How Well Do Traditional Momentum Indicators Work?

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1.0 Introduction

Most market technicians believe traditional momentum indicators, such as the Stochastic, RSI and MACD "work". But hard quantitative evidence is rare. Most support for the efficacy of these indicators is anecdotal, based on traders' experience or empirical, based on an indicator's performance when embedded in a trading program. In this research paper, hard evidence of how these three well-known indicators perform is presented. For purposes of this study, stops based on True Range, as detailed in the Appendix were used to measure reversals. Two aspects of indicators were studied. These were (1) whether a divergence took place preceding stops being hit and (2) whether following a divergence the market turned sufficiently to hit the stops.

The data used for this study included the most actively traded futures contracts per the July 2006 issue of Technical Analysis of Stocks and Commodities magazine. In all 43 commodities and six FOREX pairs, Australian Dollar, Canadian Dollar, Swiss Franc, British Pound, and Japanese Yen, all to the US Dollar. This data went 15 years back, if the data was available, otherwise the maximum data for the given instrument that was available was used. The data was provided courtesy of www.GenesisFT.com, and the format employed was back-adjusted normalized data. Back adjusting takes the difference between the first and second nearby contract prices upon expiration and adjusts all previous price points by that difference to remove any rollover gaps. The raw data stream, when normalized in this manner, may have negative numbers so Kase wrote a program to identify which streams had negative values and adjusted them upwards to ensure that this was no longer the case. As it turned out there was an average of about 13 years of data per instrument, or about 630 years of data studied.

2.0 Stop Hits and True Range Excursions

In performing this study the first step was to determine the behavior of the stops regardless as to whether a divergence took place. This was done by finding all the instances of the average stop being hit. To translate, the "average stop being hit" is determined as follows. (1) Moving averages of 10 and 21 were calculated. (2) If the fast moving average was above the slow moving average, the market is assumed to be rising, and if below falling. (3) If the market was considered to be rising, and then declined by an amount equivalent to the average of a two bar True Range, as defined in the sidebar below, plus one tick, the average stop was considered to have been hit, and vice versa for a declining market. Once the average stop was hit, the stops based on that bar were frozen so that the remaining stops based on those in place at the same time of the average stop hit could be evaluated. The key is that because the stop is based on True Range, which varies over time and is based on volatility, a trailing stop can change even if a new high or new low was not made. This can happen because the value of the amount added to a low or subtracted from a high itself changes due to the change in volatility, even though the high or low didn't change. This is why the stop levels are frozen at the time the average stop is hit. Having stops that don't change is important for purposes of the study because the stops in place at that moment in time that the average stop is hit are all the analyst has to work with, as opposed to future stop points that may change due to changes in volatility.

The process ended if the market closed beyond a stop based on 3.6 standard deviations of a double TrueRange excursion (referred to as Stop3 hereinafter), if the peak or low dip just prior to the

average stop that was hit was exceeded or moving averages (the 10 and 21 referred to above) crossed and the average stop in the opposite direction was hit.

Figure 2.1 below, shows an example of the count being stopped based on a close beyond a stop having a reversal value of 3.6 standard deviations of TrueRange, Stop3. The chart shows a valid bearish divergence as marked by the cyan dotted lines. Two bars later a new high was made and so the program stopped looking at stops being hit for that divergence at that point. At the new high, another valid bearish divergence took place. Then the market turned, prices dropped and the program counted the stops until the market closed below Stop3, as shown by the blue arrow.

Figure 2.1 Methods of Stopping Stop Hit Count, Corn Continuation

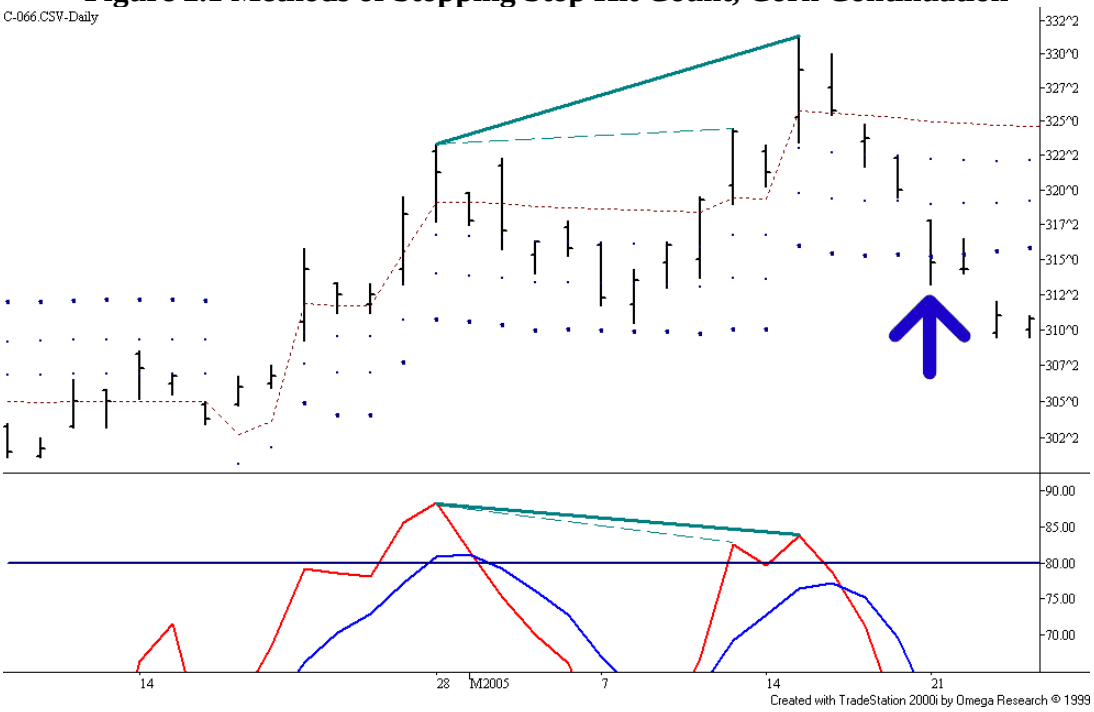
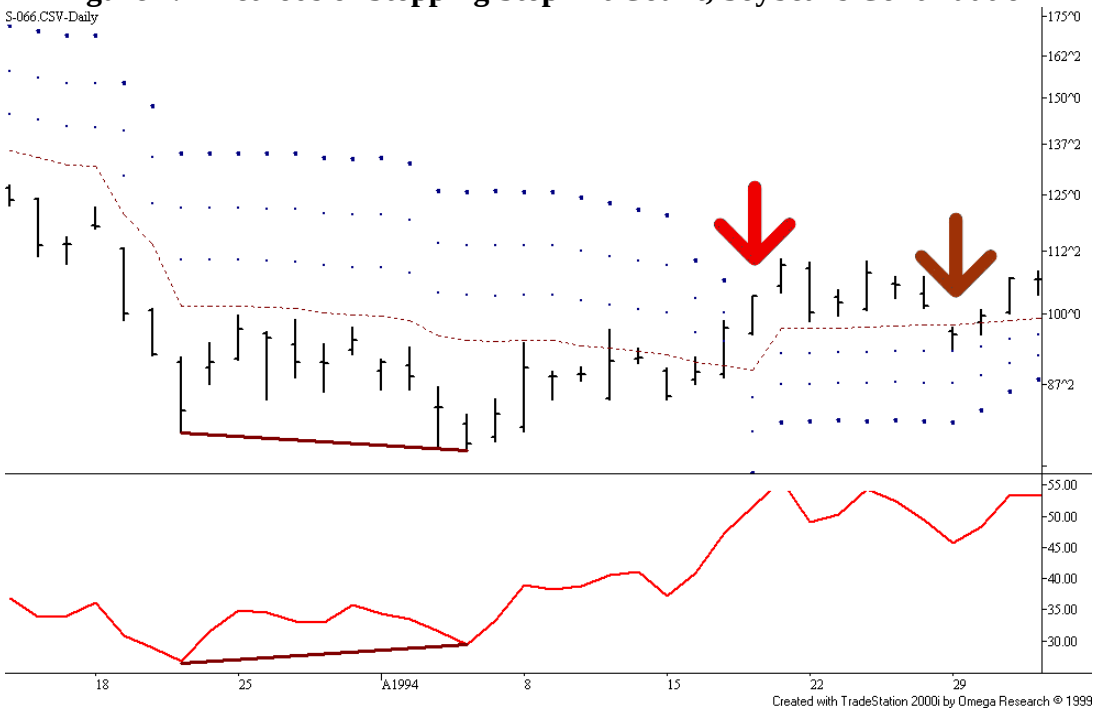


Figure 2.2 shows a case where the program stopped counting stops based on the stops "flipping" based on the underlying moving averages crossing and the average stop being hit in the opposite direction. The chart shows a valid bullish divergence, marked by the dark red lines. One bar after Stop1 was hit the moving averages underlying the stop placement crossed at which point the stops flipped from short to long, as shown by the red arrow. After the stops flipped from short to long the average stop was hit, which was, by definition, in the opposite direction of the initial count. At this point, shown by the dark red arrow, the count was stopped.

Figure 2.2 Methods of Stopping Stop Hit Count, Soybeans Continuation



It was found that of the 157,206 bars of data, the average stop was hit a total of 14,582 times, or about nine percent of the time, approximately once every 11 bars. Once the average stop was hit, the follow through to the remaining stops was evaluated. Specifically reversals were defined as magnitudes equal to Stop1, Stop2 or Stop3, where the Stops are defined as reversals of 1, 2.2 and 3.6 standard deviations above the mean of a two bar True Range, as defined in the sidebar.

Once the average stop is hit, the probability of hitting the other stops can be estimated as well, as shown in Figure 2.3. For example if the average stop is hit, there is a 63% chance that Stop2 will be hit. Follow through based on other stops can be calculated also. For example if Stop3 is hit, there is an 84% chance that there will be a close beyond that stop. The probabilities can be used both for forecasting purposes and for risk control.

Figure 2.3 - Stop Hit Follow Through

Measure	Number		Follow	Through >>		
Total Bars	157206	Total				
Average Stop	14582	9	Hit			
Stop1	11601	7	80	Hit		
Stop2	9174	6	63	79	Hit	
Stop3	7075	5	49	61	77	Hit
Close Beyond	5914	4	41	51	64	84

Sidebar: Calculating Two Bar True Range

H = highest high of two consecutive bars
L = lowest low of two consecutive bars
C = close of the most recent bar
Two Bar True Range = TBTR = maximum of absolute value H – L, H – C, C – L.

Average TBTR = average over n bars (default 30) of TBTR
Standard deviation TBTR = standard deviation over n bars (default 30) of TBTR

end Sidebar

3.0 Indicator Functionality

The next aspect of the study involved identifying when divergence took place on each of the three indicators noted above and to measure whether there was follow through in the form of a statistically significant move in the direction of the divergence (down for bearish divergence following an up market and up for bullish divergence following a down market). For purposes of this research, statistically significant moves were defined by evaluating divergences in two directions.

This required coding a divergence identification algorithm, given that none of the canned "divergence" programs that are available in the public domain on charting packages meet an appropriately strict definition of technical analysis. To find divergence signals, first peaks in price and in momentum were defined and identified. A peak was defined as a high in price or momentum such that the day on which the high took place was preceded and followed by lower values. The program allowed for peaks to be also formed of plateaus that consist of up to three equal bars preceded and followed by lower values. The reverse logic was used for dips.

Once peaks and dips were identified, if price peaks took place on the same bar as momentum peaks, or within a tolerance of plus or minus two bars of momentum peaks a matching pair was found. The inverse was true for dips.

The charts below show examples of within tolerance and outside of tolerance, using the Stochastic as the momentum indicator. Figure 3.1 below, shows a divergence in which both peaks in price matched the peaks on the Stochastic exactly.

Figure 3.1 Divergence on Stochastic, Corn Continuation

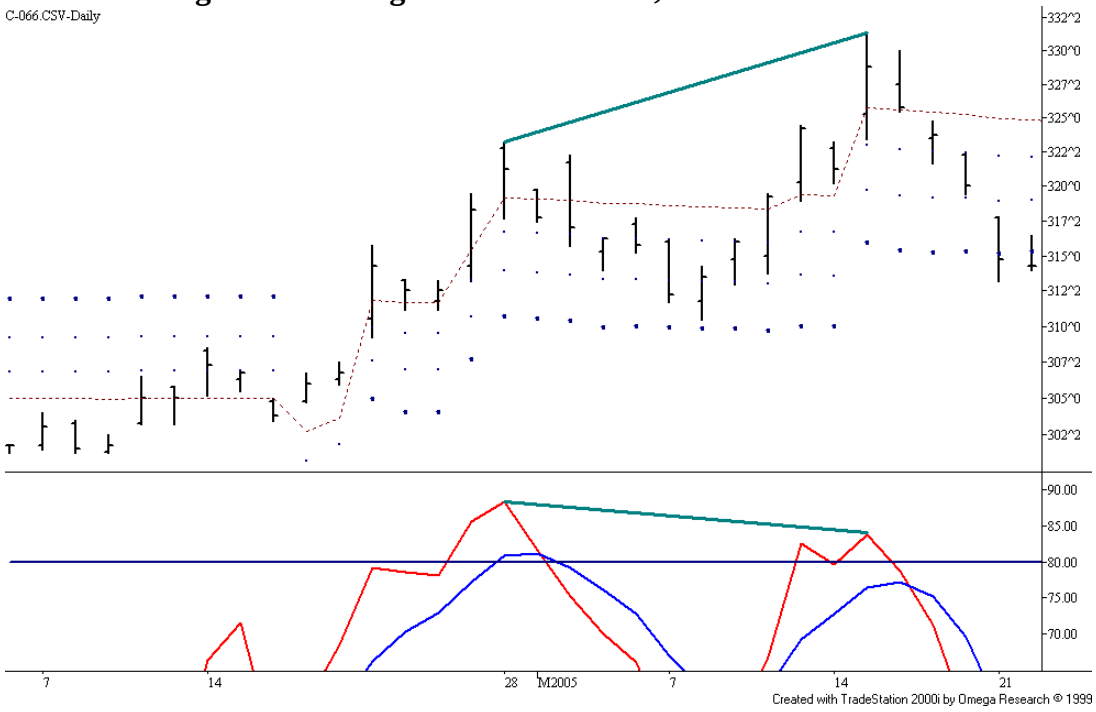
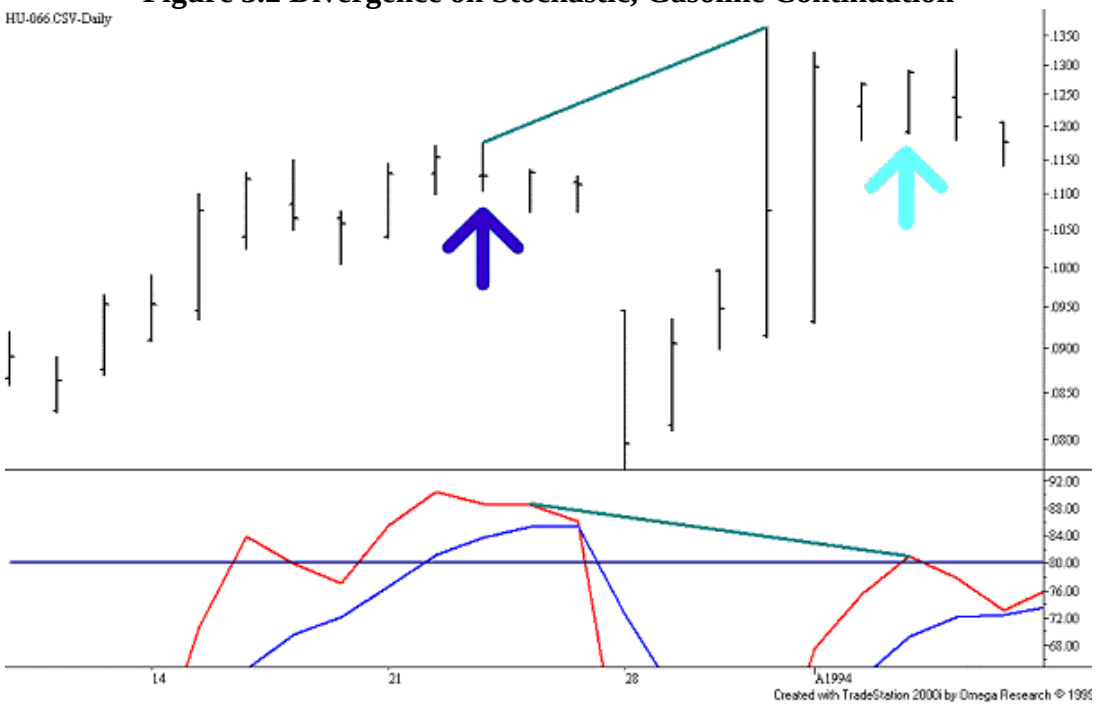


Figure 3.2, following, shows examples or peaks defined "within" and "outside" of tolerance. The first peak on the left, as shown by the blue arrow is within tolerance because the peak in price is followed one bar later by a peak in momentum. The peak in momentum does not match the peak in price shown by the cyan arrow until three bars later, and therefore, with a two bar tolerance was breached.

Figure 3.2 Divergence on Stochastic, Gasoline Continuation



Once a matching set of peaks or dips was found, the algorithm looked back up to 100 bars for an earlier pair of lower peaks or higher dips. The two pairs of matching peaks or dips were then checked for divergence. In this study bearish divergence was defined as a higher or equal peak in price matched by a lower or equal peak in momentum, and bullish divergence as a lower or equal dip in price matched by a higher or equal dip in momentum.

3.1 Divergence Preceding Stops

Once all divergences were found, the next step was to see how often each average stop hit instance was preceded by a valid divergence on each of the three indicators studied, as well as when combinations of the indicators were used. Figure 3.1.1 shows that the results indicate that divergences found on all three of the indicators studied preceded a turn that hit the average stop about the same percentage of the time, 18% for the Stochastic and RSI and a slightly lower 16% for the MACD.

Figure 3.1.1 - Average stop Hits Caught or Missed

Average stop	Number	Caught	Missed
Total Hits	14582	-	-
Stochastic	2601	18	82
RSI	2657	18	82
MACD	2885	16	84
Stochastic and RSI	4206	29	71
Stochastic and MACD	3177	22	78
RSI and MACD	3280	22	78
All Three Indicators	4502	31	69

What is very interesting is that there was a significant increase in the turns caught when the Stochastic and RSI were combined. An improvement of 11 percentage points from 18% to 29%, resulting in 60% more turns being caught was achieved as demonstrated in Figure 3.1.2. Adding the MACD to either the RSI or Stochastic did not improve the results as much, only improving performance by about four percentage points. This indicates that there must be a fairly high degree of overlap relative to the MACD for the Stochastic and RSI, and much less overlap between the latter.

Combining all three indicators versus just using the Stochastic and RSI only yields a marginal two-percentage point improvement. Thus the conclusion is that using the Stochastic and RSI is warranted, with the addition of the MACD only justified in cases where a trader might be looking at one chart on a position basis or if using a computerized model where the work involved in adding the MACD is insignificant.

Figure 3.1.2 also shows the percent of each stop that was caught by a particular indicator. The overall pattern remains the same, and the values are roughly the same regardless as to what stop is viewed, with a slight peak at the Stop2 (set at reversal value of 2.2 standard deviations of a two bar True Range). While it is outside of the scope of this study to determine why there is variation, the most likely explanation has to do with minor variations in the degree of skew relative to the log-normality of the distribution of range.

Figure 3.1.2 - Percent of Time Stop Caught by Indicator or Combination

Stop>>>	Average	Stop1	Stop2	Stop3	Close
Stochastic	18	17	16	17	18
RSI	18	17	17	18	20
MACD	16	16	16	17	19
Stochastic and RSI	29	26	25	27	31
Stochastic and MACD	22	20	19	21	24
RSI and MACD	22	20	20	22	25
Any Indicator	31	28	27	29	34

3.2 Stops Hit Following Divergence

The next aspect of the study had to do with follow through. This means that once the average stop is hit, how often there is a continuation against the direction of the trend such that the more distant Stops 1, 2 and 3 (at one, 2.2 and 3.6 standard deviations) are hit, and/or if a close beyond Stop3 takes place.

The second column in Figure 3.2.1 indicates the number of times a particular stop was hit, and when a close beyond Stop3 took place. The percent column shows the corresponding percent of the time, relative to the average stop being hit that follow through took place. So for example 80% of the time that the average stop was hit, there was follow through with Stop1 being hit, and 41% of the time the market continued against the original direction to an extent that a close beyond Stop3 took place. This was then compared to the follow through that took place after a divergence. The results indicated that follow through in terms of all three indicators studied was about the same so a representative column is shown as "Indicator". What is interesting here is that the follow through of all the stops was slightly less, with the follow through on a close beyond Stop3 slightly higher. Though the differences are not large it could mean that the indicators have a slight bias to finding a somewhat larger number of reversals that are of larger magnitude.

Figure 3.2.1 - Follow Through after Hitting Average stop

Stop	Number	All	Indicator
Stop1	11601	80%	76%
Stop2	9174	63%	58%
Stop3	7075	49%	48%
Close Beyond	5914	41%	44%

Figure 3.2.2 shows the percent of the time each stop was hit based on each individual indicator and combinations. Each individual indicator has similar follow through, which is consistent not only with the average stop, as noted above, but also with the other stops. If a signal is received on the MACD and either the RSI or Stochastic at the same time, there was no significant difference. The same is true for all three, but the lack of differentiation may be due to the very small number of signals. If a signal took place at the same time for the Stochastic and RSI, the likelihood of hitting the average stop and Stop1 increased, but the results for the lower stops remained the same. The implications of this may be that if a trader has stops set at the average stop or Stop1, the odds of being hit are slightly larger so a slightly more aggressive exit strategy may be warranted. However, if the stops are set at Stop2 or greater, no change in strategy is justified. In the writer's opinion though, the change is not large enough to call for modification of trading strategies.

Figure 3.2.2 - Percent of Time Indicator Hit Reversal

Stop	# Signals	% Signals	Average	Stop1	Stop2	Stop3	Close Beyond
Stochastic	2601	25	85	63	47	39	35
RSI	2657	26	82	61	47	39	36
MACD	2354	23	83	65	51	43	38
Stochastic RSI both	1325	13	90	67	49	42	40
Stochastic MACD both	472	5	86	62	48	42	40
RSI MACD both	544	5	85	62	48	41	39
Improvement	-	-	*4*	*3*	*2*	*3*	*4*
All Above, same time	342	3	85	62	48	40	39

Another implication of the results is that the indicators predict average stop hits about 9.2 times as frequently as random. The odds of hitting a average stop are about 83% following an indicator divergence signal, versus 9% for random hits. The Stochastic RSI combination is ten times more frequent than random.

4.0 Impact of Optimization

In this portion of the study, the periodicity of the Stochastic and RSI was varied, using values of 5, 8, 13, 21, 34 and 55 in addition to the eSignal defaults to determine if there was any improvement in functionality as periodicity varied. As reflected in Figure 4.1, there was only a slight degradation in the percent of the average stop was hit and follow through after a divergence took place. The major difference was found when evaluating the performance of the indicator from the opposite direction, that is, of the times the average stop was hit, how often was it preceded by a divergence signal, or to put it another way, how many of the hits did the indicator catch. Here the performance more or less increased as periodicity decreased, making the RSI and Stochastic set at the smallest reasonable setting the best choice.

Figure 4.1

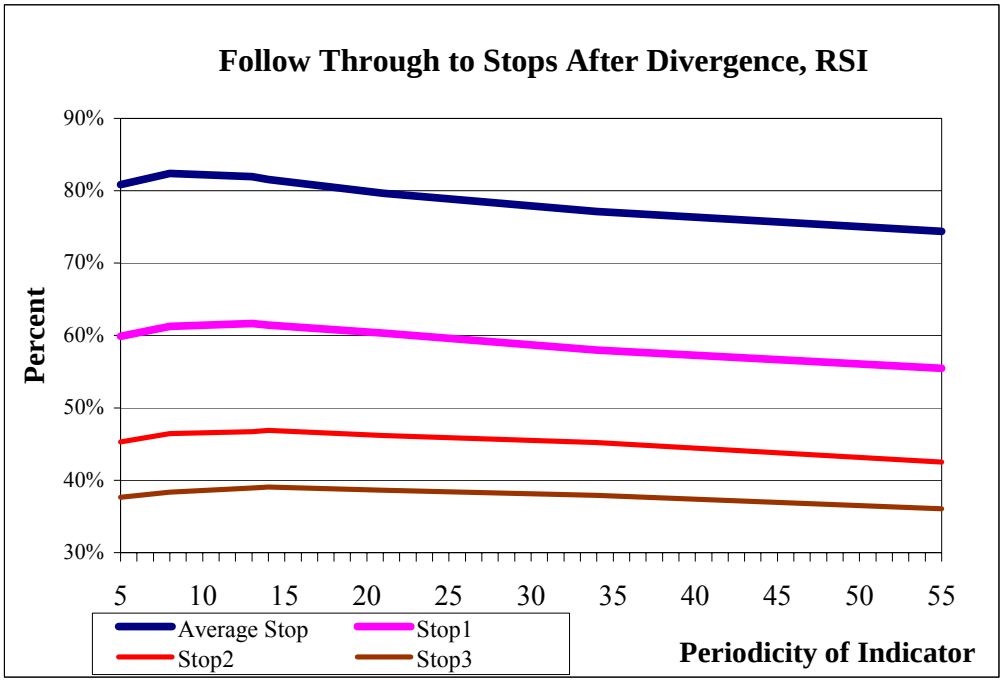


Figure 4.2 shows the relationship between the percent of the time average stop preceded by a divergence with the relationship clearly one in which the accuracy of the indicator declines as the periodicity increases.

Figure 4.2

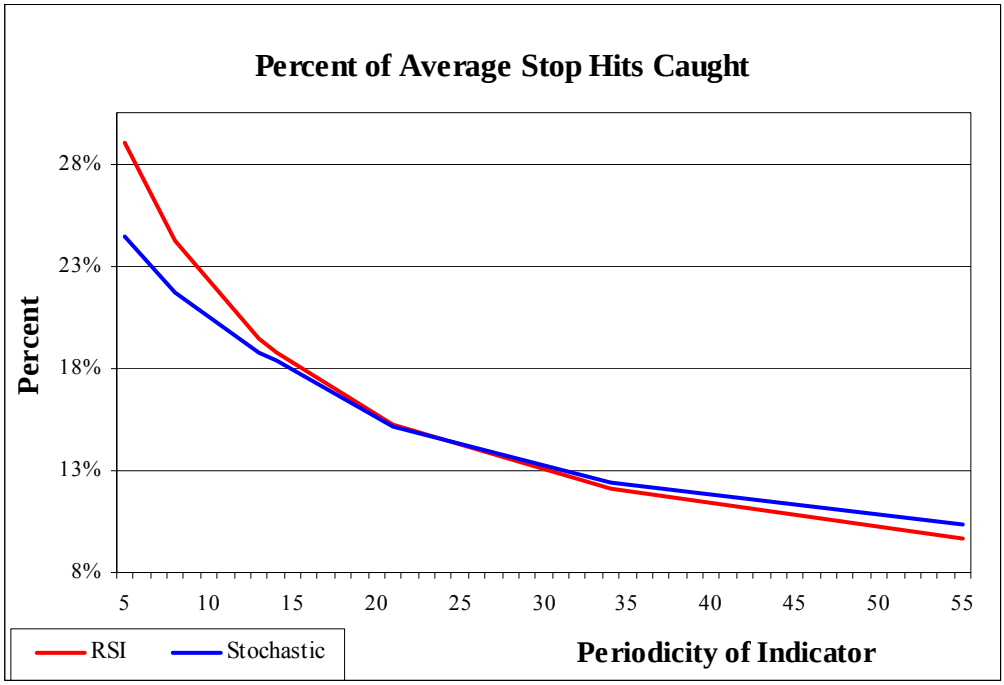


Figure 4.3 below shows the detail of the optimal indicators versus the defaults in table format. While it makes sense that the shorter the periodicity, the more accurate the indicator, one might expect that there would be a degradation in the amount of time the average stop was hit after a divergence. That is, one might have expected an increase in false signals as a trade-off for fewer stops being missed. As shown in Figure 4.2 discussed earlier this was not the case. The table below summarizes the difference between the indicators when using a periodicity of five versus the default settings at 14. Again the best combination of two indicators is the Stochastic and RSI, with a 13-point improvement for the five versus 14 period indicators, a 45% improvement overall.

Figure 4.3 - Average stop Hits Optimized vs. Default Indicators

Average Stop	# Optimal	% Optimal	% Default	Δ Points	Δ %
Stochastic	3490	24	18	6	33%
RSI	4165	29	18	11	61%
Stochastic and RSI	6118	42	29	13	45%
Stochastic and MACD	4381	30	22	8	36%
RSI and MACD	4921	34	22	12	55%
All Three Indicators	6450	44	31	13	42%

5.0 Variation Among Markets

The last part of the study was conducted to determine if there was any significant difference in the performance of the indicators between differing commodity or instrument types. Thus, approximately 2,000 data points for each of six FOREX pairs of US Dollar to Australian Dollar, Canadian Dollar, Swiss Franc, Euro, British Pound and Japanese Yen was compared to the six most active agricultural commodities, again based on approximately the 2,000 most recent data points. These included Corn, Cotton #2, Soybeans 5000 bushels, Sugar - World #11, Soybean Meal, and Wheat - Soft Red.

Figure 5.1 - Percent of Follow Through after Signal
Difference Between FOREX and Agricultural
Average Stop *and Close Beyond Stop3 (Italic)*

	All	FOREX	Ags	*All*	*FOREX*	*Ags*
Stochastic	85	88	83	*35*	*33*	*30*
RSI	82	81	81	*36*	*32*	*36*
MACD	83	82	81	*38*	*38*	*39*
Stochastic RSI both	90	91	91	*40*	*33*	*34*
Stochastic MACD both	86	88	83	*40*	*37*	*33*
RSI MACD both	85	84	79	*39*	*32*	*38*
All Above, same time	85	86	86	*39*	*33*	*38*

As shown in the Figure 5.1 above, there was little difference found. In comparing FOREX to the agricultural commodities, the average stop hit percentages were about two percent better, and the close beyond Stop3 one percent worse. Comparing the FOREX to all the data contained in the entire study the results were one percent better and four percent worse, and for agricultural products two and one percent worse, respectively. These minor differences can be attributed to small variations in market activity, such as fewer trend reversals, than any factors inherent in either market segment.

Figure 5.2 - Percent Stops Preceded by Signal
Average Stop *and Close Beyond Stop3 (Italic)*

Average Stop	All	FOREX	Ags	*All*	*FOREX*	*Ags*
Stochastic	18	19	15	*24*	*23*	*22*
RSI	18	17	18	*29*	*29*	*27*
MACD	16	15	15	*16*	*15*	*15*
Stochastic and RSI	29	28	26	*42*	*42*	*39*
Stochastic and MACD	22	22	20	*30*	*29*	*29*
RSI and MACD	22	22	23	*34*	*33*	*32*
All Three Indicators	31	30	29	*44*	*43*	*42*

In evaluating performance in the reverse direction, that is, relative to how often a turn was preceded by a particular signal, no differences were found on average between all the data and FOREX. Agricultural products scored two percent worse, which is again considered a minor variation.

6.0 Conclusions

This study has shown that momentum indicators can predict market turns that are of sufficient magnitude to generate an average double-bar True Range reversal in increasing rates of accuracy as indicator periodicity decreases, from about 18 percent for a single indicator with eSignal default settings to 44% using all three indicators with optimized settings. Combinations of the Stochastic and RSI are far better than either indicator combined with the MACD. Once the average stop has been hit, there is no significant variation in follow through between instances in which a stop was hit and not preceded by a divergence or in cases in which a divergence did take place. Finally, no significant variations between markets, specifically in the cases of FOREX and agricultural products, were found.

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Software and Data

All code used in this study was programmed in-house by Kase and Company, Inc.
Data courtesy of www.GenesisFT.com
eSignal 8.0, eSignal, Hayward, CA
MS Office 2000 Standard Edition, Microsoft Corporation, Redmond, WA
TradeStation 2000i, TradeStation Securities, Inc., Plantation, FL