On the Persistence of Cointegration in Pairs Trading

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Pairs Trading

Coca-Cola (KO) vs. Pepsi (PEP), 3/1/2013 – 7/13/2013
(source: Yahoo!)

How to Make a Pairs Trade:

1. Identify two securities that tend to travel together.
2. When a gap opens between their prices, buy the cheaper security and sell short the more expensive one.
3. When the gap closes, close the position and collect a profit.
Cointegration

$X_t$ and $Y_t$ are cointegrated if:

(a) Neither series is mean-reverting by itself, and
(b) Some linear combination of $X_t$ and $Y_t$ is mean-reverting

In equations:

$Y_t = \alpha + \beta X_t + R_t$

$R_t = \rho R_{t-1} + \epsilon_t$

Engle-Granger two step procedure:

1. Find $\alpha$ and $\beta$ through a linear fit of $Y_t$ vs. $X_t$
2. Find $\rho$ through a linear of $R_t$ vs $R_{t-1}$
   Check whether $|\rho| = 1$
Persistence Defined

What a cointegration test distinguishes between:

$H_0$  During the formation period, the price series of the two securities were not cointegrated.

$H_1$  During the formation period, the price series of the two securities were cointegrated.

What we really want to know:

$H_2$  During the trading period, the price series of the two securities will be cointegrated.

The pair is deemed persistent if $H_1 \Rightarrow H_2$
Data Set

- Adjusted closing prices of S&P 500 components as of 8/13/2014 for the period 1/1/2002 – 12/31/2012 were downloaded from Yahoo!.
- Data is divided into one year periods by calendar year.
- Over 860,000 pairs were examined
Main Result:
No Evidence of Persistence Found

Many different combinations were tried:

- 6 different unit root tests
- Logged and unlogged series
- 1-year and 2-year formation periods
- $p=0.05$ and $p=0.01$
- False discovery rates tried in place of $p$-values
- Also looked for evidence of short-term persistence
EGCM package
(Engle-Granger Cointegration Models)

> library(egcm)
> yegcm("PEP", "KO", 20130101, 20131231)

KO[i] = 0.2611 PEP[i] + 18.2149 + R[i],
       (0.0147)            (1.1702)

R[i] = 0.9857 R[i-1] + eps[i],
       (0.0184)

eps ~ N(0, 0.3064^2)

R[2013-12-31] = 1.2660 (t = 1.204)

WARNING: PEP and KO do not appear to be cointegrated.
> plot(yegcm("PEP", "KO", 20130101, 20131231))