IG INDEX

Equity pairs:
a trading strategy

1st January 2009
Anthony Grech
Research Analyst
IG Index

Equity pairs: a trading strategy

Evaluating pairs trading; how to generate low-risk profits by co-relating the share price of two similar companies

Objective

This report introduces and explains a strategy known as pairs trading. It also includes a step-by-step guide on how to identify suitable pairs and construct a basic analysis.

Introduction

Pairs trading is a popular strategy whereby a trader exploits the trading pattern between two similar shares in an attempt to generate a low-risk profit, without taking a view of the overall direction of the market.

Certain securities can be observed to move in the same direction on most days: the prices of these securities can be said to be co-related. This is most often seen in shares in companies from the same sector that are very similar to each other; for example, direct competitors such as Coca Cola and PepsiCo. It stands to reason that general economic vagaries that affect the profit and loss (and therefore the share price) of Coca Cola will affect PepsiCo in similar ways.

Certain market conditions may result in a breakdown in the co-relation between two shares, however, thus widening or narrowing the historical price ratio relationship (the ratio between the two share prices).

The breakdown may be down to a rational, fundamental reason (for example, an economic factor that one company is exposed to but not the other; as we have established, this is not likely to happen with companies that are very similar, but it is possible), or the breakdown may occur because of irrational factors, such as panic-selling or trader-bias. The assumption with pairs-trading is that the latter of these two should only be a temporary discrepancy, owing to its irrational nature, and that the historical relationship between the two securities will, in time, be restored.

Once the historical price ratio between two highly co-related companies has changed, assuming that this is a transitory inconsistency, one company can be perceived to be 'undervalued' and the other 'overvalued'.

A pairs trader aims to profit in such a situation by exploiting the divergence in the share price of the pairs. This is done by placing a long position on the 'undervalued' share and simultaneously placing a short position on the 'overvalued' share, with the intent of taking a profit when the price ratio between the two securities converges back to its historical level.

It is worth mentioning that one of the positions will, in all likelihood, end up making a loss. If implemented correctly, however, the profit in the other position should more than compensate.

A major benefit of pairs trading is that it is a 'market-neutral' strategy. This means that a trader does not take a directional view on the market but, rather, makes decisions based purely on the price-relationship between the two chosen shares. Naturally, the exposure to both the short and long position should be of equal weighting in order to best avoid any exposure to overall market direction.

Some examples of shares that have historically been highly co-related, and therefore making suitable candidates for pairs trading, are:

1) Coca Cola and PepsiCo
2) Sainsbury and Tesco
3) Royal Dutch Shell 'A' shares and BP
4) Royal Dutch Shell 'A' and 'B' shares
5) Rio Tinto and BHP Billiton
6) Yahoo and Google

Apart from placing a short and long position on shares, variations on the basic concept of pairs trading may also be implemented in a variety of ways, including trading from a fundamental analysis perspective (e.g. placing a short position on a share trading at an above average PE to the benchmark and placing a long position on a rival trading below the average PE benchmark). Another variation involves going short on an index and going long on a stock that is expected to outperform that index, or going long on an index and short on a stock that is a part of the index but expected to decline.

Basic pairs trade application

This section provides a basic step-by-step guide on how I would implement a pairs trade. I have used Coca Cola and PepsiCo as examples.

1) The first step is to choose two companies that you think might be highly co-related. As already mentioned, a good place to start is with two companies in the same sector that are clearly similar in their business operations. A visual comparison of historical share price movement using charts will allow you to quickly identify if theres some kind of basic co-relation.

2) The second step is to test quantitatively the share-price co-relation of the two securities being analysed. As a rule of thumb, the higher the co-relation, the better.

Co-relation coefficients vary between 1.00 and -1.00, with 1.00 indicating that the share price of the two securities is moving in the same direction 100% of the time and -1.00 connoting that one security is moving in the opposite direction to the other asset 100% of the time. To be on the safe side, I would place a co-relation of 0.75 and above as being significant.

I have calculated the co-relation coefficient for Coca Cola and PepsiCo for the period between October 31, 2007 and October 31 2008. The co-relation for this pair was 0.84, meaning that Coca Cola and PepsiCo moved in the same direction 84% of the time during this period, and consequently, should be appropriate for pairs trading.

The simplest way of calculating the co-relation is by importing the two sets of share price data into Microsoft

Excel, which has a specific function designed for this very purpose. To do so, type '=correl(' in a cell. You will then be prompted to complete the formula by entering two 'arrays' (an array is a range of cells that contain the values of the data sets to be compared). Select the column containing the share price of one company in the section labelled 'Array 1' and select the column containing the other company's share price into 'Array 2' (the arrays should be separated by a comma in the formula). Finish the formula with a closing bracket. See illustration below:

	A	B	C Coca Cola Close	D Pepsi Close
226	224	19-Sep-08	52.72	73.19
227	225	22-Sep-08	51.38	71.08
228	226	23-Sep-08	50.68	70.75
229	227	24-Sep-08	50.19	70.1
230	228	25-Sep-08	51.46	71.3
231	229	26-Sep-08	52.48	71.71
232	230	29-Sep-08	51.03	69.66
233	231	30-Sep-08	52.88	71.27
234	232	01-Oct-08	54.16	71.64
235	233	02-Oct-08	53.6	70.91
236	234	03-Oct-08	52.57	69
237	235	06-Oct-08	50.92	66.64
238	236	07-Oct-08	49.3	65.12
239	237	08-Oct-08	47.41	63.61
240	238	09-Oct-08	43.3	59.52
241	239	10-Oct-08	41.5	57.8
242	240	13-Oct-08	47.26	61.77
243	241	14-Oct-08	43.73	54.4
244	242	15-Oct-08	44.21	51.25
245	243	16-Oct-08	45.78	53.08
246	244	17-Oct-08	44.2	53.88
247	245	20-Oct-08	46.46	56.76
248	246	21-Oct-08	46.03	55
249	247	22-Oct-08	45.30	53.64
250	248	23-Oct-08	43.06	53.48
251	249	24-Oct-08	41.61	51.76
252	250	27-Oct-08	41.01	51.49
253	251	28-Oct-08	45.25	55.83
254	252	29-Oct-08	43.85	55
255	253	30-Oct-08	44.66	57.08
256	254	31-Oct-08	44.06	57.01
	Correlation		84%	

CORREL =CORREL(C3:C256,D3:D256)

Function Arguments — CORREL
Array1 C3:C256 = {60.21;59.37;58.99,...
Array2 D3:D256 = {72.06;70.76;71.34,...
= 0.842150895
Returns the correlation coefficient between two data sets.
Array2 is a second cell range of values. The values should be numbers, names, arrays, or references that contain numbers.
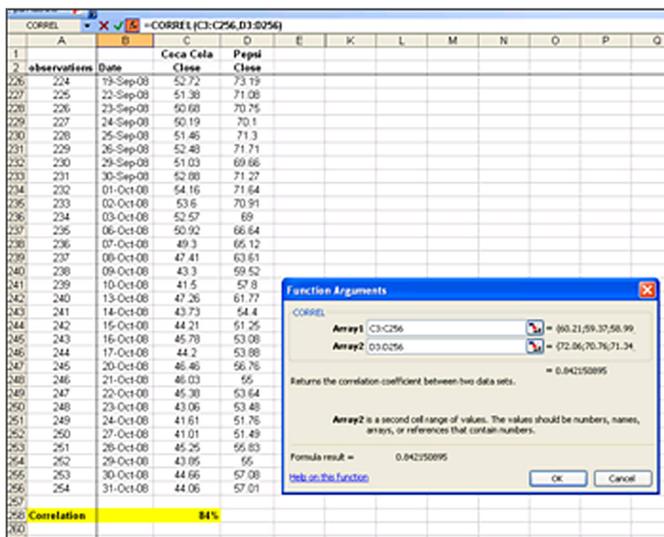Formula result = 0.842150895

Chart 2, overleaf, provides a visual representation of Coca Cola and PepsiCo's co-relation. Notice that they move in the same direction most of the time.

3) The next step is to calculate the 'price ratio', as I have done in Chart 3. The price ratio is calculated by simply dividing the share price of one company by another. For simplicity of analysis it is easier to divide the share price of the company with the higher share price by the one with the lower share price.

In my example I have divided the share price of PepsiCo by Coca Cola's. The blue line on the chart indicates the price ratio between the share price of PepsiCo and Coca Cola, (referred to as 'P/C' in the key of Chart 3 and shown in column F of the Excel illustration below).

4) Now that the daily price ratio has been calculated, it is possible to calculate the average (arithmetic mean) of the price ratio. By definition, we would, more often than not, expect a closely co-related pair to return to the mean after any period of divergence away from the mean. This will be a useful measurement in trying to construct a yardstick by which to measure when to enter a pairs trade (once the price ratio between a pair has moved sufficiently far away from the mean) and when to close a pairs trade (when the price ratio between a divergent pair has returned to the mean).

The average is calculated by summing the price ratio data over the period under review and dividing the result by the number of observations. The average can be calculated easily in Excel by typing '=average (' into a cell, and then selecting the column containing the price ratio data (once again you'll need a closing bracket on the end to complete your formula). In my example, the average price ratio between Coca Cola and PepsiCo's share price between October 31, 2007 and 31, October 2008 was 1.23, illustrated in column G.

5) The penultimate step involves subtracting the mean price ratio (or average price ratio) from the actual price ratio so as to calculate how far the ratio has diverged from the mean level. My example is illustrated in column H, below, derived by subtracting column G from column F.

F261 =AVERAGE(F3:F256)

	A	B Date	C Coca Cola Close	D Pepsi Close	F Price Ratio Step 3	G Mean Ratio Step 4	H Diff from mean ratio Step 5
216	214	05-Sep-08	51.56	68.92	1.34	1.23	0.11
217	215	08-Sep-08	53	70.34	1.33	1.23	0.10
218	216	09-Sep-08	53.5	71	1.33	1.23	0.10
219	217	10-Sep-08	53.43	71.83	1.34	1.23	0.11
220	218	11-Sep-08	54.15	72.62	1.34	1.23	0.11
221	219	12-Sep-08	54.5	73.15	1.34	1.23	0.11
222	220	15-Sep-08	54.75	72.35	1.32	1.23	0.09
223	221	16-Sep-08	54.85	72.98	1.33	1.23	0.10
224	222	17-Sep-08	52.66	71.68	1.36	1.23	0.13
225	223	18-Sep-08	53.39	73.23	1.37	1.23	0.14
226	224	19-Sep-08	52.72	73.19	1.39	1.23	0.16
227	225	22-Sep-08	51.38	71.08	1.38	1.23	0.15
228	226	23-Sep-08	50.68	70.75	1.40	1.23	0.17
229	227	24-Sep-08	50.19	70.1	1.40	1.23	0.17
230	228	25-Sep-08	51.46	71.3	1.39	1.23	0.15
231	229	26-Sep-08	52.48	71.71	1.37	1.23	0.14
232	230	29-Sep-08	51.03	69.66	1.37	1.23	0.13
233	231	30-Sep-08	52.88	71.27	1.35	1.23	0.12
234	232	01-Oct-08	54.16	71.64	1.32	1.23	0.09
235	233	02-Oct-08	53.6	70.91	1.32	1.23	0.09
236	234	03-Oct-08	52.57	69	1.31	1.23	0.08
237	235	06-Oct-08	50.92	66.64	1.31	1.23	0.08
238	236	07-Oct-08	49.3	65.12	1.32	1.23	0.09
239	237	08-Oct-08	47.41	63.61	1.34	1.23	0.11
240	238	09-Oct-08	43.3	59.52	1.37	1.23	0.14
241	239	10-Oct-08	41.5	57.8	1.39	1.23	0.16
242	240	13-Oct-08	47.26	61.77	1.31	1.23	0.08
243	241	14-Oct-08	43.73	54.4	1.24	1.23	0.01
244	242	15-Oct-08	44.21	51.25	1.16	1.23	-0.07
245	243	16-Oct-08	45.78	53.08	1.16	1.23	-0.07
246	244	17-Oct-08	44.2	53.88	1.22	1.23	-0.01
247	245	20-Oct-08	46.46	56.76	1.22	1.23	-0.01
248	246	21-Oct-08	46.03	55	1.19	1.23	-0.04
249	247	22-Oct-08	45.30	53.64	1.18	1.23	-0.05
250	248	23-Oct-08	43.06	53.48	1.24	1.23	0.01
251	249	24-Oct-08	41.61	51.76	1.24	1.23	0.01
252	250	27-Oct-08	41.01	51.49	1.26	1.23	0.02
253	251	28-Oct-08	45.25	55.83	1.23	1.23	0.00
254	252	29-Oct-08	43.85	55	1.25	1.23	0.02
255	253	30-Oct-08	44.66	57.08	1.28	1.23	0.05
256	254	31-Oct-08	44.06	57.01	1.29	1.23	0.06
	Correlation		0.84				
	Mean Price Ratio					1.23	

6) The objective of the final step is to calculate the standard deviation of the price ratio. Standard deviation measures the dispersion of a set of numbers from the average. In other words, it indicates how far we might expect the price ratio to diverge from the mean ratio on average. A low standard deviation means that most of the values are near the mean, and a high standard deviation means that the price ratio may vary a lot from the mean value. So, it is a useful measure of how much we might typically expect the ratio to diverge from the mean, thus providing a pointer as to when the price ratio is likely to begin reverting to the mean.

Once again there is a specific function in Excel that can be used to do the calculations for you: in this case, the formula is =stdev (data array). So, type '=stdev(' into a cell and then select the column containing the difference from mean ratio (column H in the Excel illustration above).

The standard deviation of the divergence from the mean ratio for Coca Cola and PepsiCo during the period under review was 0.06. This gives us a measure of the typical magnitude of divergence of the price ratio between PepsiCo and Coca Cola's above and below the mean price ratio of 1.23 between October 2007 and October 2008.

Using the standard deviation as the yardstick by which we measure when we should enter a trade (and believing that the historical data we are looking at establishes a pattern that is likely to be repeated going forward), it suggests that our signal for buying Coca Cola and selling PepsiCo should be when the price ratio between the two share prices reaches 0.06 above the mean ratio (which was 1.23). In other words, if the ratio between the two reaches as high as 1.29, we enter this trade. Similarly, our signal for going short on Coca Cola and long on PepsiCo should be whenever the ratio falls to 1.17 (the mean minus the standard deviation of 0.06). This relationship may be viewed on Chart 3, below.

Charts 2 and 3 - Nominal Share Price & Price Ratio
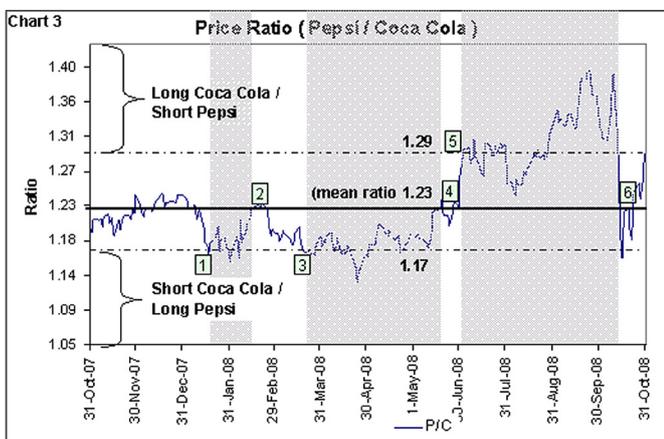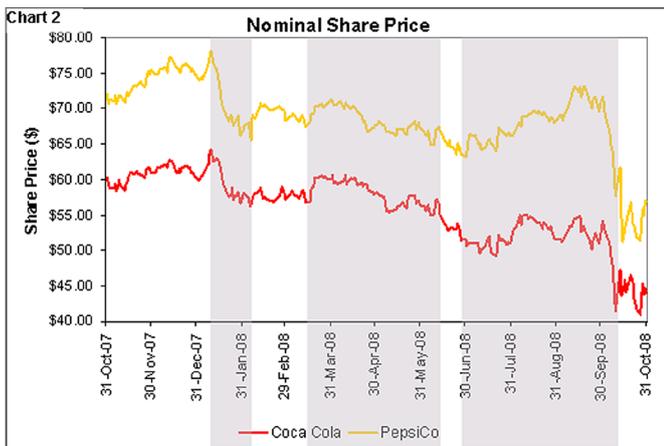
Source: Raw data retrieved from Bloomberg (November 3, 2008)

Making sense of what has been explained so far

The most important characteristic illustrated by Chart 3 is the mean reverting relationship: notice that the price ratio converges reasonably quickly back to the mean ratio of 1.23 after diverging to the 1.29 (upper band) and 1.17 (lower band) price ratio levels.

The upper and lower bands mark the periods when we should be entering a pairs trade while the mean level of 1.23 indicates the level when we should be closing the pairs trade.

Although having a mean reverting model is crucial, it is equally important that the share price of the two companies have a high co-relation and that the difference from the mean ratio has a low standard deviation. As a rule of thumb, the lower the standard deviation, the better. This is because once you've entered a trade, you would expect your net position to move against you by less if the standard deviation is small.

It is also important to understand that the price ratio relationship between two companies may break down over time – this is one of the major risks of pairs trading. The price ratio relationship between two companies may permanently break down on the back of company-specific information such as an earnings or credit-rating downgrade, that affects only one of the two companies.

It is important, therefore, to understand that the analysis presented in this report is likely to be more effective in the absence of company-specific information. As a result, make a habit of trying to discern whether something has clearly caused the price ratio between two companies to deviate. If there isn't any particular reason (i.e. it is a result of the market behaving irrationally) then it could be a good pairs trading opportunity.

Risk management is also very important; always keep the exposure to each company balanced. For instance, if you are dealing with companies that have share prices of $40 and $50, your transaction size for the $50 share should be 80% of your transaction size for the $40 share. If your exposure to each company is not equal, it removes the market-neutral aspect of your pairs trade.

Finally, reversion of the price ratio to the mean may take time: a week, three months, maybe more. Therefore, this type of trading is not suitable if you are looking for a very short-term solution.

Pairs trading in practice

Now that I have explained how to construct a basic pairs trading model and how to interpret it, the next question is can you really make a profit by trading price ratio differentials?

I will look at the profit that would have resulted from executing a pairs trade with PepsiCo and Coca Cola whenever the price ratio touched the 1.29 and 1.17 levels.

Chart 3 (label 1) shows the price ratio between PepsiCo and Coca Cola's share price deviating to the 1.17 level on January 30, 2008, which is the level usually reached before reverting back to the mean price ratio. The price ratio touched this level because PepsiCo's share price had fallen at a faster pace than Coca Cola's share price.

It is important to consider whether or not the price ratio had moved away from the mean because of information that may have fundamentally altered the co-relation between the companies. If there is some piece of news that specifically affects one of the companies but not the other, the deviation is more than likely justified, in which case it would not be a good move to enter a pairs trade, as this information is likely to alter the crucial mean-reverting price ratio characteristic between the companies' share prices.

In my example there wasn't any information justifying the deviation from the mean price ratio at the time, suggesting that the deviation was irrational and would eventually prove to be transitory. Had I placed a $1 short position on Coca Cola and $0.86 long position on epsiCo on January 30, as illustrated on the Chart 3 (label 1), and closed that trade on February 19, 2008 the day the price ratio had reverted back to the average price ratio, see Chart 3 (label 2), I would have had a balance of $281.75 in my P&L account– see calculation below.

Notice that my pairs trade exposure when entering a trade is always equal; for instance, my Coca Cola exposure, at $1 per point, on January 30, 2008 was $56.62. Since PepsiCo's share price was higher, I had to place a $0.86 per point position on this security in order to obtain the equivalent exposure of $56.62.

Chart	Trading	Coca Cola	PepsiCo	
Labels	Date	share price	share price	price ratio
1	30-Jan	$56.62	$66.20	1.17
2	19-Feb	$56.95	$69.88	1.23
	Position	short	long	
	per point position	$1.00	$0.86	
	exposure	$56.62	$56.62	
	difference (cents)	-33	368	Total P&L
	Profit or Loss	-$33.00	$314.75	$281.75

NB: Above calculation based on closing prices

Chart	Trading	Coca Cola	PepsiCo	
Labels	Date	share price	share price	price ratio
3	26-Mar	$60.32	$70.28	1.17
4	18-Jun	$52.78	$64.66	1.23
	Position	short	long	
	per point position	$1.00	$0.86	
	exposure	$60.32	$60.32	
	difference (cents)	754	-562	Total P&L
	Profit or Loss	$754.00	-$482.35	$271.65

NB: Above calculation based on closing prices

Chart	Trading	Coca Cola	PepsiCo	
Labels	Date	share price	share price	price ratio
5	10-Jul	$49.69	$65.19	1.31
6	14-Oct	$43.73	$54.40	1.23
	Position	long	short	
	per point position	$1.00	$0.76	
	exposure	$49.69	$49.69	
	difference (cents)	-596	1079	Total P&L
	Profit or Loss	-$596.00	$822.45	$226.45

NB: Above calculation based on closing prices

Other examples

This section identifies other suitable pairs trades. It applies the methodology explained in the previous sections of this report to different companies in order to provide the reader with a better understanding of how to identify viable pairs.

I have also arranged the examples in order of 'model strength', with one indicating that the companies in the pairs trade satisfy only one of the criteria for identifying pair trade opportunities and three indicating a strong model, satisfying all of the three criteria.

Suitable pairs will satisfy all of the following three criteria:

1) Strong mean reverting relationship

2) High price co-relation, preferably above 0.75.

3) The standard deviation of the difference from mean price ratio should be low.

1) Sainsbury / Tesco Model Strength: 3
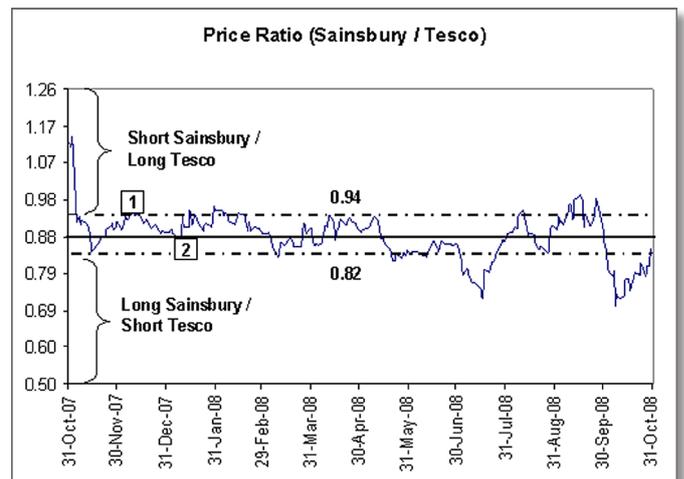
Raw data sourced from Bloomberg (November 3, 2008) and based on end of day closing prices.

Review period: October 31, 2007 to October 31, 2008
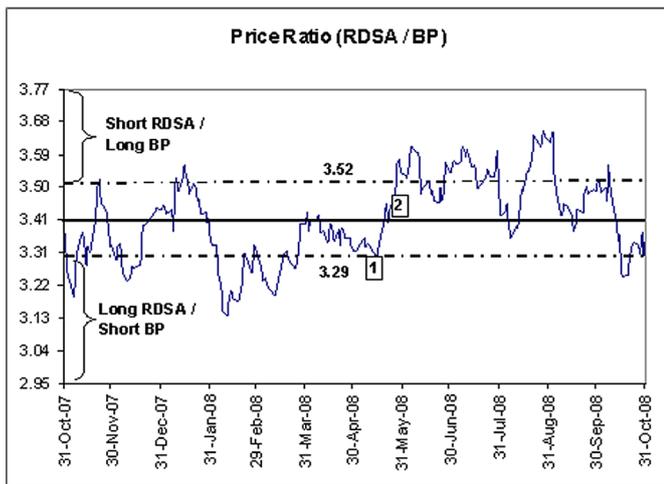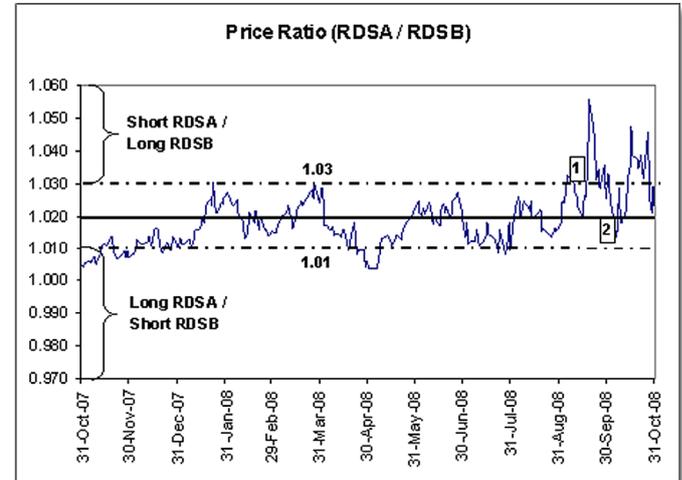
Co-relation: 0.91

Mean Price Ratio: 0.88

Standard Deviation (difference from mean ratio): 0.06

Upper band: 0.94

Lower band: 0.82

Labels	Trading	Sainsbury	Tesco	
	Date	Sp (pence)	Sp (pence)	price ratio
1	10-Dec	449.3	476.8	0.94
2	07-Jan	391.0	445.5	0.88
	Position	short	long	
	per point position	£1.00	£0.94	
	exposure (pence)	449	449	Profit
	difference (pence)	5825	-3125	(pence)
	Profit or Loss (pence)	5,825	-2,945	2,880

2) Royal Dutch Shell 'A' shares / BP
Model Strength 3

Raw data sourced from Bloomberg (November 3, 2008) and based on end of day closing prices.

Review period: October 31, 2007 to October 31, 2008
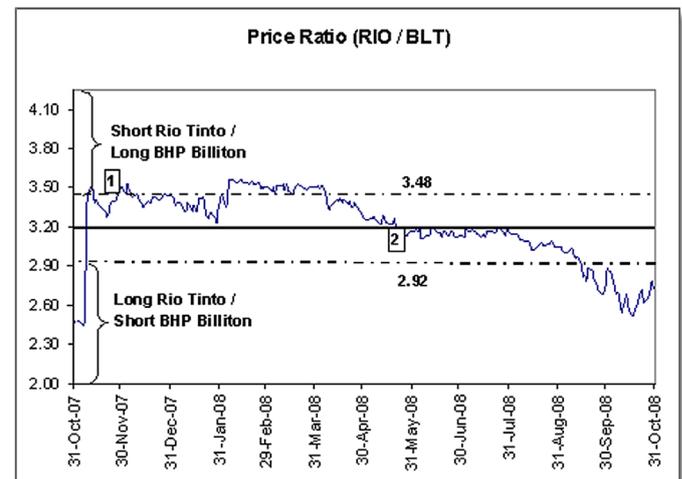
Co-relation: 0.94

Mean Price Ratio: 3.41

Standard Deviation (difference from mean ratio): 0.12

Upper band: 3.52

Lower band: 3.29

Labels	Trading	RDSA	BP	
	Date	Sp (pence)	Sp (pence)	price ratio
1	15-May	2,059	626	3.29
2	20-May	2,141	628	3.41
	Position	long	short	
	per point position	£1.00	£3.29	
	exposure (pence)	2,059	2,059	Profit
	difference (pence)	8200	-250	(pence)
	Profit or Loss (pence)	8,200	-823	7,377

3) Royal Dutch Shell 'A' / 'B' shares
Model Strength 3

Raw data sourced from Bloomberg (November 3, 2008) and based on end of day closing prices.

Review period: October 31, 2007 to October 31, 2008

Co-relation: 0.998

Mean Price Ratio: 1.02

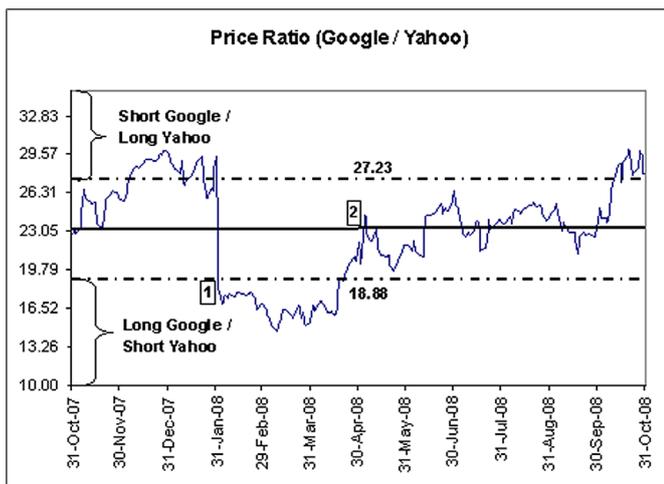Standard Deviation (difference from mean ratio): 0.01

Upper band: 1.03

Lower band: 1.01

	Trading	RDSA	RDSB	
	Date	Sp (pence)	Sp (pence)	price ratio
	17-Sep	1,602	1,562	1.03
	06-Oct	1,502	1,479	1.02
	Position	short	long	
	per point position	£1.00	£1.03	
	exposure (pence)	1,602	1,602	Profit
	difference (pence)	10000	-8300	(pence)
	Profit or Loss (pence)	10,000	-8,513	1,487

4) Rio Tinto / BHP Billiton Model Strength 2

Raw data sourced from Bloomberg (November 3, 2008) and based on end of day closing prices.

Review period: October 31, 2007 to October 31, 2008

Co-relation: 0.93

Mean Price Ratio: 3.2

Standard Deviation (difference from mean ratio): 0.28

Upper band: 3.48

Lower band: 2.92

	Trading	RIO	BLT	
	Date	Sp (pence)	Sp (pence)	price ratio
1	29-Nov	5,637	1,618	3.48
2	21-May	6,641	2,066	3.21
	Position	short	long	
	per point position	£1.00	£3.48	
	exposure (pence)	5,637	5,637	Profit
	difference (pence)	-100400	44800	(pence)
	difference (pence)	-100,400	156,080	55,680

NB: The Rio / BHP Billiton chart illustrates a weak mean reverting relationship.

5) Google and Yahoo Model Strength 2

Price Ratio (Google / Yahoo)

Raw data sourced from Bloomberg (November 3, 2008) and based on end of day closing prices.

Review period: October 31, 2007 to October 31, 2008

Co-relation: 0.50

Mean Price Ratio: 23.05

Standard Deviation (difference from mean ratio): 4.18

Upper band: 27.23

Lower band: 18.88

	Trading	Google	Yahoo	
	Date	share price	share price	price ratio
1	01-Feb	$515.90	$28.38	18.18
2	12-May	$584.94	$25.26	23.16
	Position	long	short	
	per point position	$1.00	$18.18	
	exposure	$515.90	$515.90	
	difference (cents)	6904	312	Total P&L
	Profit or Loss	$6,904.00	$5,671.63	$12,575.63

NB: Although the mean reverting relationship and share price co-relation in this example are weak, it is still possible to implement a pairs trade. The accuracy of the model's entry and exit points diminishes, however, raising your risk levels.

Concluding remarks

I hope that this report has served its educational purpose of teaching readers more about pairs trading. Also note that pairs trading, like any trading strategy, can be risky. The analysis explained in this report is based on historic relationships that could permanently break down on the back of company specific news and result in a loss-making position.

It is also important to note that traders are not allowed to place short positions on designated financial services shares listed on the London Stock Exchange.

In mid-September 2008, the Financial Services Authority (FSA) banned short-selling of 32 UK financial companies until January 16 2009 in an attempt to curb downward speculative pressures on their share prices.

The footnotes at the bottom include the 32 companies forming part of the FSA short-selling ban. [1]

Disclaimer

[1] The following companies form part of the FSA's short selling list:
1) Admiral Group 2) Alliance & Leicester 3) Alliance Trust 4) Arbuthnot Banking Group 5) Aviva 6) Barclays 7)Bradford & Bingley 8) Brit Insurance Holding 9) Chesnara 10) Close Brothers Group 11) European Islamic Investment Bank 12) Friends Provident 13) HBOS 14) Highway Insurance Group 15) HSBC Holdings 16) Investec 17) Island Bank of Britain 18) Just Retirement Holdings 19) Legal & General 20) Lloyds TSB Group 21) London Scottish Bank 22) Novae Group 23) Old Mutual 24) Prudential 25) Rathbone Brothers 26) Royal Bank of Scotland 27)RSA Insurance Group 28) Schroders 29) St James Place 30) Standard Chartered 31) Standard Life 32) Tawa.