Proof That Technical Analysis Really Works

Of course technical analysis really works! But since the days of early chartists like Edwards and McGee, technicians have struggled to prove it directly – as demanded by sceptics – with hard mathematical evidence. This article, which focuses on the performance of momentum indicators, demonstrates that now, with the number crunching power that computerisation affords, all that has changed and the proof is in. By **CYNTHIA KASE**.

TESTING TECHNICAL INDICATORS the 'old fashioned way' most often meant embedding an indicator into a trading system and then showing empirically that the system worked. Momentum indicators have been even more difficult to test because the most widely used momentum signal – momentum divergence – is very tricky to properly programme.

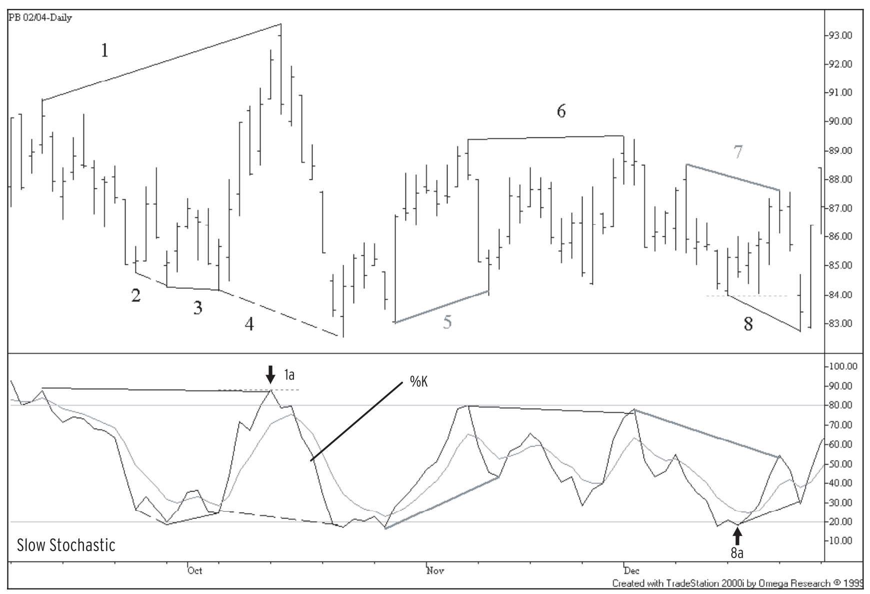
Now that dynamic linked libraries (DLLs) have become a common tool for interfacing with charting packages, it is possible to implement the complex algorithms necessary to accurately identify and plot divergence. This has made it possible to test momentum indicators on vast amounts of data through the use of fast processors, which perform millions of calculations per second. The research presented here focuses on the behaviour of five popular indicators; three traditional indicators, the Stochastic, RSI and MACD and two developed more recently, the Kase PeakOscillator (KPO) and KaseCD (KCD). For all of the indicators, we used the defaults found in both eSignal® and TradeStation® charting packages. Specifically, for both the Stochastic (for which we used the 'slow' form) and the RSI, a length of 14, which sets the number of bars, was used. For the MACD, the study used the 'histogram' form, and settings of 12 and 26 for the fast and slow moving averages, and nine for the moving average of the differential. (For more information on the indicators studied, as well as the Kase DevStops discussed further on, see the bibliography and suggestions for further reading at the end of this article).

> The key proviso in making comparisons is to compare highs in rising markets and lows in falling markets <

To conduct the study, we used life-of-contract daily charts on a wide range of futures contracts including coffee, corn, cotton, crude oil and natural gas, EuroYen, live and feeder cattle, gold, Libor 1 Month, the S&P 500 Index and 10 Yr Treasury notes – an average of 25 years of data per contract, or almost 75,000 days comprising 300 years of data in total. (See sidebar: Specifics on Data, and Figure 1).

In order to answer the question, "Does technical analysis really work?" as it pertains to momentum, let's begin by defining what the term "*really work*" means. For our purposes, we will define "*work*" in two ways. (Definition 1) *Work* means that after a momentum signal the market turns and hits stops, and; (Definition 2) *Work* means a momentum signal preceded the market turning enough to hit stops. Let's lay the groundwork for our study by defining the terms 'momentum signal' and 'the market turning enough to hit stops'.

Figure 2. Pork Bellies, PBG04 with Momentum Comparisons



Source: Kase & Company

Defining 'Momentum Signal'

The most common type of momentum signal is called 'momentum divergence' and usually means a higher or equal high in price and a lower or equal high in momentum, or vice versa for lows. The key proviso in making comparisons is to compare highs in rising markets and lows in falling markets. Momentum divergence is read the same way on all the indicators studied in our research. Figure 2 shows correct versus incorrect momentum divergence comparisons. In this figure, we examine a February 2004 Pork Belly chart with the Stochastic. The stochastic uses a line, shown in the figure in black, called the %K, to identify divergence.

The following list discusses the momentum comparisons with the corresponding number marked in Figure 2.

1. This correct signal shows a higher high in price and a lower high in momentum.
2. Here, as shown by the dashed line, two lows in price are properly compared with two lows in momentum, but because the second low in momentum is lower than the first, no divergence has taken place.
3. Again the solid black lines indicate correct divergence in that a lower low in price is matched with a higher low in momentum.
4. As shown by the dashed line, as in Figure 2. a correct comparison shows no divergence.
5. The incorrect signal indicated by the thick dark grey line shows that an error has been made in the comparison because the lows in price are rising, not falling.
6. These solid black lines indicate a correct divergence in that a higher high (however slight) matches a lower high in momentum.
7. The incorrect signal indicated by another thick dark grey line shows an error has been made in comparing falling highs.
8. The last comparison shown correctly identifies divergence with a lower low in price matched by a higher low in momentum.

Sidebar: Specifics on Data

The data that we used is detailed in Figure 1. The end date is approximately June 30th 2004. In addition to the daily data, excerpts of the data amounting to about 45,000 data points or about 5,000 weekly bars were used to confirm that the results are also valid for weekly data.

Figure 1. 300 Years of Data Used in Study

Symbol	Description	Exchange	Start Date	# Data Points	% Total
KC	Coffee	CSCE	08/17/73	7704	10
C	Corn	CBOT	03/28/68	9139	12
CT	Cotton	NYCE	08/22/72	7975	11
CL	Crude Oil	NYMEX	03/30/83	5325	7
JE	EuroYen	CME	02/12/92	3039	4
FC	Feeder Cattle	CME	06/03/76	7080	10
GC	Gold	NYMEX	12/31/74	7399	10
EM	Libor 1 Month	CME	04/05/90	3579	5
LC	Live Cattle	CME	08/29/69	8778	12
NG	Natural Gas	NYMEX	04/03/90	3557	5
SP	S&P 500 Index	CME	04/21/82	5598	7
TY	10 Yr Notes	CBOT	07/09/82	5534	7
Total				**74,707**	

Source: Kase & Company

Momentum Fine Points

Matching Peaks

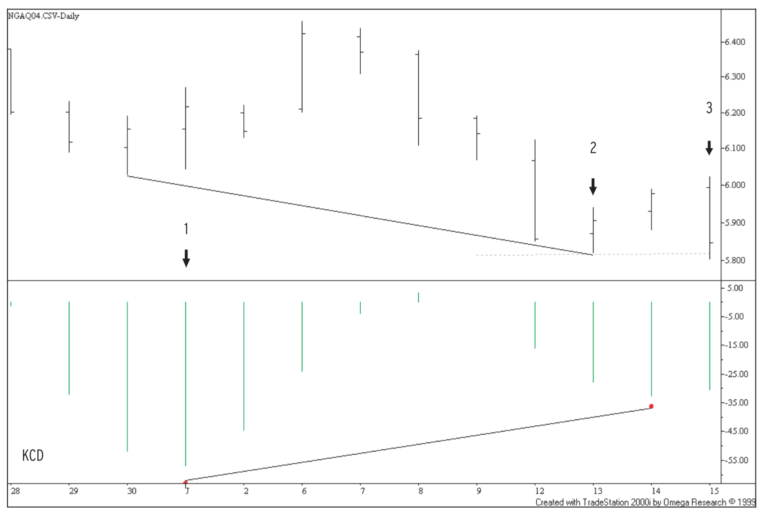
Some fine points involved in divergence identification are shown by the arrows '1a' and '8a' for the correct divergences '1' and '8' on Figure 2. Peaks in price and momentum don't always match up exactly, so it is a good idea to allow the peaks to be off by a couple of bars. In '1' a close look will reveal that the second peak on the momentum indicator came one bar before the peak on the price. In '8', where the arrow points to the first set of peaks, the opposite phenomenon took place with the peak on the momentum indicator coming one bar after the peak on price. In each of these cases the peaks are only off by one bar, so the divergences are valid. However, if they had been off by four or five bars, the divergences wouldn't count. After some testing it was determined that a tolerance of three bars seems to be the best compromise, and this was the setting used for this study.

Null Divergence

Whenever the peaks don't line up exactly there is a risk of the divergence being nullified before completion. Looking at arrow '1a' again on Figure 2, we have seen that the peak on momentum came one bar early, thus while the price was in the process of forming its peak one bar later, the momentum indicator could have turned back up and risen above its previous high, which is marked by the horizontal dotted grey line. If that had happened, the divergence would have been invalid or 'null'. The same principal is true in reverse for arrow '8a'. In this case the price peaked one bar early. So, as the momentum peak was forming it could have been invalidated by the price falling below the dotted grey line as shown.

Now let's look at Figure 3. which shows an actual example of null divergence. As noted by the first arrow '1', on July 1st 2004 the first valid momentum low peak was one bar after the price low peak and formed a valid price/momentum pair. On July 13th a valid price low took place, arrow '2', followed by a low in momentum the following day. There must always be a bar following a low or high to show that it was actually a peak (as opposed to a new low or high following the bar tentatively thought to be a peak). Thus, on July 15th as the momentum turned higher, which confirmed the low peak in momentum, prices make a new low, arrow '3', invalidating the previous price low and nullifying a divergence which would tentatively have been drawn to the July 13th price and July 14th momentum lows.

Figure 3. Natural Gas, NGQ04 Example of Null Divergence



Source: Kase & Company

Sidebar: TrueRangeDouble and DevStop Calculations

1. True range is very similar to the high-low range of a bar, except that it considers gaps, so
2. TrueRange =@max (H, C[1]) - @min(L, C[1]), so the range of a pair of bars is
3. TRD (TrueRangeDouble) = @max (H, H[1], C[2]) - @min(L, L[1], C[2])
4. Reversals included in stop magnitudes relating to TRD as follows
   a. Rev1 = one standard deviation over average TRD
   b. Rev3 = 3.6 standard deviations over average TRD
5. DevStop price level calculated by
   a. Deducting applicable Rev from high if up market
   b. Adding applicable Rev to low if down market

Source: Kase & Company

Filtering the Momentum Peaks

Some momentum indicators such as the MACD, KPO, and KCD can generate a series of very small peaks that are only minutely different from the surrounding data. So, traders may wish to filter out peaks that are very close to the zero line in the case of the MACD and KCD and which appear to be very similar to the surrounding data on the KPO. Based on some optimisation testing, for purposes of this study a 1% filter for peaks was used on the MACD and a 2% filter on the KPO and KCD, where the actual peak point has at least an x% difference versus the surrounding data. No filters were needed on the Stochastic or RSI.

Difference Between Peaks

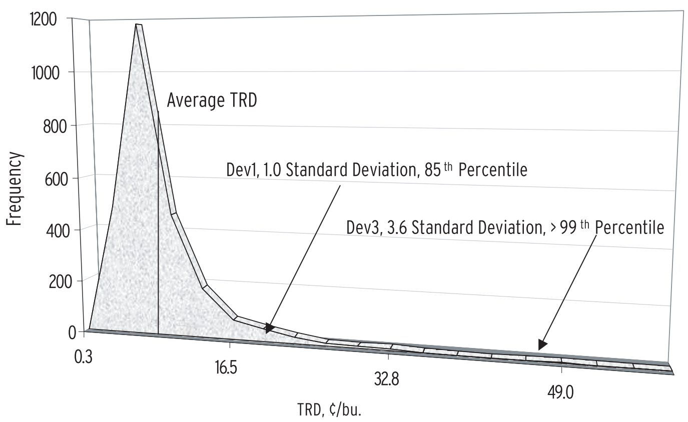
When programming divergence, the maximum allowable number of bars between peaks must be defined, otherwise the program theoretically could look at an infinite number of bars between peaks. After testing numbers between 65 and 100, a range of 89 bars was chosen.

Overbought/Oversold

In addition to divergence signals, it is possible to use ‘overbought/oversold’ signals for all but the MACD. For the Stochastic and RSI, however, the market can be in overbought or oversold territory, typically above 80% or below 20%, for long periods of time. So only such signals for the KPO and KCD, which have much more discrete overbought/oversold signals, were employed.

Figure 4. Corn Distribution of TrueRange Double

10 Years of data to June 2004



Source: Kase & Company

Defining ‘The Market Turning Enough to Hit Stops’

A market turn is a move against the prevailing market direction, which is of a large enough magnitude to hit stops. For our purposes we will employ the stop levels intrinsic to the Kase DevStop. This indicator defines the prevailing market trend using a 10 and 21 period simple moving average such that if the fast moving average is above the slow it assumes the market has been going up, and vice versa. The magnitude of the DevStops is defined by using standard deviations of the TrueRange of two bar sets, called the TrueRange Double (TRD). (See bibliography and suggestions for further reading for more information on the DevStop and True Range.) The DevStops employ four standard stop levels, the warning line, Dev1, Dev2 and Dev3, which evaluate excursions against the trend of the mean TRD and are defined as 1, 2.2 and 3.6 standard deviations over the mean. The 2.2 level adds 10% to the two standard deviation point and the 3.6 level adds 20% to the three standard deviation point to account for skew. In this study, we will focus primarily on Dev1 and Dev3 at roughly the 85th and 99th percentile positions. Figure 4. shows a phenomenon common to all instruments. Range, which is proportional to volatility, is skewed to the right. This means that the size of the bars above the mean is larger than would be predicted by a normal distribution, necessitating the correction for skew.

Momentum Indicators Work (Definition 1)

“After a momentum signal the market turns and hits stops.”

Figure 5. shows a detail of the divergences that we labelled ‘1’ and ‘3’ in Figure 1., as well as a ‘mini divergence’ (a term used when two smaller momentum peaks take place within a larger peak formation) labelled ‘i’ that took place prior to the date range in the earlier chart, Figure 2. The stops are shown with the Dev1 in grey and Dev3 in black. (The dashed line is the average or mean TRD stop, usually called ‘the warning line’ and the small grey dot is Dev2 not discussed in detail in this analysis.) The stops ‘flip’ as the moving averages used to define up and down markets cross.

It is easy to see that in all three divergences shown, not only the first stop, Dev1, was broken, but also the third stop, Dev3, as indicated by the ovals around the bar breaking that stop. In two cases, divergences ‘1’ and ‘3’, the market closed beyond Dev3. The example in Figure 5. is indicative of the behaviour of all of the five momentum indicators we studied. Figure 6. shows the percentage of the time a certain stop was hit following a signal. The Dev1 column shows the percent of the time Dev1 was hit. Dev3, inclusive of Dev1 and Dev2, shows how often Dev3 was hit, and ‘Close’ shows how often there was a close beyond Dev3. The program stopped counting on a close beyond Dev3, a break of the price peak that took place upon the divergence, or when the internal DevStop moving averages flipped.

From Figure 6. we conclude that there is a small, but statistically significant advantage in using the KPO or KCD versus the traditional indicators.

Figure 6. Stops Hit After Signal

Indicator	Dev1	Dev3	Close>>
RSI	70	27	18
MACD	74	31	22
Stochastic	68	27	18
Average Traditional	70.7	28.3	19.3
KPO	76	35	25
KCD	76	35	25

Source: Kase & Company

The best of the traditional indicators, the MACD, averaged over three percentage points worse than either the KPO or KCD, and the average performance of the traditional indicators was 6 percentage points worse.

Momentum Indicators Work (Definition 2)

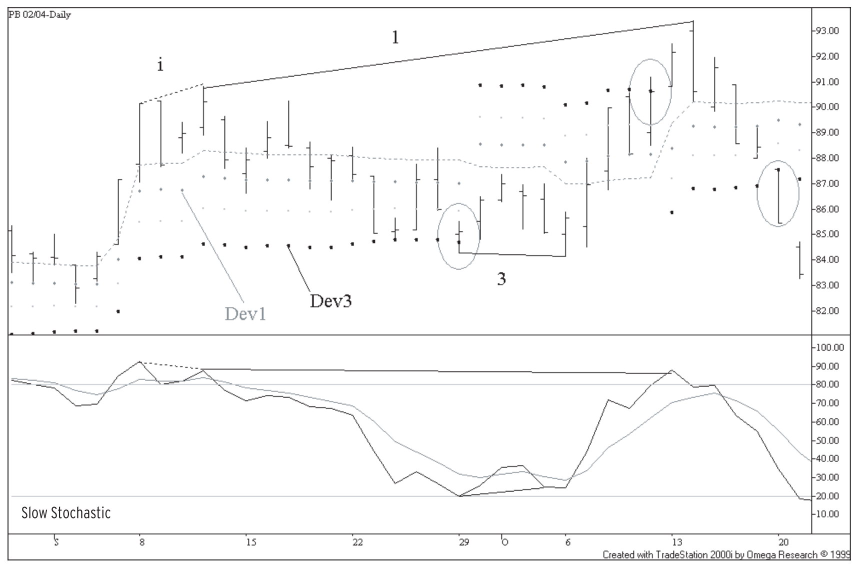
"A momentum signal preceded the market turning enough to hit stop."

Rather than looking forward to see what happens after a signal is generated, stops can be evaluated to find out if there was a warning ahead of time in the form of a momentum divergence signal or setup.

The fact is that, although momentum indicators average over a 70% success rate in hitting Dev1, Dev1 may often be hit without a prior signal having been generated. Sometimes a signal is generated before a turn, and sometimes not. When a momentum signal fails to take place before a turn, trades may be stopped out without warning. To illustrate the point, let's look at Figure 7. This chart shows the June 2004 S&P 500 Index with the MACD and KCD in the top and bottom sub-graphs respectively.

1. The first momentum divergence comparison shows a 'miss' or failure to generate any signal at all on the MACD, and a completed, standard bullish divergence on the KCD.

Figure 5. Pork Bellies, PBG04 with Momentum Divergence & DevStops



Source: Kase & Company

2. The second valid momentum comparison was non-divergent on both indicators, showing that with this combination of indicators, the turn would have been missed.
3. The final valid momentum comparison shows that the MACD was non-divergent and if used alone would have missed the turn, while the KCD generated a classic bearish divergence.

So while momentum indicators that generate signals have good follow though, they may not be as reliable as warnings that turns may be immanent. Figure 8. summarises this study's findings and shows how the indicators really work. For our purposes, indicators in combinations of two and three were evaluated. Performance was analysed in two ways. First performance was analysed based on the raw improvement in percentage points, for example 75% is 25 points better than 50%. The second way was to look at the improvement by percent. In the prior example, a 25 point improvement relative to 50% is an improvement of 25/50, or 50%.

1. The first set of pairs of traditional indicator results indicate that on average the traditional indicator pairs give a warning that stops will be hit less than 50% of the time, averaging 46% overall.

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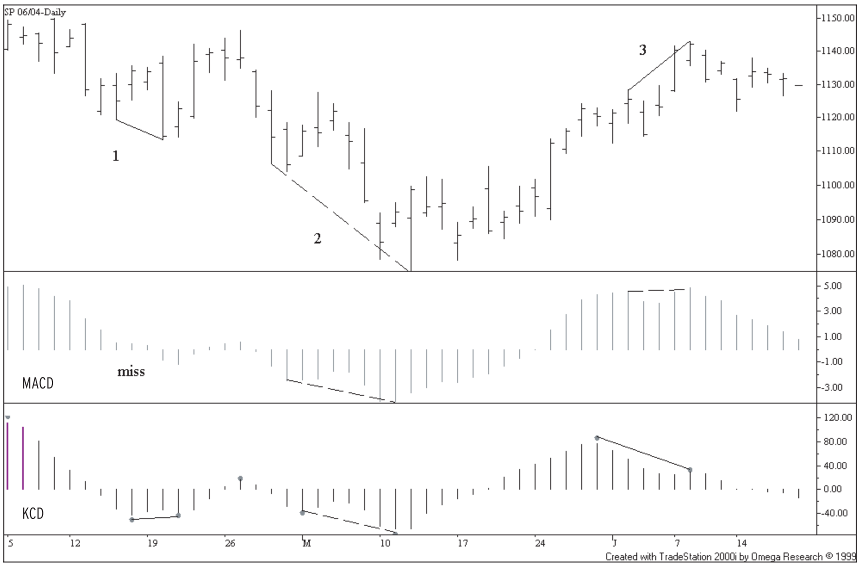
2. The second group, which pairs the two Kase indicators, shows a marked improvement with an average of 75% of the turns predicted. It is also interesting to see that the performance improves as the size of the turn increases, rising from 74% at Dev1 to 80% for closes beyond Dev3.

Comparing the Kase indicators against the best pair of traditional indicators, the RSI and Stochastic, performance improved by ***27 points or over 55%***.

3. When three traditional indicators are used there is very little improvement gained versus using only two. The improvement averages ***six points*** for a 13% increase in efficacy. Thus, the gain realised by using the KPO and KCD is twice that realised by using a combination of three indicators, which takes a lot more mental energy.
4. In a similar manner, the addition of the Stochastic to the KPO/KCD indicator pair results in little gain, as the original pair already works very well. Adding a third indicator only improves performance by ***seven*** points, or ***9%***. However, this combination is a full ***28 points or 53%*** better than the combination of the three traditional indicators.
5. Finally using all five indicators yields the largest improvement of ***33 points***

or over 60% relative to using two or three traditional indicators. Relative to the KPO and KCD indicators though, only marginal gains of nine points or 12% were achieved.

Figure 7. June 2004 S&P 500 Index with Market Turn



Source: Kase & Company

Conclusion: Momentum Indicators Do Work

Our study has proven that the momentum indicators we have evaluated really do 'work'. The study leads to the conclusion that traditional indicators work well in one direction only while the more recently developed Kase indicators work well in both. In other words, when the traditional indicators 'work' they work very well, but they often don't work at all, while the Kase indicators 'work' very well and work well most of the time. Performance across all the indicators studied work about the same when it comes to predicting that a turn will take place. Follow through on the traditional indicators was about 71% for smaller market reversals and 28% for larger ones, versus a superior 76% and 35% for the Kase indicators. Using more rigorous mathematical indicators like the KPO and KCD does yield a modest statistically significant advantage, with a 33% difference in improvement versus traditional indicators.

It is obvious though that the real difference comes when performance is viewed looking back from the stops. Using different pairs of indicators, the study found that any given pair of traditional indicators works less than half the time (46%) when it comes to warning of a market turn. The KPO and KCD indicators, however, work very well in both directions, catching 75% of the turns ahead of time.

The data in this study shows what to expect following momentum divergence signals, when to look for market turns, and conclusively proves that technical analysis, in the form of momentum indicators, does indeed work ■

Figure 8. Momentum Warnings vs Stops

Indicator Combination	Dev1	Dev3	Close	Avg
i.				
RSI and Stochastic	50	43	45	48
MACD and Stochastic	47	40	43	44
MACD and RSI	49	42	44	46
ii.				
KPO and KCD	74	74	80	75
RSI and Stochastic, ***points***	25	34	36	30
RSI and Stochastic, ***percent***	50	79	80	63
iii.				
MACD, RSI and Stochastic	**57**	**49**	**52**	**54**
RSI and Stochastic, ***points***	6	6	7	6
RSI and Stochastic, ***percent***	12	14	15	13
iv.				
KPO, KCD and Stochastic	**81**	**79**	**86**	**82**
points				
RSI and Stochastic	31	37	40	34
MACD, RSI and Stochastic	24	30	33	28
KPO, KCD	5	3	4	5
percent				
SI and Stochastic	61	85	89	73
MACD, RSI and Stochastic	43	62	64	53
KPO, KCD	7	4	5	6
v.				
All Indicators Combined	**86**	**83**	**90**	**86**
points				
RSI and Stochastic	35	41	44	39
MACD, RSI and Stochastic	29	34	37	32
KPO, KCD	10	7	8	9
KPO, KCD and Stochastic	5	4	4	4
percent				
RSI and Stochastic	41	49	49	45
MACD, RSI and Stochastic	34	41	42	38
KPO, KCD	12	8	9	10
KPO, KCD and Stochastic	6	5	5	5

Source: Kase & Company

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CYNTHIA KASE is President of Kase and Company, Inc.
www.kaseco.com