

Two Functions That Complement, To Calculate

Reversing MACD

These two functions complement the MACD and can be used to calculate the price value of a specific MACD level and the price value that will cause the MACD to change direction. Find out how you can apply it to your trading.



Moving average convergence/divergence (MACD) created by Gerald Appel is probably one of the more popular momentum oscillators in use today. It is calculated using two exponential moving averages (EMAs) of different lengths and is the value of the shorter (fast) period MACD less the value of the longer (slow) period EMA. MACD fluctuates above and below the zero value where the moving averages cross.

In Giorgos Siligardos' article "Reverse Engineering RSI," he showed that the reverse-engineered relative strength index (RSI) can help determine the following time period's closing price using the value of the oscillator. And in the article "RSI Bands," François Bertrand showed overlaying RSI overbought/oversold levels on the price chart.

I will show the calculation of the price value of a specific MACD level and the calculation of the price value that will cause the MACD to change direction. These values in relation to price can then be shown by overlaying them on the price chart. Price charts and code shown here are from the AmiBroker charting package.

REVERSE MACD PRICE RELATIONSHIP

Let us start with a definition of MACD:

$$\begin{aligned} \text{MACD}_t &= \text{MACD}(P_t, X_t, Y_t) \\ &= \text{EMA}(P_t, X_t) - \text{EMA}(P_t, Y_t) \end{aligned}$$

where:

P_t is the input series, traditionally a series of closing prices

X_t is the fast period, which usually is 12

Y_t is the slow period, which usually is 26

$$\text{EMA}(P_t, X_t) = \alpha_X * P_t + (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1})$$

$$\text{EMA}(P_t, Y_t) = \alpha_Y * P_t + (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1})$$

$$\alpha_X = \frac{2}{1 + X} \text{ is the multiplier weighting for period value } X$$

$$\alpha_Y = \frac{2}{1 + Y} \text{ is the multiplier weighting for period value } Y$$

Besides plotting the two exponential moving averages, how can we project some MACD information onto the price chart? One way is to find the required price P_t where the MACD_t attains the same value as the previous bar MACD_{t-1} value. If the actual value is greater than the derived P_t then the MACD value will be greater than MACD_{t-1} and if it is less, then the MACD value will be less than MACD_{t-1} . Here is one way to do the calculation. We know that:

$$\text{MACD}(P_t, X_t, Y_t) = \text{EMA}(P_t, X_t) - \text{EMA}(P_t, Y_t)$$

Now substitute the calculation for $\text{EMA}(P_t, X_t)$ and $\text{EMA}(P_t, Y_t)$ to get:

$$\begin{aligned} \text{MACD}(P_t, X_t, Y_t) &= \\ &(\alpha_X * P_t + (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1})) \\ &- (\alpha_Y * P_t + (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1})) \end{aligned}$$

which results in:

$$\begin{aligned} \text{MACD}(P_t, X_t, Y_t) &= \\ &(\alpha_X - \alpha_Y) * P_t + (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1}) \\ &- (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1}) \end{aligned}$$

By the definition of MACD, the previous value of MACD_{t-1} would be:

$$\begin{aligned} \text{MACD}(P_{t-1}, X_{t-1}, Y_{t-1}) &= \\ &\text{EMA}(P_{t-1}, X_{t-1}) - \text{EMA}(P_{t-1}, Y_{t-1}) \end{aligned}$$

by Johnny Dough

So for price P_t that would make:

$$\text{MACD}(P_t, X_t, Y_t) = \text{MACD}(P_{t-1}, X_{t-1}, Y_{t-1})$$

then:

$$\begin{aligned} &(\alpha_X - \alpha_Y) * P_t + (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1}) \\ &\quad - (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1}) \\ &= \text{EMA}(P_{t-1}, X_{t-1}) - \text{EMA}(P_{t-1}, Y_{t-1}) \end{aligned}$$

which simplifies to:

$$\begin{aligned} &(\alpha_X - \alpha_Y) * P_t - \text{EMA}(P_{t-1}, X_{t-1}) * \alpha_X \\ &\quad + \text{EMA}(P_{t-1}, Y_{t-1}) * \alpha_Y = 0 \end{aligned}$$

and results in:

$$P_t = \frac{\text{EMA}(P_{t-1}, X_{t-1}) * \alpha_X - \text{EMA}(P_{t-1}, Y_{t-1}) * \alpha_Y}{(\alpha_X - \alpha_Y)}$$

or

$$P_{t+1} = \frac{\text{EMA}(P_t, X_t) * \alpha_X - \text{EMA}(P_t, Y_t) * \alpha_Y}{(\alpha_X - \alpha_Y)}$$

Using AmiBroker, the function `PMACDeq()` represents this equation. Now, let us consider price where a particular MACD level is at. We know that:

$$\begin{aligned} \text{MACD}_t &= \text{MACD}(P_t, X_t, Y_t) \\ &= \text{EMA}(P_t, X_t) - \text{EMA}(P_t, Y_t) \end{aligned}$$

Expanding the definitions for EMAs:

$$\begin{aligned} \text{MACD}_t &= \alpha_X * P_t + (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1}) \\ &\quad - (\alpha_Y * P_t + (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1})) \end{aligned}$$

which results in:

$$\begin{aligned} &P_t * (\alpha_X - \alpha_Y) \\ &= \text{MACD}_t + (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1}) \\ &\quad - (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1}) \end{aligned}$$

Finally:

$$P_t = \frac{(\text{MACD}_t + (1 - \alpha_Y) * \text{EMA}(P_{t-1}, Y_{t-1}) - (1 - \alpha_X) * \text{EMA}(P_{t-1}, X_{t-1}))}{(\alpha_X - \alpha_Y)}$$

So if $\text{MACD}_t = 0$, the P_t will essentially represent the line where MACD_t is zero. Using AmiBroker, the function `PMACDlevel()` represents the equation.

From the function for `PMACDlevel()`, you can also derive the function for `PMACDeq()`. It is simply substituting the value for MACD_t with $\text{EMA}(P_{t-1}, X_{t-1}) - \text{EMA}(P_{t-1}, Y_{t-1})$ since we want MACD_t to equal the value of MACD_{t-1} .



EXAMPLES

The code in AmiBroker Formula Language (AFL) found in the entry “AmiBroker Formula Language Code For Reversing MACD” at Traders.com in the Subscriber’s Area is listed in two parts, one of which is the listing for the price chart and the second of which is the listing for the indicator panel. Use the parameter “plot chart”

to select what to overlay in the price chart and use the parameter “plot indicator” on the indicator panel to select which indicator to display.

Naturally, you would like to see what the resultant chart looks like and compare it to the MACD itself. I will show several charts as examples, displaying different ways that MACD indicators are plotted and displaying what similar techniques look like with the reverse mapping that are plotted on the price charts. On each chart, there will be the line or lines produced from the function `PMACDeq()` and the line produced from the function `PMACDzero()`, which is just `PMACDlevel()` with a value of zero for the MACD level.

Note when the MACD values are positively high, the function `PMACDzero()` derived price required to cross MACD of zero could be mathematically less than zero. In the code, `PMACDzero()` and `PMACDeq()` are just overlaid on the price chart without rescaling the vertical axis. This can be changed by manually adjusting the y-axis or changing the “plot rescale” parameter to “yes.”

Figure 1 (“Plot chart” set to “PMACD”) shows the Standard & Poor’s 500 price chart on the top panel and on the bottom panel (“Plot indicator” set to MACD), a standard MACD of the closing price denoted by the blue dotted line and its red signal line. On the price chart, the blue line is the `PMACDeq()`, the red line is the nine-period EMA of `PMACDeq()`, and the black line is the `PMACDzero()`.

All three lines are, by the default parameter, plotted one bar ahead. Note that the black line is plotted without rescaling the chart. Otherwise, it may skew to the vertical scale of the chart. From December 2010 to the fourth week of February 2011, the `PMACDzero()` black line is clipped (the `PMACDzero()` values are lower than the line displayed) and in June 2011, the `PMACDzero()` values are higher than the line displayed.

Between December 2010 and February 2011, the `PMACDeq()` line is basically in an uptrend with the closing price oscillating around it. The corresponding



FIGURE 1: S&P 500 WITH MACD, PMACDEQ(), NINE-PERIOD EMA OF PMACDEQ() AND PMACDZERO() OF THE CLOSING PRICE. Between December 2010 and February 2011, the PMACDEq() line is basically in an uptrend with the closing price oscillating around it. The corresponding MACD is positive, fluctuating up and down almost in a horizontal line, showing that trend may be positive.

MACD is positive, fluctuating up and down almost in a horizontal line, showing that trend may be positive. Starting from the second bar from the right (July 1, 2011), you can see that the MACD() value is 0.25 (just crossing above zero line) and the corresponding white candle closed at 1339.67 above the PMACDEq() value of 1289.47 (this is where the two exponential moving averages would have crossed).

The next day (July 5, 2011), the market closed lower at 1337.88 and MACD() still increased to 3.25. What the blue line shows for the following day (July 6), which has not happened yet, is that the MACD() could still increase

even if the market drops but closes above 1308.96. The black line shows that the market could drop from 1337.88 to close above 1268.28 and the MACD() can still be above zero. Note that the last set of information has been added to the MACD on the lower panel, hence complementing it.

Some may prefer to use the high or low prices instead of the closing price to plot MACD. On the bottom subchart in Figure 2 (“Plot indicator” set to MACD_HLC”), there are MACD lines of the high, close, and low prices denoted by the green, blue and red lines, respectively. On the top (“Plot chart” set to PMACD_HLC), PMACDEq() of the high, close, and low are

plotted as a band. As you can see, there are several times the MACD of the high, low, and close lines are similar in value, whereas the derivative PMACDEq() lines may be significantly different and may be useful to display as a band on a price chart.

Bollinger Bands are usually volatility bands applied to price series, but they can also work with many standard indicators like the commodity channel index (CCI) or MACD. In Figure 3, Bollinger Bands of the MACD() are shown on the bottom panel (parameter “Plot indicator” set to PMACD_BB) and the Bollinger Bands of the PMACDEq() is overlaid on the price chart (“Plot chart”

I will show the calculation of the price value of a specific MACD level and the calculation of the price value that will cause the MACD to change direction.

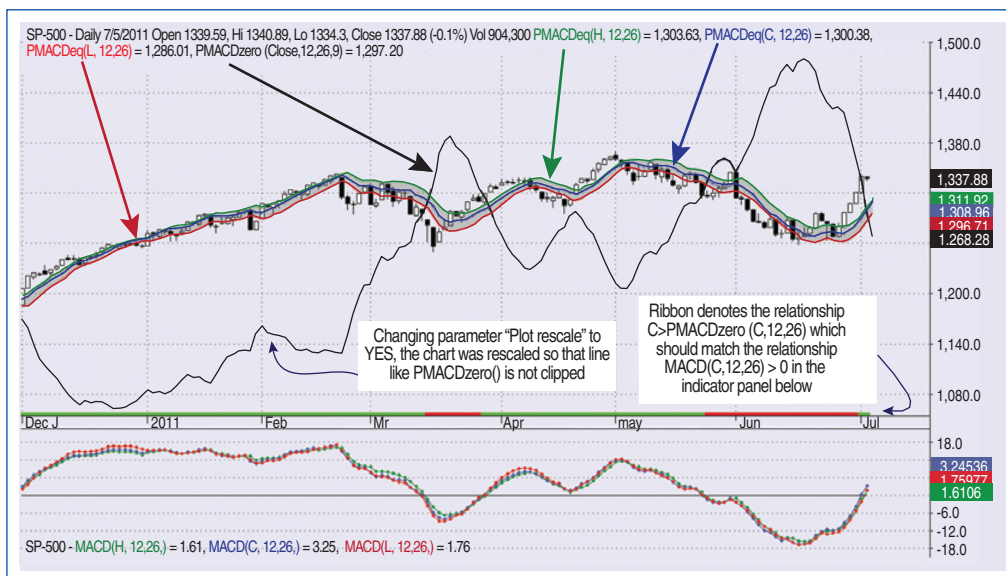


FIGURE 2: STANDARD & POOR'S 500 CHART WITH PMACDEQ() OF THE HIGH, LOW, AND CLOSING PRICES AND PMACDZERO() OF THE CLOSING PRICE. The bottom panel displays the MACD indicator of the high, low, and closing prices. There are several times that the MACD of the high, low, close lines are similar in value, whereas the derivative PMACDEq() lines may be significantly different and may be useful to display as a band on a price chart.

INDICATORS



FIGURE 3: STANDARD & POOR'S 500 CHART WITH PMACDEQ() OF THE CLOSING PRICE AND BOLLINGER BAND AND PMACDZERO() OF THE CLOSING PRICE. The bottom panel displays the MACD with a Bollinger Band. Between December 2010 and February 2011, note what the price chart lines and bands are doing and compare it to the MACD_BB indicator.

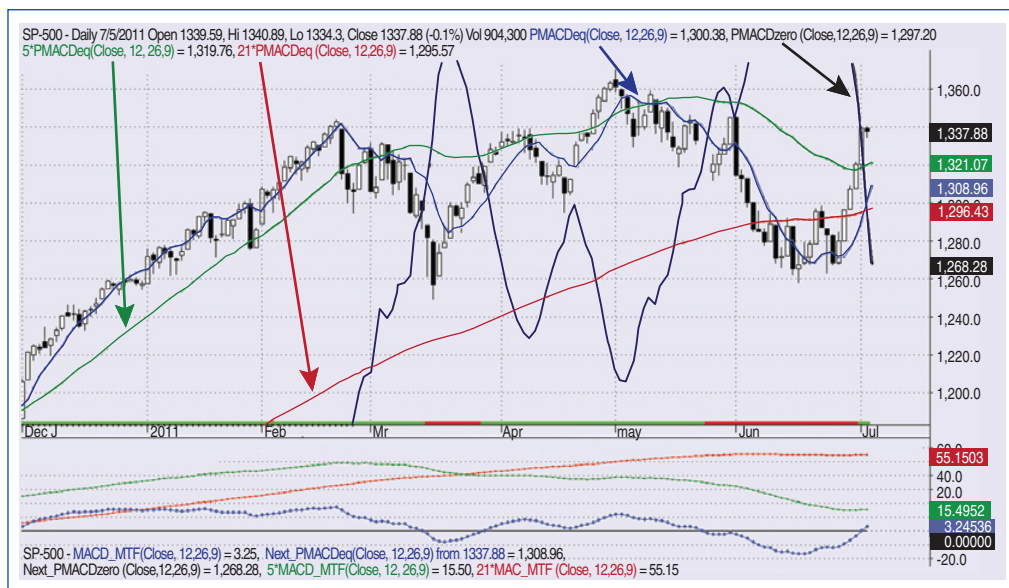


FIGURE 4: MULTIPLE TIME FRAMES. STANDARD & POOR'S 500 CHART WITH THREE PMACDEQ() OF THE CLOSING PRICE AND PMACDZERO() OF THE CLOSING PRICE. On the chart of the S&P 500 you see three PMACDEQ() of the closing price and PMACDzero() of the closing price. The bottom panel displays the three MACD indicators.

set to PMACD_BB). Between December 2010 and February 2011, note what the price chart lines and bands are doing and compare it to the MACD_BB indicator.

Figure 4 (“Plot chart” parameter set to PMACD_MTF and “Plot indicator” set to MACD_MTF) shows an example with indicators using three various periods. On the indicator panel, you can see the standard MACD line in blue, the MACD with five times the standard periods in green, and the MACD with 21 times the standard period in red. Since the default time frame is daily, think of how the green and red lines approximate the weekly MACD and monthly MACD, respectively.

IN CLOSING

In this article, I have shown two functions that complement the MACD. The first function PMACDeq() calculates what the next bar price needs to be for the MACD value to be the same. The second function, PMACDlevel(), calculates what the price needs to be for the MACD value to be a particular constant value. Function PMACDzero() is basically the PMACDlevel() function when the level constant value is zero. It calculates what the price is required to be for the moving averages of the MACD to cross. As the functions are price based, other technical indicators can be applied such as moving averages and Bollinger Bands.

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SUGGESTED READING

- Appel, Gerald [2005]. *Technical Analysis: Power Tools For Active Investors*, FT Press.
- Bertrand, François [2008]. “RSI Bands,” *Technical Analysis of STOCKS & COMMODITIES*, Volume 26: April.
- Siligardos, Giorgos [2003]. “Reverse Engineering RSI,” *Technical Analysis*

of STOCKS & COMMODITIES, Volume 21: June.

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See our **Traders’ Tips** section beginning on page 63 for implementation of Johnny Dough’s technique in various technical analysis programs. Accompanying program code can be found in the Traders’ Tips area at Traders.com.



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