

INDICATORS

Waxing And Waning

Phase Change Index

Which phase is your market going through? Find out by using this indicator.

by M.H. Pee



Prices at any time can be up, down, or unchanged. A period where market prices remain relatively unchanged is referred to as a *consolidation*. A period that witnesses relatively higher prices is referred to as an *uptrend*, while a period of relatively lower prices is called a *downtrend*. The phase change index (PCI) is an indicator designed specifically to detect changes in market phases.

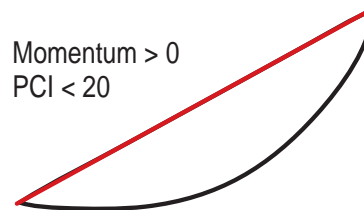
THEORY BEHIND THE PCI

Six phase changes are possible, as illustrated in Figures 1–6 (the black line represents the closing prices for a particular period, in this case 35 days). Just how does the PCI differentiate between the six? First, note that in order to trade the market profitably, you will have to hold long positions during uptrends, be short during downtrends, and be flat (or at least remain with the previous position) during consolidations until you are sure of the market direction. Hence, for the scenarios in Figures 1 and 3, you would like to be long (they signal what could be the beginning of an uptrend). For the scenarios in Figures 2 and 4, you would prefer to be short, and for the scenarios in Figures 5 and 6, you would be happy to remain with your position.

So what is the difference between Figures 1 and 3, Figures 2 and 4, and Figures 5 and 6? To find out, draw an imaginary gradient line connecting the starting and ending closing prices for the selected period (see the red line in Figures 1–6). For the scenarios in Figures 1 and 3, note that most of the closes for the period remain below this line. In addition, the gradient line slopes upward.

For Figures 2 and 4, most of the closes were above the gradient line for the chosen period, and the gradient line slopes downward. For Figure 5, most of the closes remain above the gradient line (which is the same as Figures 2 and 4), but its gradient line slopes up instead of down. Finally, Figure 6 shows the majority of the closes below the gradient line (which resembles Figures 1 and 3), but it displays a downward-sloping gradient line.

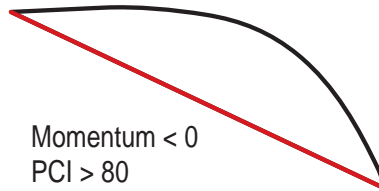
The 35-day momentum line measures the slope of the gradient line, while the position of the closes relative to the gradient line is represented by the 35-day PCI. Now let's get



Momentum > 0
PCI < 20

FIGURE 1: PHASE CHANGE FROM CONSOLIDATION TO UPTREND.

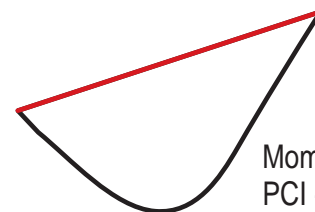
You would be looking to enter long positions in this scenario.



Momentum < 0
PCI > 80

FIGURE 2: PHASE CHANGE FROM CONSOLIDATION TO DOWNTREND.

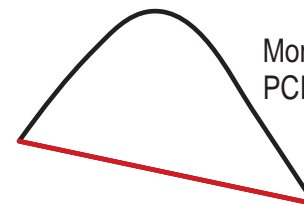
Here you would look to enter short positions.



Momentum > 0
PCI < 20

FIGURE 3: PHASE CHANGE FROM DOWNTREND TO UPTREND.

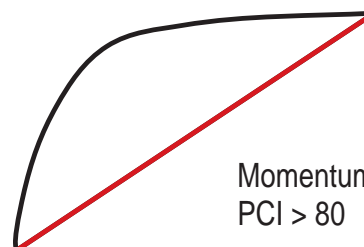
Here is another situation where you would look to enter long positions.



Momentum < 0
PCI > 80

FIGURE 4: PHASE CHANGE FROM UPTREND TO DOWNTREND.

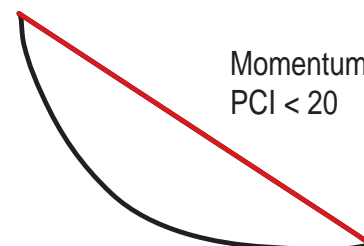
You would be looking to enter short positions in this scenario.



Momentum > 0
PCI > 80

FIGURE 5: PHASE CHANGE FROM UPTREND TO CONSOLIDATION.

Here you are better off remaining with your previous position.



Momentum < 0
PCI < 20

FIGURE 6: PHASE CHANGE FROM DOWNTREND TO CONSOLIDATION.

There is no need to take on new positions while the market is consolidating.

into the specifics of how to calculate the 35-day momentum and 35-day PCI.

DEFINITION

To calculate the 35-day phase change index, you need to find the deviation of the closes from the imaginary gradient line for each of the last 35 days. (See sidebar.) The deviation is defined as up if the close is above the gradient line, and down if the close is below the gradient line. Hence, up deviations are calculated by subtracting the value of the gradient line from that particular day's close, while down deviations are defined as the subtraction of the close from the gradient line value on that particular day. The 35-day PCI is thus given by the formula:

$$35\text{-day PCI} = [(D+) / ((D+) + (D-))] * 100$$

where:

D+ is the sum of the up deviations for the last 35 days, and
D- is the sum of the down deviations for the last 35 days.

TO ILLUSTRATE

Here's an example to illustrate the calculation of the PCI. For simplicity, I chose to show the calculations of the five-day PCI. The calculation of the 35-day PCI, or any other time period, is similar. Figure 7 shows the hypothetical closing prices of a particular market in a particular week. All the intermediate steps used to arrive at the five-day PCI are shown in detail.

This example should clarify the calculation of the PCI. The calculated five-day PCI is 7.23, and the five-day momentum is a positive 1.8. This corresponds to the scenario in Figure 1 or 3, which means you should expect the beginning of an uptrend. Note that the close and the gradient line have the same value at the start and end of the five-day period. This is exactly what is expected, as shown in Figures 1–6.

INTERPRETING THE INDEX

Because of the way the 35-day PCI is defined, it basically indicates the percentage of the total deviations of closes that are up relative to the gradient line for a period of 35 days. Hence, a value of 100 for the 35-day PCI indicates that all the closes were above the gradient line in that particular 35-day period. Conversely, a value of zero for the 35-day PCI would indicate that the market closes below the gradient line for each and every one of the 35 days in that period. Note that the PCI only fluctuates between zero and 100.

Values of the 35-day PCI above 80 or below 20 indicate the presence of phase changes in that particular 35-day period. These changes could be from consolidation to uptrend, or any of the other possible six scenarios illustrated in Figures 1–6. Values of the 35-day PCI between 20 and 80 indicate the absence of phase changes. This means that the current market

Day	Closes	5-day momentum	Gradient line	Up deviation
Mon	35.41		$35.41+1.8*0/4 = 35.41$	
Tue	35.01		$35.41+1.8*1/4 = 35.86$	
Wed	35.62		$35.41+1.8*2/4 = 36.31$	
Thur	36.88		$35.41+1.8*3/4 = 36.76$	$36.88-36.76 = 0.12$
Fri	37.21	$37.21-35.41 = 1.8$	$35.41+1.8*4/4 = 37.21$	

Day	Closes	Down deviation	D+	D-	(D+) + (D-)	5-day PCI
Mon	35.41					
Tue	35.01	$35.86-35.01 = 0.85$				
Wed	35.62	$36.31-35.62 = 0.69$				
Thur	36.88					
Fri	37.21		0.12	$0.85+0.69 = 1.54$	$0.12+1.54 = 1.66$	$0.12/1.66*100 = 7.23$

FIGURE 7: EXAMPLE ILLUSTRATING THE CALCULATION OF THE PHASE CHANGE INDEX

phase is holding steady.

To describe the six possible phase changes in Figures 1–6, you would need the 35-day momentum. The 35-day momentum is the close 35 days ago subtracted from the current day's close. As I mentioned, you would like to enter long for the scenario in Figures 1 and 3 — that is, when the 35-day momentum is positive and the 35-day PCI is less than 20. You would like to be short in Figures 2 and 4, which are characterized by having a negative 35-day momentum and a 35-day PCI with a value greater than 80. For the remaining cases, you would remain with your previous positions.

To summarize, enter long at the open tomorrow if today's 35-day momentum is positive and the 35-day PCI value is less than 20. Enter short at the open tomorrow if today's 35-day momentum is negative and the 35-day PCI has a value greater than 80. Otherwise, let your current position remain.

HYPOTHETICAL TESTING RESULTS

The PCI was tested as a reversal system. This means that at any particular time you are either long or short — never flat. When you are long, you will reverse to a short position at the open tomorrow only when today's 35-day momentum is negative and the 35-day PCI has a value greater than 80. Conversely, when you are long, you will reverse to short positions at the open tomorrow if the 35-day momentum is positive today and the 35-day PCI value today is less than 20.

The testing portfolio included 35 markets, from January 2, 1980, through April 30, 2003 — a total of about 23 years. Only one contract was taken per trading signal, and a total of \$75 was deducted from each trade to reflect slippage and commission. As of April 30, 2003, all open positions were arbitrarily closed, and the exit price was taken to be the close of that day.

The testing was done on continuous contracts to avoid the rollover problem, and because they are easier to test without vastly affecting the test results. Figure 8 shows the hypothetical testing results of the PCI using its default parameter value of 35 days, with all the statistics in the table rounded off to the nearest two decimal places.

To convince you that the parameter value of 35 days is not curve-fitted, I also varied the parameter value of the PCI

across four other parameter values. The results of this variation are shown in Figure 9. Note that only the parameter value is changed, with all the other factors remaining similar.

The other four parameters are selected by varying the previous parameter value by 20%. For example, by increasing the default parameter value by 20%, you will arrive at 42 days (1.2)(35). Similarly, decreasing the default parameter by 20% will result in 28 days (0.8)(35).

COMMENTS ON THE TEST RESULTS

In Figure 8, the 35 markets are subdivided into seven different market groups. Upon closer examination of these market groups, we see all the seven market groups are profitable

when we hypothetically test the 35-day PCI on them. In addition, 26 markets are profitable out of the 35 tested, which is equivalent to having about 75% of the markets being profitable. However, this percentage is the lowest among the parameters chosen (see Figure 9).

At its best performance, the 42-day PCI shows 30 out of 35 markets being profitable, which converts to being profitable on 85% of the markets traded. This truly demonstrates the robustness of the PCI across markets.

Next, we shall see the robustness of the PCI across parameter values. This means that you want the PCI to be consistently profitable trading the portfolio, not only on a few parameter values, but also on a range of parameter values.

EXCEL CODES FOR PCI

In this section, I will provide the Excel codes for the 35-day PCI. Sidebar Figure 1 (following page) shows all the required calculations for the 35-day PCI on the euro between January 2, 2002, and April 12, 2002, inclusively. The data is represented in continuous contract format. The date, open, high, low, and close are entered into columns A, B, C, D, and E, respectively. The date is represented using eight digits, with the first four representing the year, the next two the month, and the last two the day. For example, the number 20020301 represents March 1, 2002.

Column F represents the value of the 35-day momentum divided by 34. The 35-day momentum is the result of the subtraction of the close 35 days ago from today's close. Divide this value by 34 to obtain the value recorded in column F. As for the Excel codes for column F, enter the following formula in cell F35 and copy it down to the bottom of the spreadsheet:

$$=(E35-E1)/34$$

Column G shows the sum of the up and down deviation for the last 35 days. This is in fact the denominator for the formula of the 35-day PCI. Enter the following codes in cell G35 and copy it down to the bottom of the spreadsheet:

$$\begin{aligned} &=ABS(E2-E1-F35)+ABS(E3-E1-2*F35)+ABS(E4-E1-3*F35)+ABS(E5-E1-4*F35)+ABS(E6-E1-5*F35)+ABS(E7-E1-6*F35)+ABS(E8-E1-7*F35)+ABS(E9-E1-8*F35)+ABS(E10-E1-9*F35)+ABS(E11-E1-10*F35)+ABS(E12-E1-11*F35)+ABS(E13-E1-12*F35)+ABS(E14-E1-13*F35)+ABS(E15-E1-14*F35)+ABS(E16-E1-15*F35)+ABS(E17-E1-16*F35)+ABS(E18-E1-17*F35)+ABS(E19-E1-18*F35)+ABS(E20-E1-19*F35)+ABS(E21-E1-20*F35)+ABS(E22-E1-21*F35)+ABS(E23-E1-22*F35)+ABS(E24-E1-23*F35)+ABS(E25-E1-24*F35)+ABS(E26-E1-25*F35)+ABS(E27-E1-26*F35)+ABS(E28-E1-27*F35)+ABS(E29-E1-28*F35)+ABS(E30-E1-29*F35)+ABS(E31-E1-30*F35)+ABS(E32-E1-31*F35)+ABS(E33-E1-32*F35)+ABS(E34-E1-33*F35) \end{aligned}$$

Column H shows the difference between the sum of the up deviations for the last 35 days (D+) and the sum of the down deviations for the last 35 days (D-). This is basically obtained by subtracting the value of (D-) from the value of (D+). Enter the following formula into cell H35 and copy it down to the bottom of the spreadsheet:

$$=SUM(E1:E35)-35*E1-595*F35$$

Column I records the sum of the up deviation for the last 35 days (D+). This is the numerator for the formula of the 35-day PCI. Key the following lines into cell I35 and copy it down to the bottom of the spreadsheet:

$$=IF(H35>0,(G35-H35)/2+H35,(G35+H35)/2)$$

Column J shows the value of the 35-day PCI. This is the result of dividing the value of D+ recorded in column I by the value of ((D+) + (D-)) as shown in column G, then multiplying the result by 100. The Excel codes given below should be entered in cell J35 and copied to the bottom of the spreadsheet:

$$=I35/G35*100$$

Column K shows the position you should be holding as of the open tomorrow, with "1" indicating a long position, "-1" representing a short position, and zero showing that you are flat or neutral. Enter the following code in cell K35 and copy it down to the bottom of the spreadsheet:

$$=IF(F35>0,IF(J35<20,1,K34),IF(J35>80,-1,K34))$$

Finally, column L indicates the entry price of the trade tomorrow. This is the open of the next day, as defined by the system's rules. If it shows a blank, this means that no trade is to be entered the next day. The code for column L is shown below. Enter it in cell L35 and copy it down to the bottom of the spreadsheet:

$$=IF(K35=K34,"",B36)$$

—MHP

SIDEBAR FIGURE 1: EXCEL SPREADSHEET EXAMPLE FOR 35-DAY PCI

A	B	C	D	E	F	G	H	I	J	K	L
Date	Open	High	Low	Close	35-day mom./34	(D+) +(D-)	(D+) - (D-)	D+	35-day PCI	Mkt Pos	Price
20020102	88.42	88.62	88.17	88.35							
20020103	88.32	88.39	87.72	87.96							
20020104	87.54	87.77	87.36	87.49							
20020107	86.95	87.35	86.88	87.29							
20020108	87.03	87.25	86.9	87.21							
20020109	87.17	87.21	86.63	87.03							
20020110	87.1	87.36	87	87.14							
20020111	87.19	87.23	86.93	87.19							
20020114	87.21	87.45	87.13	87.39							
20020115	87.17	87.22	86.38	86.4							
20020116	86.12	86.39	86.08	86.23							
20020117	86.16	86.2	85.98	86.14							
20020118	86.09	86.5	85.99	86.47							
20020122	86.3	86.62	86.12	86.59							
20020123	86.56	86.6	85.69	85.78							
20020124	85.68	85.96	85.6	85.69							
20020125	84.64	84.81	84.35	84.52							
20020128	83.85	84.25	83.77	84.17							
20020129	84.27	84.61	84.1	84.52							
20020130	84.46	84.62	84.05	84.21							
20020131	84.42	84.44	83.84	83.9							
20020201	84.37	84.5	84.01	84.23							
20020204	84.43	85.16	84.42	85.08							
20020205	84.92	85.38	84.58	84.81							
20020206	84.69	85.15	84.4	84.95							
20020207	84.71	85.26	84.57	85.19							
20020208	85.47	85.52	85.27	85.42							
20020211	86.03	86.11	85.74	85.75							
20020212	85.64	85.87	85.61	85.74							
20020213	85.44	85.55	85.21	85.25							
20020214	85.07	85.57	85.03	85.5							
20020215	85.16	85.51	85.14	85.39							
20020219	85.08	85.96	85.07	85.72							
20020220	85.54	85.61	85.13	85.16							
20020221	85.14	85.32	84.95	85	-0.0985294	30.75265	-28.765	0.993824	3.231668245	0	
20020222	85.69	85.89	85.53	85.71	-0.0661765	37.005	-37.005	-3.9E-13	-1.05607E-12	0	
20020225	85.41	85.45	85.02	85.04	-0.0720588	23.165	-19.975	1.595	6.885387438	0	
20020226	84.92	85.27	84.3	84.53	-0.0811765	21.37471	-10.51	5.432353	25.41486639	0	
20020227	84.64	84.83	84.44	84.71	-0.0735294	21.44	-14.84	3.3	15.39179104	0	
20020228	84.67	85.14	84.45	85.04	-0.0585294	23.19382	-19.635	1.779412	7.67192077	0	
20020301	84.96	85.09	84.49	84.68	-0.0723529	22.57235	-17.61	2.481176	10.99210382	0	
20020304	84.62	85.32	84.61	85.1	-0.0614706	29.01382	-27.875	0.569412	1.962553347	0	
20020305	84.98	85.37	84.68	85.34	-0.0602941	37.425	-37.425	-8.5E-14	-2.27829E-13	0	
20020306	85.3	85.93	85.27	85.8	-0.0176471	30.50706	-29.74	0.383529	1.257182523	0	
20020307	85.79	86.58	85.59	86.54	0.00911765	40.68382	-39.575	0.554412	1.362732695	1	86.16
20020308	86.16	86.26	85.39	85.54	-0.0176471	25.27	-21.19	2.04	8.072813613	1	
20020311	85.62	85.91	85.6	85.75	-0.0211765	32.80765	-31.03	0.888824	2.709196206	1	
20020312	85.54	85.82	85.25	85.81	-0.0229412	36.16235	-34.84	0.661176	1.828355781	1	
20020313	85.54	86.05	85.45	85.87	0.00264706	23.79618	-22.435	0.680588	2.860073912	1	
20020314	86.31	86.67	86.24	86.46	0.02264706	30.89147	-30.505	0.193235	0.625529606	1	
20020315	86.8	86.93	86.31	86.44	0.05647059	14.95118	-8.93	3.010588	20.13612936	1	
20020318	86.14	86.52	86.1	86.43	0.06647059	14.84	-0.72	7.06	47.57412399	1	
20020319	86.53	86.63	86.18	86.5	0.05823529	14.16588	-5.74	4.212941	29.74005481	1	
20020320	86.34	86.82	86.32	86.65	0.07176471	15.13941	-0.81	7.164706	47.32486304	1	
20020321	86.45	86.67	86.29	86.41	0.07382353	17.28265	11.015	14.14882	81.86722486	1	
20020322	86.17	86.41	85.72	85.91	0.04941176	19.07412	16	17.53706	91.94165176	1	
20020325	85.83	85.98	85.77	85.96	0.02588235	12.86706	1.98	7.423529	57.69406601	1	
20020326	85.61	86.21	85.57	85.92	0.03264706	14.35618	8.245	11.30059	78.71586323	1	
20020327	85.69	85.8	85.45	85.53	0.01705882	17.74941	13.34	15.54471	87.57871015	1	
20020328	85.49	85.57	85.26	85.35	0.00470588	18.13235	12.69	15.41118	84.99270073	1	
20020401	85.66	86.48	85.62	86.33	0.02676471	14.68794	-7.345	3.671471	24.99649572	1	
20020402	86.27	86.43	86.04	86.16	0.01205882	16.17382	-9.405	3.384412	20.92524231	1	
20020403	86.29	86.58	86.2	86.36	0.01823529	16.90706	-12.12	2.393529	14.15698281	1	
20020404	86.71	86.85	85.95	86.04	0.02323529	13.47147	2.355	7.913235	58.74069384	1	
20020405	86.17	86.43	86.1	86.2	0.02058824	13.34882	-3.87	4.739412	35.50434055	1	
20020408	86.04	86.19	85.63	85.69	0.00882353	16.83706	7.17	12.00353	71.29231737	1	
20020409	85.91	86.4	85.88	86.34	0.01823529	15.49	-9.03	3.23	20.85216269	1	
20020410	86.27	86.45	86.17	86.33	0.03441176	12.29676	1.555	6.925882	56.32280131	1	
20020411	86.24	86.77	86.23	86.6	0.04705882	12.57706	1.07	6.823529	54.25377672	1	
20020412	86.29	86.38	86.05	86.22	0.015	13.775	-3.485	5.145	37.35027223	1	

PHASE CHANGE INDEX (35 DAYS)						
Time period tested: 01/02/1980–04/30/2003						
Commission/slippage: \$75.00						
Type of contract: continuous						
Market groups	Total PL (\$)	Avg trade (\$)	Max drawdn (\$)	Total trades	Win (%)	P: L
Currencies						
Australian dollar	7045.00	75.75	21,145.00	93	36.56	1.88
British pound	139,356.30	1,233.24	31,950.00	113	44.25	2.62
Canadian dollar	-4,970.00	-37.09	20,960.00	134	32.84	1.91
Dollar index	84,795.00	892.58	17,435.00	95	48.42	2.12
Euro currency–DM	232,987.50	2,080.25	19,925.00	112	52.68	2.24
Japanese yen	139,762.50	1,100.49	15,987.50	127	42.52	2.54
Swiss franc	153,850.00	1,292.86	9,625.00	119	49.58	2.40
Interest rates						
Eurodollar	39,650.00	392.57	9,400.00	101	37.62	3.01
Muni bonds	20,437.50	194.64	18,506.25	105	33.33	2.34
T-bonds	-7,818.75	-58.79	30,181.25	133	33.83	1.87
T-notes (10 yr)	60,803.13	568.25	11,871.88	107	42.99	2.25
T-notes (5 yr)	35,528.13	514.90	6,306.25	69	44.93	2.49
Energies						
Crude oil	27,640.00	242.46	22,330.00	114	42.98	1.68
Heating oil	22,488.60	157.26	33,923.40	143	40.56	1.71
Natural gas	90,810.00	1,261.25	16,855.00	72	44.44	2.59
Unleaded gas	-7,972.80	-64.30	38,106.00	124	37.90	1.55
Metals						
Copper	-2,912.50	-20.66	27,800.00	141	33.33	1.95
Gold	36,185.00	260.32	22,825.00	139	35.97	2.38
Palladium	55,325.00	395.18	32,640.00	140	29.29	3.50
Platinum	-29,525.00	-186.87	48,245.00	158	29.75	1.79
Silver	121,680.00	856.90	46,980.00	142	33.10	3.55
Softs						
Coffee	124,106.30	1,025.67	43,275.00	121	38.02	2.52
Cotton	13,070.00	92.70	37,605.00	141	27.66	2.86
Lumber	-34,797.00	-246.79	78,873.00	141	37.59	1.34
Orange juice	2,520.00	18.39	45,945.00	137	33.58	2.02
Sugar	37,590.00	298.33	18,478.80	126	40.48	2.20
Grains						
Corn	26,375.00	202.88	8,037.50	130	40.00	2.52
Oats	-5,400.00	-38.03	18,212.50	142	28.87	2.21
Rough rice	56,190.00	802.71	3,690.00	70	44.29	3.71
Soybeans	-11,887.50	-76.20	57,612.50	156	34.62	1.73
Soybean oil	5,550.00	40.22	12,495.00	138	36.96	1.86
Wheat	37,275.00	293.50	11,537.50	127	39.37	2.63
Meats						
Feeder cattle	25,982.50	212.97	17,080.00	122	35.25	2.42
Live hogs	59,034.00	476.08	15,059.00	124	40.32	2.70
Pork bellies	-43,795.00	-275.44	56,835.00	159	30.19	1.82

FIGURE 8: HYPOTHETICAL RESULTS OF PHASE CHANGE INDEX (35 DAYS)

PORTFOLIO PERFORMANCE RESULT OF PCI ACROSS VARIOUS PARAMETER VALUES					
Parameter values	22 days	28 days	35 days	42 days	50 days
Net profit	\$1,199,750.00	1,146,265.00	1,506,958.00	1,692,858.00	1,563,880.00
Maximum drawdown	122,730.00	170,369.10	134,870.80	109,989.90	90,344.65
% return	29.37	22.13	34.53	44.64	46.82
No. of profitable markets out of 35	27	26	26	30	29
No. of profitable years out of 23	17	18	20	20	19
Average trade	181.26	211.96	349.24	467.25	511.74
No. of trades	6,619	5,408	4,315	3,623	3,056
% winners	35.78	36.04	37.40	38.34	38.87
P/L ratio	2.22	2.22	2.33	2.42	2.37

FIGURE 9: PERFORMANCE RESULTS. These results show the performance of the PCI across various parameter values.

Note that a profitable parameter in the past is not necessarily a profitable parameter in the future. Hence, if the PCI is only profitable on a few parameters, with the profitable parameter values constantly changing, a high probability exists that you may in fact be trading a losing parameter. However, if the PCI shows consistent profitability on a wide range of parameter values, even if you were to randomly select one from the range, it is likely to be profitable.

Take a look at Figure 9. You will see that the PCI is profitably trading the portfolio using any of the five parameters. In fact, I am quite confident that the PCI will be profitable trading the portfolio for any parameter between 22 days and 50 days inclusively, even though I have not tested it. Its profitability does not necessarily have to be confined in this range; it may well extend beyond. Test it to convince yourself, and you may be surprised that the PCI is trading the portfolio profitably in almost any parameter, as long as it is not extremely large (200 days) or small (three days).

Returning to Figure 9: at its best performance, the 42-day PCI netted \$1,692,858 in profits. Its worst performance out of the five occurs when using the 28-day PCI. However, it is still profitable, making \$1,146,265 trading the portfolio of 35 markets, and taking only one contract per trading signal per market. This certainly shows the robustness of the PCI across parameter values.

Finally, let's take a look at its robustness across the years. There are a total of 23 years in the test period (January 1, 2002, to April 30, 2003, is treated as one year). At its worst, the 22-day PCI is profitable in 17 out of 23 years, which is equivalent to being profitable in about 75% of the years tested. At its best, we have 20 profitable years out of 23 tested, which is more than 85%.

I will end this section by looking at the annual percentage return of trading the portfolio. If the account size required to trade a portfolio is the sum of its maximum closed trade drawdown and its margin of approximately \$55,000, the 50-

day PCI returns about 46.82% per annum. Even its worst parameter value of 28 days managed to produce a 22.13% yearly return.

CONCLUSION

The phase change index is robust across parameters, markets, and years. It managed to net a profit in excess of \$1 million trading a portfolio of 35 markets over a 23-year period, taking only one contract per market per trading signal. I will leave you to imagine how much more the indicator would produce if you were to incorporate proper money management rules into the indicator, increasing the number of contracts as the profit in the account accumulates over the hypothetical 23 years.

The PCI is tested here as a reversal system *without* any money management stop-losses or trailing stops. If you were to incorporate stops, you might make a good indicator even better.

If you do make any amendments to the indicator, remember to test the new version thoroughly before trading it. I hope you find the PCI useful enough to make it part of your trading arsenal. If you have any comments about the indicator, I would love to hear from you.

M.H. Pee is a private trader specializing in systems development. He has developed several indicators and systems, some of which are currently being tracked by Futures Truth.

SUGGESTED READING

Pee, M.H. [2002]. "Trend Intensity Index," *Technical Analysis of STOCKS & COMMODITIES*, Volume 20: June.
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†See *Traders' Glossary for definition*

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