Time Cycle Oscillators

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Abstract

In the field of technical analysis, time cycles are used to identify price turning points. The lows are normally used to define the cycle periods—which are uniform—to anticipate the lows for future time intervals. Therefore, some discrepancies such as inversions and phase shift occur due to the non-uniform price movement. In this article, new time cycle oscillators are introduced to technical analysis. The role of the oscillators is to measure the irregular cycle periods. Besides, mathematical steps are taken to prove that cycle periods precede volumes. Several systems in nature exhibit periodic motion with different types of oscillations. In this article, a scientific approach is introduced to measure the periods of cycles. Time cycle oscillators pave the way to analyze the market weaknesses and strengths from a time perspective.

Introduction

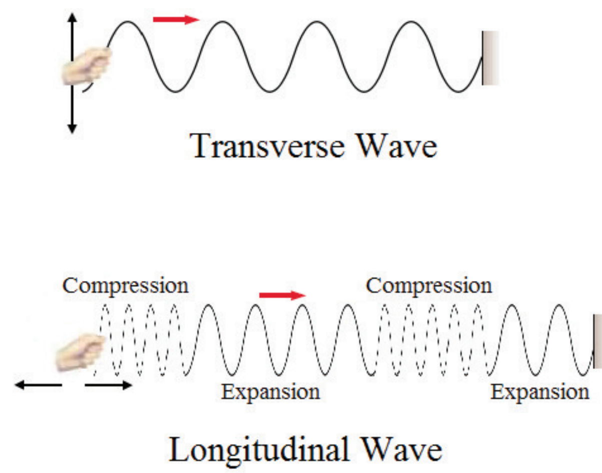
Cycle Discrepancy

We find oscillatory motions in several systems in nature. For example, "the molecules in a solid oscillate about their equilibrium positions; electromagnetic waves, such as light waves, radar, and radio waves, are characterized by oscillating electric and magnetic field vectors" (Serway and Jewett, p. 453). Since the cyclic movement of price is non-uniform, a discrepancy in uniform measurements appears like cycle inversions, which are very difficult to be observed. An inversion is when a cycle low is expected to occur but a peak is formed instead. Another aspect is the phase shift when cycles frequently change their periods. The aim of this article is to approach an alternative method and to measure the irregular period of cycles through new leading oscillators: wave period oscillator, simple harmonic index, and simple harmonic oscillator. In addition to time cycle oscillators, a new method is proposed to lead prices and oscillators by phase.

Properties of Waves

There are two types of waves in nature: transverse and longitudinal. A transverse wave is a traveling wave that causes the elements of the disturbed medium to move perpendicular to the direction of propagation. A longitudinal wave is a traveling wave that causes the elements of the medium to move parallel to the direction of propagation.

Figure 1. Transverse and Longitudinal Waves

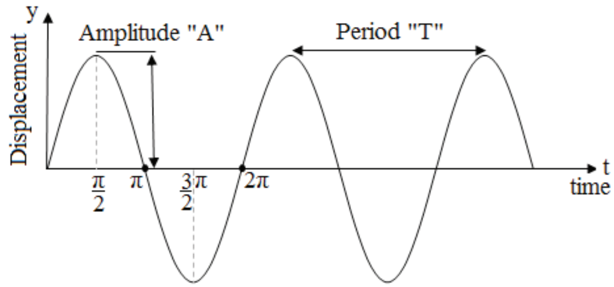


In Figure 1, the wave runs in series of compressions and rarefactions (expansions). A compression is a region in a longitudinal wave where the particles forming the wave are closest together. A rarefaction is a region in a longitudinal wave where the particles are furthest apart.

Figure 2. S&P 500—Weekly Values

In Figure 2, during the periods of 2007–2008 and Q4 2014–2016, the S&P 500 cycles are compressed as the index moves sideways. The distance between the lows decreases. During the period of 2008–Q4 2014, the cycles are expanded as the index moves in trend. The distance between the lows increases, while the trend is running with more power.

Figure 3. Displacement versus time for simple harmonic motion



A simple harmonic wave or ideal wave of price has a relation between price displacement from equilibrium and time. This relation is expressed by:

$$y = A \sin(\omega t + \varphi)$$

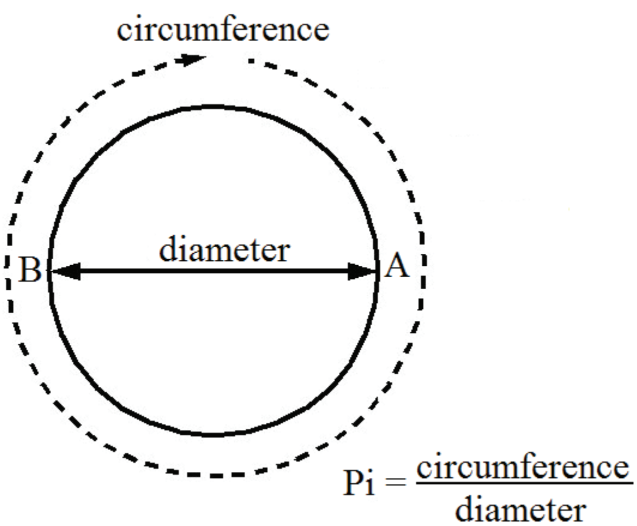
Where the amplitude *A* is the maximum displacement of the price from its equilibrium. The angular frequency ω is the number of cycles per unit time. The quantity (ωt + φ) is called the phase of the motion while the phase constant φ, is the difference between two successive waves. In this article, φ is equal to zero, assuming that any cycle starts from its reference point with no phase shift. So, (ωt + φ) will be expressed by θ. Hence,

$$y = A \sin(\omega t) \quad \text{Or} \quad y = A \sin\theta$$

$$\omega = 2\pi f$$

Where the frequency *f* is the number of cycles per unit time. Pi π is a mathematical constant approximated to 3.14 and is defined by the ratio of a circle's circumference to its diameter. A body in motion completes half cycle when it moves on the circumference from point A to B. π is equivalent to a half cycle while 2π or 6.28 is equivalent to one complete cycle (360 degree).

Figure 4. Definition of the mathematical constant (Pi)



The period *T* of a wave is the time interval required to form two identical points such as the peaks of adjacent waves. The period is the inverse frequency of a wave, hence,

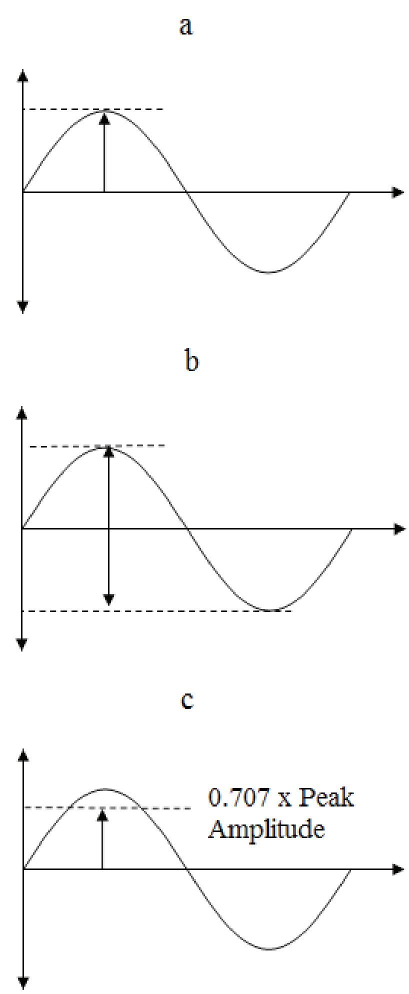
$$T = \frac{1}{f}$$

Where its unit is time (number of price bars) per one cycle. Eventually, we can rewrite the first equation as the following,

$$y = A \sin\left(\frac{2\pi}{T} t + \varphi\right)$$

Although the previous equation yields one result for the wave amplitude, we may represent the amplitude by three different means as shown in Figure 5. The most widely used is the peak amplitude representation especially in astronomical measurements of nearby stars, audio system measurements, and telecommunications. The peak-to-peak amplitude of electric oscillations is a direct measurement of oscilloscope devices. This representation was previously proposed by James Hurst. The root mean square amplitude is used in electrical engineering. In this article, we will use the peak amplitude representation.

Figure 5. (a) Peak amplitude (b) Peak-to-peak amplitude (c) Root mean square amplitude



The Phase Lead

Measuring the change in price *(Today's close – Yesterday's close)* is one way to construct a leading oscillator to price. Another method is to calculate the inverse price *(1/Close)* or divide the price by another variable *(Close/High)*. As shown in Figures 6 and 7, the oscillator is leading the price by phase.

Table 1. Price versus inverse price

Day	Price	Inverse Price
1	2.00	0.50
2	2.50	0.40
3	3.00	0.33
4	2.50	0.40
5	2.00	0.50
6	1.50	0.67
7	1.00	1.00
8	1.50	0.67
9	2.00	0.50
10	2.50	0.40
11	3.00	0.33

Figure 6. Price versus inverse price

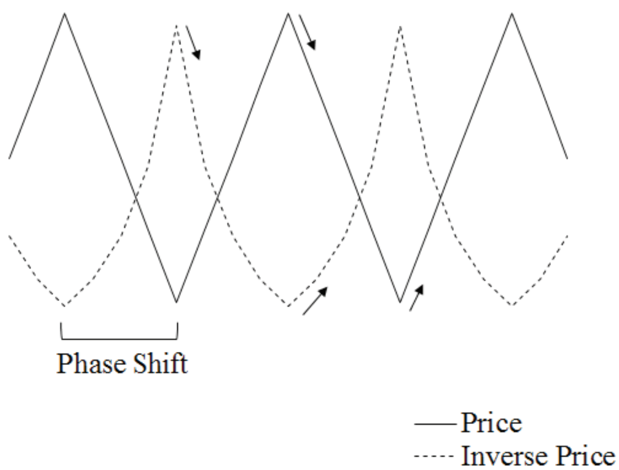
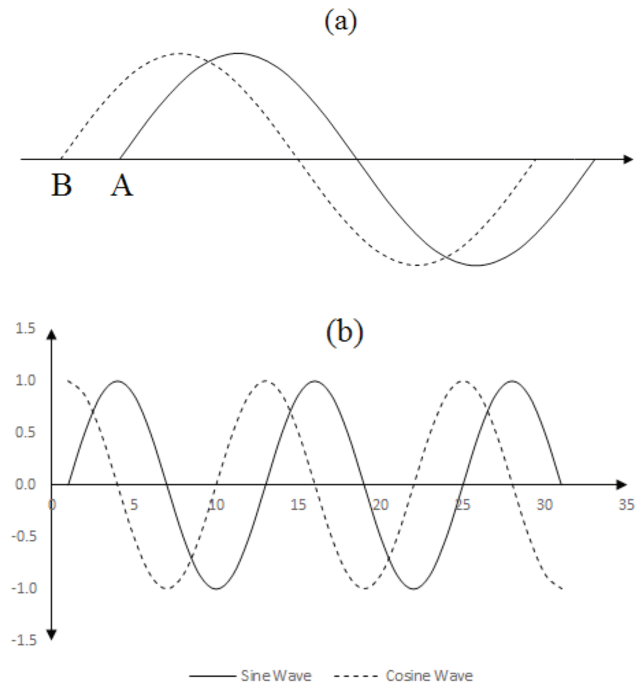


Figure 7. (a) Phase shift between two cycles (b) Sine versus cosine waves



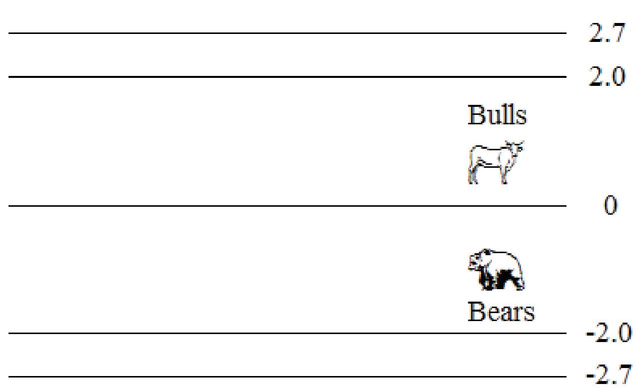
In Figure 6, the inverse prices lead prices by phase. In Figure 7, wave B is ahead of A. In other terms, B leads A. Another method of "phase lead" is by using the sine and cosine functions. For example, if the closing price is x, then cos(x) is leading to sin(x). The phase lead concept allows researchers to create leading oscillators without increasing the number of whipsaws occurring on the equilibrium lines.

Wave Period Oscillator (WPO)

Description

The WPO is a short-term oscillator that measures the buying and selling period of price cycles over a certain time interval. The leading oscillator indicates a rise in buying period when it moves above the zero line and a rise in selling period when it moves below the zero line.

Figure 8. The main boundaries of the WPO



Calculation

$$y = A \sin\left(\frac{2\pi}{T} t\right)$$

The value of time t is the number of days on the chart. For example, t is equal to 1 for the first day and 2 for the second day, etc. In this article, the value of t will be equal to 1 since the aim is to calculate T for each day separately. Therefore,

$$y = A \sin\left(\frac{2\pi}{T}\right) \text{ Or } y = A \sin\theta$$

Below is an explanation to the above formula in depth:

- The displacement y is the closing price of today.
- The amplitude can be represented by the high of today or the maximum price within n days ago. A = H or A = Max (C, 3).
- The inverse of the sine function *arcsin* is used to calculate the angle θ in degree.

$$\theta = \arcsin\left(\frac{y}{A}\right)$$

- The aim is to find the wave period which is expressed in decimals. Therefore, θ is converted from degree to radian θ^{rad}.

$$\theta^{rad} = \theta \cdot \frac{\pi}{180^{\circ}}$$

- One-day period T is equal to $2\pi/\theta^{rad}$ or $6.28/\theta^{rad}$.
- When today's price is greater than yesterday's price, the value of T is given a positive sign. If the price is less than yesterday's price, then the value of T is given a negative sign.
- WPO = EMA (T, 14). An exponential moving average is for ±T smoothing while the default parameter of the WPO is 14. However, it can be adjusted for sensitivity or for different timeframes.

Table 2. Data sample for the calculation of one-day period

Day	Closing Price	Amplitude	Sin Angle Sin θr	Angle in Radians θr	Period ±T
t	C	A = High	C/A	arcsin . (sin θr)	6.28t/ θr
1	43.07	43.83	0.983	1.38	4.54
2	43.44	43.9	0.990	1.43	4.40
3	43.54	44.05	0.988	1.42	4.43
4	41.97	43.54	0.964	1.30	-4.83
5	41.99	43.11	0.974	1.34	4.68
6	41.81	42.43	0.985	1.40	-4.49
7	41.22	42.31	0.974	1.34	-4.67
8	41.55	42.01	0.989	1.42	4.41
9	40.98	42.09	0.974	1.34	-4.68
10	41.59	41.75	0.996	1.48	4.23

Longitudinal Waves Setup

The longitudinal price waves, as mentioned before, have successive areas of compressions and expansions during sideways and rallies, respectively. To identify the irregular cycle lines, we shall use the WPO crossovers. First, we add an oversold and overbought levels at periods -2 and +2. The WPO line completes half cycle when it moves from equilibrium to overbought level as the one-day period T is equal to $2\pi/\theta^{rad}$, where θ^{rad} is equal to (180° or π). Therefore, the overbought level has a value of 2 and the oversold level has a value of -2. To trace an extreme overbought level,

- We calculate the difference between the period of half cycle and three-quarters cycle.
- At half cycle T = 2; and at three-quarters cycle T = 1.33.
- Therefore, the difference in periods is equal to 0.66 (2-1.33), which is approximated to 0.7.
- By adding the difference to the half cycle period (+2/-2), the extreme (overbought/oversold) levels will be at (+2.7/-2.7).

When the WPO crosses its extreme levels, this indicates extreme optimism and pessimism. Reaching the extreme levels after price rally shows that prices have attained their maximum momentum and the trend is most likely to be changed.

In Figure 9, the extreme level -2.7 crossover refers to the cycle lows. From mid-June to November 10, the distance between extreme periods of WPO is being contracted. Hence, prices move sideways after November 10. The following cycle lines expand January 17. Afterward, prices move in trend. When the oversold level -2 is used instead of the extreme level, more crossovers and cycle lines are generated. Multiple and near cycle lines like the circled ones in Figure 10 can be considered as a single line. The longitudinal waves setup helps in determining how prices act in the following phase. In case of trending moves, a buy and hold strategy might be favorable. On the other hand, trading a range is used during sideways where cycle lines are compressed.

Figure 9. Egyptian Stock Exchange—Daily Values of Global Telecom (GTHE.CA)

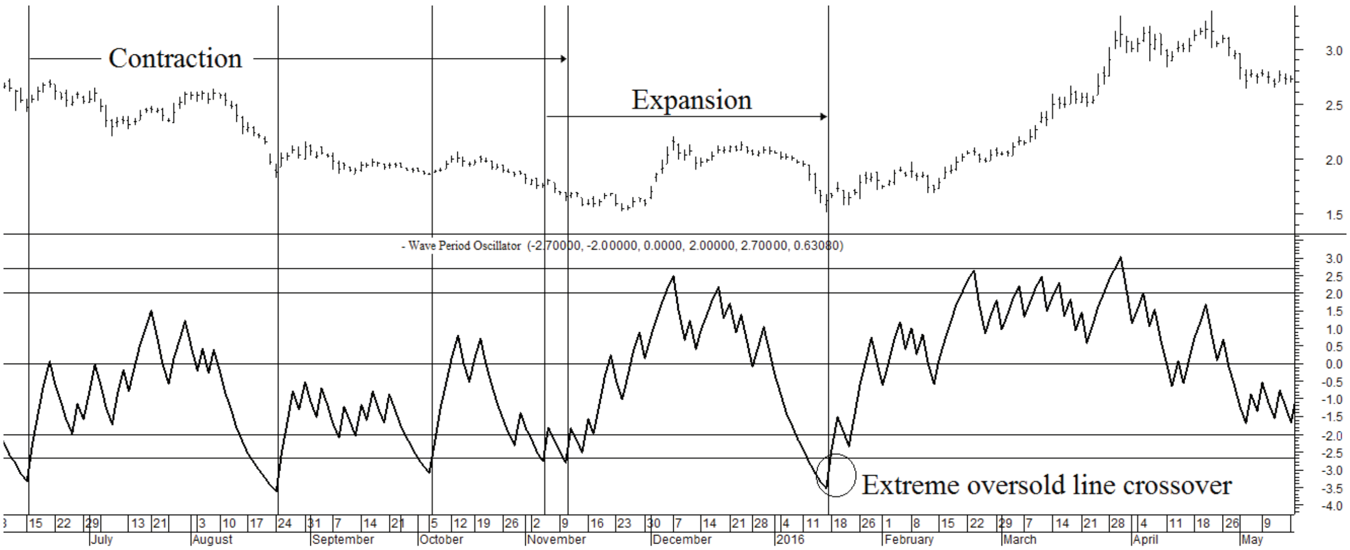
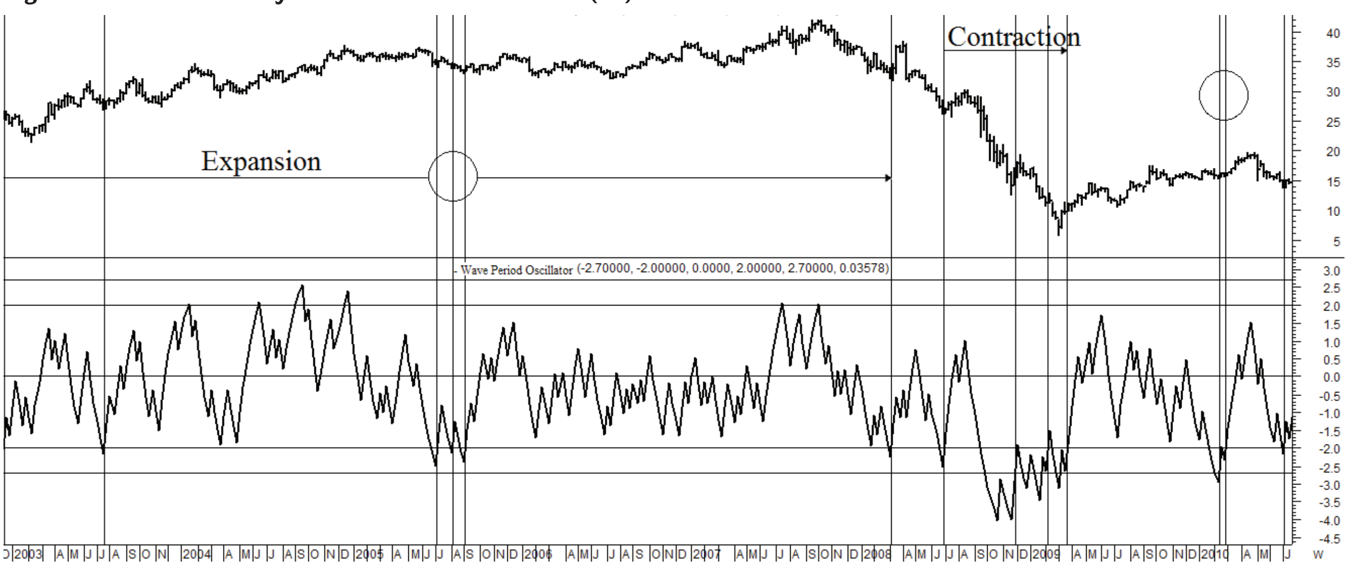


Figure 10. NYSE—Weekly Values of General Electric (GE)



Trading Tactics

Centerline Crossover: As shown in Figure 11, a bullish centerline crossover occurs when the WPO line moves above the zero level to turn positive. A bearish centerline crossover occurs when the WPO line moves below the zero level to turn negative. When bulls are in control, the price rally begins and the average of the bull's period T increases to drive the WPO line above the centerline. A buy signal is subsequently triggered. When the bulls start to loose power, prices move sideway and the average period decreases. In this case, the WPO line may flutter near the centerline and cause false signals, whipsaws. To avoid the whipsaws occuring on the centerline, the following trading tactics are proposed.

Figure 11. Signals of the WPO line

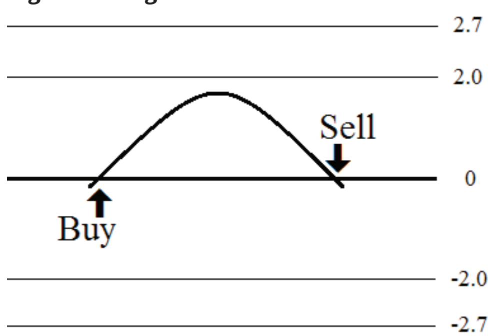
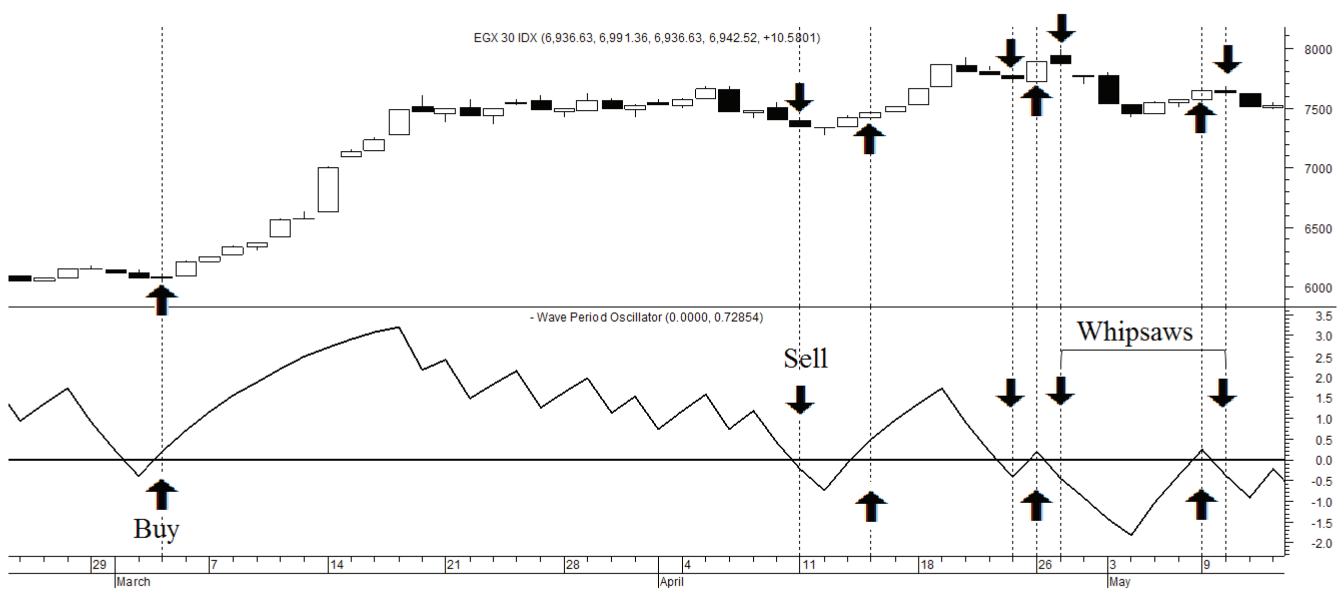


Figure 12. Egyptian Stock Exchange—Daily Values of EGX30 index (.EGX30)



Uptrend Tactic: During an ideal uptrend, the WPO does not reach the lower boundary -2 and usually rebounds from a higher level than -2. This means that the bulls have taken control earlier. Hence, a zero line crossover generates a buy signal. The WPO crosses the upper boundary at +2 then pulls back again below +2 to generate a sell signal, as shown in Figure 13.

Figure 13. Buy and sell signals during uptrend

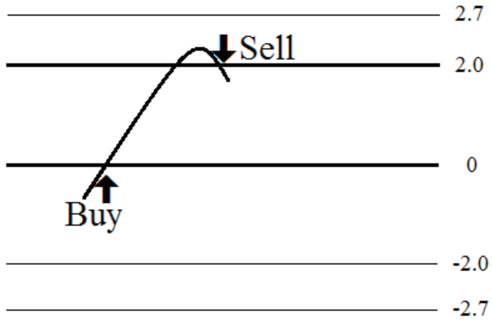
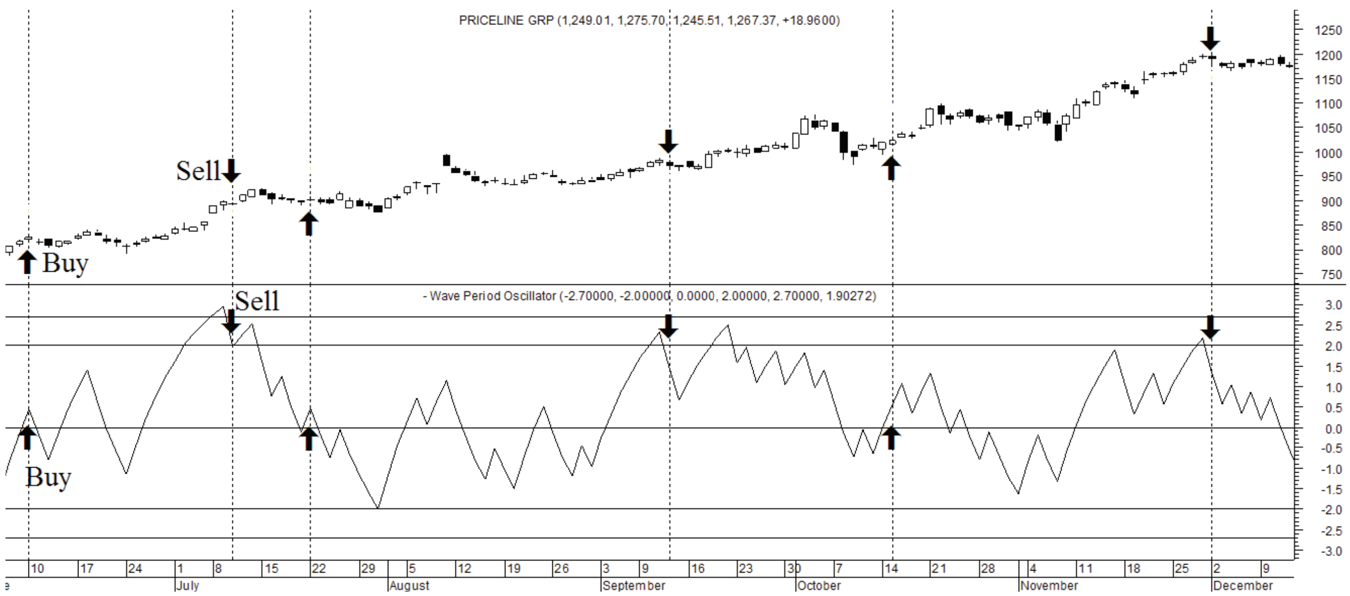


Figure 14. NYSE—Daily Values of Priceline Group (PCLN.O)



Sideways Tactic: During sideways, the WPO fluctuates between the lower and upper boundaries -2 and 2. This tactic is also used in an uptrend where corrections are strong enough to drive the WPO line below the lower boundary.

Figure 15. WPO signals during sideways

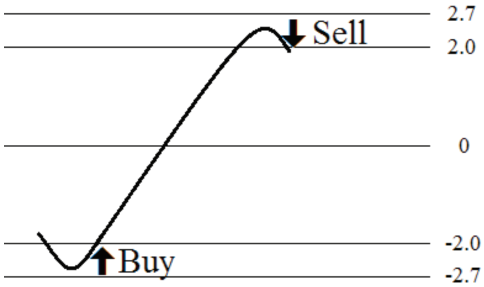
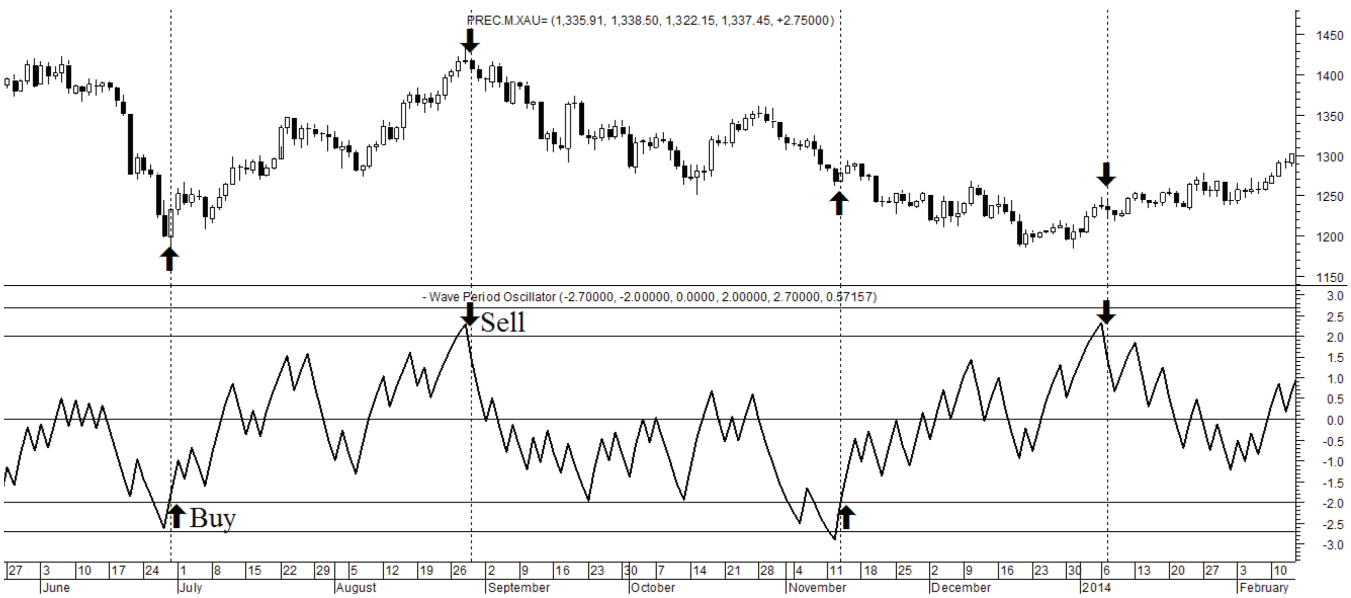


Figure 16. Daily values of Gold (XAU=)



Downtrend Tactic: During downtrends, the WPO fails to reach the upper boundary and oscillates between the 0 and -2 levels. The bears enter early indicating an obvious weakness in the market. Therefore, crossing the zero level generates a sell signal. Figures 17 and 18 demonstrate the WPO behavior during downtrends.

Figure 17. WPO signals during downtrends

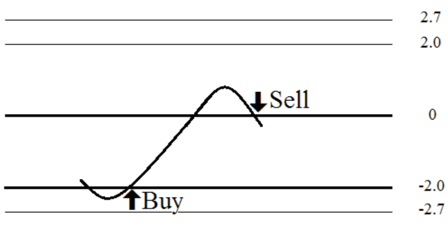
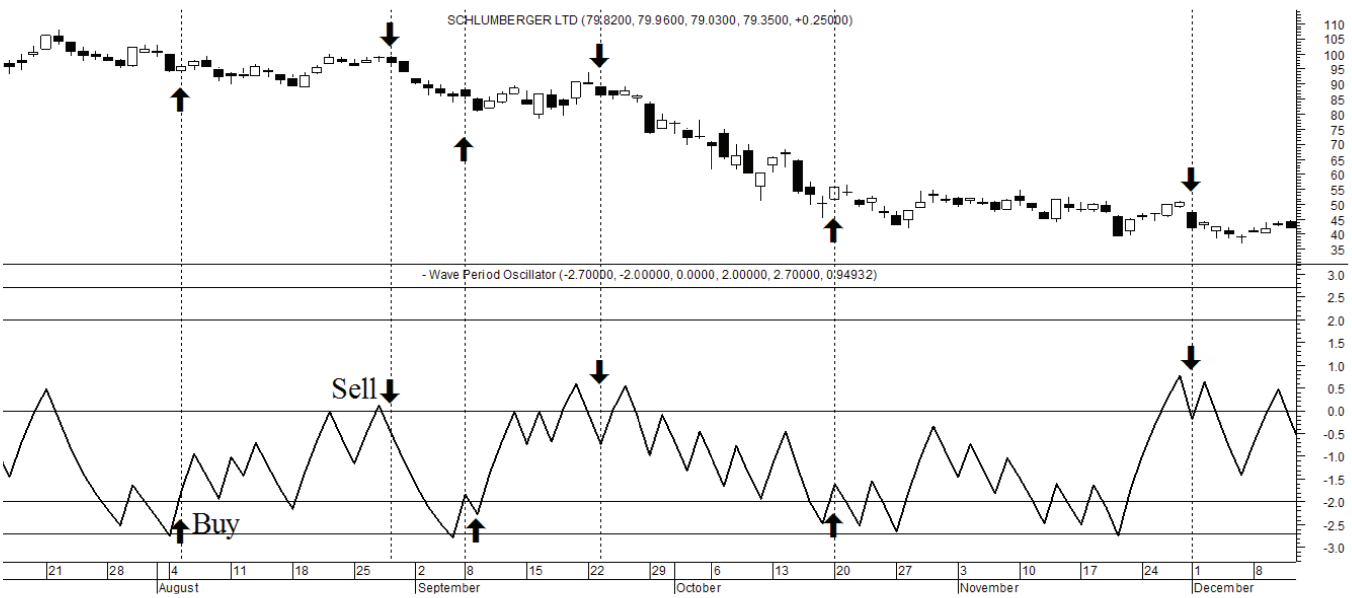


Figure 18. NYSE—Daily Values of Schlumberger Ltd (SLB)



Exit at Weakness: During uptrend reversals and downtrends, the WPO oscillates between the centerline and the lower boundary -2. The bears are controlling the market and move in wide cycle periods while the bull's strength is almost absent. An exit signal is triggered once the WPO crosses -2. When prices decline, the WPO may cross its extreme lower boundary at -2.7, as demonstrated in Figure 19. Therefore, a swift exit signal is triggered once the WPO crosses -2.

Figure 19. Buy and sell signals during uptrend reversal and downtrend

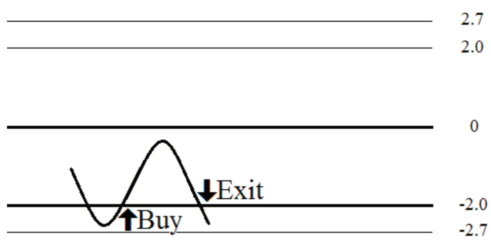
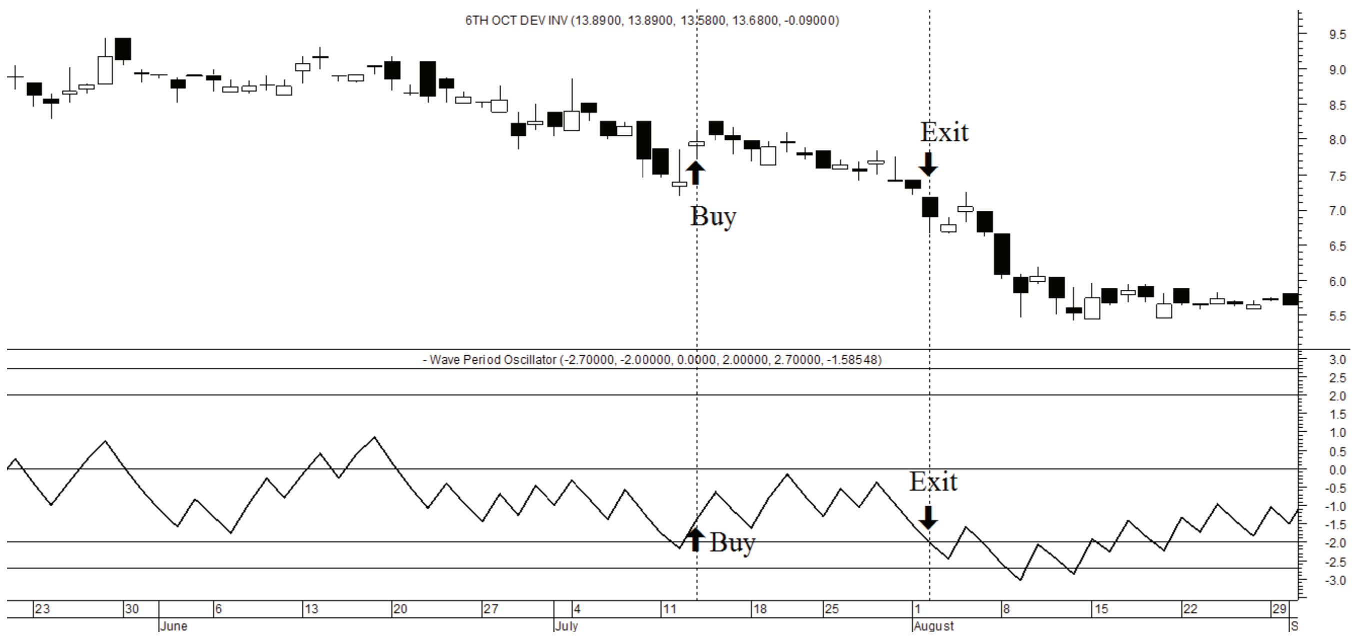


Figure 20. Egyptian Stock Exchange—Daily Values of Six October Development (OCDI.CA)



Re-Entry: During uptrend, the WPO crosses down the upper boundary level at +2 to generate a sell signal. Yet, it does not reach the zero line and the oscillator moves back toward the upper boundary. This case is considered as strength while a re-entry signal occurs at the +2 level crossover. In Figure 21, the WPO is pulled back to the upper boundary +2 referring to high strength in the market. The sell signal is generated when the WPO line crosses down the upper boundary. Figure 22 demonstrates an example for re-entry signals.

Figure 21. Re-entry signals

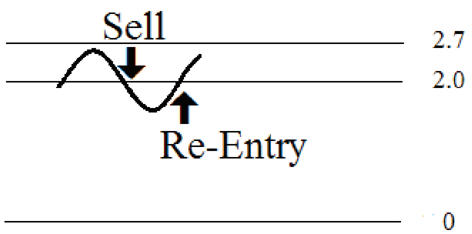
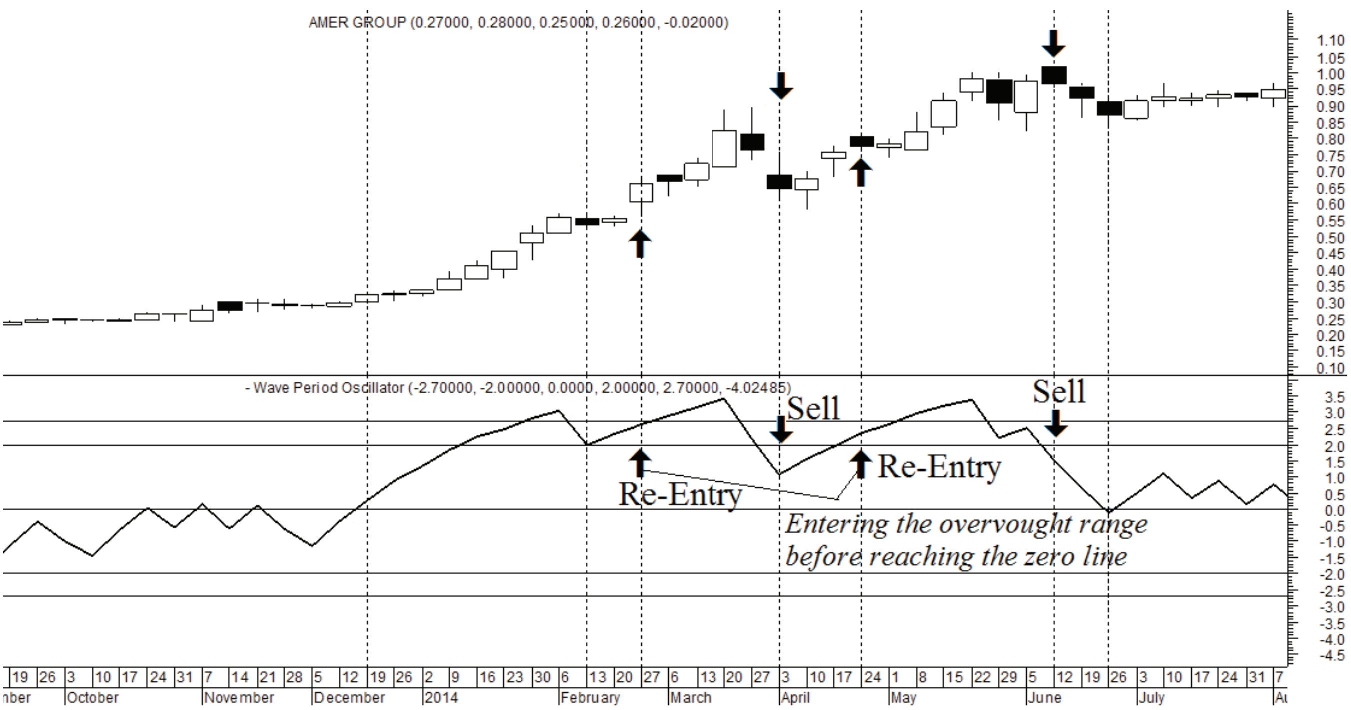


Figure 22. Egyptian Stock Exchange—Weekly Values of Amer Group (AMER.CA)



Divergences

Divergence refers to a situation where technical indicators fail to confirm the price movement. A negative divergence occurs when prices rise and the WPO declines. Conversely, a positive divergence occurs when prices decline and the WPO rises. The high sensitivity of the oscillator increases the odds to have several divergences. Figures 23 and 24 demonstrate examples of divergences.

Figure 23. NYSE—Weekly Values of Dow Jones Industrial Average (.DJI)

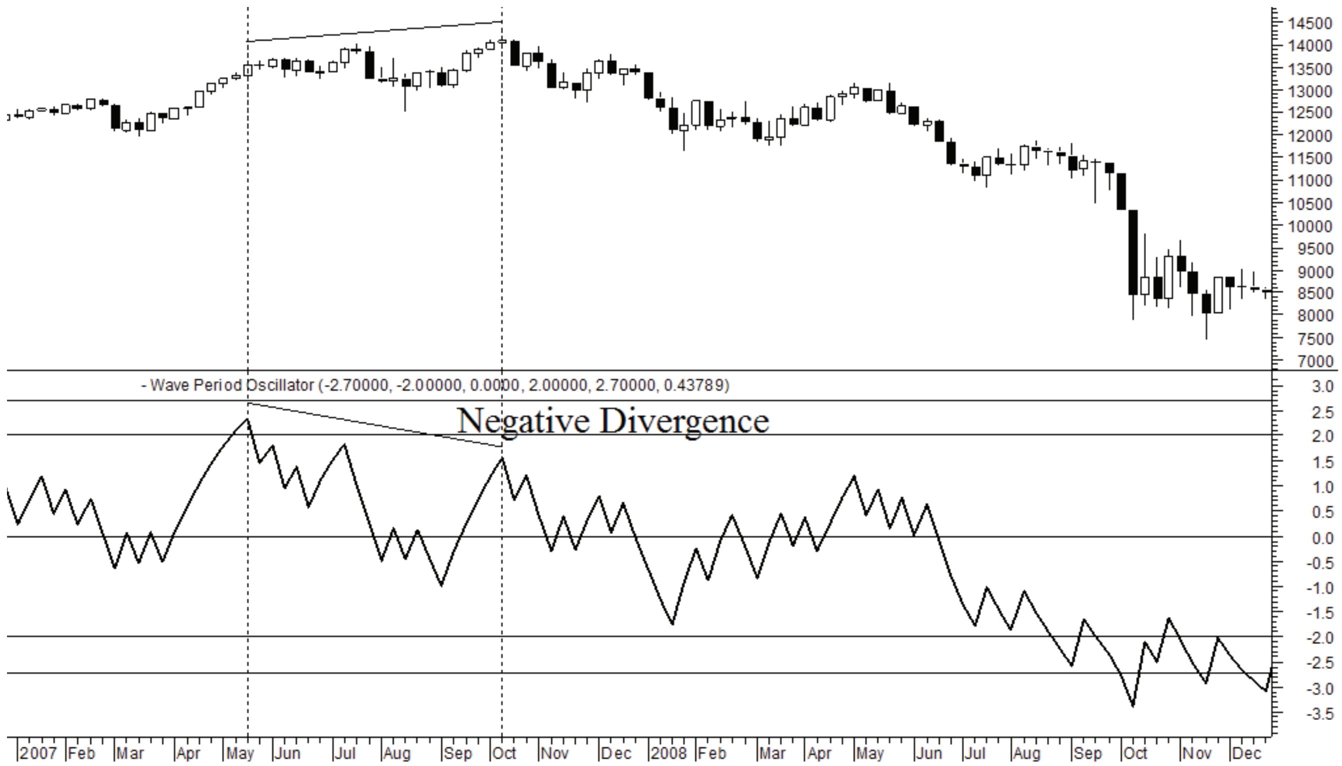
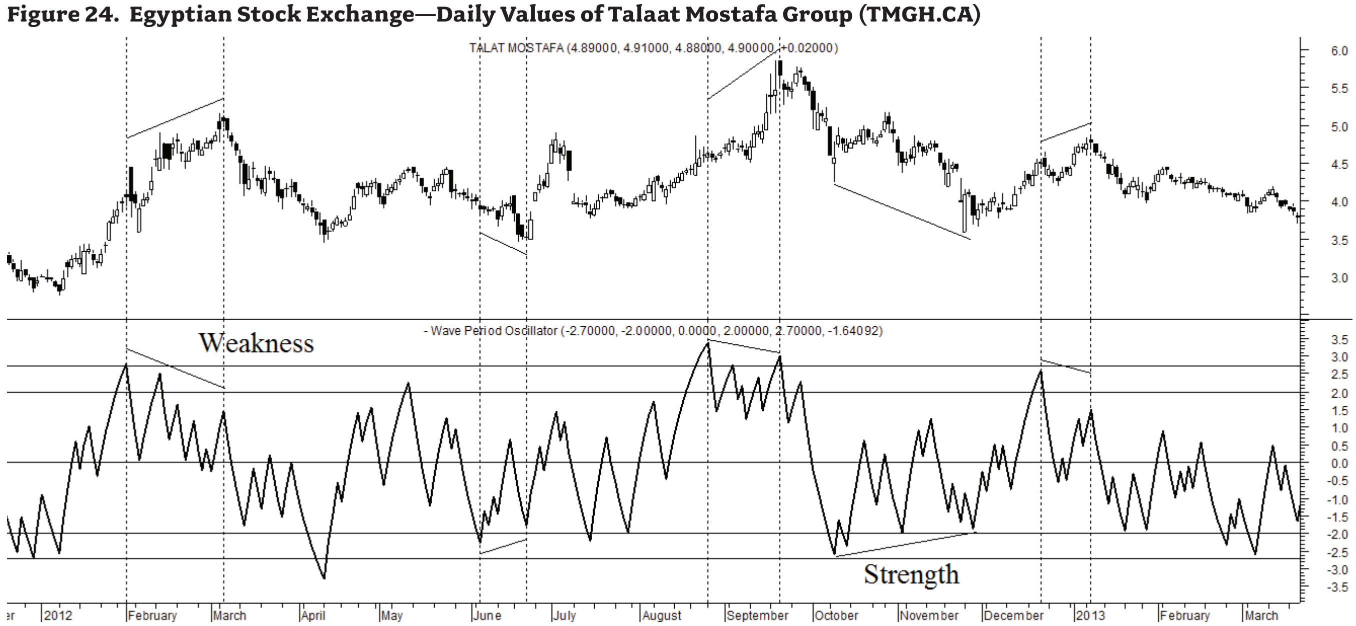


Figure 24. Egyptian Stock Exchange—Daily Values of Talaat Mostafa Group (TMGH.CA)



Simple Harmonic Index (SHI)

Concept

The simple harmonic index (SHI) is based on the derivations of the simple harmonic equation,

$$y = A \sin(\omega t + \varphi)$$

As *y* is the position of the oscillating wave at a certain time t, the change in positions with respect time expresses the velocity of the wave. Therefore, the velocity is *v*

$$v = \omega A \cos(\omega t + \varphi)$$

The acceleration *α* is the change in velocity with respect to time. Therefore,

$$a = -\omega^2 A \sin(\omega t + \varphi)$$

By substituting *y* in the previous equation,

$$a = -\omega^2 y$$

$$\omega^2 = -\frac{a}{y}$$

By taking the absolute value for both sides of the equation,

$$\omega^2 = \frac{a}{y} \quad \text{and} \quad \omega = \sqrt{\frac{a}{y}}$$

Since "ω is equal to 2πf" and the period T is equal to 1/f then,

$$T = 2\pi\sqrt{\frac{y}{a}}$$

From the last equation, we find that the period of the oscillating price is related to the price displacement and the acceleration by which the price is moving. Unlike the WPO, the period of the SHI is independent of amplitude and phase shift. The simple harmonic index is a leading oscillator which revolves around its centerline. The bulls period increases when the SHI line crosses the centerline to the upside. On the other hand, the bears period increases when the SHI line crosses down the centerline as shown in Figure 25.

Figure 25. SHI Interface

Calculation

Again, the acceleration *α* is the change in the price velocity with respect to time. If C is the closing price of today, C_y is the closing price of yesterday and C_{by} is the closing price of before yesterday; then, the price velocity of today is expressed by

$$v_t = C - C_y$$

While the price velocity of yesterday is

$$v_y = C_y - C_{by}$$

Hence, the price acceleration of today is expressed by

$$a_t = (C - C_y) - (C_y - C_{by})$$

To reduce the sensitivity of the SHI, we calculate the average of one-day acceleration so that

$$a = \text{EMA (14) of } a_t$$

The price displacement y is equal to $(C - C_y)$; therefore, the one-day period T is expressed by

$$T = 2\pi\sqrt{\frac{y}{a}} \quad \text{or} \quad T = 6.28\sqrt{\left|\frac{(C - C_y)}{EMA_{14}\left[(C - C_y) - (C_y - C_{by})\right]}\right|}$$

When y has a negative value, the period should have a negative value by its turn. However, when both y and a have negative signs, the period will yield a positive value indicating a buying strength. To prevent such a discrepancy, an absolute value is taken for the above equation. In this article, we will consider *y* is equal to $(price_{today} - price_{yesterday})$ instead of (today's price). The reason for this change is that the SHI should not easily reach its extreme levels during uptrends and downtrends. The change in price will reduce the values of the oscillator to prevent the SHI line from crossing the extreme levels frequently. If C is greater than C_y, then T is given a positive sign. If C is less than C_y, then T is given a negative sign. Finally,

$$SHI = \text{EMA (14) of } T$$

Trading Tactic

The trading tactic used for the simple harmonic index is merely the centerline crossover. A buy signal is generated when the SHI line moves above the zero level to turn positive. The period of the bull cycle rises, leading to an increase in price displacement. A sell signal is generated when the SHI line crosses down the centerline to turn negative. Figures 26 and 27 demonstrate the signals of the oscillator.

Figure 26. Centerline crossover signals of the SHI

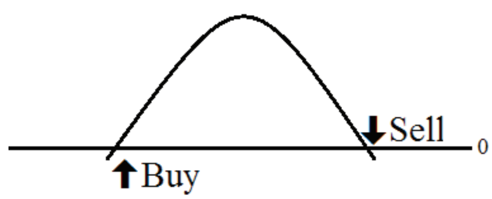
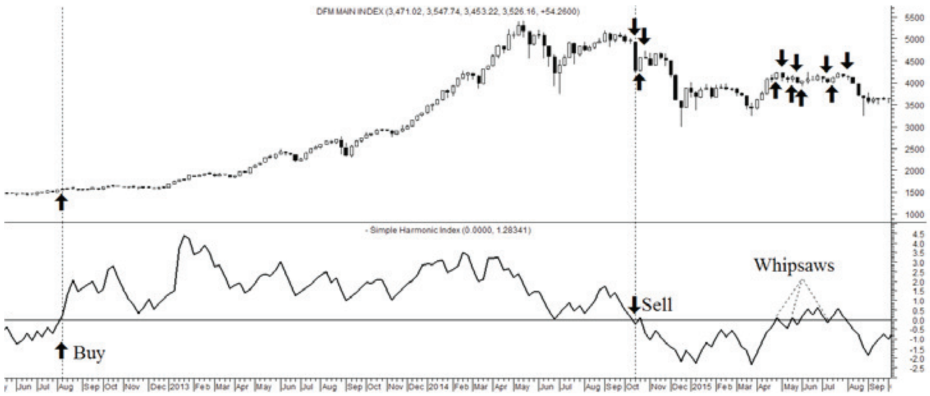


Figure 27. Dubai financial market—Weekly values of Dubai General Index (.DFMGI)



Support and Resistance Analysis

Like the price, SHI forms highs and lows that can be connected to each other and creates support and resistance lines. Sometimes the SHI breaks its support or resistance earlier. This behavior can be used as a leading move indicating that the price support or resistance will be broken during the following phase. In Figure 28, the SHI has broken its support before the price breakout.

Figure 28. Egyptian Stock Exchange—Daily Values of Al Ahly Development (AFDI. CA)

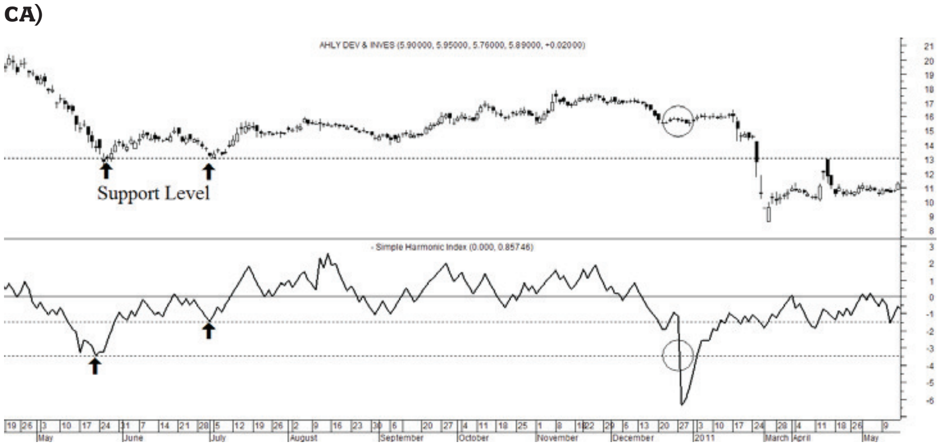
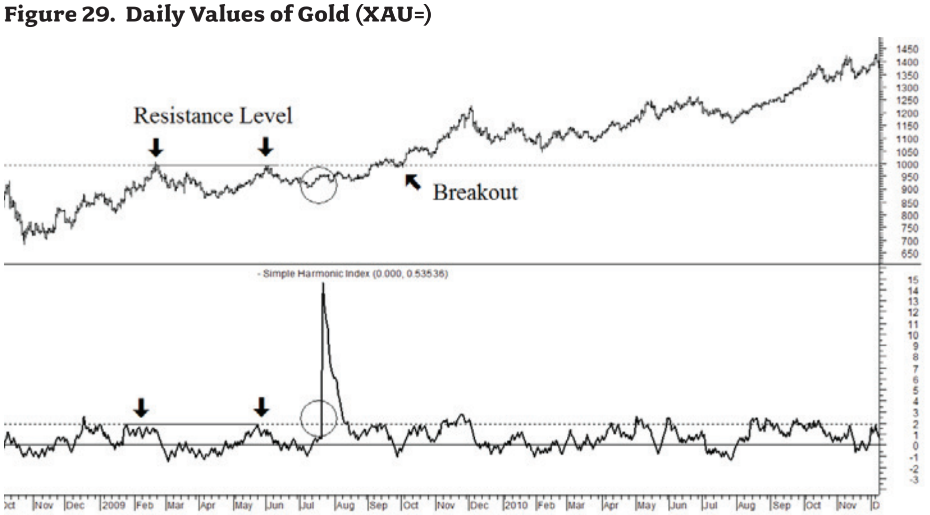


Figure 29. Daily Values of Gold (XAU=)



Divergences

Like the WPO, the simple harmonic index exhibits divergences with price. Figures 30 and 31 demonstrate an example of the SHI divergence.

Figure 30. NYMEX—Weekly Values of Light Crude Oil (CLc1)

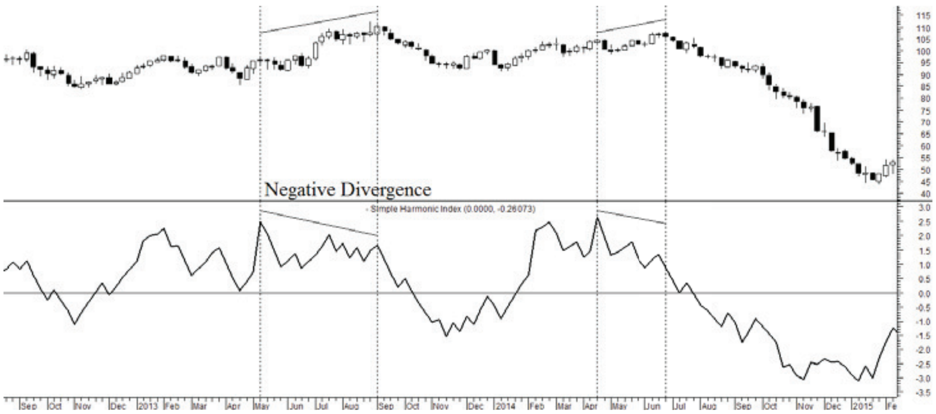
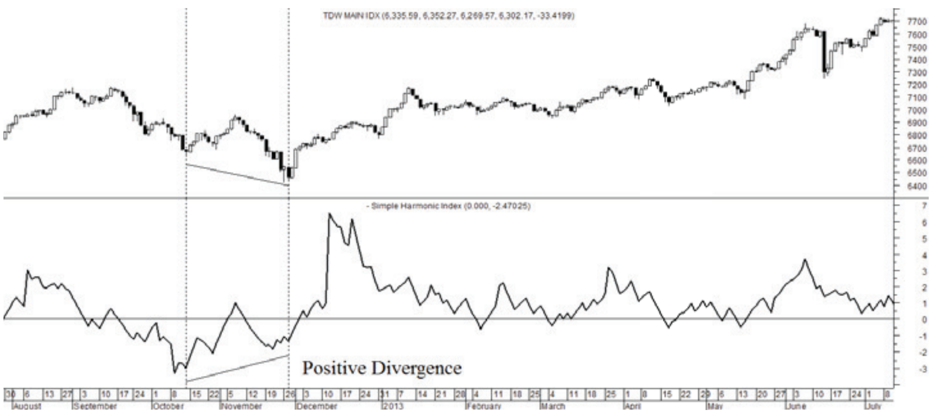


Figure 31. Saudi Stock Exchange—Daily Values of Tadawul Main Index (.TASI)



Simple Harmonic Oscillator (SHO)

Structure

The SHO is a bounded oscillator for the simple harmonic index that calculates the period of the market's cycle. The oscillator is used for short and intermediate terms and moves within a range of -100 to 100 percent. The SHO has overbought and oversold levels at +40 and -40, respectively. At extreme periods, the oscillator may reach the levels of +60 and -60. The zero level demonstrates an equilibrium between the periods of bulls and bears. The SHO oscillates between +40 and -40. The crossover at those levels creates buy and sell signals. In an uptrend, the SHO fluctuates between 0 and +40 where the bulls are controlling the market. On the contrary, the SHO fluctuates between 0 and -40 during downtrends where the bears control the market. Reaching the extreme level -60 in an uptrend is a sign of weakness. Mostly, the oscillator will retrace from its centerline rather than the upper boundary +40. On the other hand, reaching +60 in a downtrend is a sign of strength and the oscillator will not be able to reach its lower boundary -40.

Calculation

The SHO calculation consists of two main parts: The variable period VP and the total period TP. The variable period is equal to the SHI value, and the total period is equal to the exponential moving average of a one-day period. Consider the following equation:

$$T = 6.28\sqrt{\left|\frac{(C - C_y)}{EMA_{14}\,[(C - C_y) - (C_y - C_{by})]}\right|}$$

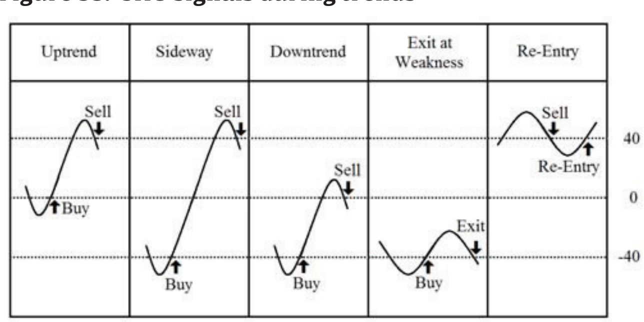
Following the steps below:

- Ti = +T if C > Cy
- Ti = -T if C < Cy
- VP = EMA (14) of Ti
- TP = EMA (14) of T
- $SHO = \frac{VP}{TP} \times 100$

Trading Tactics

Like the wave period oscillator, the SHO trading tactics consist of uptrend, sideway, downtrend, exit at weakness, and re-entry tactics as shown in Figure 33.

Figure 33. SHO signals during trends



Examples of SHO Signals: Figures 34, 35, and 36 demonstrate the signals generated by the SHO during uptrend, sideways, and downtrend, respectively.

Figure 34. Egyptian Stock Exchange—Daily Values of Pioneers Holding (PIOH.CA)

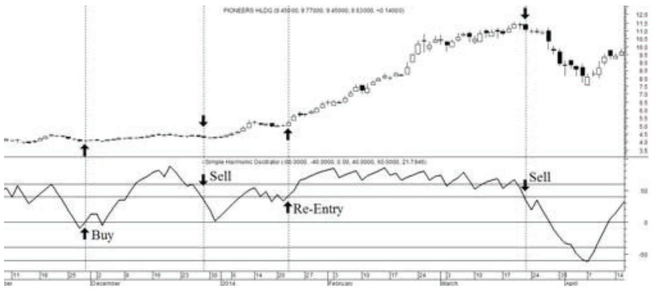
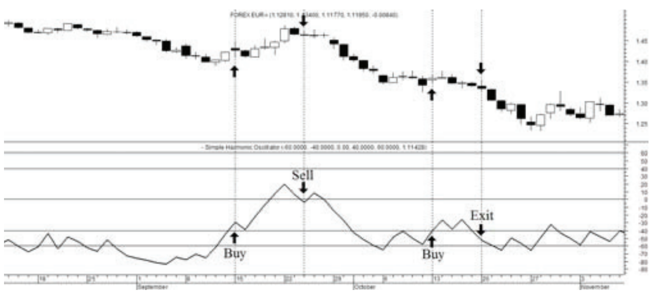


Figure 35. Egyptian Stock Exchange—Daily Values of EFG Hermes Holding (HRHO.CA)

Figure 36. Daily Values of Euro-Dollar (EUR=)

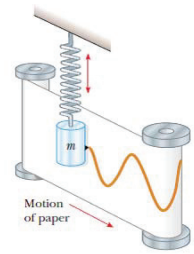


Periods Precede Volumes

Mathematical Approach

Periods precede volumes is based on Hooke's law, named after the British physicist Robert Hooke. Hooke's law finds the relation between the period and the mass of oscillating bodies. In Figure 37, a body with mass m is attached to a spring moving only in upward and downward directions. A marker is attached to the body to trace its motion on a rolling paper, which moves in the right direction, perpendicular to the motion of the body. As a result, the marker attached to the oscillating body traces out a sinusoidal pattern on the moving chart paper.

Figure 37. An experimental apparatus demonstrating the simple harmonic motion (adapted from *Physics for Scientists and Engineers* 2004, p. 456)



Such a mechanism exists in the price movement. The closing price of one weekly bar rises or falls during the week. However, we see it as a sinusoidal line on the daily timeframe. The daily time axis moves only to the right from present to future like the motion of the paper. Figure 38 demonstrates the closing price of one weekly bar with equal increments during the week. The first day starts at 20, then the price changes each day by +10 and -10.

Figure 38. The relation between the closing price levels of one weekly bar and the daily closing prices for the same week

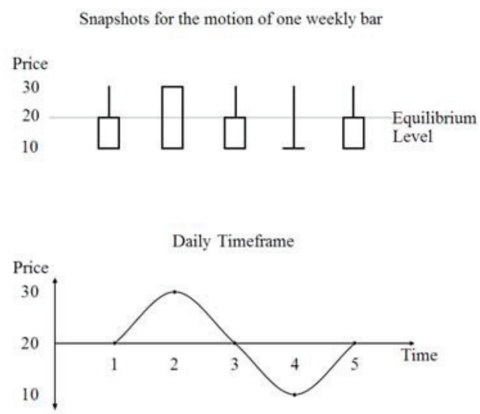
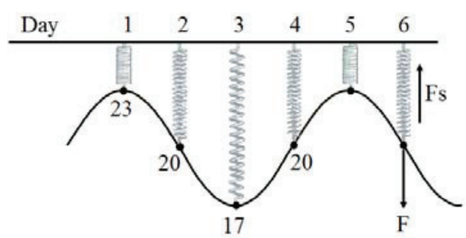


Figure 39. Example of applied forces on oscillating price



In Figure 39, the price at any day is considered a moving body with mass m. The stock's volume is considered the mass of the "price body," which will not exist if the volume is equal to zero (no trade). Let us assume that the price body is attached to a spring. When the spring is neither stretched nor compressed, the price becomes at the equilibrium position of the system which we identify at 20. On the third day, the price moves down by 3 units to close at 17. The spring stretches down and builds a restoring force Fs trying to pull back the price body to its equilibrium position again. In this example, the market force F refers to the dominant sellers while Fs refers to the resisting buyers during the first three days.

According to Hooke's law, the force of the spring is

$$F_s = -k.y$$

where k is called the spring constant. The negative sign indicates that Fs is in the opposite direction of the force F, where F is the product of mass and acceleration. According to Hooke law, F = Fs. Therefore,

$$m.a = - k.y$$

Therefore,

$$k = \frac{- m.a}{y}$$

As derived earlier, ω^2 is equal to (- a/y). Consequently, the angular frequency

$$\omega = 2\pi f = \sqrt{\frac{k}{m}}$$

And the wave period

$$T = 2\pi \sqrt{\frac{m}{k}}$$

By applying the above equation on prices, the one day period will be equal to

$$\text{T of today} = 6.28 \sqrt{\frac{\text{volume of today}}{\text{k of today}}}$$

When the value of the spring constant *k* rises or falls, the period will be considered as the change in volume, therefore, the periods will lead volumes by phase.

Examples of Leading Periods

The following examples include a comparison between the 14-day exponential moving averages of volumes, wave periods, and simple harmonic periods.

Figure 40. Egyptian Stock Exchange—Daily Values of Heliopolis Housing (HELI.CA)

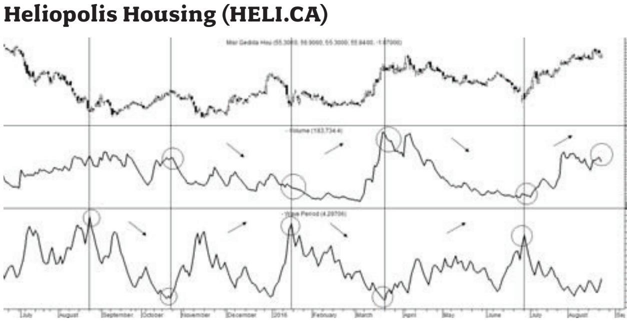
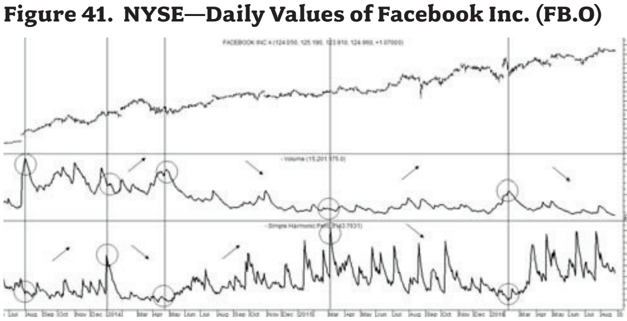


Figure 41. NYSE—Daily Values of Facebook Inc. (FB.O)



In Figure 41, the major peaks of volumes and periods are used to define the phases. During the first phase, the period indicator starts to rise until January 2014. During the second phase, the volume rises by its turn until mid-April. Simultaneously, the period falls leading to a decline in volumes within the third phase from mid-April 2014 to March 2015.

Figure 42. Egyptian Stock Exchange — Daily Values of Arab Cotton Ginning (ACGC.CA)

Figure 42 above demonstrates a comparison between the SHO and the volume zone oscillator (VZO) created by Waleed Khalil. "*Volume Precedes Price* is the conceptual idea for the VZO" (Khalil 2009, p.18). During phases A and B, the SHO rises to approach the upper boundary driving the VZO to fluctuate between its centerline and the extreme upper boundary in phase C. The behavior of the VZO indicates an increase in the average volume leading to price rally. In phase D, the SHO fails to reach the upper boundary showing a weakness in the average period of buyers. Hence, the pull back of the SHO confirms the importance of the sell signal generated by the VZO. The positive divergence between the SHO and the VZO has led the latter to move from the extreme oversold level to its centerline while confirming the importance of the VZO buy signal at -40.

Testing Results

Centerline Crossover Tactic

This tactic is tested during uptrends. The buy signals are generated when the WPO/SHI cross their centerlines to the upside. The sell signals are generated when the WPO/SHI cross down their centerlines. To define the uptrend in the system, stocks closing above their 50-day EMA are considered while the ADX is above 18.

Uptrend Tactic

During uptrends, the bulls control the markets, and the oscillators will move above their centerline with an increase in the period of cycles. The lower boundaries and equilibrium line crossovers generate buy signals, while crossing the upper boundaries will generate sell signals. The "Re-entry" and "Exit at weakness" tactics are combined with the uptrend tactic. Consequently, we will have three buy signals and two sell signals.

Sideways Tactic

During sideways, the oscillators fluctuate between their upper and lower boundaries. Crossing the lower boundary to the upside will generate a buy signal. On the other hand, crossing the upper boundary to the downside will generate a sell signal. When the bears take control, the oscillators will cross down the lower boundaries, triggering exit signals. Therefore, this tactic will consist of one buy signal and two sell signals. The sideway tactic is defined when stocks close above their 50-day EMA and the ADX is below 18.

Downtrend Tactic

During downtrends, the bears control the markets and the time cycle oscillators will move below their centerline with an increase in the period of cycles when the downtrend runs with high momentum. The lower boundary crossovers generate buy signals, while crossing the centerline to the downside will generate sell signals. The "Exit at weakness" tactic is combined with the downtrend tactic. Consequently, we will have one buy signal and two sell signals. To define the downtrend in the system, stocks closing below their 50-day EMA are considered while the ADX is above 18.

Table 3. WPO testing results for 10 years in Egyptian Stock Market

Egyptian Stock Exchange 1/1/2006–1/1/2016				
Tactics	Centerline Crossover	Uptrend	Sideways	Downtrend
Net Profit %	3412.13%	1120.32%	192.77%	88.11%
Exposure %	38.28%	69.34%	51.31%	44.35%
Net Risk Adjusted Return %	8913.92%	1615.80%	375.71%	198.68%
Annual Return %	42.74%	28.42%	11.34%	6.52%
Risk Adjusted Return %	111.66%	41.00%	22.10%	14.71%
All trades	11288	5595	2483	7000
Avg. Profit/Loss %	1.47%	2.57%	3.09%	0.63%
Avg. Bars Held	5.2	18.23	25.15	6.73
Winners	3190 (28.26 %)	2118 (37.86 %)	948 (38.18 %)	2436 (34.80 %)
Total Profit	700,848.29	558,711.93	113,355.23	91,946.53
Avg. Profit %	10.68%	17.45%	20.29%	9.22%
Avg. Bars Held	10.58	24.24	32.52	9.59
Largest win	16,675.66	13,579.46	2,894.75	1,953.35
# bars in largest win	54	29	12	12
Losers	8098 (71.74 %)	3477 (62.14 %)	1535 (61.82 %)	4564 (65.20 %)
Total Loss	-359,634.88	-446,679.67	-94,077.96	-83,135.40
Avg. Loss %	-2.16%	-6.49%	-7.53%	-3.95%
Avg. Bars Held	3.08	14.57	20.59	5.2
Largest loss	-3,677.90	-3,009.85	-821.16	-338.04
# bars in largest loss	2	19	17	19
Max. trade drawdown	-3,677.90	-3,452.86	-1,636.79	-628.24
Max. system % drawdown	-17.18%	-50.91%	-41.69%	-56.96%
Profit Factor	1.95	1.25	1.2	1.11
Payoff Ratio	4.95	2.05	1.95	2.07
Risk-Reward Ratio	1.34	0.41	0.31	0.08

Table 4. SHI testing results for 10 years in Egyptian Stock Market

Egyptian Stock Exchange 1/1/2006–1/1/2016	
Tactics	Centerline Crossover
Net Profit %	1500.85%
Exposure %	48.55%
Net Risk Adjusted Return %	3091.55%
Annual Return %	31.96%
Risk Adjusted Return %	65.83%
All trades	6725
Avg. Profit/Loss %	1.82%
Avg. Bars Held	9.29
Winners	1674 (24.89 %)
Total Profit	352,087.87
Avg. Profit %	16.12%
Avg. Bars Held	22.94
Largest win	13564.3
# bars in largest win	17
Losers	5051 (75.11 %)
Total Loss	-202,002.98
Avg. Loss %	-2.92%
Avg. Bars Held	4.77
Largest loss	-1864.7
# bars in largest loss	12
Max. trade drawdown	-3772.65
Max. system % drawdown	-23.41%
Profit Factor	1.74
Payoff Ratio	5.26
Risk-Reward Ratio	1.39

Table 5. SHO testing results for 10 years in Egyptian Stock Market

Egyptian Stock Exchange 1/1/2006–1/1/2016			
Tactics	**Uptrend**	**Sideways**	**Downtrend**
Net Profit %	2759.79%	242.00%	236.64%
Exposure %	52.48%	35.61%	41.33%
Net Risk Adjusted Return %	5258.95%	679.66%	572.54%
Annual Return %	39.84%	13.08%	12.91%
Risk Adjusted Return %	75.92%	36.75%	31.23%
All trades	9984	2749	8164
Avg. Profit/Loss %	1.65%	2.31%	0.70%
Avg. Bars Held	9.92	15.94	6.23
Winners	3603 (36.09 %)	1154 (41.98 %)	2621 (32.10 %)
Total Profit	1,009,423.53	105,133.15	113,352.45
Avg. Profit %	12.33%	14.63%	9.09%
Avg. Bars Held	14.31	18.73	9.96
Largest win	38824.65	2,861.13	1,951.49
# bars in largest win	26	8	13
Losers	6381 (63.91 %)	1595 (58.02 %)	5543 (67.90 %)
Total Loss	-733,444.11	-80,932.75	-89,688.82
Avg. Loss %	-4.39%	-6.61%	-3.26%
Avg. Bars Held	7.44	13.93	4.47
Largest loss	-4009.91	-955.32	-419.02
# bars in largest loss	8	14	6
Max. trade drawdown	-4366.96	-2,800.69	-727.82
Max. system % drawdown	-34.48%	-35.95%	-48.08%
Profit Factor	1.38	1.3	1.26
Payoff Ratio	2.44	1.8	2.67
Risk-Reward Ratio	0.73	0.38	0.73

Conclusion

Time cycle oscillators give an insight about the relation between time, volume, and price movements. In this article, we used the oscillators to differentiate between the time taken by bulls and bears to complete one cycle.

Advantages of the time cycle oscillators

- The time cycle indicators can replace the volume data in FX market.
- The irregular cycle lines generated by the WPO analyze the volatility of markets.
- SHO has fewer whipsaws than the WPO on their equilibrium lines.
- Both SHO and WPO can be used simultaneously to minimize their whipsaws.
- The cycle period, calculated by the SHI and SHO, is independent of the amplitude and the phase constant.

Disadvantages of the time cycle oscillators

- The oscillators are not based on the forced and damped oscillations concepts which take into account the change in amplitude during the day.

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Software and Data

Testing was performed by AmiBroker software.

Data and charts used in this article are provided by Thomson Reuters data feed and Metastock software.

Appendix

Indicator Codes

Indicators	Metastock	Amibroker

Wave Period Oscillator (WPO)	n:=14;
	Cy:= Ref(C,-1);
	A:= H;
	sinwt:= C/A;
	sinsq:= Power(sinwt, 2);
	cossq:= 1-(sinsq);
	coswt:= Sqrt(cossq);
	Angle:= atan(sinwt,coswt);
	Rad:= 3.14*Angle/180;
	Tt:= 6.28/Rad;
	Ti:= If(C > Cy, Tt, -Tt);
	WPO:= Mov(Ti,n,E);
	WPO
		n = 14;
		Cy = Ref(C,-1);
		A = H;
		sinwt = C/A;
		Angle = asin(sinwt);
		Tt = 6.28/Angle;
		Ti = iif(C > Cy,Tt,-Tt);
		WPO = EMA(Ti,n);

Simple Harmonic Index (SHI)	n:=14;
	Cy:= Ref(C,-1);
	vt:= C-Cy;
	vy:= Ref(vt,-1);
	at:= vt-vy;
	a:= Mov(at,n,E);
	d:= C-Cy;
	Tt:= Sqrt(Abs(d/a));
	Ti:= If(C>Cy,Tt,-Tt);
	SHI:= Mov(Ti,n,E);
	SHI
		n= 14;
		Cy= Ref(C,-1);
		vt= C-Cy;
		vy= Ref(vt,-1);
		at= vt-vy;
		a= EMA(at,n);
		d= C-Cy;
		Tt= Sqrt(Abs(d/a));
		Ti= iif(C>Cy,Tt,-Tt);
		SHI= EMA(Ti,n);

Simple Harmonic Oscillator (SHO)	n:=14;
	Cy:= Ref(C,-1);
	vt:= C-Cy;
	vy:= Ref(vt,-1);
	at:= vt-vy;
	a:= Mov(at,n,E);
	d:= C-Cy;
	Tt:= Sqrt(Abs(d/a));
	Ti:= If(C>Cy,Tt,-Tt);
	VP:= Mov(Ti,n,E);
	TP:= Mov(Tt,n,E);
	SHO:= VP/TP*100;
	SHO
		n=14;
		Cy= Ref(C,-1);
		vt= C-Cy;
		vy= Ref(vt,-1);
		at= vt-vy;
		a= EMA(at,n);
		d= C-Cy;
		Tt= Sqrt(Abs(d/a));
		Ti= iif(C>Cy,Tt,-Tt);
		VP= EMA(Ti,n);
		TP= EMA(Tt,n);
		SHO= VP/TP*100;