573_HW_6

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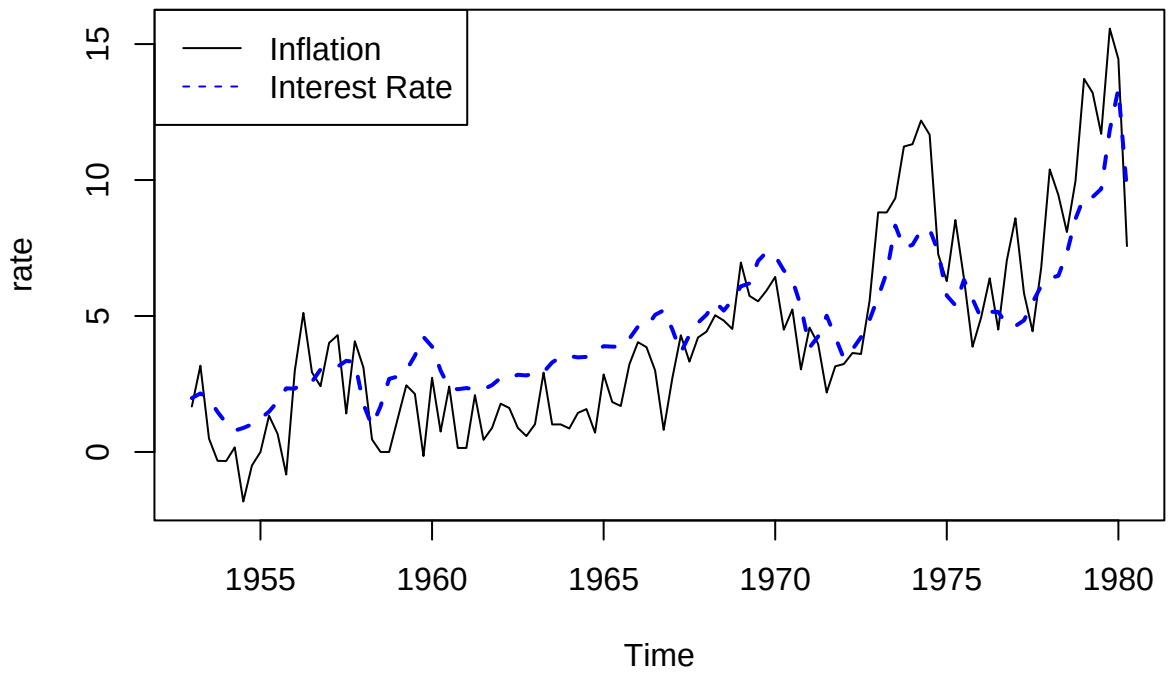
```
library(astsa)
plot(qinfl,ylab="rate")
lines(qintr,col="blue",lty=2,lwd=2)
legend("topleft",c("Inflation","Interest Rate"),
col=c("black","blue"),lty=c(1,2))
```




```
N <- length(qinfl)
Z <- array(0,dim =c(1,2,N))
Z[1,1,] <- rep(1,N)
Z[1,2,] <- qintr

library(MARSS)
```

```
## Warning: package 'MARSS' was built under R version 4.4.2
```

```r
model <- list(
  B="diagonal and unequal",# The AR parameter(s) of latent
  U=matrix(c("u1","u2"),2,1),
  A=matrix(0,1,1), # We're ignoring this
  Q="diagonal and unequal", # Variance of the latent process
  Z= Z, # Relates Y to X
  R=matrix("r",1,1), # Variance of the observed process
  x0=matrix(1,2,1), # Initial state vector
  V0=diag(0.01,2),
  tinitx=0)

fit <- MARSS(qinfl, model=model, method = "kem")
```

```
## Warning! Reached maxit before parameters converged. Maxit was 500.
##  neither abstol nor log-log convergence tests were passed.
##
## MARSS fit is
## Estimation method: kem
## Convergence test: conv.test.slope.tol = 0.5, abstol = 0.001
## WARNING: maxit reached at  500  iter before convergence.
##  Neither abstol nor log-log convergence test were passed.
##  The likelihood and params are not at the MLE values.
##  Try setting control$maxit higher.
## Log-likelihood: -198.2366
## AIC: 410.4732   AICc: 411.5712
##
##           Estimate
## R.r         1.0040
## B.(X1,X1)   0.7902
## B.(X2,X2)   0.5771
## U.u1       -0.2975
## U.u2        0.5102
## Q.(X1,X1)   0.2527
## Q.(X2,X2)   0.0297
## Initial states (x0) defined at t=0
##
## Standard errors have not been calculated.
## Use MARSSparamCIs to compute CIs and bias estimates.
##
## Convergence warnings
##  Warning: the  U.u1  parameter value has not converged.
##  Type MARSSinfo("convergence") for more info on this warning.
```

```r
fit <- MARSS(qinfl, model=model, method = "BFGS", inits = fit)
```

```
## Success! Converged in 24 iterations.
## Function MARSSkfas used for likelihood calculation.
##
## MARSS fit is
## Estimation method: BFGS
## Estimation converged in 24 iterations.
## Log-likelihood: -195.4736
```

```
## AIC: 404.9472   AICc: 406.0452
##
##            Estimate
## R.r        1.40e+00
## B.(X1,X1)  4.81e-01
## B.(X2,X2)  8.97e-01
## U.u1      -5.12e-01
## U.u2       1.12e-01
## Q.(X1,X1)  7.11e-07
## Q.(X2,X2)  1.42e-02
## Initial states (x0) defined at t=0
##
## Standard errors have not been calculated.
## Use MARSSparamCIs to compute CIs and bias estimates.
```

```
model_ar <- list(
  B = matrix(list(1, 0,
                  0, "phi"), 2, 2),
  U = matrix(c("0", "ub"), 2, 1),
  A = matrix("a",1,1),
  Q = "diagonal and unequal",
  Z = Z,
  R = matrix("r",1,1),
  x0 = matrix(c("x01", "x02"), 2, 1),
  V0 = diag(0.01, 2),
  tinitx = 0
)

inits_ar <- list(
  x0 = matrix(c(0, 0), 2, 1) # or another guess
)

fit_ar <- MARSS(qinfl, model=model_ar, method="kem", inits=inits_ar)
```

```
## Warning! Abstol convergence only. Maxit (=500) reached before log-log convergence.
##
## MARSS fit is
## Estimation method: kem
## Convergence test: conv.test.slope.tol = 0.5, abstol = 0.001
## WARNING: Abstol convergence only no log-log convergence.
##  maxit (=500) reached before log-log convergence.
##  The likelihood and params might not be at the ML values.
##  Try setting control$maxit higher.
## Log-likelihood: -197.6183
## AIC: 413.2365   AICc: 415.0365
##
##            Estimate
## A.a       -7.20e-01
## R.r        1.02e+00
## B.phi      3.49e-01
## U.0        1.90e-02
## U.ub       6.67e-01
## Q.(X1,X1)  5.63e-02
## Q.(X2,X2)  3.68e-02
```

```
## x0.x01    -1.40e-06
## x0.x02     9.50e-05
## Initial states (x0) defined at t=0
##
## Standard errors have not been calculated.
## Use MARSSparamCIs to compute CIs and bias estimates.
##
## Convergence warnings
##  Warning: the  x0.x01  parameter value has not converged.
##  Type MARSSinfo("convergence") for more info on this warning.
```

```
fit_ar <- MARSS(qinfl, model=model_ar, method="BFGS", inits=fit_ar)
```

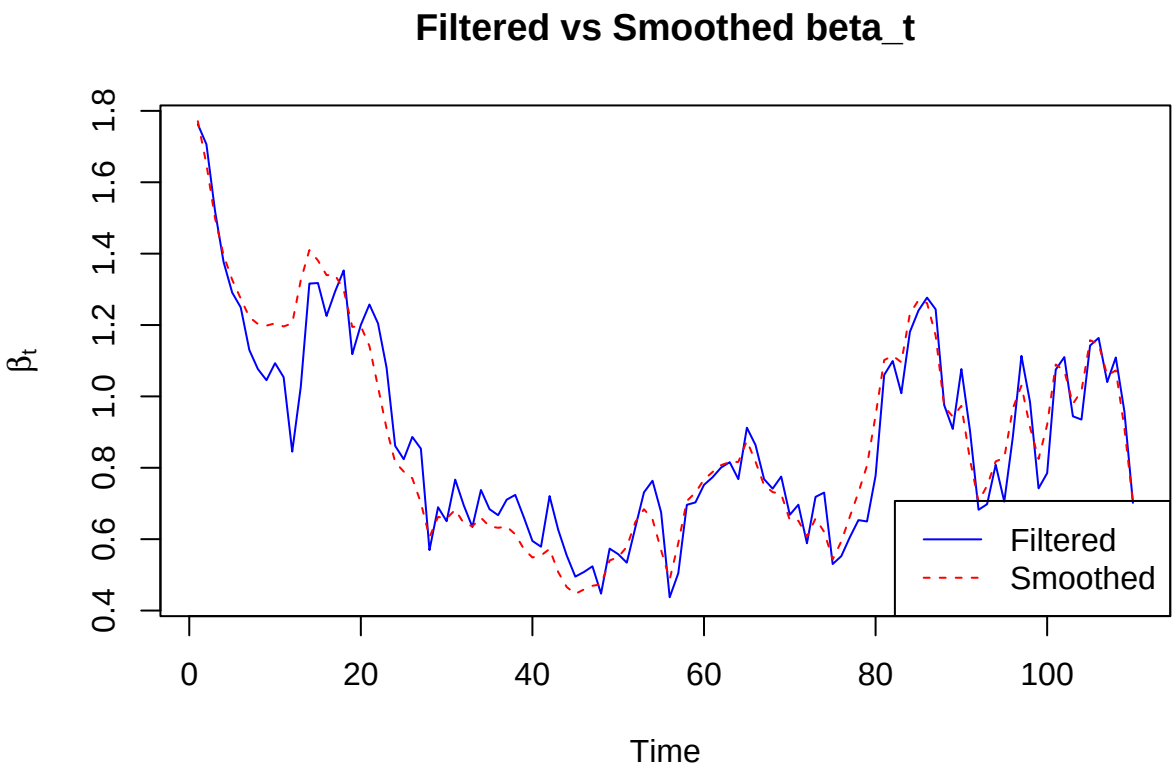
```
## Success! Converged in 31 iterations.
## Function MARSSkfas used for likelihood calculation.
##
## MARSS fit is
## Estimation method: BFGS
## Estimation converged in 31 iterations.
## Log-likelihood: -193.7395
## AIC: 405.479   AICc: 407.279
##
##            Estimate
## A.a       -1.18e+00
## R.r        1.23e+00
## B.phi      8.66e-01
## U.0        3.41e-02
## U.ub       1.08e-01
## Q.(X1,X1)  3.54e-12
## Q.(X2,X2)  1.96e-02
## x0.x01    -4.64e-01
## x0.x02     1.92e+00
## Initial states (x0) defined at t=0
##
## Standard errors have not been calculated.
## Use MARSSparamCIs to compute CIs and bias estimates.
```

```
# Extract filtered and smoothed states
kf <- MARSSkf(fit_ar)
filtered_states <- kf$xtt
smoothed_states <- fit_ar$states

#print(filtered_states)

time_index <- seq_along(qinfl)

plot(
  time_index, filtered_states[2, ], type = "l", col = "blue", lty = 1,
  ylab = expression(beta[t]), xlab = "Time", main = "Filtered vs Smoothed beta_t"
)
lines(time_index, smoothed_states[2, ], col = "red", lty = 2) # Add smoothed states
legend("bottomright", legend = c("Filtered", "Smoothed"), col = c("blue", "red"), lty = c(1, 2))
```


Filtered vs Smoothed beta_t
β_t
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0
20
40
60
80
100
Time
Filtered
Smoothed