crossings inside a specific window size. The Segment Length is shown in Figure 1. Figure 2 shows that, the Average Segment Length scales with Slow Period. The Average Segment Length also scales with volatility but, as shown in Figure 3, it has little variation with volatility, having a near zero slope A in the equation 1. Unlike other segment descriptive parameters, the Average Segment Length is independent of volatility.

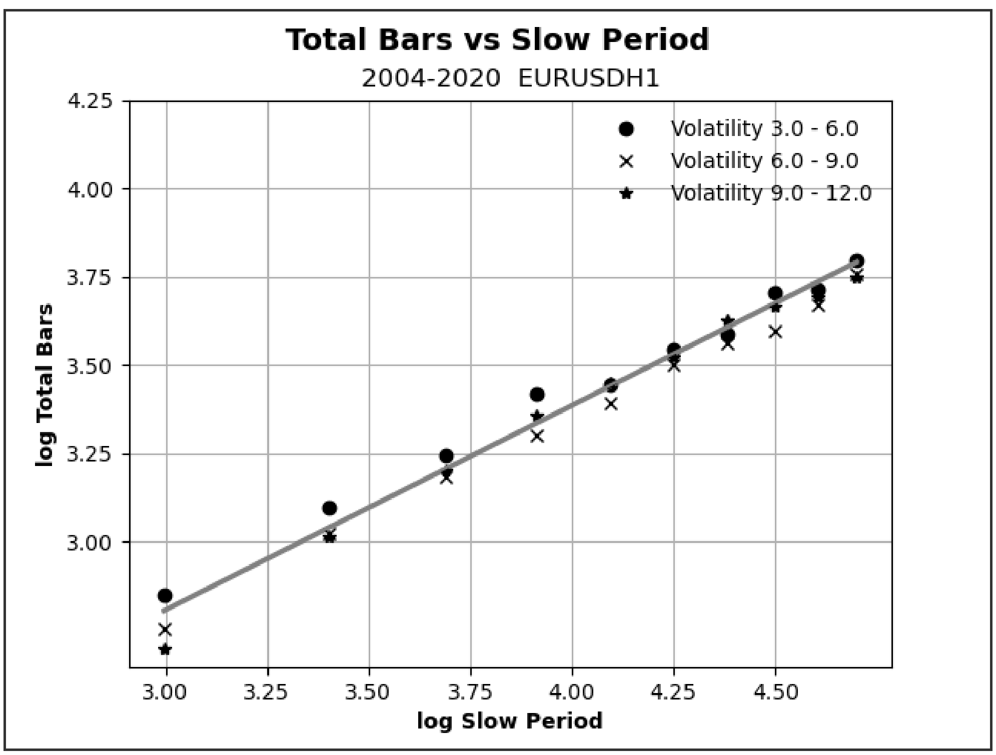

FIGURE 2: AVERAGE NUMBER OF BARS IN SEGMENT VERSUS SLOW PERIOD. The Average Segment Length scales with the Slow Period. The fitted lines from equation 1 are shown with the data.

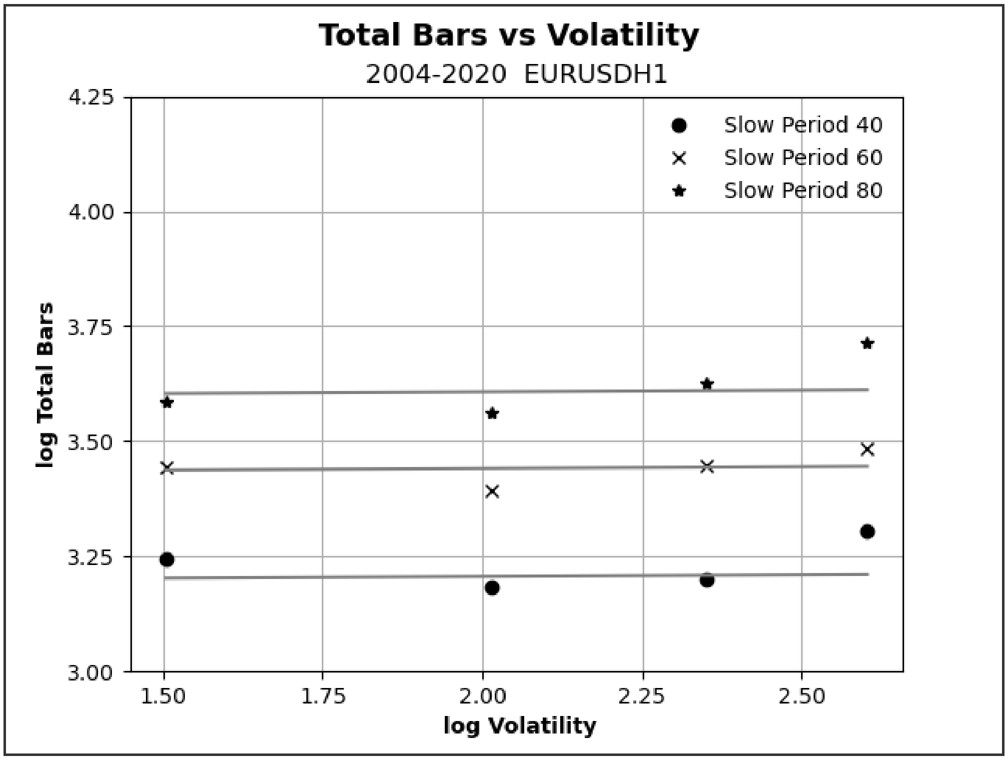

FIGURE 3: AVERAGE NUMBER OF BARS IN SEGMENT VERSUS Volatility. The Average Segment Length scales with the Volatility. The fitted lines from equation 1 are shown with the data.

Analyzing the Average Price Overshoot

The Average Price Overshoot is the maximum price change (for a Cross Up pattern) from the trade entry point. The Price Overshoot is shown in Figure 1. The trade entry point is the crossover point of the fast and slow moving averages. The trade is closed and the segment is complete when the slow moving average crosses back in the reverse direction from the trade initiation.

The Overshoot Price is price change and is described in pips. The crossover point may be from an upward crossing or downward crossing pattern so the Price Overshoot may be a maximum positive change (upward) or a maximum negative change (downward) from the entry point. In a simulated trade operation, the Price Overshoot determines the trade profit by triggering a Take Profit limit while the Price Undershoot determines the trade loss by triggering a Stop Loss limit.

Analysis shows that the Average Price Overshoot (<POS>) follows the scaling laws:

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

for Volatility (V) and constants A and B.

$$< POS(P) > = \left(\frac{P}{C}\right)^{D}$$

for Slow Period (P) and constants D and C.

Further analysis shows that the Average Price Overshoot also follows a two dimensional scaling law:

$$< POS(V,P) > \; = \; \left(\frac{V}{B}\right)^{A} \left(\frac{P}{C}\right)^{D}$$

The previous equation can be written in the log-log form as:

Log(<POS(V,P)> A Log(V) + D Log(P) + K Eq. 2

where A and D are slope constants and K is the intercept constant.

Figures 4 and 5 show that the two dimensional scaling model, described by equation 2, works well for the Average Price Overshoot with input parameters Slow Period and Volatility.

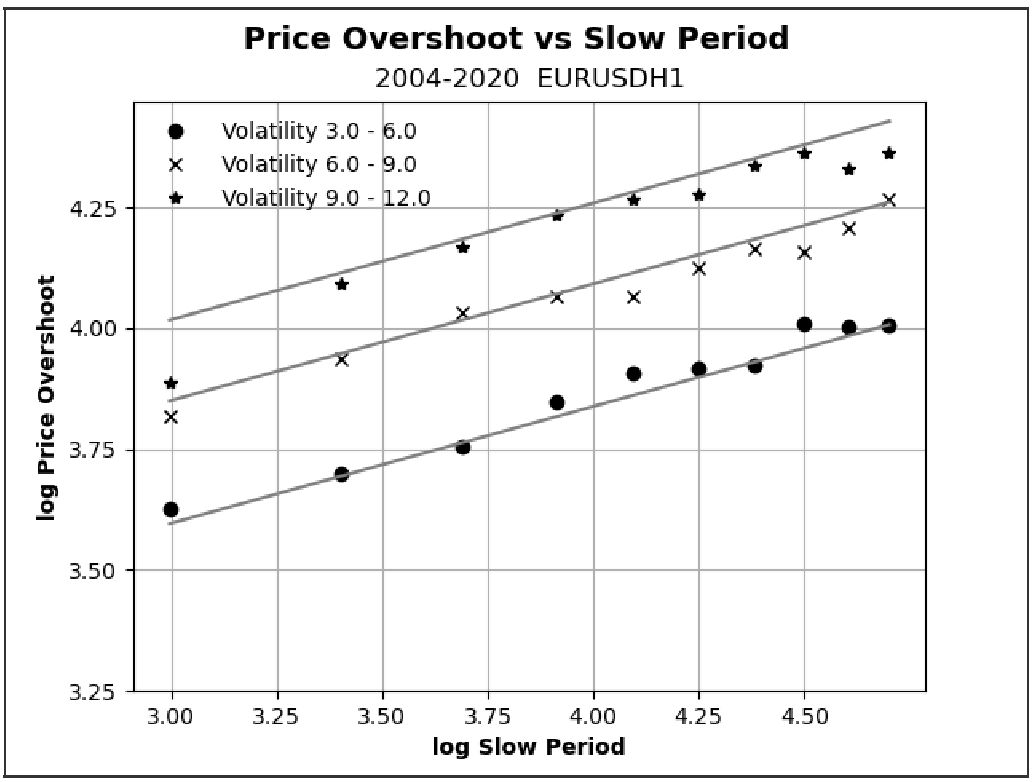

FIGURE 4: LOG AVERGE PRICE OVERSHOOT VERSUS LOG SLOW PERIOD. The fitted lines from equation 2 are shown with the data.

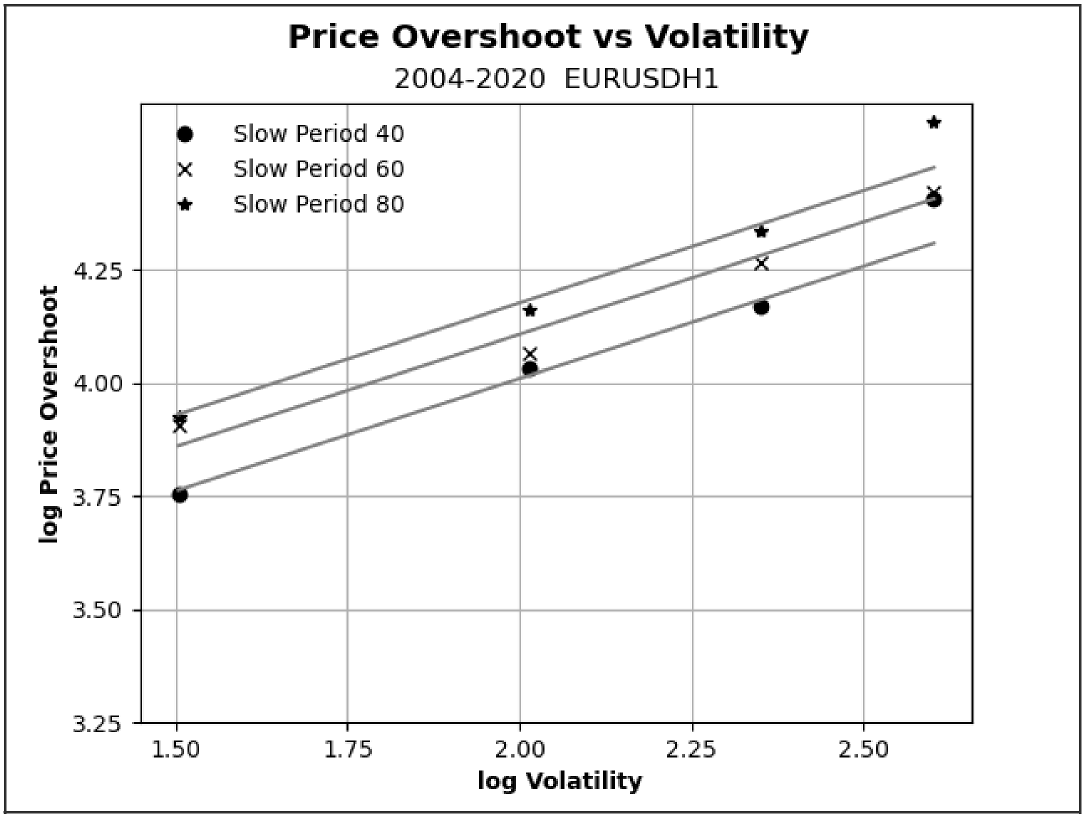

FIGURE 5: LOG AVERGE PRICE OVERSHOOT VERSUS LOG VOLATILITY. The fitted lines from equation 2 are shown with the data.

Analyzing the Average Bars Overshoot

Similar to the Average Price Overshoot, the Average Bars Overshoot (<BOS>) also follows a two dimensional scaling law with input parameters Slow Period and Volatility.

Log(<BOS(V,P)> A Log(V) + D Log(P) + K Eq. 3

for Volatility (V), Slow Period (P), slope constants A and D and intercept K.

Figures 6 and 7 show that the two dimensional scaling model, described by equation 2, works well for the Average Bars Overshoot with input parameters Slow Period and Volatility.

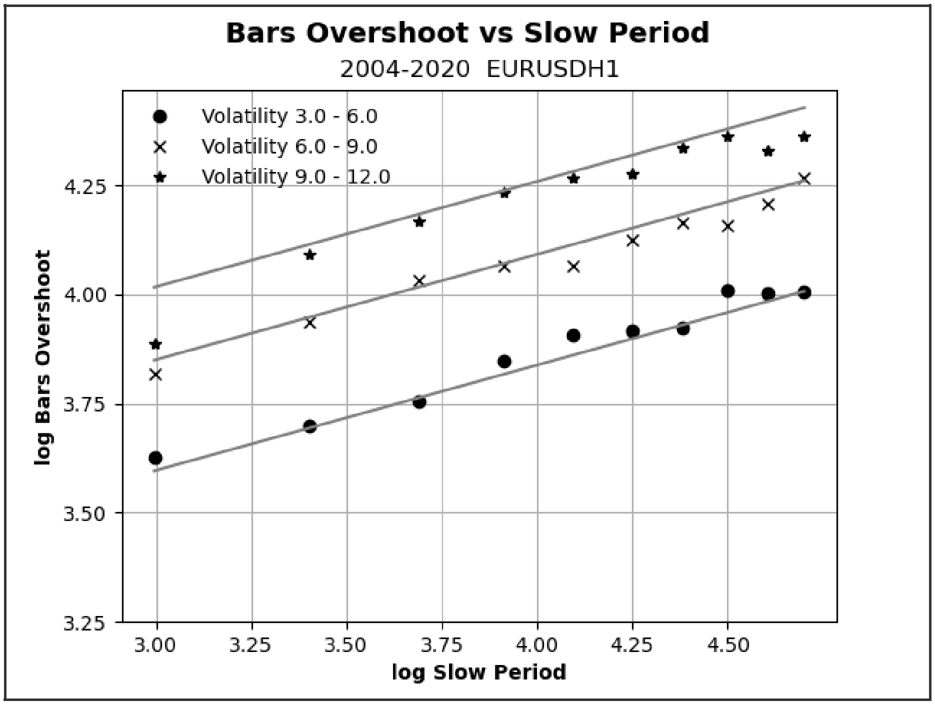

FIGURE 6: LOG AVERGE BARS OVERSHOOT VERSUS LOG VOLATILITY. The fitted lines from equation 3 are shown with the data.

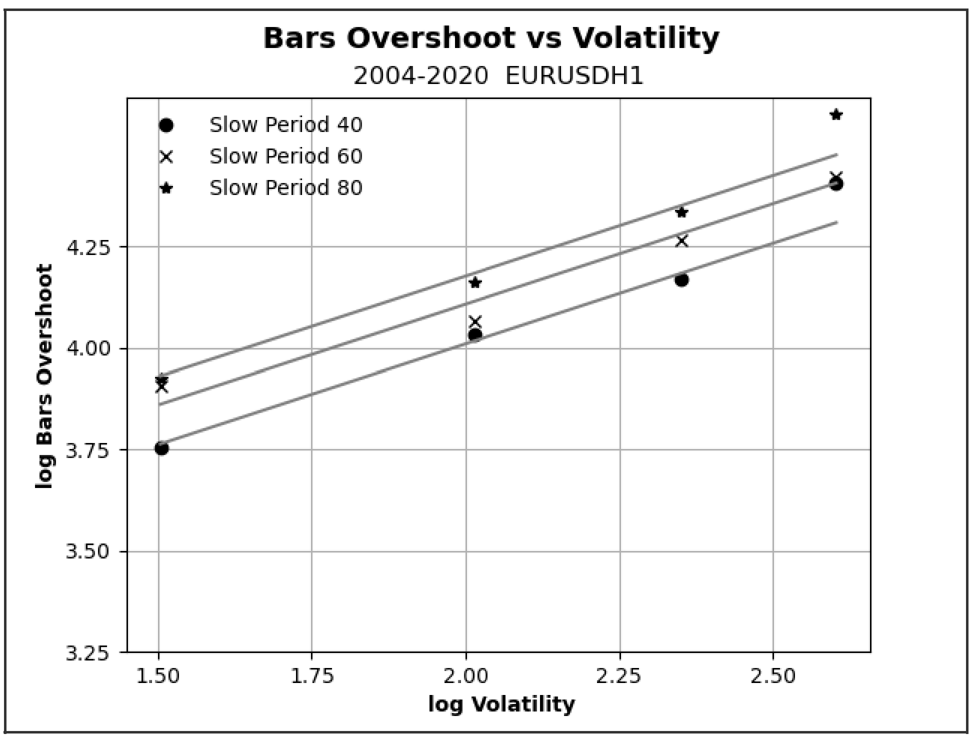

Figure 7: LOG AVERGE BARS OVERSHOOT VERSUS LOG VOLATILITY. The fitted lines from equation 3 are shown with the data.

Conclusion

The key descriptive parameters of the moving average crossover pattern, Segment Length, Price Overshoot and Bars Overshot all follow two dimensional scaling laws of the form in equation 1. This enables the average values of these parameters to be predicted based on the choice of slow moving average period and measured volatility.

Discussions of trading strategies for the moving average crossover pattern and incorporation of scaling law predictions into trading models are discussed in the October 2020 issue of *Technical Analysis of Stocks and Commodities*.