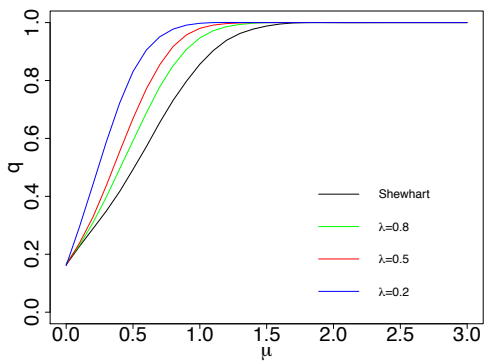
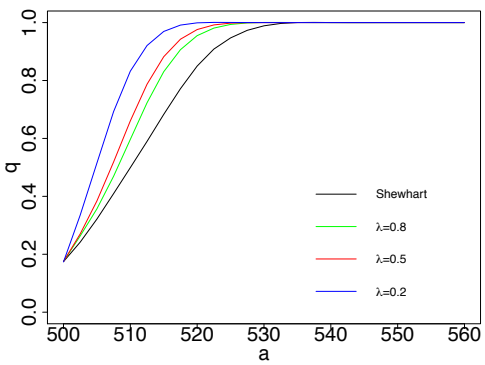
SUPPLEMENTAL MATERIAL

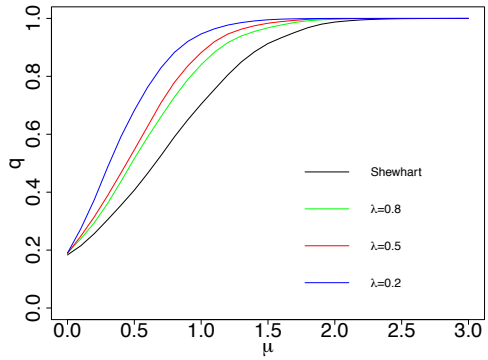
Section A: q performance of Shewhart, EWMA and CUSUM with different in-control q_0



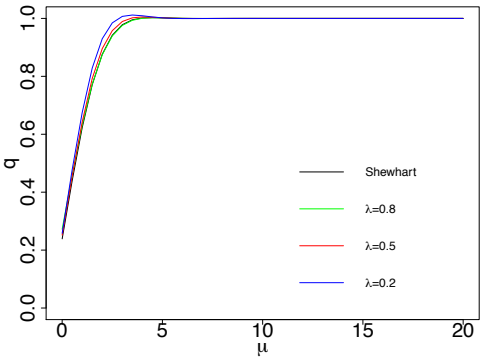
(a) $N(0,1)$



(b) Beta(500, 1500)

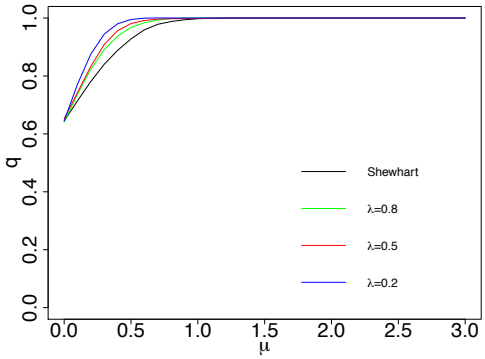


(c) AR(1) with $\phi_1 = 0.5$

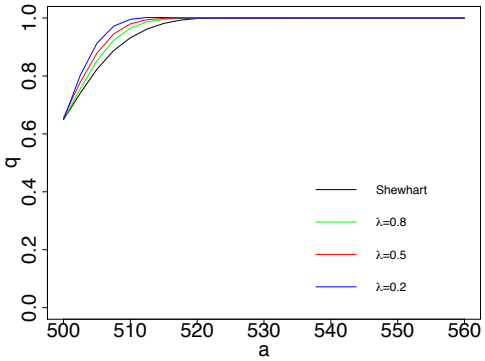


(d) IMA(1,1) with $\theta_1 = -0.5$

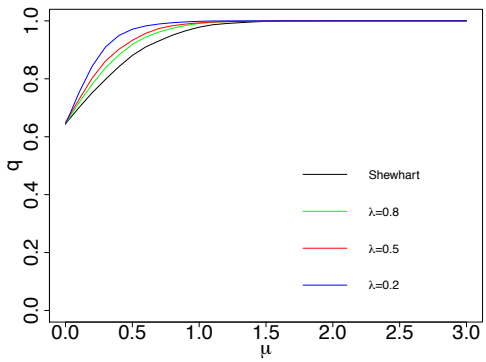
FIGURE 10 Shewhart chart ($\alpha_S = 1\%$) vs EWMA chart



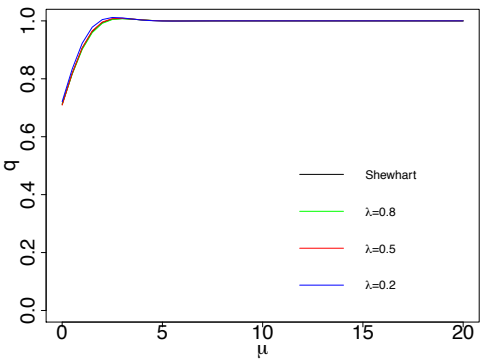
(a) $N(0, 1)$



(b) Beta(500, 1500)

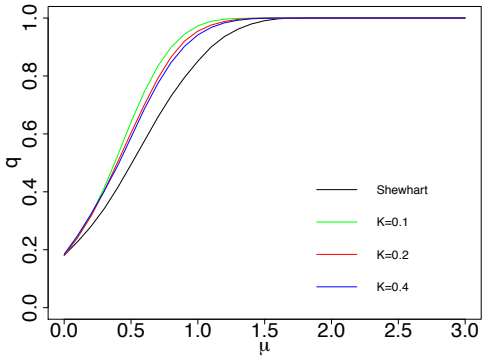


(c) AR(1) with $\phi_1 = 0.5$

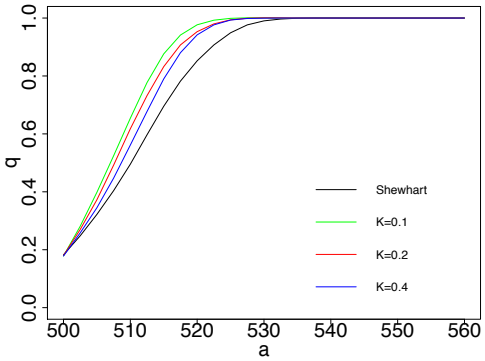


(d) IMA(1,1) with $\theta_1 = -0.5$

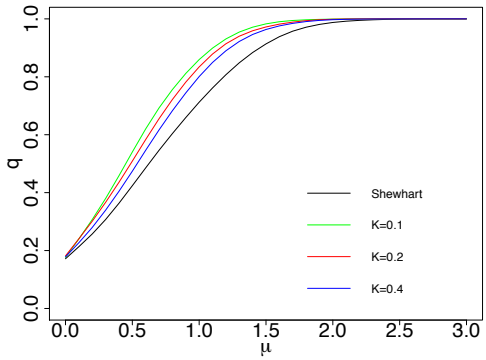
FIGURE 11 Shewhart chart ($\alpha_S = 5\%$) vs EWMA chart



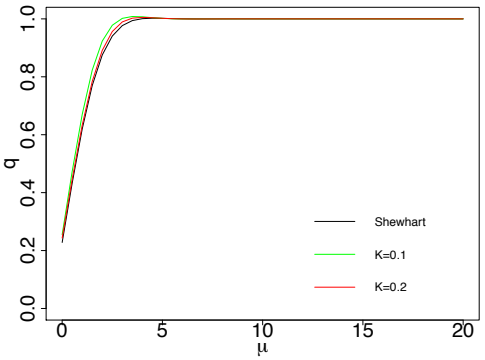
(a) $N(0,1)$



(b) Beta(500, 1500)

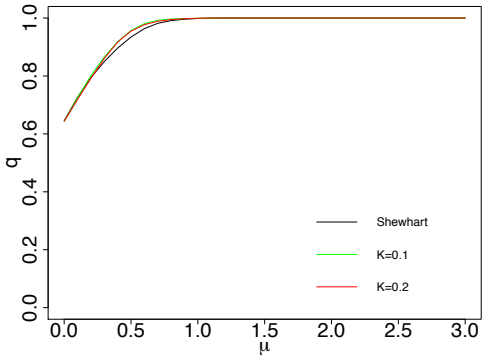


(c) AR(1) with $\phi_1 = 0.5$

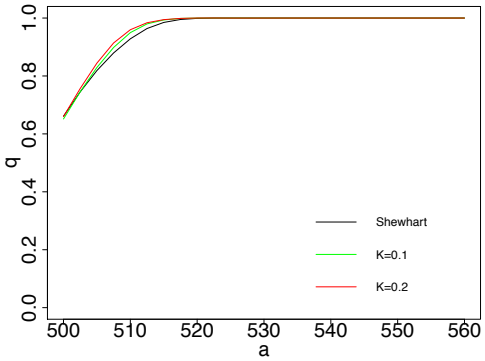


(d) IMA(1,1) with $\theta_1 = -0.5$

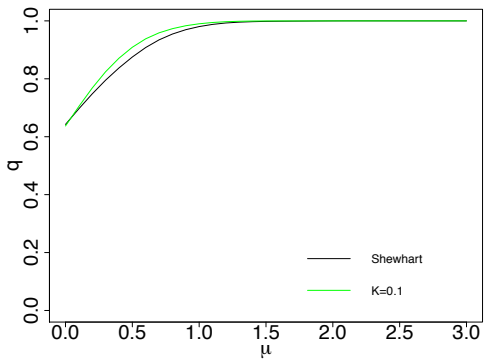
FIGURE 12 Shewhart chart ($\alpha_S = 1\%$) vs CUSUM chart



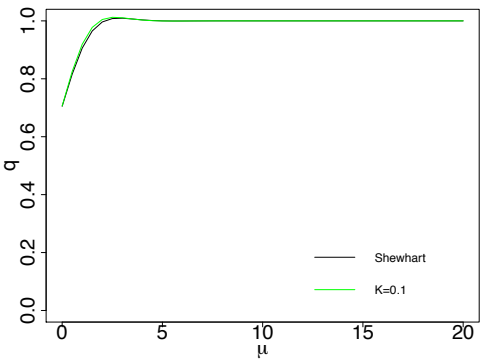
(a) $N(0, 1)$



(b) Beta(500, 1500)



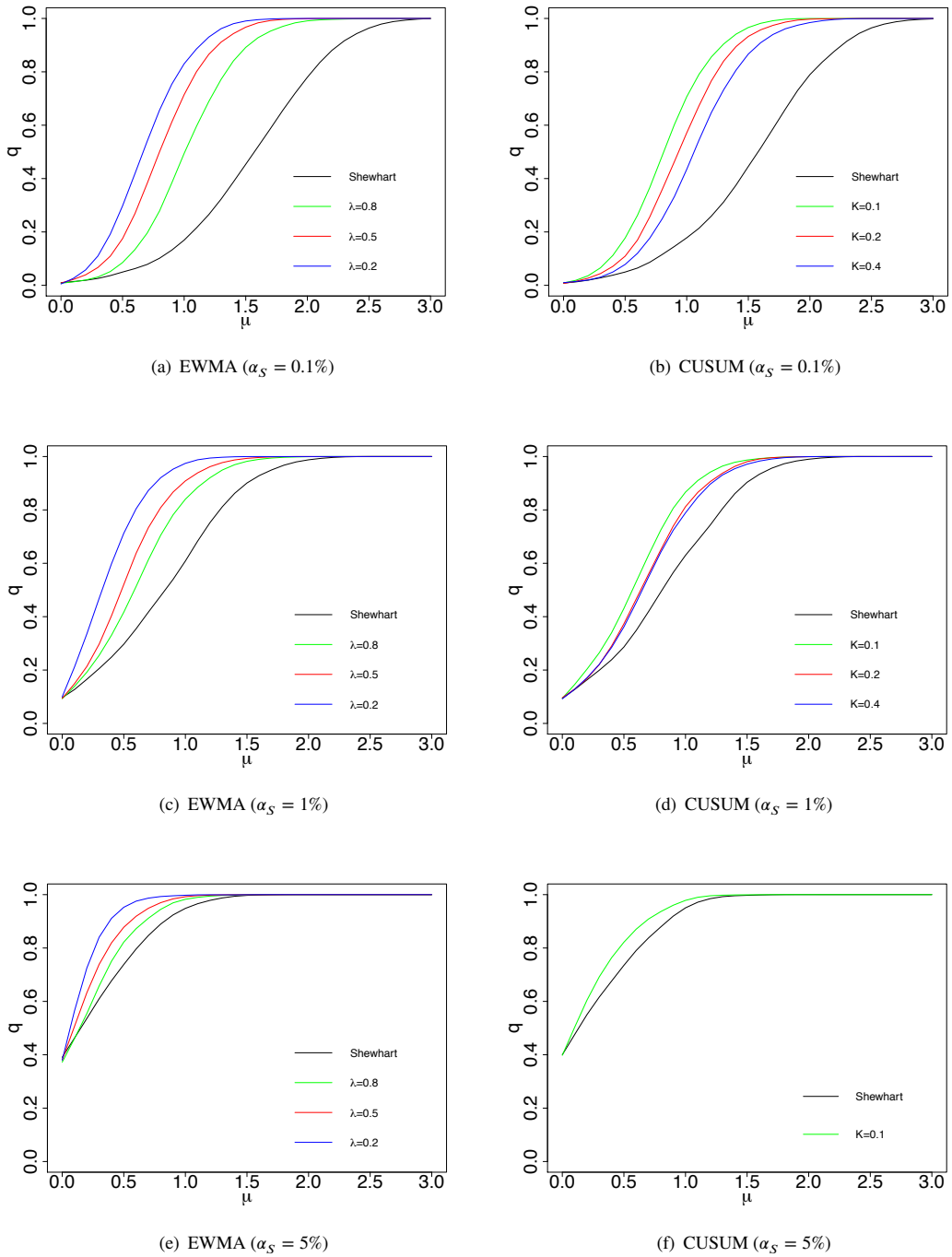
(c) AR(1) with $\phi_1 = 0.5$



(d) IMA(1,1) with $\theta_1 = -0.5$

FIGURE 13 Shewhart chart ($\alpha_S = 5\%$) vs CUSUM chart

Section B: q performance of Shewhart, EWMA and CUSUM for normal process with different production length N



(a) EWMA ($\alpha_S = 0.1\%$)

(b) CUSUM ($\alpha_S = 0.1\%$)

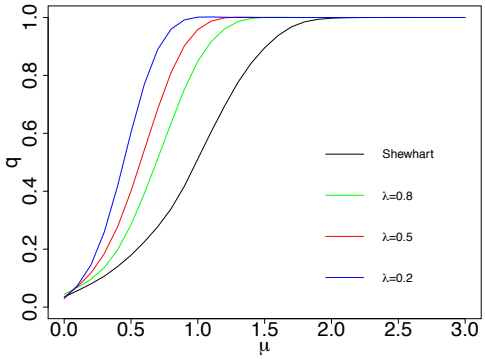
(c) EWMA ($\alpha_S = 1\%$)

(d) CUSUM ($\alpha_S = 1\%$)

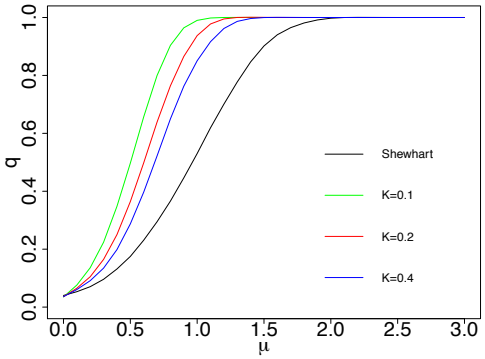
(e) EWMA ($\alpha_S = 5\%$)

(f) CUSUM ($\alpha_S = 5\%$)

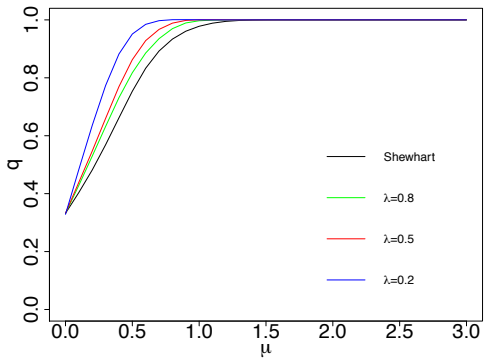
FIGURE 14 Shewhart chart vs EWMA and CUSUM chart ($N = 10$)



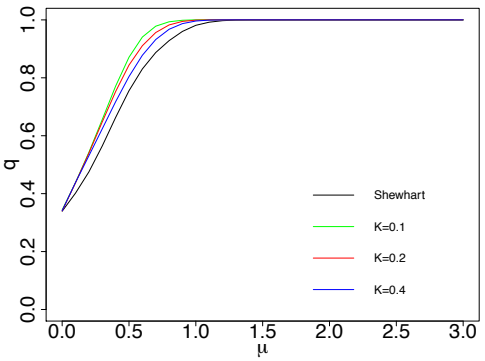
(a) EWMA ($\alpha_S = 0.1\%$)



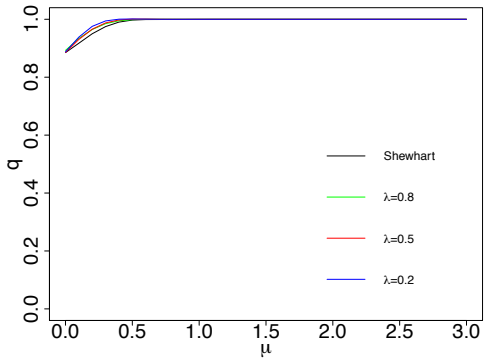
(b) CUSUM ($\alpha_S = 0.1\%$)



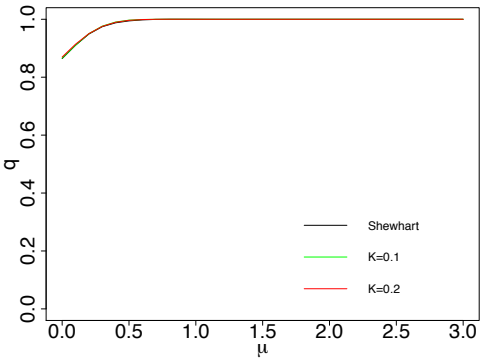
(c) EWMA ($\alpha_S = 1\%$)



(d) CUSUM ($\alpha_S = 1\%$)



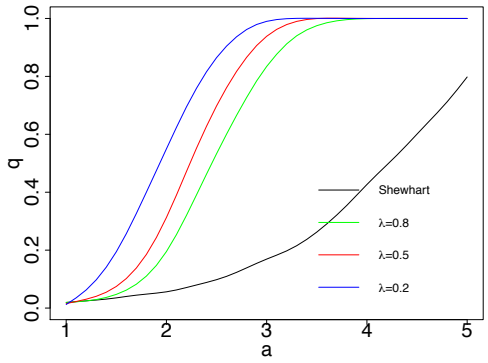
(e) EWMA ($\alpha_S = 5\%$)



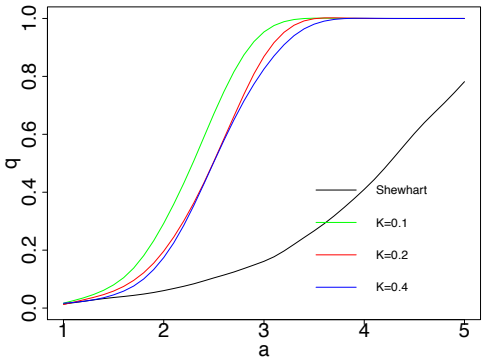
(f) CUSUM ($\alpha_S = 5\%$)

FIGURE 15 Shewhart chart vs EWMA and CUSUM chart ($N = 40$)

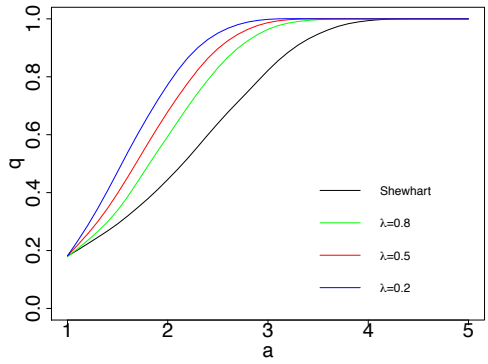
Section C: q performance of Shewhart, EWMA and CUSUM for beta process $Y \sim \text{Beta}(1, 49)$



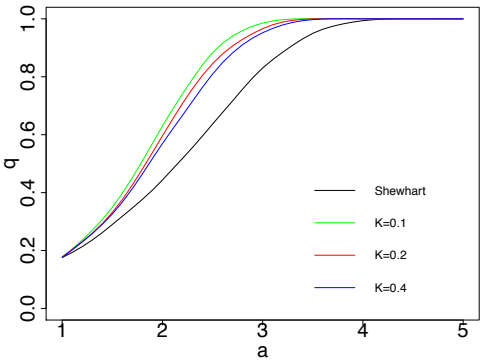
(a) EWMA ($\alpha_S = 0.1\%$)



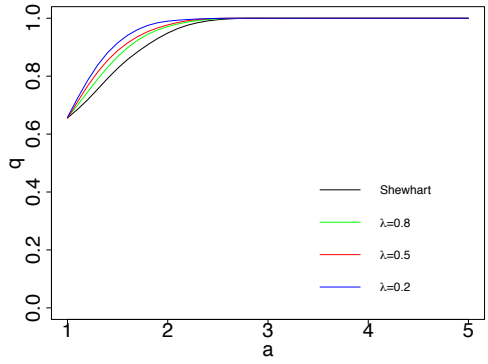
(b) CUSUM ($\alpha_S = 0.1\%$)



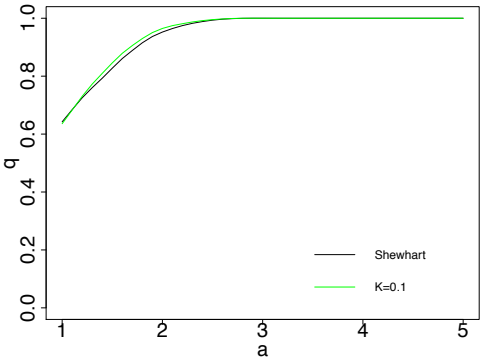
(c) EWMA ($\alpha_S = 1\%$)



(d) CUSUM ($\alpha_S = 1\%$)



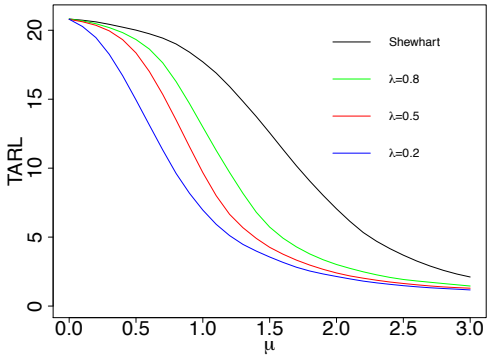
(e) EWMA ($\alpha_S = 5\%$)



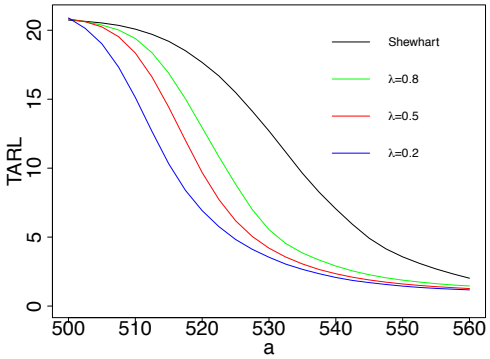
(f) CUSUM ($\alpha_S = 5\%$)

FIGURE 16 Shewhart chart vs EWMA and CUSUM chart ($N = 20$)

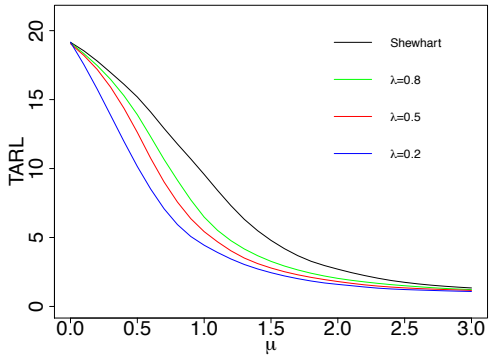
Section D: TARL performance of Shewhart and EWMA ($N = 20$)



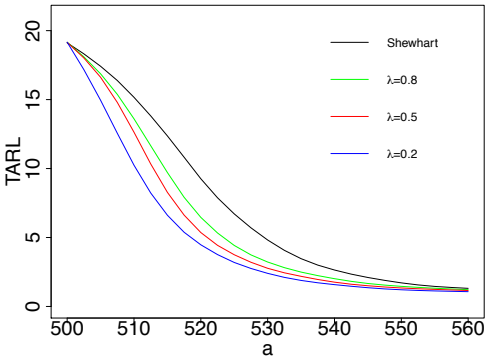
(a) Normal ($\alpha_S = 0.1\%$)



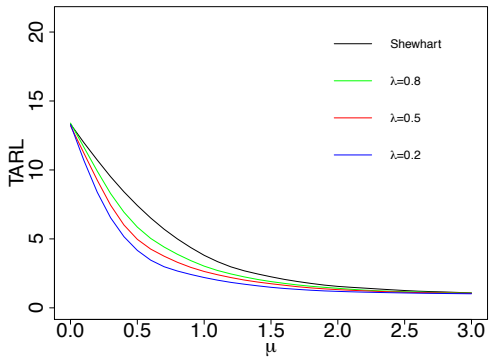
(b) Beta ($\alpha_S = 0.1\%$)



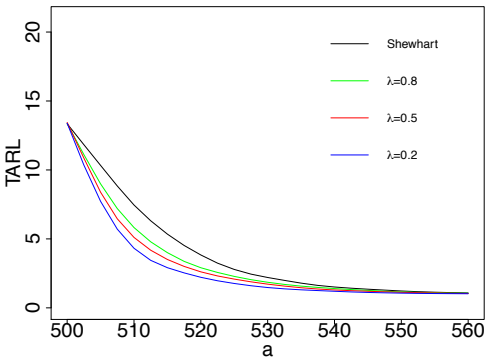
(c) Normal ($\alpha_S = 1\%$)



(d) Beta ($\alpha_S = 1\%$)

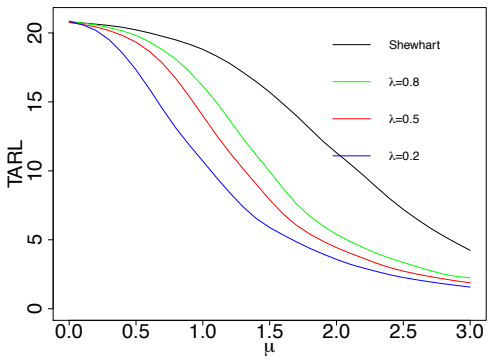


(e) Normal ($\alpha_S = 5\%$)

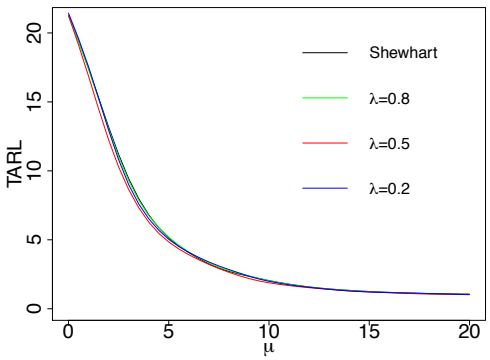


(f) Beta ($\alpha_S = 5\%$)

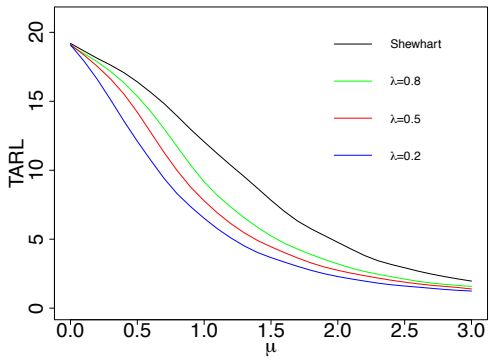
FIGURE 17 EWMA vs Shewhart chart for normal process $N(0, 1)$ and beta process Beta(500, 1500)



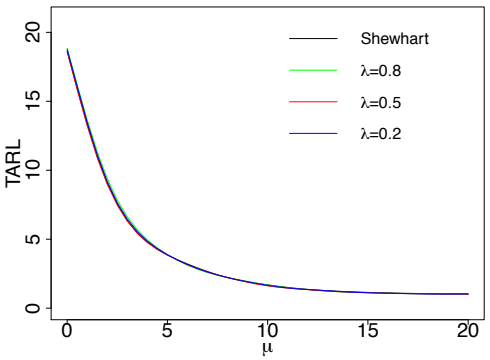
(a) Stationary ($\alpha_S = 0.1\%$)



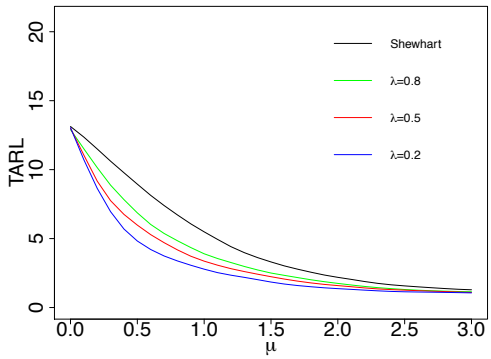
(b) Non-stationary ($\alpha_S = 0.1\%$)



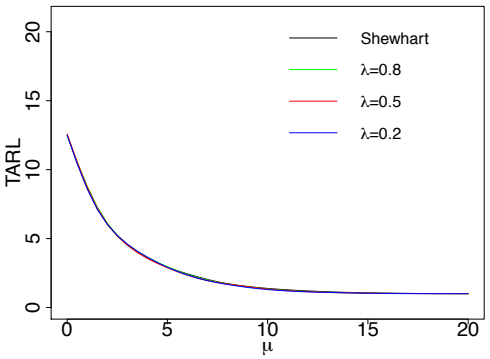
(c) Stationary ($\alpha_S = 1\%$)



(d) Non-stationary ($\alpha_S = 1\%$)



(e) Stationary ($\alpha_S = 5\%$)



(f) Non-stationary ($\alpha_S = 5\%$)

FIGURE 18 EWMA vs Shewhart chart for stationary process AR(1) with $\phi_1 = 0.5$ and non-stationary process IMA(1,1) with $\theta_1 = -0.5$

Section E: Summary statistics of 24 batches whole milk powder

TABLE 6 Mean and SD of quality characteristics of whole milk powder for 24 batches

Batch		Moisture		Protein		Fat		PSNF	
Id	Size	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	8	2.87%	0.0007	24.42%	0.0016	26.37%	0.0009	34.50%	0.0023
2	10	2.86%	0.0010	24.39%	0.0007	26.33%	0.0005	34.45%	0.0011
3	13	2.87%	0.0003	24.37%	0.0007	26.35%	0.0010	34.44%	0.0013
4	16	3.03%	0.0005	24.38%	0.0012	26.49%	0.0020	34.60%	0.0022
5	12	3.00%	0.0016	24.46%	0.0017	26.49%	0.0012	34.69%	0.0023
6	10	2.91%	0.0008	24.32%	0.0007	26.43%	0.0021	34.42%	0.0016
7	8	2.74%	0.0009	24.31%	0.0006	26.31%	0.0005	34.26%	0.0006
8	7	2.36%	0.0006	24.46%	0.0012	26.44%	0.0005	34.35%	0.0016
9	20	2.68%	0.0025	24.37%	0.0006	26.40%	0.0006	34.36%	0.0013
10	13	2.97%	0.0007	24.28%	0.0003	26.39%	0.0010	34.37%	0.0005
11	13	2.88%	0.0012	24.28%	0.0008	26.36%	0.0008	34.32%	0.0010
12	14	3.02%	0.0008	24.26%	0.0009	26.33%	0.0016	34.34%	0.0016
13	16	2.89%	0.0015	24.35%	0.0009	26.41%	0.0013	34.44%	0.0015
14	13	2.94%	0.0006	24.35%	0.0010	26.36%	0.0013	34.44%	0.0020
15	15	2.92%	0.0008	24.32%	0.0005	26.38%	0.0013	34.40%	0.0009
16	15	2.93%	0.0018	24.32%	0.0008	26.34%	0.0008	34.38%	0.0007
17	16	2.88%	0.0008	24.36%	0.0005	26.34%	0.0023	34.42%	0.0013
18	13	3.11%	0.0008	24.29%	0.0011	26.30%	0.0014	34.41%	0.0016
19	15	2.93%	0.0008	24.30%	0.0008	26.28%	0.0010	34.32%	0.0014
20	14	3.02%	0.0012	24.31%	0.0010	26.23%	0.0010	34.36%	0.0011
21	18	2.82%	0.0014	24.29%	0.0005	26.35%	0.0008	34.30%	0.0008
22	17	2.82%	0.0009	24.32%	0.0013	26.25%	0.0005	34.29%	0.0015
23	4	2.82%	0.0001	24.35%	0.0004	26.23%	0.0003	34.31%	0.0006
24	11	2.84%	0.0009	24.31%	0.0005	26.28%	0.0004	34.30%	0.0006
All		2.89%	0.0017	24.34%	0.0010	26.35%	0.0014	34.39%	0.0017