**Z7 Algorithm**

Assume we have the following dataset comprising of, time (t), ROA (r) and CAR (EA):

**Table 1 – Initial dataset**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **t** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| **r** | 2 | 13 | 9 | 12 | 10 | 19 | 15 | 17 | 14 | 3 | 8 | 20 | 16 | 4 | 18 | 6 | 5 | 1 | 7 | 11 |
| **EA** | 3 | 17 | 20 | 12 | 8 | 13 | 6 | 15 | 9 | 4 | 2 | 5 | 11 | 16 | 7 | 14 | 18 | 10 | 19 | 1 |

, and for each , a corresponding and with .

**Step 1 + 2**

Fit rolling linear models with window length , and set . Extract coefficients, observed in Table 2.

**Step 3**

Extract the detrended observations from residuals observed at , and define them as “detrends”.

**Step 4**

Extract by using “sapply” in R. This method applies a function: the rounded value of for each over the length of the detrended observations .

**Step 5**

Define midpoints as , and calculate the mean of midpoints

**Table 2 – Rolling linear model coefficients, midpoints and detrends**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **t** | **(Intercept)** | **beta** | **detrends** |  | **midpoints** |
| **1** | 1.0000000 | 3.5 | 5.0000000 | 13 | 8.000000 |
| **2** | 12.8333333 | -0.5 | -2.3333333 | 9 | 11.333333 |
| **3** | 8.3333333 | 0.5 | 1.6666667 | 12 | 10.333333 |
| **4** | -3.8333333 | 3.5 | -3.6666667 | 10 | 13.666667 |
| **5** | -0.3333333 | 2.5 | 4.3333333 | 19 | 14.666667 |
| **6** | 24.0000000 | -1.0 | -2.0000000 | 15 | 17.000000 |
| **7** | 19.3333333 | -0.5 | 1.6666667 | 17 | 15.333333 |
| **8** | 74.3333333 | -7.0 | 2.6666667 | 14 | 11.333333 |
| **9** | 38.3333333 | -3.0 | -5.3333333 | 3 | 8.333333 |
| **10** | -83.1666667 | 8.5 | -2.3333333 | 8 | 10.333333 |
| **11** | -33.3333333 | 4.0 | 5.3333333 | 20 | 14.666667 |
| **12** | 117.3333333 | -8.0 | 2.6666667 | 16 | 13.333333 |
| **13** | -1.3333333 | 1.0 | -8.6666667 | 4 | 12.666667 |
| **14** | -5.6666667 | 1.0 | 8.6666667 | 18 | 9.333333 |
| **15** | 113.6666667 | -6.5 | -3.6666667 | 6 | 9.666667 |
| **16** | 46.5000000 | -2.5 | 1.0000000 | 5 | 4.000000 |
| **17** | -13.6666667 | 1.0 | -3.3333333 | 1 | 4.333333 |
| **18** | -88.6666667 | 5.0 | 0.6666667 | 7 | 6.333333 |

**Step 6**

Calculate the standard deviation of the detrendes above. This gives. Note that is a biased estimator as Bessel’s correction is an insufficient adjustment. When taking the square root in the normal standard deviation equation, the estimated sample standard deviation becomes biased upwards and should be corrected downwards.

**Step 7**

Calculate the coefficient of variation

**Step 8**

Remove the bias in by assuming detrends are normally distributed, and use Cochran’s theorem so that the square of , where is the length of the detrended observations, 18, the degrees of freedom are = 17, is the biased sd, and being the actual standard deviation. This gives a true estimate:

**Step 9**

Predict ROA\_{T+1} by using the Intercept and beta from , in Table 2. Recall that T = 20, so T+1 = 21.

ROA\_{T+1} = -88.6666667 + 5\*(T+1) = 16.33333.

**Step 10**

Define EA\_{T} = 1, the EA value at observed at

**Step 11**

Calculate the variance of the prediction

**Step 12**

Calculate Z7 with a conditional statement as follows:

If the variance of the prediction is very small, use a conservative homoscedastic adjustment so that:

Z7 = (-EA\_{T} - ROA\_{T+1}) / = -4.024853

Else, use the variance of the prediction as the adjustment for the Z so that:

Z7 = (-EA\_{T} - ROA\_{T+1}) / ( = -2.591995