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A Quicker Reaction

Buy & Sell Pressure And A Faster RSI

Most of you are familiar with the relative strength index (RSI), but are you taking full advantage of it? Here, we deconstruct the RSI to lead to a more intuitive and symmetrical gauge of buying and selling pressure and a more responsive indicator.

by Tushar S. Chande, PhD

Many novice and even intermediate traders have told me over the years that they find the ever-popular relative strength index (RSI) indicator confusing. The RSI is an oscillator plotted on a scale of zero to 100, and is typically used as an overbought/oversold indicator, which means that it is used to signal impending reversals in direction. However, during strong trends, the RSI can remain at "extreme" levels, either high or low, for the duration of the trend, and thus, it's not precise as an indicator of impending reversals. This is partly due to range compression, which I will discuss later in this article.

Digging Deeper

Even expert technicians have expressed their concern about the smoothing built into the indicator. In brief, calculations begin by separating daily changes into absolute values separated by days on which a market (or stock) closes up on the day or down on the day, so that there are two columns of positive numbers, one showing today's close minus yesterday's close (changes on up days or zero), and the other featuring yesterday's close minus today's close (changes on down days or zero). These two columns of positive numbers are then smoothed using a variation of exponential moving averages, whose length can be estimated as twice the length of the lookback period minus one.

So, for the 14-day period popular everywhere, a 27-day exponential average (EMA) is used to smooth the data in the two columns. In an intermediate calculation step, the smoothed data is next used to compute the ratio of the up-day average to the down-day average (called the relative strength). This ratio is then converted into an oscillator on a 0–100 scale.

The Trouble With Range Compression

The complaint arises because the intermediate ratio, relative strength, is calculated using relatively long EMAs, which therefore have a long memory (that is, they need a lot of data to stabilize and are heavily influenced by old data) and make the RSI practically unresponsive as the length of the lookback period increases. I have previously proposed a solution to this problem via the stochastic RSI or stochRSI.

A bigger problem is that because the RSI is plotted on a fixed 0–100 scale, as opposed to an open scale with no upper or lower limit, there is massive range compression at the extremes, or the

area of the most interest. Visualize the two columns of daily close-to-close changes described earlier as buying pressure or selling pressure. If there is strong selling pressure, the absolute daily close-to-close changes on down days will be much greater than the close-to-close changes on up days. So the ratio of selling pressure to buying pressure could be 10:1 or greater (and vice versa).

Imagine a stock that surges on strong earnings, with strong buying over many days as investors follow through. In this case, the proportion of buying to selling pressure, that is, the ratio of the average of up-day close-to-close changes to the average of the down-day close-to-close changes, could move from 3:1 to 12:1, a 300% increase, and yet the RSI would only shift from 75.0 to 92.31, a mere 23% increase. As a short-term trader, you would rather be alerted to the 300% increase in buying pressure than a 23% increase in RSI. The range compression gets even more extreme as the ratio of buying pressure to selling pressure increases.

In defense of the design of the RSI, it is a brilliant and practical solution to the problems of its time, when computers were uncommon and data were plotted by hand. In order to speed up hand calculations, the use of moving averages that required just one row to be calculated anew each day was most convenient, even essential. Similarly, the ability to plot RSI data on a fixed 0–100 scale greatly simplified the problem of updating a large number of charts by hand. However, today we can rework the problem to overcome these computational or charting challenges.

UNDERSTANDING RSI CALCULATIONS

I'll illustrate the quirks of the RSI calculations using a few simple calculations. First, I show the smoothing factors built into the calculations (see Figure 1).

The first column shows a range of lookback periods ranging from six to 42 days incremented in steps of two days. The smoothing factor corresponding to each length of RSI is simply an inverse of the length (see column 2). The equivalent length of the corresponding EMA is shown in column 3, using the usual formula that the index of the EMA is given by (2/(L+1)), where *L* is the length of the average. Clearly, if you want the RSI to respond more quickly to market changes, you can shorten the length, or simply change the type of moving average used to calculate the smoothed quantities used in the calculations.

In Figure 2, I illustrate the range compression feature of RSI calculations by constructing a series of hypothetical values for the up-closes and down-closes EMA. I first vary the up-closes EMA from 10 to 1 in steps of 1, while keeping the down-closes EMA fixed at 1 (see columns 1 and 2, and the first 10 rows in Figure 2). I compute the relative strength (RS) by taking the ratio of the values in the first two columns. The fourth column converts the RS values into the equivalent RSI values using the formula RSI = (1-(1/(1+RS))*100. Note the range compression: When the RS increases from 1:1 to 10:1, the RSI only increases from 50 to 91, approximately. The range compression also works similarly on the downside. For example, when the RS decreases from 1 to 0.1, a 10-times drop, the RSI itself drops from 50 to 9 or so.

The fixed range has two effects: nonlinear range compression, and asymmetric values. First, when the range compression is nonlinear, the greater the difference between the up-closes and down-closes averages, which is precisely when the indicator should be drawing your attention to that stock or market. Second, though the displacement from the center is symmetric, the numeric readout

Length of RSI	Smoothing Factor	Effective Length of EMA
6	0.16667	11
8	0.12500	15
10	0.10000	19
12	0.08333	23
14	0.07143	27
16	0.06250	31
18	0.05556	35
20	0.05000	39
22	0.04545	43
24	0.04167	47
26	0.03846	51
28	0.03571	55
30	0.03333	59
32	0.03125	63
34	0.02941	67
36	0.02778	71
38	0.02632	75
40	0.02500	79
42	0.02381	83

FIGURE 1: SMOOTHING BUILT INTO THE RELATIVE STRENGTH INDEX (RSI). The smoothing factor seen in column 2 is an inverse of the length of the RSI.

Up-closes EMA	Down-closes EMA	Relative Strength (RS)	Relative Strength Index (RSI)
10	1	10.0000	90.91
9	1	9.0000	90.00
8	1	8.0000	88.89
7	1	7.0000	87.50
6	1	6.0000	85.71
5	1	5.0000	83.33
4	1	4.0000	80.00
3	1	3.0000	75.00
2	1	2.0000	66.67
1	1	1.0000	50.00
1	2	0.5000	33.33
1	3	0.3333	25.00
1	4	0.2500	20.00
1	5	0.2000	16.67
1	6	0.1667	14.29
1	7	0.1429	12.50
1	8	0.1250	11.11
1	9	0.1111	10.00
1	10	0.1000	9.09

FIGURE 2: RANGE COMPRESSION IN RSI CALCULATIONS. When the RS increases from 1:1 to 10:1, the RSI only increases from 50 to 91, approximately. When the RS decreases from 1 to 0.1, a 10-times drop, the RSI itself drops from 50 to 9 or so.

Up-closes EMA	Down-closes EMA	Relative Strength	RSI - Relative Strength Index	Chande Buy/Sell Pressure (CBSP)
10	1	10.0000	90.91	10
9	1	9.0000	90.00	9
8	1	8.0000	88.89	8
7	1	7.0000	87.50	7
6	1	6.0000	85.71	6
5	1	5.0000	83.33	5
4	1	4.0000	80.00	4
3	1	3.0000	75.00	3
2	1	2.0000	66.67	2
1	1	1.0000	50.00	1
1	2	0.5000	33.33	-2
1	3	0.3333	25.00	-3
1	4	0.2500	20.00	-4
1	5	0.2000	16.67	-5
1	6	0.1667	14.29	-6
1	7	0.1429	12.50	-7
1	8	0.1250	11.11	-8
1	9	0.1111	10.00	-9
1	10	0.1000	9.09	-10

FIGURE 3: BUY/SELL PRESSURE CONVERTED FROM RSI FIXED SCALE TO OPEN SCALE. The open scale tells you instantly the relative magnitudes of the two pressures, and the sign tells you which is greater.

is not. For example, a 4:1 upside ratio or 1:4 downside ratio produces a similar 30-point deviation from the center line at 50, but the readout is 80 or 20, not symmetric as 4:1 or 1:4. Thus, the RSI numerical values are not intuitively related to the force of buying or selling pressure.

CHANDE BUY/SELL PRESSURE (CBSP)

I would like to convert the usual RSI calculations away from the fixed scale into an open scale to get away from range compression and get a symmetric readout. I would also like to signal if buying pressure exceeds selling pressure or vice versa.

Recall that in the core RSI calculations, the RS = (up-day average)/(down-day average). Rather than visualize the ratio as relative strength, I look at it as a ratio of buying pressure to selling pressure, that is, buy/sell pressure or BSP. I use the following formulas:

If RS < 1, CBSP = -1/RS and
If RS >= 1, CBSP = RS.

You can just as easily rewrite the CBSP using the RSI values directly as follows:

If RSI < 50, then CBSP = (0.01*RSI-1)/(0.01*RSI), else
(RSI >= 50), then CBSP = (0.01*RSI)/(1-0.01*RSI)

With this formulation, CBSP < 0 when RSI < 50, and CBSP>0 when RSI>=50, and the sign indicates which is greater—the buying or selling pressure.

In Figure 3 I show how the RSI values can be converted into BSP values using the same synthetic data as in Figure 2. First, when you compare columns 3 and 5, note that BSP is the same as RS when the RS is >=1, but is equal to -1/RS when RS is < 1. The convenience of this definition is that now you get an open scale and symmetric values of buy/sell pressure that instantly communicate the relative magnitudes of buying or selling pressure. For example, from the first line, when the RS=10 and buying pressure is 10 times the selling pressure, BSP =10. Symmetrically, from the last line, when the selling pressure is 10 times the buying pressure, BSP = -10.

Thus, the open scale instantly tells you the relative magnitudes of the two pressures, and the sign tells you which is greater. This is a more intuitive formulation of buying and selling pressure, and gets closer to the natural price action. I will now apply these calculations to a few real-life examples to appreciate their implications.

THE 2015 RALLY IN DUPONT (DD)

In the fourth quarter of 2015, Dow 30 component Dupont (DD) had been falling steadily, past the Chinese revaluation selloff in August into October. Then, as the rest of the market rebounded in October, DD gapped higher, and rallied hard through early December, ending with an exhaustion gap. In Figure 4 you see a chart of the DD price action along with the 14-day RSI in the upper panel. Observe how the RSI values remained above 70 for more than 45 days as DD trended higher.

I reproduced the RSI calculations from Figure 4 in an Excel spreadsheet (see Figure 5) to provide the bridge to a later discussion. The ending value, on December 31, 2015, is 50.79, which is the same in Figure 4. Thus, I can cross-check my calculations against a commercial package for completeness. I can now use the RSI calculations in Figure 5 and compare them directly to buy/sell pressure calculations (see Figure 6).

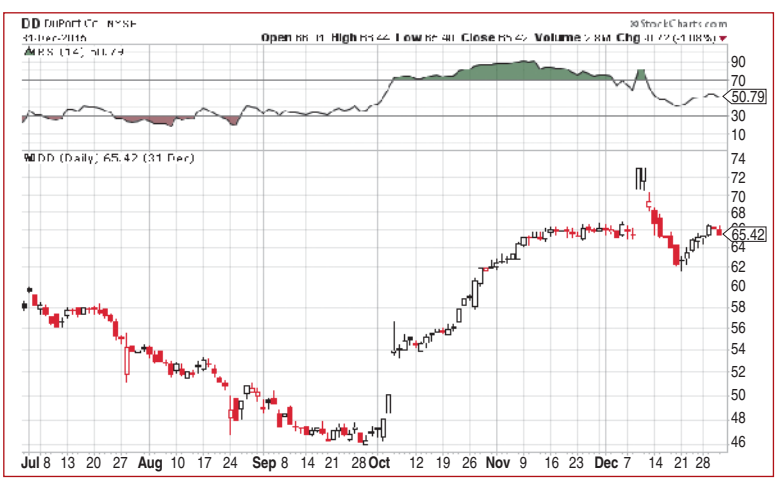

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FIGURE 4: BUY/SELL PRESSURE IN DUPONT (DD). Dupont rallied in late 2015 and the RSI stayed above 70 for more than 45 days.

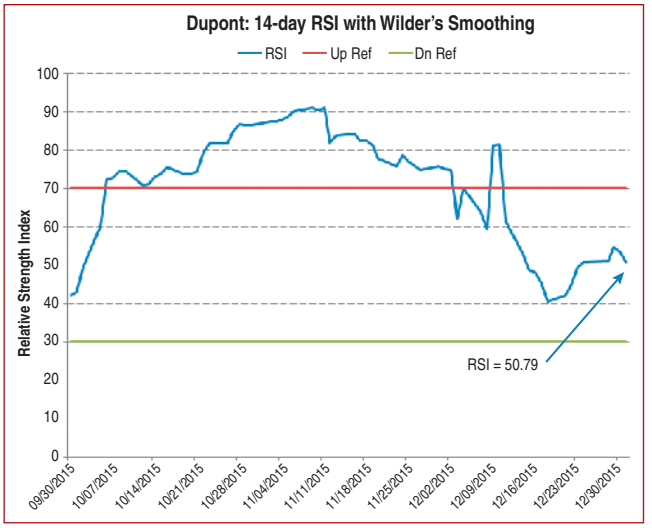

FIGURE 5: 14-DAY RSI WITH WILDER'S SMOOTHING. Here, the RSI calculations were reproduced in an Excel spreadsheet. The RSI value of 50.79 on December 31, 2015 is the same as in Figure 4.

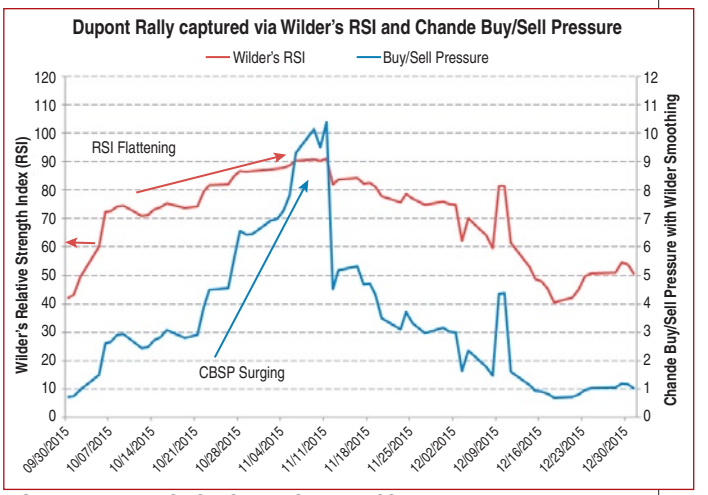

FIGURE 6: WILDER'S RSI VS. BUY/SELL PRESSURE. The values are consistent with those in Figure 3. The buying pressure was 10 times the selling pressure (values above 10) with RSI greater than 90 just before DD flattened out in mid-November. The acceleration in CBSP values makes the buying pressure more obvious than the flattening out seen in RSI values.

The rapid acceleration in buying pressure is more intuitively obvious in Figure 6, even as the RSI values begin to flatten out, topping out above 90 for BSP > 10, as can be expected from the calculations in Figure 3.

I'll now briefly revisit the internals of RSI smoothing. Wilder's formulation does not quite follow the usual EMA formula. For example, for a 14-day RSI, it adds 1/14 of the new value to 13/14 of old value, instead of adding 2/15 of the new value to 13/15 of the old value to compute the updated averages. This subtle change slows down the RSI computations. I compared the RSI values during the DD rally using the two different smoothing schemes in Figure 7. The "proper" EMA formulation, denoted by "standard EMA smoothing" in Figure 7, responds more quickly than the Wilder formulation, which should be expected since I am using a larger fraction of the incoming data (0.13 vs. 0.07) to update the new value for the moving averages used to calculate the relative strength.

THE SPILL IN KIMBERLY CLARK

The shares of Kimberly Clark (KMB) had a bit of a spill in late 2016. These defensive stocks have been following the bond market lower, after bonds peaked in the immediate aftermath of the "Brexit" scare. I show in Figure 8 how the selling pressure reached -4, with the RSI in the range below 20, as is expected from Figure 3. The CBSP instantly communicates selling pressure four times the buying pressure, whereas the RSI readout is merely an oversold condition below 30. Thus, when you compare the pressure of buying

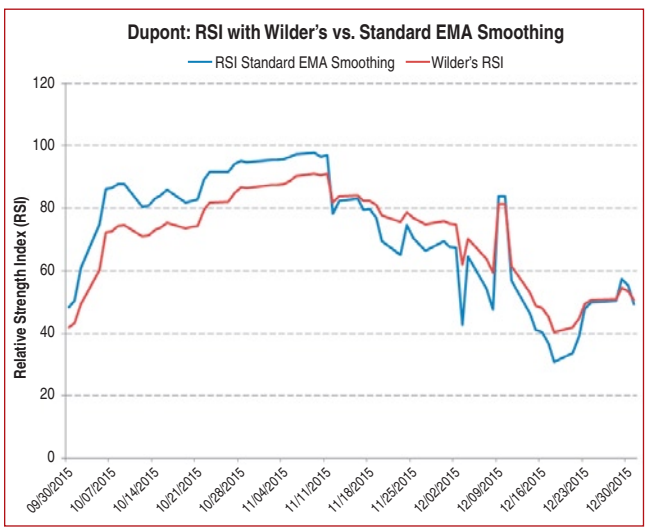

FIGURE 7: WILDER'S RSI VS. STANDARD EMA SMOOTHING. The RSI calculation using the standard EMA formula reacts faster because it uses a larger proportion of new data to update its internal moving averages. The more responsive RSI can be quite attractive to short-term traders.

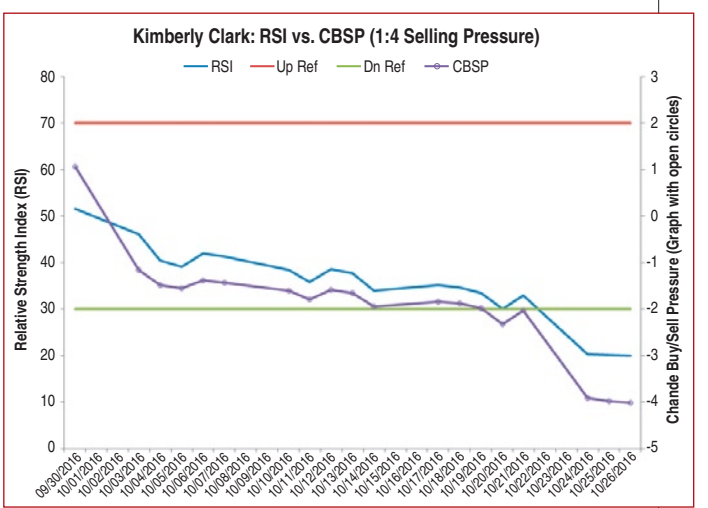

FIGURE 8: RSI CALCULATION AND CBSP. The selling pressure here is four times the buying pressure, giving a CBSP reading of -4, intuitively clarifying that the stock is under significant selling pressure. The RSI readout at about 20 merely shows an oversold condition. Thus, the CBSP gives symmetrical readings (4:1 or 1:4, that is, +4 or -4) for the intensity of buying or selling pressure.

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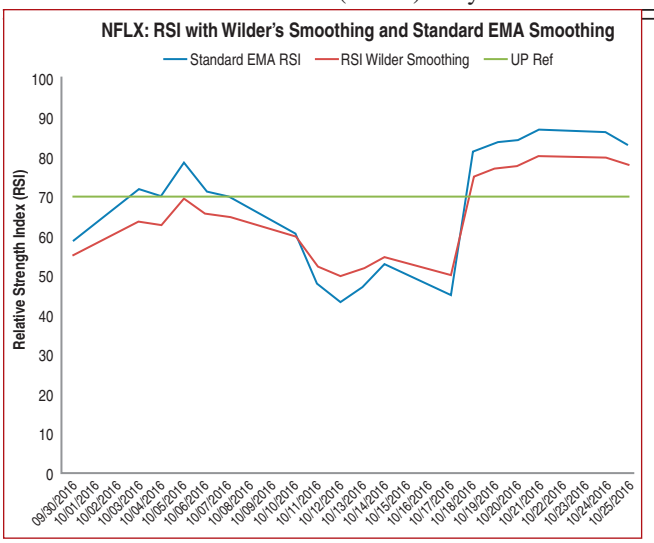


FIGURE 9: PRICE JUMPS AND RESPONSE TIME. The 20% or so jump in NFLX in a single day was heavily damped in the RSI calculations using the Wilder smoothing formula. However, using the standard exponential moving average formula led to a faster response from the resulting RSI.

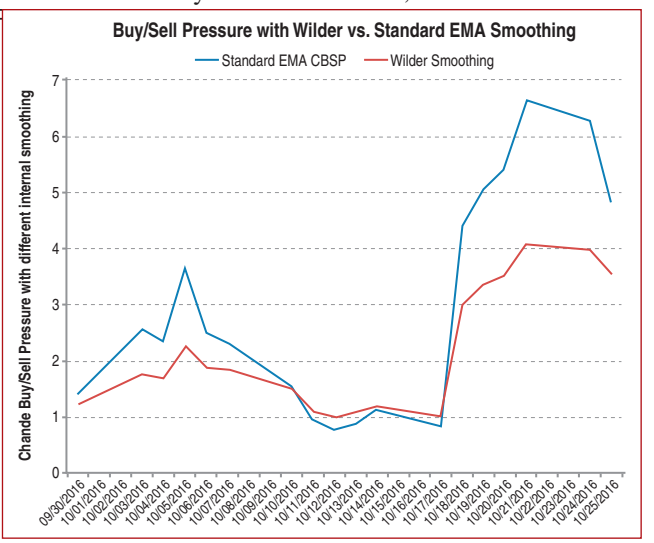
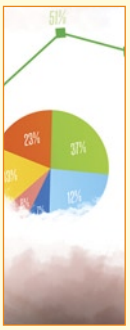


FIGURE 10: BUY/SELL PRESSURE WITH WILDER VS. STANDARD EMA SMOOTHING. The Chande buy/sell pressure (CBSP) calculations using the regular exponential average definitions responded more quickly to the one-day jump in NFLX than the CSBP calculations using the Wilder smoothing method. The CBSP intuitively shows the sudden surge in buying pressure, and shows that it is many times the selling pressure.



The open scale instantly tells you the relative magnitudes of the buying and selling pressures, and the sign tells you which is greater, making it a more intuitive formulation of buying and selling pressure, and closer to the natural price action.

or selling, the CBSP gives a more intuitive readout of which side is dominating and by how much.

A SURGE IN NETFLIX

Traders and investors rewarded Netflix (NFLX) with a 20% or so jump in stock price when the company's performance exceeded expectations in October 2016. The sudden one-day jump in price shows the lags due to the smoothing built into RSI calculations. I first compared the standard 14-day Wilder RSI calculations to the RSI calculations using a standard 14-day EMA (see Figure 9). It is clear that the Wilder smoothing built into the RSI is less responsive than the usual definition of an EMA.

The corresponding buy/sell pressure calculations can be seen in Figure 10. Once again, the calculations using the regular EMA formula respond much more quickly. This intuitively shows that the buying pressure is six times greater than selling pressure. This is easier to absorb than just an RSI reading above 70, which merely indicates an overbought condition.

VARIATIONS ON THE EVER-POPULAR RSI

The ever-popular RSI indicator is used in many situations, for both systematic and discretionary trading. Users can now add a couple of variations to their menu. One, they can use a different smoothing scheme, to get a more responsive RSI. Or they can recast it as Chande buy/sell pressure to get a symmetric, open-scale variant that instantly summarizes the relative magnitudes of buying or selling pressure. Remember that because the core calculations are closely related, the "shape" of the variations will look alike, though the numerical readouts will differ.

Tushar Chande, PhD, MBA, has two decades of experience trading the futures markets as a CTA and hedge fund head of research. He is the developer of numerous widely used original technical indicators such as VIDYA, CMO, and AROON. He is the author or coauthor of several books on technical analysis. His website, ETFmeter.com, offers trend analysis of more than 1,200 ETFs, stocks, and international indexes, and buy/sell pressure data. Users can build and rebalance risk-managed ETF portfolios.

FURTHER READING

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