ADAPTIVE MOVING AVERAGE

Perry Kaufman points out in *Smarter Trading* that if you could achieve only one goal in analyzing the price of investments, it should be to identify the direction, or trend, of the market involved. Further, he writes that "everyone wants a short-term, fast trading trend that works without large losses. That combination does not exist." It *is* possible to have fast trading trends in which one must get in or out of the market quickly, but these have the distinct disadvantage of being whipsawed by market noise when the market is volatile in a sideways trending market. During these periods, the trader is jumping in and out of positions with no profit-making trend in sight. However, it is possible to avoid the noise by using very long moving averages. These are little affected by the day-to-day changes in price, but they also miss much of the profit to be gained, or saved as the case may be, by the lag between the time that the trend actually changes and the moving average gives a buy or sell signal.

In an attempt to overcome the problem of noise and still be able to get closer to the actual change of the trend, Kaufman developed an indicator that adapts to market movement. This indicator, an *adaptive moving average (AMA),* moves very slowly when markets are moving sideways but moves swiftly when the markets also move swiftly, change directions or break out of a trading range.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	1														
2	2		0.66667	0.0645						0.15				Buy	Sell
3	3			10-Day	Abs	10-Day	10-Day	Smooth		1st Diff	E/X	AMA(t)	AMA(t)	Trade	Trade
4	4	DATE	DMZ92	D(t)	1DP	V(t)	ER(t)	C(t)	AMA(t)	DAMA	Filter	Lows	Highs	Signal	Signal
5	5	920601	6063						6063.0			6063.0	6063.0		
6	6	920602	6041		22				6041.0	-22.0		6041.0	6063.0		
7	7	920603	6065		24				6065.0	24.0		6041.0	6065.0		
8	8	920604	6078		13				6078.0	13.0		6041.0	6078.0		
9	9	920605	6114		36				6114.0	36.0		6041.0	6114.0		
10	10	920608	6121		7				6121.0	7.0		6041.0	6121.0		
11	11	920609	6106		15				6106.0	-15.0		6106.0	6121.0		
12	12	920610	6101		5				6101.0	-5.0		6101.0	6121.0		
13	13	920611	6166		65				6166.0	65.0		6101.0	6166.0		
14	14	920612	6169		3				6169.0	3.0		6101.0	6169.0		
15	15	920615	6195	132	26	216	0.61	0.187	6173.9	4.9	3.6	6101.0	6173.9	BUY	
16	16	920616	6222	181	27	221	0.82	0.311	6188.8	15.0	3.2	6101.0	6188.8	BUY	
17	17	920617	6186	121	36	233	0.52	0.142	6188.4	-0.4	3.3	6188.4	6188.8		
18	18	920618	6214	136	28	248	0.55	0.158	6192.4	4.0	3.3	6188.4	6192.4	BUY	
19	19	920619	6185	71	29	241	0.29	0.059	6192.0	-0.4	3.1	6192.0	6192.4		
20	20	920622	6209	88	24	258	0.34	0.073	6193.2	1.2	3.1	6192.0	6193.2		

SIDEBAR FIGURE 1: MICROSOFT EXCEL SPREADSHEET: *Here's the AMA using the efficiency ratio to adjust the speed of the moving average.*

In order to construct the AMA, many different qualities of the market must be known. First is the *price direction* , or the net price change over *n* days. This is the difference between the price today and the price *n* days ago. Kaufman uses *n* of 10 days in *Smarter Trading* :

$$\text{Direction} = \text{Price} - \text{price}(n)$$

In the accompanying spreadsheet in sidebar Figure 1, the formula to measure price direction is entered in cell D15 and copied down to the end of the available data. In Microsoft Excel, it looks like this:

=C15-C5

The *volatility* , or noise, is the sum of the absolute values of the daily price changes over *n* days and is always expressed as positive:

Volatility = Sum (abs (price-price[1]),*n*)

To be able to have a sum of absolute individual daily values, we must have those values to add. To get daily volatility, we put this formula in cell E6 and copy down:

=ABS(C6-C5)

Then to get the 10-day volatility needed for use in the spreadsheet, this formula is entered in cell F15 and copied down:

=SUM(E6:E15)

The *efficiency ratio* (ER), sometimes referred to as *generalized fractal efficiency*, is a combination of direction and volatility:

Efficiency ratio = direction/volatility

As the direction is indicated in column D, and volatility is in column F, the efficiency ratio is calculated next. Enter into cell G15 the following formula and copy down:

=ABS(D15/F15)

As long as the market is moving in the same direction for all *n* days, volatility and direction are the same and the ER = 1. But when the market just moves up and down in a sideways pattern, then direction is zero and therefore ER moves toward a value of zero. This ER can be applied to any trend speed, with the fastest having an ER of 1 and the slowest having an ER of zero. The ER itself is expressed as a percentage between the two extremes.

An exponential moving average (EMA) uses a smoothing constant (sc) and the approximate speed of the trend can be changed into a smoothing constant for any given *n* days by using the formula

sc = 2/(*n* +1)

The smaller the *n*, the faster the speed of the EMA. Likewise, the larger the *n*, the slower the speed of the EMA. In the spreadsheet, the smoothing constants used are the following formulas, which are entered into cells C2 and D2 with the values of two and 30 substituted for *n*, respectively, as used in this example.

In cell C2: =2/(2+1)

In cell D2: =2/(30+1)

By using both a slow and fast smoothing constant in combination with the ER, it is possible to develop a scaled smoothing constant (ssc). The ER is used as a percentage to scale the smoothing constant, used by the AMA, between the fast and slow speeds.

Scaled smoothing constant = ER (fast sc - slow sc) + slow sc

The periods of two and 30 days are used to give us the fast sc and slow sc. Using the formula for *sc* = 2/*n* +1 for the faster *sc* = 2/(2+1) or 0.6667 and the slower *sc* = 2/(30+1) or 0.0645:

ssc = ER (0.6667-0.0645) + 0.0645 = ER (0.6022 + 0.0645)

This *ssc* is then squared to bring its movement nearly to a stop in a market that is mostly noise and little actual movement.

c = (ssc)(ssc)

When the *ssc* is squared, it becomes the constant (*c*) in the formula for the AMA. The complete formula for *c* is entered into cell H15 and copied down:

=(G15*(C2-D2)+D2)^2

This scaling of the trend speed makes it adaptive to the market's movements. The adaptive moving average is recalculated every day using this formula:

AMA = AMA[1] + c (price - AMA[1])

Enter the following formula into cell I15 and copy down:

=I14+H15*(C15-I14)

Note that in cells I5 through I14, the actual values from column C must be used, as 10 days of data is needed prior to the formula being usable.

To use the AMA in trading, there are two basic rules: Buy when the AMA turns up, and sell when the AMA turns down. As with any trading system that uses trends, there must be some kind of filter to remove false trading signals. As with the rest of the system, it should be able to adapt itself to the market conditions. This filter would be a small percentage of the AMA trendline. In the example given, the percentage is 0.15 and is entered as such into cell J2. The formula for the filter is:

filter = (percentage)(standard deviation)(AMA - AMA[1], *n*)

In order to be able to use this formula, the difference in today's AMA and yesterday's AMA, or AMA[1], must be known. To ascertain that data, the following is placed in cell J6 and is copied down:

=I6-I5

With this information, the formula for the filter can now be placed in cell K15 and is copied down:

=STDEVP(J6:J15)*J2

To add the filter, the AMA trading system changes the rules to buy when the AMA - lowest AMA is greater than the filter, and sell when the highest AMA - AMA is greater than the filter. Finding the lowest and highest AMA uses two different columns, columns L and M. Each day's AMA value is compared with yesterday's low value for the AMA. If the AMA today is lower than the recent low, it is returned in the formula; otherwise, the current low AMA value is returned. To do this in cell L6, the low AMA is determined by using the following formula and copying down:

=IF(I6<I5,I6,L5)

In like manner, cell M6 has the formula for the high AMA:

=IF(I6>I5,I6,M5)

It is now possible to put into the spreadsheet the finalized versions of the rules for using the filtered AMA trading system. The spreadsheet will now give a buy or sell signal for each day. Only the first of each signal would be used. That position would be carried until the opposite signal is given. For the buy signal, in cell N15 insert:

=IF((I15-L15)>K15,"BUY","")

For the sell signal, this is placed in cell O15:

=IF((M15-I15)>K15,"SELL","")

The data in columns B and C must be input. The data/formulas in row 2 are input only once. The data in L5 and M5 are the same as that in I5. The formulas in the rest of the cells mentioned are entered and then copied down to the end of the data in column C (except I5 to I14 as described above).

-Bruce Faber, Staff Writer