Cointegration is not the same as correlation

By Ernest P. Chan, Ph.D.

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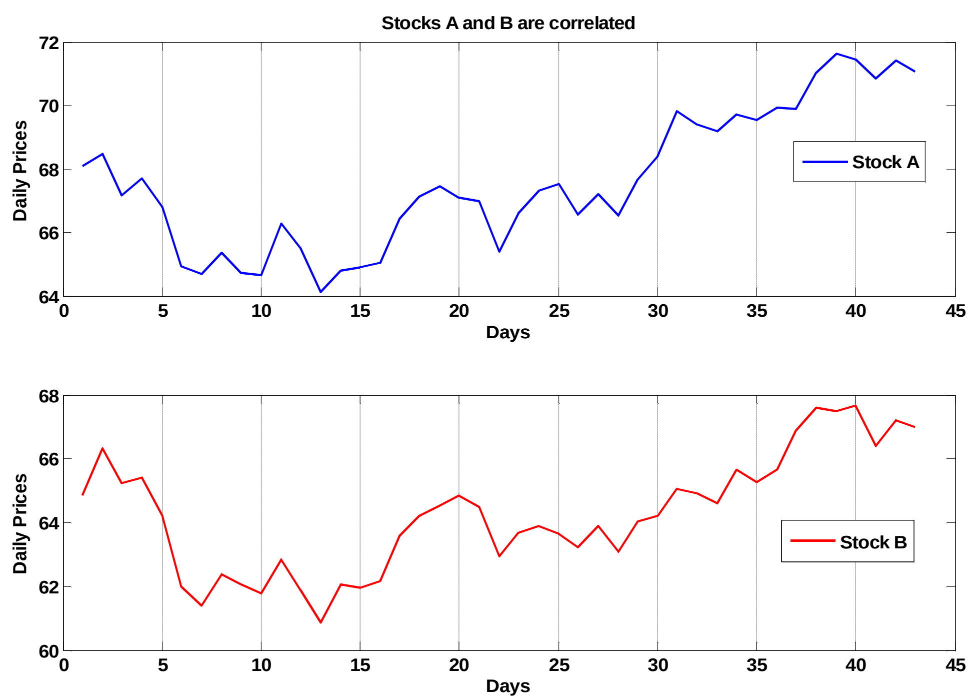
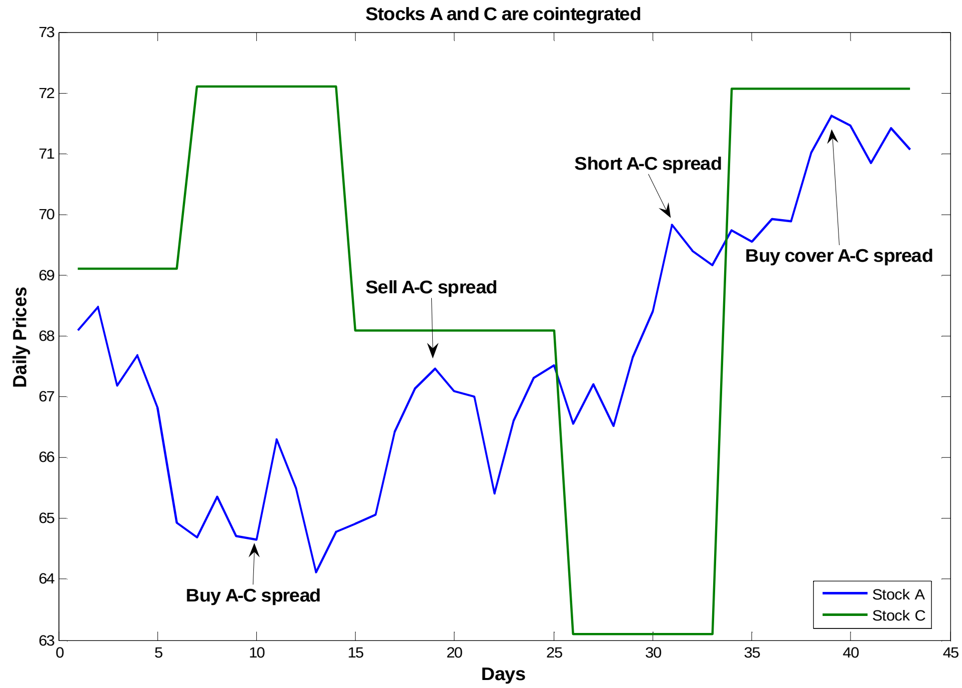
A reader asked me recently why I believe that energy stock prices (e.g. XLE) are correlated with crude oil futures front-month contract (QM). Actually I don't believe they are necessarily correlated – I only think they are "cointegrated".

What is the difference between correlation and cointegration? If XLE and QM were really correlated, when XLE goes up one day, QM would likely go up also on the same day, and *vice versa*. Their daily (or weekly, or monthly) returns would have risen or fallen in synchrony. But that's not what my analysis was about. I claim that XLE and QM are cointegrated, meaning that the two price series cannot wander off in opposite directions for very long without coming back to a mean distance eventually. But it doesn't mean that on a daily basis the two prices have to move in synchrony at all.

Two hypothetical graphs illustrate the differences. In the first graph, stock A and stock B are correlated. You can see that their prices move in the same direction almost everyday.



Now consider stock A and stock C.



Stock C clearly doesn't move in any correlated fashion with stock A: some days they move in same direction, other days opposite. Most days stock C doesn't move at all! But notice that the spread in stock prices between C and A always return to about $1 after a while. This is a manifestation of cointegration between A and C. In this instance, a profitable trade would be to buy A and short C at around day 10, then exit both positions at around day 19. Another profitable trade would be to buy C and short A at around day 31, then closing out the positions around day 40.

Cointegration is the foundation upon which pair trading ("statistical arbitrage") is built. If two stocks simply move in a correlated manner, there may never be any widening of the spread. Without a temporary widening of the spread in either direction, there is no opportunity to short (or buy) the spread, and no reason to expect the spread to revert to the mean either.

For further reading:

Alexander, Carol (2001). *Market Models: A Guide to Financial Data Analysis*. John Wiley & Sons.

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